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The relevance of Hayek's theory of the trade cycle for understanding the United Kingdom business cycle

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Declaration

Part I. DECLARATION by the candidate for a research degree. To be bound in the thesis

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(c) The data and results presented are the genuine data and results actually obtained by me during the conduct of the research
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Abstract

The 'Great Recession' has brought about a justified critique of the neoclassical economic model. It is within the context of this shock to the mainstream that the economic orthodoxy can be queried. The calls for a new economic paradigm request the mainstream's acceptance of heterodox ideas creating a pluralist approach to economic theory, research and teaching.

Following the shock of the financial crisis, UK government economic institutions indeed appear more pluralist than before the crisis. The Bank of England's One Bank Research Agenda (2015) aims to remove its institutional 'group think' to incorporate different economic perspectives to better allow its efficient monitoring of the UK economy. Her Majesty's Revenue and Customs have embraced pluralist economics, Senior Ministerial Advisors within HMRC learn Behavioural Economics, the work of Hyman Minsky, Jesus de Soto and Fredrich Hayek alongside neoclassical economics and fiscal sociology to gain a thorough understanding of economic phenomena. Andy Haldane, Director of Financial Stability at the Bank of England, has called for a pluralist economic methodology and in 2010, Conservative MPs proposed a Financial Services Bill based on the work of Hayek.

Given this willingness for Policy at least to accept a pluralist economic approach, alternative economic theories must be evaluated to determine their relevance. Calls for a pluralist economic paradigm do not simply seek to replace one orthodoxy with another or indeed abandon entirely neoclassical economics. A pluralist economic paradigm is one where numerous explanations of economic phenomena are considered and policy is based on the most appropriate rather than the default. The thesis contributes to knowledge by providing an evaluation of Hayek's theory of the trade cycle using a testable model and both reduced form and structural analysis, this is the first time this has been explicitly done addressing the shortfall in the literature identified in Kuehn (2013). Furthermore the thesis provides a consideration of the relevance of Hayek's theory of the trade cycle for the UK addressing this gap in the Austrian Empirical Literature. The chosen analysis of a variety of models and tests also contributes to the Austrian methodological literature providing a comprehensive approach to the evaluation of Hayek's theory. The UK data used for the empirical evaluation does not feature in any of the reviewed literature and thus its use represents a further contribution toward the UK gap in the Austrian Econometric Literature.

An empirical evaluation of Hayek's theory of the trade cycle using UK timeseries data contributes to the pluralist debate by determining the relevance of the theory for future policy consideration. A testable model of Hayek's theory is developed and examined with various econometric tests to determine the support present in the data. Primarily Vector-Auto Regression, Vector Error Correction and Granger Causality Tests were used in the evaluation alongside Finite-Distributed Lag Models and an initial statistical evaluation of the theory and data. Within the calls for pluralism all empirical evaluation is conducted in a manner acceptable to the majority of Hayekian economists, yet utilising standard econometric tests to provide a persuasive and universally accessible evaluation of the theory.

Whilst some evidence for Hayek's theory of the trade cycle is found, the results show strong support for individual components of the theory, but limited support for the central tenet of the Theory, that of the unsustainable boom sowing the seeds of its own destruction. Yet, evidence is found for the predicted effects of the interest rate and of predicted endogenous turning points in the data, which are seen by several Austrian economists to be unique features of Hayek's theory. A replication study of a key empirical study supporting Hayek's theory with US timeseries data is also conducted with UK data, finding less support for the theory than its US counterpart.

Given the calls for a pluralist economic paradigm, perhaps it is time to isolate the valid components of Hayek's theory and incorporate them with other heterodox and orthodox theories. After all a true pluralist paradigm does not mean the primacy of a single approach.

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Chapter 1: Research Introduction

1.1 Introduction

"This is the first time since the Great Depression that Hayek's Business-Cycle Theory (as opposed to his broader philosophical perspectives) has registered at all in the public imagination, raising the obvious question: Is there anything to the theory?"

Kuehn (2013, p498)

The research presented in this thesis considers the relevance of heterodox business cycle theory for the UK economy in the aftermath of the recent financial crisis, following an initial literature review the theories of money, banking and credit of the Austrian School of Economic Thought were selected as being of particular relevance to the recent financial crisis. Evans & Baxendale (2008) question whether, due to the success of Austrian Economics in identifying early symptoms of the financial crisis and providing early warnings of the excess of fiduciary media and the constraints of a fractional reserve banking system, if there is now room for the ideas of the Austrian School at the highest levels of global economic policy. In the UK, Douglas Carswell MP[1] (2010) stated in the House of Commons that it is now time to take seriously the prescriptions of de Soto, The Ludwig Von Mises Institute and The Cobden Centre. Respectively a leading economist of the Austrian School and arguably the two leading institutions of the School of Thought. Furthermore de Soto (2010) presented the annual Hayek lecture at the London School of Economics delivering Austrian ideas to leading UK economists both academic and in practice. Miller (2009) argues that Austrian analysis of money and banking has significant relevance for the recent financial crisis and considers that future

[1] Though himself a controversial and mercurial figure in UK politics.

economic historians may assess the recent crisis as less severe than the Great Depression but more aligned with Austrian theory than the Neoclassical.

The general financial slowdown (2000), the rapid expansion that followed and recent financial crisis, have provoked interest and discussion in the business cycle theory first proposed by Hayek in the 1920s (Oppers 2002, Evensky 2012, Neck 2014, Russell & Langemeier 2015). The crisis has reignited academic (Evans & Baxendale 2008, Laidler 2011, Bordo & Landon-Lane 2013, Kuehn 2013, Lester & Wolf 2013, Luther & Cohen 2014, Murphy 2015, White 2015) and political (Carswell 2010, Paul 2011) interest in the Austrian School of Economic Thought and Hayek's Business Cycle Theory[2]. 2012 US vice-presidential candidate Paul Ryan claimed that his ideas are inspired by Hayek and handed out copies of The Road to Serfdom "to bring new staffers up to speed"[3]

The business cycle theory proposed by Hayek shall be referred to as the Hayek's theory of the trade cycle (HTTC) and is formalised in Chapter 3 and demonstrated in model form in Chapter 5 (figure 12). Hayek's theory is frequently referred to in the literature as Hayek's business cycle theory (or variations of) or indeed the Austrian Business Cycle Theory. In short Hayek's theory claims that the cause of recession stems from a centrally set interest rate, which has political or flawed (for Hayek) economic incentive to set a rate of interest lower than the 'natural' rate of interest for the economy. This coupled with the financial system's ability to create credit (artificial money in the Hayekian and Austrian Literature e.g. de Soto 2009b), sets a series of micro processes or linkages leading to recession. Hayek's theory considers that the 'too low' centrally set interest rate creates excess credit, fuelling commercial investments past the time and risk horizon of the economy, in short spending and investment past the

[2] In June 2010, Glenn Beck on the Fox News Channel, spent an entire hour long show encouraging his audience to read The Road to Serfdom.

[3] Reported in Harcourt, B. (2012). How Paul Ryan enslaves Fredrich Hayek's The Road to Serfdom. The Guardian Online. Wednesday 12th Septhember. 2012.

economy's willingness to save for it (Oppers 2002, de Soto 2009a+b, 2010). This creates an imbalance with the economy's productive capacity switching to longer term production (production for immediate consumption) and consumption in the economy artificially increased through the 'too low' interest rate.

The idea of the Hayekian Temporal structure of production is explored in detail in Chapter 3 and demonstrated in figure 5, however in brief; for Hayek the productive structure of the economy can be viewed in stages from early stage production (for example raw materials) through successive value creation processes to end or late stage production, e.g. complete consumer products. Recession occurs in Hayek's theory when the imbalance between consumers spending on end stage production generates a shift in the economy's use of resources from early stage to late stage (Cwik 2008) which triggers a competition for financial resources, particularly investment finance, forcing the interest rate back toward its natural level. This ceases the artificial consumption of individuals and prompts a reversal in the resource shift, this reversal is in effect the liquidation of long term projects which under the new interest rate regime are no longer positive accounting calculations (de Soto 2010). The Austrians see the 'correction decision' as a purely accounting process, e.g. Cwik (2008). Simply a project with a time dimension generates a predicted future profit which is inversely related to the interest rate, when conventionally used as the discount rate. When the interest rate rises the future profitability falls, this rational accounting decision is appropriate as a trigger for the correction phase, but Hayek considers that the correction phase may have momentum which carries it below the optimum level for the economy[4] (a correction turns into a depression), this is contrary to the rational decision maker of orthodox economics and is suggestive of herd like behaviour, behavioural biases and heuristics.

[4] This is where Hayek is in favour of Keynesian expansion techniques (de Soto 2006).

This thesis evaluates the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle. The key issues of research design have been carefully considered and addressed both within the traditions of economic research and within the methodological stance taken. Hakim (2000, p.3) considers that the value of research is demonstrated through the thorough and rigour of research design, and both Creswell (2009) and White (2009) consider that research design is of the utmost importance. A key issue in need of reassessment (Stiglitz 2010, Solow 1985, 2008) in economic research design is that described by Hakim (2000, p2) where economists predominantly use a standard design of secondary analysis of existing data sets and to such an extent that the research design issues are often simply reduced to the choice of dataset and econometric technique. However Angrist and Pischke (2010) have noted a growing recognition within the field of the importance of every aspect of traditional research design. They note how in the economic specific database, Econlit, a comprehensive search for economic papers containing a research design or similar (strategy, plan etc) produced only 19 papers in the period 1970-1989, increasing to 742 in the period 1990-2009[5].

1.2 Research Background – The Mainstream, the heterodoxy and Post-Crash Economics

In this section, the thesis considers the positions of mainstream, orthodox and heterodox economics in order to provide a background to the research. Colander *et al* (2004) consider that the intellectual orthodoxy of neoclassicism has passed and 21st century economics can be considered the post-neoclassical era (Barkley Rosser, 2008). The current cutting edge of economics research is in search of the neoclassical replacement. Indeed, Agent-Based

[5] Of course this is a simple empirical exercise, it is noted that some papers may include an implicit research design and that the inclusion of a research design phrase does not ensure that the research design is a good one. Yet the dramatic shift in emphasis reflects a trend that is not simply semantic (Angrist & Pischke 2010). A similar examination produces 315 papers 2010 to present, showing a similar trend, however the results may be lifted by Angrist & Pischke's (2010) paper and subsequent discussion.

Economics, Behavioural Economics, Experimental and Neuro-economics are pushing the boundaries of economic knowledge. This thesis aims to determine the relevance of Hayek's theory of the trade cycle (discussed in detail in Chapter 3) to the modern economic debates. At the outset, it must be stressed that this thesis does not intend to argue for the primacy of the Hayekian/Austrian approach (even key authors and proponents of this school do not consider that it tells the full story, e.g. Callahan & Garrison, 2003) but simply to discover whether it has some exploratory power over observed events, particularly at the time of crisis and a considered changing course of academic economics (Lawson 2009, Colander *et al* 2008, 2009, Kirman 2009, Green & Hay 2015).

For Lawson (2009), the spotlight was turned on groups of orthodox economists and blame was placed accordingly (but not necessarily appropriately) by members of the heterodoxy. It is useful here to actually differentiate the wide groups of economists discussed in this thesis, mainly the orthodox, heterodox and mainstream economics. Colander *et al* (2004) considers the orthodox is an intellectual category having established the structures and ideas or a paradigm, for instance the neo-classical paradigm characterised by rationality and equilibrium. For Colander *et al* mainstream economics is a sociological grouping, the leading professionals and academics who are dominant in the leading relevant organisations, universities and journals. In this thesis the mainstream and orthodoxy refer predominantly to the neoclassical format of economics and the terms orthodox and neoclassical are used interchangeably. The heterodox in this thesis refers to the study of economic theory and phenomena outside of the neoclassical orthodoxy and usually outside of the mainstream. McCloskey (2003) also considers the heterodoxy alien to the mainstream sometimes even to the point of persecution, citing the case of Notre Dame University (USA) losing its heterodox economics programme in favour of a neoclassical one. However, at least post-crisis this 'persecution' has potentially abated[6] with the introduction of behavioural economics at the highest level of policy (Behavioural Insight Team, aka the Nudge Unit), discussions in Parliament concerning Austrian/Hayekian ideas and the development of a 'fiscal sociology' to inform HMRC Policy. It is useful here to explain that is the neoclassical orthodoxy that was criticised during the Global Financial Crisis, and even though they are as similar as to be interchangeable, the mainstream it is not by definition neoclassical and it can incorporate new ideas. The mainstream position is to accept paradigms and is not necessarily tied to any particular one. Given Stiglitz's (2010) call for a new economic paradigm, the consideration and empirical examination of alternative business cycle theory may produce evidence for the incorporation of this theory into the mainstream. Kuehn (2013) with respect to Hayek's theory argues for the incorporation of the working aspects to inform a wider business cycle theory.

For Kuhn (1996) in order for a mainstream change of view to occur, the orthodoxy embraced by the mainstream must be moving through a period of upheaval, strong enough to shake the mainstream's faith. The 2007-2009 financial and economic crisis may have provided this. Colander *et al* (2009) consider that as a rule (though there were exceptions e.g. Baker & Nelson 2005 or Jones 2006), the economics mainstream were unaware of the build-up to the global financial crisis and were generally unaware once it had begun of its depths, stubbornness and longevity. This, for Colander et al (2008, 2009), Asensio (2013, 2014) and Kirman (2009), is quite simply a result of mainstream acceptance of an orthodoxy that relied on models too far removed from reality (Stiglitz, 2010) and furthermore a heavy reliance and disregard of the limitations of such models.

Hayek's Business Cycle Theory was rejected by the economic mainstream (Oppers 2002, Kuehn 2013), yet adherents of the Austrian School claim to see clear evidence of Hayek's

[6] or at least lessened.

theory of the trade cycle in a variety of historical business cycles (e.g. Luther & Cohen 2014, Carilli & Dempster 2008, Mulligan 2006, Montgomery 2006 etc[7]). The research reported in this thesis provides an empirical examination of the relevance of Hayek's theory of the trade cycle for understanding the UK economy.

1.2.1 The heterodox criticisms of the orthodoxy

This section considers the heterodox criticisms of the orthodoxy and mainstream reliance on a methodology far 'removed from reality'. An examination of these criticisms is vital to the approach of this thesis and for the positioning of the objective of an evaluation of the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle.

"In our hour of greatest need, societies around the world are left to grope in the dark without a theory. That, to us, is a systematic failure of the economics profession".

(Colander et al., 2009, p2)

"The majority of economists thus failed to warn policy makers about the threatening system crisis and ignored the work who did"

(Colander et al., 2009, p2)

Colander *et al* above consider that the flaw in mainstream economics is that there is a belief that the market is inherently stable and is only ever capable of veering off course temporarily. Of course, the economics profession is not alone in failing to see the crisis coming[8]. Bankers, policy makers, regulators and journalists all share the blame of imperfect prescience, however most economists did not see it coming and much more disturbingly for Stiglitz (2010), most models were not able to predict the crisis or said it would not happen. Stevens (2008) describes the crisis as a tail outcome, an event that routine forecasting will never predict. This

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[7] Russell & Langemeier (2015, p24) consider that though there are few econometric studies to test Austrian Business Cycle Theory they have "largely found favourable results".

[8] "She was asking me if these things are so large, how come everyone missed it". Luis Garicano commenting on the Queen's visit to the LSE.

should come as a “wakeup call for the mainstream”. The heterodoxy argue that the models of the orthodoxy do not work in reality, albeit an extreme reality. Yet fundamentally, this is a type II error, models which reject the correct hypothesis (crisis) as unlikely, when in reality crisis occurred.

A review of the pre-crisis literature certainly reinforces the view that ‘everyone missed it’ (British Academy 2009). The views that financialization, increased global systemic risk or sub-prime real estate and its associated derivatives were heading for that disaster were scant and if identified, the *deus ex machina* of government action was assumed. For instance, Wellink (2009) cites an IMF report on the global real estate book that stated little evidence of possible crisis. Bezemer (2010) highlights how in fact culprits of the crisis, an increasingly complex and decreasingly transparent financial system were seen to mitigate risk. Greenspan (2005) stated “development of financial products, such as asset-backed securities, collateral loan obligations and credit default swaps, that facilitate the dispersion of risk…these increasingly complex financial instruments have contributed to the development of a far more flexible, efficient and hence, resilient financial system than the one that existed just a quarter of a century ago”. Furthermore on a possible real estate problem, Greenspan (2005) as chairman of the FED reported to the US Financial Services Committee, “I don’t expect that we will run anything resembling a collapsing bubble”. Das (2006) considered that the financial system had increasingly eliminated risks through off balance sheet transactions and innovative products. The IMF (2006) stated conclusively that “there is little systemic evidence to support widely cited claims that financial globalisation by itself leads to deeper and more costly crises”. USA today in 2006 stated about the starting fall in house prices, “the good news is that far more economists are in the optimist camp than the pessimist camp…the majority anticipate the economy will grow” (Hagenbauch, 2006). Allen (2009) is telling when he states, “it’s not just that they (economists) missed it, they positively denied it could happen”. Kaletsky (2008) considers almost every leading economist and financier in the world to have failed to foresee the gravity of the crisis and Greenspan (2008) states his "shocked belief" at the collapse of his "whole intellectual edifice".

1.2.2 "Why was this missed?"

There is a long a rich history of the academic economic study of crisis from the work of Bagehot (1873) to modern day work, yet Colander *et al* (2009) at the 98th Dahelm Workshop consider this 'tradition' to have been neglected or even supressed. This 'Dahelm Report' considers a blindness in academia, stemming from a view that crises have been studied in the past, but 'this time it is different'[9]. The Great Depression for instance, was viewed as an improbable event whose legacy was to simply remain in the memory of investors making them too risk averse (Cogley & Sargent, 2008). The dominant theoretical model excludes boom and bust cycles, unemployment and discounts the possibility of financial crisis. The restriction of economic models to times of 'normality' (Stiglitz, 2010) removes economics as a study from reality. Colander et al., (2009) identify three areas of concern in theory and method, which for them, are the principle reasons for why the crisis was missed.

1. Models (or the Use of Models) as a Source of Risk.
2. Unrealistic Model Assumptions and Unrealistic Outcomes.
3. The lack of robustness and data driven empirical research.

1.2.2.1 Models (or the Use of Models) as a source of risk

Kirman (2009) considers that the "Economic Crisis is a Crisis for Economic Theory" and that the financial crisis has given economists a shock to reflect on the models and methodology of the mainstream. Financial market models are generally representative agent models, where

[9] "The four most dangerous words in investing are: 'this time it's different.'" Sir John Templeton

the agent maximises their utility with full rationality over their often infinite lifetime assessing the possibilities of future assurances faultlessly. This model is combined with Walrasian General Equilibrium Theory, incorporating the Arrow-Debrev two period model assumption of eliminating uncertainty if there are enough contingent claims, thus a model constructed on these lines has no other outcome than derivatives increase welfare. A claim that, in hindsight, is questionable, but certainly (Colander *et al* 2009) endorsed by Alan Greenspan. However this model outcome is predetermined by a model which when stated in a verbal formalism above is clearly far too abstract to handle real world events.

Here however lies one of the Dahelm Report's (2008) key methodological and behavioural points, that is the illusion of control, the mathematical rigour and numerical outcome of a model has a tendency to remove attention from any weaknesses of the model. Clinton Greene (2003) as discussed in Ziliak & McCloskey (2004) applies the same argument to timeseries modelling and Eichengreen (2008) considers that the development of mathematical models to quantify risk by economists and financiers, led to the increase in leverage, that is the use of risk relies on estimates of previous data, the data pre-crisis were remarkably low in volatility and did not have the flexibility to provide estimations appropriate to the circumstance.

1.2.2.2 Unrealistic Model Assumptions and Unrealistic Outcomes

A large number of pre-crisis models tend to be built on dual premises of rational expectations and a representative agent. That representative agent in essence means modelling the entire macro environment through the individual agent, assuming that all macro concepts are completely reducible to the level of the individual. This conceptual reductionism (Lux & Westerhoff 2009) is alien to the standard notion of reductionism in natural sciences where the interaction of complex phenomena is studied. The representative agent approach in economics has assumed the micro effects equal the macro effects. As discussed in Chapters 2 and 3 of this thesis, Hayek's Business Cycle Theory envisages the macro business cycle through a study of its' micro components.

The inclusion of rational expectations is contrary to a large volume of empirical data and the field of behavioural economics. It is worth noting that Colander *et al* (2009) identify the need to put 'reality' back into economic modelling. Fundamentally for the rational expectations aspect this assumption is contrary to the discoveries of psychology, behavioural and experimental economics. For instance Sokol-Hessner *et al* (2009) demonstrate through fMRI research that occupations affect our decision making, and that 'thinking like a trader' generates different decision making approaches than other professions.

1.2.2.3 Robustness and Data Driven Empirical Research

Juselius and Franchi (2007) consider the foundations of the standard models to be weak and suggest that they fail to perform empirically. For Colander *et al* (2008), economics has moved from goodness of fit to simple calibration. In terms of the data, Solow's (1986) view of the danger of this time series is explored, Solow considers that for appropriate analysis a timeseries must be both long and stable, yet in practice only one of these conditions can usually be met. In particular, time series in financial data contain major changes in the regulatory framework, exchange rate regimes and possible monetary union, this non-stationarity aspect must be appropriately solved. As per Hakim (2000), much pre and post crisis economics research is method driven, that is the use of pre-selected models and assumptions. Colander et al., (2008, 2009) argue for the use of a data-driven approach, using techniques appropriate to the data and not simply the most cutting edge mathematical techniques. This is comparable to the New Austrian School of Economic Thought and Hayek's rejection of *scientism* where econometric techniques which maintain the richness of the data are used.

1.3 The Research Problem

Section 1.3 explores the research problem leading to the development of the research objectives of this thesis. The research problem often overlooked in method driven economic research (Hakim 2000) or given little consideration (Van de Ven 2007), plays a crucial role in grounding the objective and is vital to the entirety of the research (*ibid*). Using Blakie's (2000) framework for the determination of a research problem, the research problem is the relevance of heterodox economics for the post crisis UK economy. This broad problem is refined to the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle.

Whilst the order is not always apparent, objectives then specific aims or *vice versa* (White 2009) and it is not uncommon for these to be treated as parallel processes (Van de Ven 2007), for the purposes of this thesis there is a strong causal progression from the methodological objective to the associated aims and thus it is appropriate to discuss these issues in the same order. Furthermore an explicit effort has been made to remove this study from the method driven research prevalent in economics (Hakim 2000) criticised as a failing of academic economics (Lawson 2009) and famously as the "con of econometrics" (Leamer 1983) and toward an objective led research programme seeking good questions as oppose to simply safe methodical answers (Angrist & Pischke 2010).

The objectives of this study are twofold; firstly to assess the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle, and secondly to provide an assessment of this theory which is acceptable and appropriate to the Austrian School of

thought and accessible to the economic orthodoxy and the wider macroeconomic community.

The first objective, that of an analysis of Austrian theory, is born directly of the research problem of an analysis of alternate economic theory, is situated as a possible solution to the crisis in academic economics (Lawson 2009) and the aforementioned calls for a new pluralist economic paradigm to address the mainstream failings of prediction and policy highlighted by the recent financial crisis (Stiglitz 2010). Secondly the objective of performing the analysis of relevance in such a way that it is acceptable and accessible to the two polarised camps of Austrian and Neoclassical economics stems from the calls for a methodological pluralism as discussed for instance by Caldwell (1982) or Dow (1996, 1997), the need for new imagination in economics called for by the British Academy (2009) and the critique of mono-method economics provided by Hakim (2000), Yin (1994) and Colander et al (2009) amongst many others.

The methodological pluralism and dual-method approach, especially as it incorporates the Austrian School, described by Blaug (1992) as anti-empirical and alien to the spirit of economic study requires a particularly rigorous research design as well as strong methodological foundations to ensure its value and justification. The approach of this thesis can be seen to be explicitly derived from the existing Austrian-Empirical literature in Chapter 4.This is to ensure an approach accessible to the wider economic community and acceptable to the Austrian School.

1.4 Research Objectives

This section provides an overview of the research objectives of the thesis. The first objective is an assessment of the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle. This following the advice of White (2009) can be reduced to three specific aspects or research questions.

1. Development of a testable model of Hayek's theory of the trade cycle.
2. What are the measurement criteria for relevance?
3. Does the Hayek's theory of the trade cycle meet the relevance criteria?

The second objective of a pluralist economic study acceptable to the Austrian School and accessible to the wider economic community lies within the scope of the answers to these questions and the methods used.

The specific aspects of the first objective, can be considered with the following directions to meet objective two.

1. Development of a testable model of Hayek's theory.

   Reduced form models are common within the mainstream and Austrian –Econometric literature, the development of such a model derived from the literature will allow for testing against the validity criteria below. The incorporation of a structural component addresses Kuehn's (2013) criticism discussed in Chapter 5 and represents a novel contribution to the literature.

2. What are the measurement criteria for relevance?

   Austrians seek an understanding of the process and not necessarily of its conclusions (Ekelund & Hebert 1990) whereas the Neoclassical tradition seeks evaluation through prediction (de Soto 1998). In practice for this thesis this will be a number of empirical tests determined as acceptable from the Austrian Econometric Literature to evaluate the components of the testable model above.

3. Does the Austrian Theory meet the criteria for relevance?

Following the subsequent literature reviews, appropriate (to the wider macroeconomic community and the Austrian Schools of Thought) empirical tests were selected and used to measure the relevance of Hayek's theory in the timeseries data.

When considering the economic tradition of theory evaluation the format of the research question design is closely aligned to the standard approach within the field, although it is usually implicit in the study the format of identifying what is being studied, determining how to measure its performance and evaluating its performance against the determined criteria is clear in Milani (2011), Arnold *et al* (2011), Ahituv & Zeria (2011) and Mayhew *et al* (2010) amongst many others. For instance Kwon (2010) when considering research and development policy defines the topic of enquiry, defines the evaluation criteria and judges research and development policy accordingly. Likewise Czernich *et al* (2011) when examining the effects of broadband infrastructure on economic growth defines and limits the area of study, defines what would be an attributable effect on economic growth and thus assesses the effect of broadband on economic growth.

1.5 Structure of the Thesis

The Thesis is presented in eleven Chapters. This initial Chapter is to present a general introduction to the research area highlighting the background to the research of the recent Global Financial Crisis. The chapter sets out the differences between the mainstream, orthodox and heterodox in economics, to provide the context for the thesis and its evaluation of heterodox business cycle theory. The growing interest in Hayek's theory of the trade cycle from both academia and policy is shown in Chapter 1 and Kuehn's (2013) fundamental question, "Is there anything to the theory?" identifies a gap in the literature. Chapter 2, provides a literature review of the Austrian School of Economic Thought, Austrian Theories of Money, Banking and Credit, and Business Cycles. Chapter 3 introduces the Austrian Macro

Economic Framework and isolates the micro economic components of Hayek's theory of the trade cycle. In Chapter 4 Previous Empirical work on Hayekian Business Cycles is examined and relevant techniques are highlighted for use in the thesis. In this Chapter testable models of Hayek's theory and various econometric tests acceptable to the Austrian School of Economic Thought are identified. Chapter 5 provides a discussion of these tests and produces a testable model of Hayek's theory for evaluation, Chapter 6 discuss the data used for evaluation of the reduced form model, Chapters 7, 8 and 9 evaluate the model against the data, Chapter 10 interprets the results from 7, 8 and 9 and Chapter 11 provides a final discussion of the research. The following sections provide a brief summary of each chapter in the thesis:

1.5.1 Chapter 2: Literature Review

Chapter 2 provides the historical and philosophical context for the research and reviews the literature relevant to Hayek's theory of the trade cycle. Austrian Economic theory is examined to provide context for the research presented in the thesis. This thesis uses a vast amount of literature concerning Hayek's theory of the trade cycle, with a focus on the Austrian-Econometric Literature and the New School of Austrian Economics. The thesis contributes to the literature by providing a comprehensive empirical evaluation of Hayek's theory of the trade cycle using UK data contrasting the previous primarily US studies. The specific proxies used for the mechanisms of the theory further contribute to the body of literature as does the time period studied. Furthermore the thesis contributes to the pluralist debate by determining the validity of Hayek's theory using a process acceptable to the mainstream.

1.5.2 Chapter 3: The (New) Austrian Macro Economic Framework

Chapter 3 develops the theory discussed in Chapter 2 into the New Austrian Macro Economic Framework, this framework from the 'New Generation' Austrians allows for the introduction of a non-verbal formalism to Hayek's theory of the trade cycle, and thus the development of the required testable model in Chapter 5.

1.5.3 Chapter 4: Previous Empirical work on Hayekian Business Cycles

Chapter 4 discusses the econometric work primarily classified as New Generation Austrian, this work suggests appropriate tests and provides guidance for the construction of a testable model of Hayek's theory. This Chapter evaluates the principle Austrian Econometric Papers such as Wainhouse (1984), Hughes (1997), Cwik (1998), Keeler (2001) and Mulligan (2006) to determine appropriate methods to evaluate the testable model and the hypotheses.

1.5.4 Chapter 5: Methodology Chapter

The methodological issues of an empirical examination of Hayek's theory of the trade cycle are examined and the suitability of the econometric tests used by the New School of Austrian Economic Thought is discussed. A wider methodological pluralist philosophy is presented as being appropriate for the empirical examination of Hayek's theory to bridge the (bridgeable) gaps between Hayekian and Neoclassical Thought and further contribute to the pluralist debate within economics.

This chapter then presents the overall methodology of the thesis, the research constructs a testable model of Hayek's theory of the trade cycle. Tests of this model are discussed in the chapter and a reduced form Vector-Auto Regression, a Vector Error Correction Model and Granger Causality Tests as well as standard initial evaluation and descriptive processes are discussed as appropriate for econometric evaluation of Hayek's theory of the trade cycle.

1.5.5 Chapter 6: The Data

Chapter 6 discusses the data, and its treatment during the research. The Variables are constructed with input from the major Austrian Econometric Papers, displayed visually and descriptive statistics are presented. An initial correlation matrix evaluation (as per Keeler 2001) is conducted to investigate the explanations that Hayek's theory of the trade cycle can provide for UK time series data.

1.5.6 Chapter 7: Initial Statistical Evaluation

Chapter 7 presents an initial statistical evaluation of the data, Standard OLS regression is used to explore the relationships present in the data. In accordance with Keeler (2001) a simple correlation matrix is constructed to evaluate Hayek's theory of the trade cycle. In accordance with Carilli & Dempster (2008), a consideration is given to endogenous turning points in the data which are evaluated via a Finite Distributed Lag Model.

1.5.7 Chapter 8: Empirical Evaluation of Hayek's theory of the trade cycle

Chapter 8 evaluates the linkages of the reduced form model using Vector-Auto Regression Models, Orthogonalized Impulse Response Functions and Granger Causality Tests. Building on the work of Carilli & Dempster (2008) a VAR is built and post estimation tests to ensure validity are conducted. The relationships between the variables within the VAR model are used to evaluate the Second Order Predictions of Hayek's theory of the trade cycle and test hypothesis 1 (Chapter 5). To address the measurement concerns of the Austrian School (Keeler, 2001) two Austrian appropriate interest rate proxies are used to create distinct VAR models (VAR YIELD[10] and VAR YGAP).

[10] At this initial stage of the thesis it is useful to explain that the variable YIELD (always in this thesis capitalised) is a term derived from the Austrian Economic Literature (e.g. Keeler 2001) and is used within this

1.5.8 Chapter 9: Vector-Error Correction Analysis of Hayek's theory of the trade cycle

Chapter 9 evaluates the linkages of the reduced form model using Vector-Error Correction Models, Orthogonalized Impulse Response Functions and Granger Causality Tests.

Mulligan (2006) is identified in the Austrian Econometric Literature as being a key paper providing considerable econometric support to the Austrian Business Cycle Theory, as such a replication of this study using the UK timeseries data (1980-2010) is presented.

The various tests used contribute to the body of literature in a dual form; firstly they provide a clear empirical evaluation of Hayek's theory of the trade cycle using UK data whilst secondly contributing to the pluralist debate, both in methodology and theory. Furthermore a replication of Mulligan (2006) using the UK data determines if the relevance gleaned from this study for the US is transferrable to the UK.

1.5.9 Chapter 10: Interpretation of the Results

Chapter 10 presents the results from Chapters 7, 8 and 9 in order to evaluate the reduced form model and the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle.

The results of the tests are presented along with any post estimation considerations, the test results are used to accept or reject the associated prediction of Hayek's theory of the trade cycle.

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literature and thesis to describe a proxy for a movement of the market rate of interest with sole respect to the natural rate of interest. This footnote is to differentiate the capitalised YIELD variable from the common use of yield as a return on investment.

1.5.10 Chapter 11: Discussion

In Chapter 11, the results and evaluation against the reduced form model are discussed and the wider contribution and implications for policy are considered. The thesis concludes that whilst empirical support for Hayek's theory of the trade cycle as a whole is limited, there is strong support for some individual components. This being the case, then within the calls for a Pluralist Economic Paradigm, potentially it is appropriate to isolate the supported components of Hayek's theory and incorporate them into a wider pluralist business cycle theory.

The philosophical view of the Austrian School and the wider pluralist methodological debate are recapped and within this suggestions for further research are presented. This chapter concludes with revealed themes which merit further research.

1.6 Chapter Summary

This introduction chapter has discussed the overall research area, that of the challenge to the orthodoxy arising from the criticisms of following the Global Financial Crisis and presents Hayek's theory of the trade cycle as a heterodox theory gaining academic and political interest post crisis. Daniel Kuehn (2013) queries if there is anything to the theory, Evans & Baxendale (2008) question if there is now room at the top table for Austrian ideas identifying a gap in the literature. The Dahelm Report (Colander et al 2009), Kirman (2009) and Stiglitz (2010) criticise models too far removed from reality. Colander et al., (2008, 2009) argue for the use of a data-driven approach, using techniques appropriate to the data and not simply the most cutting edge mathematical techniques. This is comparable to the New Austrian School of Economic Thought and Hayek's rejection of scientism where econometric techniques which maintain the richness of the data are used.

In order to determine the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle, this thesis presents a testable model of the theory evaluated against UK time series data.

Chapter 2: Austrian Economics and Economic Crisis – A review of the literature.

2.1 Introduction

This chapter reviews the literature concerning the development and the philosophical stance of the Austrian School of Economic Thought. This provides a rich context for the research and gives a key overview of the existing research and theory. 'New Generation Austrians' are discussed in detail as this provides support for the empirical examination of Hayek's theory of the trade cycle presented in this thesis.

Chapter 2 takes a hybrid approach to the literature review process combining elements of a systematic style with those of a traditional critical review. This is to ensure a rich depth of literature is studied avoiding potential bias in the literature, both of Austrian dismissal of other approaches and of wider economic dismissal of Austrian Theory. In particular the systematic process helps to avoid non-peer reviewed, blog and opinion pieces.

The research provides a contemporary examination of Hayek's theory, the examination of Economic Philosophies, in particular The Austrian Approach, the neoclassical approach and Mises' Epistemological problems of the sciences of human action provide the necessary context for the development of an appropriate testable model and justification (to the Austrians) for empirical evaluation of such.

The literature review presented in Chapter 2, provides insight into the Austrian objections to empirical analysis and the recent developments of the School (2.4) which facilitates the thesis objective of providing an empirical evaluation of Hayek's theory of the trade cycle acceptable to the Austrian School and accessible to the wider macroeconomic community.

2.2 Literature Review: The Austrian School

Section 2.2 explains how the literature reviews (including in Chapter 4) are conducted. This literature review[11] will take the form of a hybrid systematic and narrative - critical literature review, recognising the historical and philosophical nature of the review questions and the scope of many of the theoretical arguments, elements of a traditional narrative literature review style will be utilised. The systematic approach has been incorporated for two distinct reasons; it counters against bias and it is recognised that a review concerning perspectives on financial system reform will likely encounter a significant number of publications, especially in the light of recent economic events, a systematic review process allows for the processing of this number of sources (Denyer & Tranfield 2009). A primary aim of this review is to consider the theoretical positioning within the Austrian school, much of the literature reviewed therefore will come from publications specifically within the school, such as The Quarterly Journal of Austrian Economics. The databases and resources used are set out in table 1.

Table 1: Databases and Resources Used

Databases	Libraries & Online Collections
Econ. Papers Science Direct Springer Link	Keele University Library The Sir Kenneth Green Library – MMU. Aytoun Library – MMUBS. The St George's Library – The University of Sheffield. Online Material provided by the electronic archive of the London School of Economics. Online Material provided by the Mises Institute Archive.

2.2.1 Search Criteria

In many aspects the search criteria for many of the historical review questions followed a standard format of tracing the origins and evolution of various schools of thought; coupled

[11] Much technical advice on format, style and technique, particularly with regard to research mapping and 'entering the research conversation' was obtained from the Advanced Institute for Management Research web based resource: 'learning to think like an expert researcher'. Available at www.networkedcranfield.com/logicofenquiry/pages/home.aspx .

with a consideration of the pertinent debates and key pieces of work. For the more contemporary aspects of the review and for modern perspectives on the historical political economy of finance, various comprehensive search matrices were used in the listed electronic databases.

2.2.2 Inclusion Criteria

Inclusion of material was dependant on its relevance to the research question(s) and / or objective.

2.2.3 Exclusion Criteria

Material was excluded if deemed to be irrelevant, usually determined by a review of its title or abstract. Material for which the relevance could not be determined or was of possible relevance at the initial stage was fully reviewed before being discarded.

Recognising the dynamic nature and evolution of ideas and theories in this review area; whilst quality criterion such as journal rankings were taken into account it was considered that due to the change in standing of journals over such a lengthy time period, and of course the fact that many of the ideas were / are unfashionable or at one stage 'fringe' ideas and as such unlikely to appear in the highest ranked economic (ABS) journals. Therefore the journal or similar in which the paper was presented was not necessarily a credible reason for exclusion.

2.2.4 Initial Search Results:

Due to the heterodox nature of Hayek's theory of the trade cycle and the volume of non-rigorous opinion and journalistic pieces generated post crisis, a precise and thorough literature gathering process was required. Tables 2 & 3 show various search terms relevant to the thesis and results generated from several standard and reliable databases.

Table 2: Literature search results: The limitations of the existing system as perceived by the Austrian School.

Research Objective: The limitations of the existing system as perceived by the Austrian School.					
Databases Searched			Econ. Papers.	Science Direct.	Springer Link.
Search Term 1	Hayekian Cycles		204	229	254
Variations -	Recession		164	71	147
	Banking Crisis		56	178	187
	Great Depression		22	156	238
	Financial System Failings		7	91	108
		Results	453	725	934
		Relevant Results	11	8	1
Search Term 2	Austrian Monetary Policy		446	641	128
Variations -	Fractional Reserve Banking		7	18	58
	Structural Flaw of the financial system		8	128	180
		Results	461	787	366
		Relevant Results	13	3	0
Search Term 3	Austrian perspective on financial crisis and monetary policy.		123	135	95
Variations -	Austrian - Banking		88	63	46
	Austrian - Money		93	49	96
	Austrian - Credit		85	55	16
	Austrian - Crisis		84	17	59
		Results	473	313	312
		Relevant Results	9	4	0

Table 3: Literature search results: Austrian proposals for reform.

Research Objective: Austrian proposals for reform.					
Databases Searched			Econ. Papers.	Science Direct.	Springer Link.
Search Term 1	Austrian Financial System Reform.		29	26	64
Variations -	Banking Reform		11	63	4
	Money Reform		24	55	42
	Credit Reform		30	10	32
	Austrian financial temporal subjectivism.		4	2	19
		Results	98	156	161
		Relevant Results	11	1	0
Search Term 2	Orthodox critiques of Austrian financial Reform.		158	14	14
Variations -	Neo-classical critiques		202	10	29
	Technical and ideological critiques.		158	41	14
		Results	518	65	57
		Relevant Results	14	3	1
Search Term 3	Critiques of Austrian financial reform within the Austrian School.		To provide arguments from within the School, the search process was conducted through the database and discussion papers of the Mises Institute.		
Variations -	Technical criticism				
	Philosophical criticism				
	Ideological criticism				
	Branches of thought within the school				
		Results	39		
		Relevant Results	11		

Results included in the relevant results column take into account duplication within the database searched, for instance, the article Monetary Reform from a Comparative – Theoretical Perspective, (Carilli *et al* 2004) is included within the result score for numerous search questions, but is only included within the relevant results score once.

Articles included in the relevant results, which were deemed to be irrelevant *ex post* are still however included in figures presented above. A wealth of extra material was provided through a historical tracing of the evolution of key ideas and philosophies and via serendipitous discovery (Greenhalgh & Peacock 2005). This data are not necessarily included in the figures above.

2.3 Austrian Economics: The development of the School

This aspect of the literature review discusses the development of the school to provide a historical context for the research and thesis. An understanding of the development of the school is crucial in positioning the empirical approach of the thesis accessible to the wider macroeconomic community, in a manner acceptable to the Austrian School. The rejection of *Scientism* and the adherence to subjectivism of the school results in research techniques based around verbal explication or relatively unusual constructions such as Hayekian Triangles. This thesis by contributing to the small cannon of empirical literature concerning Hayek's theory of the trade cycle produces an accessible evaluation of the relevance of the Theory for understanding the UK Business Cycle. De Soto (1998) considers the Austrian methodology to be a Verbal Formalism as opposed to the mathematical formalism of neoclassical analysis, this is born out of the origins of the school, with Carl Menger taking the position that a mathematical language cannot describe the fundamentals of a dynamic economic position and thus only a verbal approach is justified.

A key issue is regarding the approach of the school of thought, the Austrian School distinctly study the temporal aspect of the economy, whereas the neoclassical approach is one of static equilibrium. A mathematical approach can provide this fixed picture but not the subjective reality of time, the essential analytical feature of the Austrian School (de Soto 1998). Mayer (1994) states that taking the dynamic process of the economy and converting it into a fixed state through mathematical techniques, removes the essence of the process. In the natural world there are absolute constants for instance, a Hydrogen atom is identical to every other Hydrogen atom and the gravitational pull of a body is calculable and fixed, these predictable functions allow for testing to replicate the same observation time and again. We can say for absolute certainty that there is an inversely proportional relationship between absolute pressure and volume of a gas at constant temperature within a closed system, or that acceleration is produced when a force acts on a mass, the greater the mass of the object being accelerated the greater the amount of force needed to accelerate it. These physical laws, Boyle's and Newton's Second respectively, allow for this; however the Austrian view of economics is one where these functional relationships do not exist, and therefore the prescriptive functions, for example supply and demand or cost and utility can be disregarded. Mathematically a function is defined as a one to one process from an element of the initial set to the final set, A (initial set) to C (final set) via B (function or process), The Austrian school argue that with regard to human activity none of these components of a function (A, B or C) are static or measurable, making the mathematical study of them impossible. The very nature of the human animal is one of constant progress through life and experience, thus making every decision different from the next therefore the elements of the initial set (A) cannot be considered constant, the elements of the final set (C) likewise cannot be considered constant, and crucially with the process of transference (B) from A to C different for every element, and thus impossible to measure or predict, the mathematical analysis of human activity is flawed from the Austrian perspective.

Within the Austrian perspective therefore, the use of the hard science approach is considered wholly wrong as it removes the human being from the study of human action (de Soto 1998). The approach of the Austrian school, is therefore built around a logical approach to incorporate the dynamism of humanity into its analysis, Caldwell (1994) considers a great achievement, [possibly the greatest merit (de Soto 1998)], of the Austrian school to be the development of a principal of economic analysis *praxeologically*[12], without the need for the assumptions of standard economic analysis which remove human nature.

There is a clear clash between the Austrian and Neoclassical economic schools of thought; the Neoclassical school considers that economics can be treated as a hard science where human activity is rational and based on a concept of utility maximisation whereas the Austrians consider human action to be unpredictable, rational perhaps to the individual but not necessarily to the observer and dynamic. This goes some way toward explaining the methodological origin (de Soto 1998) of the schools, for de Soto the Neoclassical methodology is a positivist approach based on a hard mathematical formalism, whereas the Austrians approach economic study from a subjectivist approach and considering that mathematical study of human action is flawed take a verbal formalism or language to explain economic phenomena. When considering the role of empiricism within the analysis, a typical Neoclassical approach would be the rejection of a null hypothesis whereas the Austrian School of thought has a view that history, in this case collected data of human action, cannot prove theories. Frequently the end goal of Neoclassical analysis is prediction of future events, the Austrians consider that prediction is not possible as it lies in a future time and in future human action which having not occurred is impossible to measure due to the unpredictability and dynamism of human action[13]. The fundamental goal of Neoclassical economics is to measure

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[12] Mises (1966); logic being constant and static suffers from a similar failing to the mathematical approach, praxeology accounts for time and creativity. In essence a study of human action built from purposeful *a priori* principles.

[13] When considering prediction it is useful to consider what is actually meant. Some predictions of human behaviour can be made, even for the Austrians, for instance Mises (1966) development of a *praxeological* approach to the study of human activity based on *a priori* axioms considers some behaviours fundamental to human action that it is possible to say <u>will</u> occur. For instance the buyer of a good (of his own choice) will value that good more than the cost of the good and the seller will value the price of the good more than the good itself.

and determine the complex relationships between economic variables (Wutscher 2005). Dissecting this goal further reveals the implication of the existence of at least a number of constant variables to allow for calculation and measurement of said relationships. For the Austrians the measurability of human action, money, price, profit etc. are the results of the human mind and would not exist independent of it, for instance Mises (1977) considers that prices are expressed in terms of money rather than measured in it.

The history of the development of the scientific method is relatively well known and a detailed recap here would not be of significance, the anti-Catholicism of the reformation coupled with the Church's antagonism with scientific progress led to a general dismissal of the Catholic Church's stance, this encompassed the philosophy of Aristotle which was fundamental to Scholastic thought (Wutscher 2005). This led to the development of a new philosophy leaving the ideas of the Scholastics and Aristotle and instead focussing empirical principles, in England, where the movement against Catholicism[14] was perhaps most pronounced, empiricists such as Locke, Mill and Hulme developed a philosophy upon empirical lines. Vienna however experienced its rejection of Scholasticism far later than in England (mid 19thC-1938), this rejection resulted in the logical positivism of Comte, a philosophical system recognising only non-metaphysical facts and observable phenomena (OED 2007), a central pillar of logical positivism being that all empirical statements must be testable, for if a statement cannot be tested it is meaningless (Wutscher 2005). As a consequence of this all necessarily true statements are dismissed as tautologies which cannot produce any new meaning. Following the German Anschluss (1938) the Logical Positivists found themselves dispersed into a variety of academic institutions, worldwide but often within the Anglo-American sphere. For the Austrian School of Economic Thought the main consequence, was an American Logical

[14] And against Latin, the language of the church and the scholastics.

Positivist movement which dismissed Austrian methodology, particular Mises's *praxeology* as archaic being built upon Scholastic Aristotelian Philosophy (Gordon 2006).

The study of Aristotle was still common place in Vienna when Carl Menger formulated his particular theory of marginal utility. In contrast to this the two other independent marginal utility theorists, Jevons and Walras, were educated at strictly empiricist institutions where Aristotelian study had long been abandoned (Wutscher 2005); both Jevons and Walsras developed cardinal approaches whereas Menger's approach is purely ordinal in nature. Likewise there is a considerable difference in the Neoclassical and Austrian interpretation of reality, the economic orthodoxy generally considers reality in terms of complexity and comprehensiveness, a standard undergraduate economic textbook (Sloman 2006) explains to first year economics students how in reality the economy is far too complex to possibly be understood and the role of the economist is to simplify this complex reality through theory and mathematical model making to provide meaning. Implicit in this is the fundamental position of Neoclassical economics that at least a portion of human activity is measurable and constant, therefore for the orthodoxy the main role of economic science is reduction of the complex to the simple with the inclusion of all relevant variables and the removal of all irrelevant ones, of course a further assumption of this is that the relevant variables are measureable[15]. In contrast to this, Austrian economists have a much more complex view of what they regard to be a far more simple reality, a reality comprised of essential and conceptual truths (Wutscher 2005)[16]. Implicit throughout this body of work is the archetypal

[15] The philosophy of mathematics has three relevant considerations of mathematics for economics (Roy 1991): firstly that mathematics is an abstraction of reality (empiricism), secondly that mathematics is an abstraction of a transcendental reality (Platonism) and thirdly that mathematics is an abstraction of no sort of reality at all (formalism).

[16] This clearly leads to a discussion of abstraction and realism which could only be superficially covered within the constraints of this thesis, and as many of the epistemological issues faced are related to methodological concerns, for a greater insight into abstraction versus realism debate please see Long (2004), *Realism and Abstraction in Economics: Aristotle and Mises versus Freidman.* Mises.org.

and perhaps commonplace debate within epistemology of the two diametrically (Polleit 2011) opposed concepts of empiricism and rationalism.

In order to further contextualise this work, it is necessary to consider the methodological approach of the Austrian School. At this stage a key consideration of the research is an evaluation of Hayek's theory of the trade cycle, acceptable Austrian Schools of thought and accessible to the wider macroeconomic community. Even considering the philosophical opposition of the school, attempts have been made in this area, for instance Vector-Error correction modelling as an econometric analysis tool has been suggested as being an appropriate method for the consideration of Austrian theory from a mathematically formalist perspective (Mulligan 2006). This method provides an estimate of a structural or equilibrium process and the Error Correction or dis-equilibrium process which provides adjustment toward the hypothesised equilibrium. An Austrian rejection of the existence of any equilibrium due to human action does not discount an interest in the disequilibrium process, indeed Austrian philosophy seeks an understanding of the process and not necessarily of its conclusions (Ekelund & Hebert 1990). As with logic or mathematics, the conclusions of Austrian economics based on praxeology can be considered exact laws which can be applied to reality (Wutscher 2005), indeed Caldwell (1982) considers that the Austrian method does not merely use the functional form of mathematics in its analysis but its *a priori* form which is more suited to the study of human action, in its method of *praxeology.*

Orthodox methodology is predominantly mathematically based and highly rigorous in its application, The New Austrian School (discussed in detail later) support mathematical techniques and econometric approaches, however they question the underlying principles of these approaches and the use and validity of the resulting knowledge, especially the transfer of time and place specific knowledge to an "unashamed" prediction of human activity. The New Austrian School are demonstrated to support the tests used in this thesis in Chapter 4 (summarised in table 9). The methodology of the Austrian School based on the logic of human action (Mises 1966) and usually termed *praxeology* is highly complex, though for simplicity and for the purposes of this work can be defined as logic linked to reality (Wutscher 2005). Praxeology, rather than producing hypotheses either based in logic or mathematics, is in essence a type of logic and as such is in the same *form* as a pure *a priori* method, for praxeology necessary truths play the role of numbers in mathematics. It is thus related to the syllogism:

"If p is true, and p entails q, then it follows that q is true"

And as such praxeology can be regarded logically rigorous. Regarding the praxeological link to reality, the abstractions are universal in an Aristotelian sense, that they concern essential truths that are not dependant on temporal location and can be related to the specific *via* logical reasoning. Mises in the Epistemological Problems of The Sciences of Human Action (1966) considers that the fundamental categories of human economic action are not derived from experience, but from within just as logical and mathematical truths are conceived *a priori*. This calls for a brief consideration of the Prussian philosopher Immanuel Kant and his *critique of pure reason*, a result of Kant's *transcendental investigation* is his discovery of *a priori synthetic judgements* (Polleit 2011). *A priori* knowledge is knowledge acquired before or independently of experience, by contrast *a posteriori* knowledge is acquired through experience. Synthetic judgements describe knowledge not contained in the subject matter, whereas analytic judgements contain only knowledge within the subject matter, one would therefore expect analytical judgements are *a priori* and that synthetic judgements are *a posteriori,* yet Kant (and then for the Austrians Mises) claims that there are *a priori* synthetic judgements.

Mises presents a relatively strong anti-positivist approach, especially when considered from a Humean scepticism or its positivist versions (Wutscher 2005), Blaug (1992) describes Mises as anti-empirical and alien to the spirit of science, due to his *a priori praxeology*. As a causal process approach Austrian Economics is comparable to logic and mathematics (Maki 1992), mathematics and logic are systems whose rules, for instance truth tables or calculus are born *a priori* from central axioms and principles (Wutscher 2005) which are not dependent on experience or contingent on any exogenous variable (*ibid*). Mathematics is not dependent on any specific situation but can be applied to it, if one for instance wishes to count the number of people in a train carriage, then the application of the rules of addition is the only option, there are no separate rules of addition for this particular (or any other) scenario[17]. Long (2001) considers Wittgenstein when clarifying that mathematics is not based on experience and notes how an individual putting into a box 2+2 apples and having three in the box does not now decide that 2+2=3 or that in this specific case 2apples+2apples=3apples but that 2+2=4 and therefore an apple is missing [18]. By this process Wittgenstein concludes that mathematical rules are used in such a way that nothing counts as a falsification of them. Mathematical claims can of course be demonstrated empirically but crucially if the empirical evidence counters the mathematical rule it is the evidence that is questioned rather than the rule itself. Praxeology like mathematics is not dependent on experience but can be applied to it and in the same way that mathematical rules are derived from *a priori* axioms and reason, so are the rules of praxeology.

The distinction between what is learnt from experience and the tools used to make sense of, order or measure experience is a vital one when considering the Austrian method, within this

[17] The rules of addition for counting small objects are the same as for counting large; the rules for counting squares are the same as for counting circles and so on.
[18] This is not Frege's (1997) Gingerbread and Pebble arithmetic but a consideration of the inability to falsify mathematical rules.

distinction the Austrian approach like mathematics is non-empirical. This allows for a first defence against Blaug's (1992) criticism of anti-empiricism, praxeology like mathematics is a method for application to experience with rules derived as per mathematics, to consider this development as anti-empirical would suggest that mathematics would have no application to the making sense of, ordering or measurement of experience, clearly a view contrary to much of the economic orthodoxy.

The Austrians consider the fundamentals of economics are the necessary truths of reality, an individual's goals are subjective but can be ordered and yet the progress toward these goals is constrained by numerous factors and generally time and place dependent. The School considers simplifying assumptions to detract from the essence of the economic process but may be necessary and an abstraction from reality can be justified if it is acknowledged and accepted as such. Empirical studies can be of benefit for the checking of a particular theory as applied to a static location or the adjustment or reformulation of auxiliary aspects of the theory, but in itself empirical examination cannot create new theory. The collection of data for prediction may have limited value for short term scenarios, but such data collection cannot alone create laws of human activity for which *a priori* axioms are required. The acknowledgement of data collection allowing for short term prediction is counter to pure Austrian methodology which considers that any data collection is economic history which cannot inform the future (de Soto 1998). The decision has been made to as much as possible avoid labelling the epistemological research position of this thesis and instead hold it within a pluralist consideration, not within an impossible to defend philosophical pluralism, but a methodological and epistemological pluralist[19] as described by Caldwell (1982) and Dow

[19] From now on this thesis shall use the term methodological pluralist as proposed by Caldwell (1982) as this is a similar position to Dow's (1996, 1997) pluralist and covers much of the same ground.

(1996, 1997) respectively which will be discussed in greater detail shortly. Three possible labels concerning the positioning of this research ‘spring to mind’ and are rejected; *a priorist*, r*ationalist* and perhaps an archaic term, *verificationist*. Firstly the term *a priorist*, this has several meanings throughout economics, members of the field such as Knight, Mises, Robins and Hayek (amongst many others) all agree that fundamental axioms of economics are self-evident and apart from experience (Caldwell 1982), however only Mises derived the *praxeological* approach discussed earlier. The assumption of rationality is considered *a priori* for many economists and is practically a universal assumption in any Neoclassical model, this assumption that individuals for instance will, maximise their utility would not be considered *a priori* by Mises as the individual would need to know how and why to do this, an ability learnt from experience and hence not *a priori*. The *rationalist* label is easily dismissed by Caldwell (1982) who considers the term to be time and place dependent in that its meaning is dependent on the context in which it is applied and thus to further apply it to my own epistemological position would add no clarity. The term *verificationist* meaning here those who consider a statement meaningful only if it is capable of complete verification by observed evidence, is used to classify several different and often opposed economic philosophies, even those who warned of the dangers of verification. The term has been used as an umbrella to cover any economic philosophy being opposed (or indifferent) to falsification. Caldwell (1982) notes how it is a myopic arrogance to group economic methods such as Keynesianism and the Austrians together simply as neither advocates the attempt to falsify their theories *via* empirical testing.

Perhaps one of the most significant contributions of the knowledge philosophers is the realisation than the attempt for a single prescription for valid universal knowledge is complicated, sometimes pyrrhic and at best only ever in progress. Caldwell (1982) considers that *confirmationalism* provides no logically compelling method, *instrumentalism* is only ever applicable to those scenarios requiring predictive accuracy and whilst *falsificationism* recognises Hulme's problem of induction, if it is prescribed too strictly has significant errors in application and if it is used in too loose a manner it becomes a powerless checking tool, it is also only applicable to economics that promote or are designed for empirical testing. It is of no doubt that these issues have had a great (and perhaps damaging) impact on economic study. The pluralist position adhered to, considers as a starting fundamental that no universally applicable method of theory appraisal as yet exists and challenges the view that scientific activity is measured by the rigour of its methods and that progress is dependent on the steady accumulation of true knowledge. Kuhn (1996) suggests that science grows as a dynamic complex process and not in a linear pattern, this occurs through both constancy and flux (Caldwell 1982), not simply the following of rigid prescriptions within an established temporal paradigm but also revolutionary science. The role of this research is not however the discovery of a new universal truth, Stiglitz (2010) has called for a new economic paradigm which explores some pluralist ideas; however Lawson (2009) notes how the dominance of a mathematical economic method removed from reality continues post financial crisis. The rational reconstruction of the methodological content of economic research is no easy task, and the methodological pluralist approach should be aware and accepting (though not blindly in the name of pluralism) of ideas from other fields and consider the research programs within one's own field (Caldwell 1982). For example the epistemological foundations of Austrian economics differ considerably from Neoclassical economics, it is here in the methodological evaluation of alternative research approaches that methodological pluralism can be fully utilised and begin to bridge (the bridgeable) gaps.

The below table sets the Austrian approach to the study of human action, this table is repeated in Chapter 4 (table 10) of this thesis incorporating the approach of this body of work.

Table 4: Mainstream and Austrian Characteristics

Issue	Mainstream approach	Austrian approach
Concept of economics	Theory of decision, that is human action is rational and based on utility maximization.	Praxeology – human action is a dynamic process.
Methodological origin	Positivist approach to human action via mathematical formalism.	Subjectivist approach via verbal formalism.
Information within the analysis	Complete, objective and constant information on the economic process is a given in analysis. There is no acknowledgement of different types of knowledge within the process.	Information and knowledge is subjective and dynamic, there is an acknowledgement of different types of knowledge in analysis of the economic process.
Basis of analysis	One of equilibrium and given constants, micro and macro effects are considered separate.	The economic process is considered in its entirety.
Empiricism within the analysis	Rejection of null hypothesises.	Shared view that history (collected past data) cannot prove theories.
Prediction as a goal of analysis	The end goal of the analysis.	Prediction is impossible as it lies within future human action which has not yet occurred and is thus impossible to measure.
Formalism within the analysis	Mathematical Formalism.	Verbal Formalism.

Source de Soto (1998) plus Author additions

2.4 New Generation Austrians

In 2.4, the New Generation Austrians (also termed The New Austrian School) are considered in order to further explore and justify the empirical approach of this thesis. Subrick & Beaulier (2010) consider that Austrian failure to penetrate the mainstream despite the initial promise of the revival of Austrian Economics in 1974; is due to the failure of the Old Austrian School to present their ideas in a format where a key statement or hypothesis can be examined against the data. Austrian Economists predominantly use narratives, anecdotal or pseudo-empirical methods which whilst clearly appropriate to some are inaccessible not only to the Neoclassical Orthodoxy, but the wider macroeconomic community. Without a clear hypothesis the work of many Austrians may leave readers confused as to the evidential basis of the theory (Subrick & Beaulier 2010). A stated hypothesis (or indeed Second Order Prediction *as per* this thesis) would address this issue and reduce the costs to the mainstream in engaging in discussion of Austrian Theory.

Of course the very principle of hypothesis production is sure to raise alarm and criticism within the Old Austrian School. However the aim of the New School is not to abandon Austrian Methodology and turn to the methodology of the orthodox, but to relax the primary methodological structure of Austrianism being purely praxeological. Instead the New School wishes to acknowledge the need for focussed arguments addressing specific aspects of the theory. With specific regard to empirical research, the Austrian School has tended (though not in entirety) to adhere to the Misean view of the impracticability of measurement due to the absence of constant relations, the view of statistics as pure non-repeatable economic history and the view of the futility of the empirical economist. The New School of Austrian Economic Thought consider that in light of the current evolution of the econometric method, perhaps then this Misesan position is outdated or a little naïve (Subrick & Beaulier 2010). The New School consider that quantitative economists do not search for absolute constants but instead for relationships and address the critique of measurement error. For instance Ordinary Least Squares is a standard component on the vast majority of university economic programmes and two stage least squares and Monte Carlo Simulations are now standard methods in empirical research.

2.5 The Foundations of Austrian Macro-Economics

The foundation of Austrian theories of Money, Banking, Credit and Malinvestment being responsible for market correction or orthodox recession is the Austrian theory of the inter temporal structure of capital (Bjerkenes *et al* 2010). The cornerstone of the theory concerns the distribution of capital and productive forces within the temporal structure of production during the business cycle. Very simply, for the Austrians, if the price level affected by government action and the ready availability of fiduciary media provides false signals to investors concerning the most profitable stage of production in which to operate (de Soto 2006, 2010). This creates an unsustainable temporal capital structure which produces a fundamental disparity between supply and demand leading to an inevitable market correction process.

Austrian economic frameworks, particularly those produced by the New Austrian School concentrated at George Mason University are not dissimilar to the standard and familiar analytical models of orthodox economics taught on the vast majority of economics courses. This provides a helpful and familiar clear starting point, the (New) Austrian economic frameworks demonstrate Hayek's theory of the trade cycle in an accessible form to Mainstream and Heterodox Economists, thus it is appropriate for a brief introduction to them.

The macro-economics of the Austrian school consists of a trio of fundamental frameworks (Garrison 2001):

1. The loanable funds market
2. The Production Possibility Frontier
3. The Hayekian Triangle

These fundamental frameworks are summarised in Chapter 3 to provide the theoretical basis for Hayek's theory of the trade cycle and develop the foundations for a testable model of Hayek's theory.

2.6 Chapter Summary

An overview of the Austrian School of Economic Thought is presented (and the School's theories of Money, Banking and Credit are further developed in the following chapter). The differences between the Austrian School and The Neoclassical are explored in order to position the philosophical stance of this thesis and the 'New Generation Austrians' are discussed. The methodological stance and acceptance of empirics of the New Generation Austrians is presented as providing a foundation for the Austrian econometric approach taken in this thesis which addresses the objective of the thesis to determine the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle.

Chapter 3: The (New) Austrian Macro Economic Framework

3.1 Introduction

This chapter develops the New Austrian Macro-Economic Framework, introducing framework ideas and crucially the inter-temporal structure of production (the loanable funds market, the production possibility frontier and the Hayekian Triangle), vital for Hayek's theory of the trade cycle.

The Hayekian Triangle demonstrating the temporal structure of production, allows for an analysis of the lengthening of the capital structure causing an endogenous crash which is incorporated into the testable model of Hayek's theory of the trade cycle presented in figure 12 (Chapter 5).

The micro-effects of Artificial Monetary Expansion are considered, producing a step by step approach to Hayek's theory of the trade cycle (which is used in Chapter 5 to create the testable model, figure 12). These effects are then demonstrated in the New Austrian Macro-Economic Framework (section 3.5). The building blocks of the framework are developed in sections 3.2, 3.3 and 3.4.

Chapter 3 provides an investigation into Austrian Macroeconomics to facilitate the development of the testable model of Hayek's theory of the trade cycle and provide further understanding of Hayek's theory.

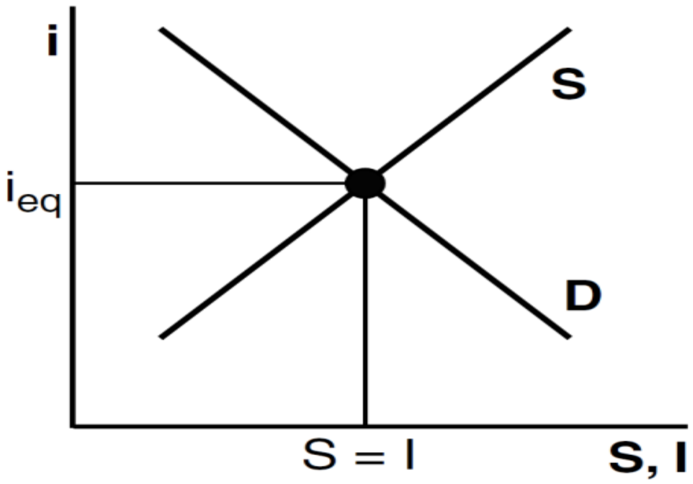
3.2 The Loanable Funds Market

For economists of the Austrian School the loanable funds market concerns all income not used for consumption and is related to the standard orthodox function[20]:

$$I = Y - C$$

However the Austrians take a broader view than the orthodoxy considering that the market for loanable funds is in fact the market for investable funds (Bjerkenes *et al* 2010). Thus supply in this market is all funds not used for immediate consumption, demand as standard is the investors need for resources and the price for borrowing these funds is the true interest rate of the market. This can be captured in the standard supply / demand framework as below:

Figure 1: A Supply and Demand framework of the loanable funds market



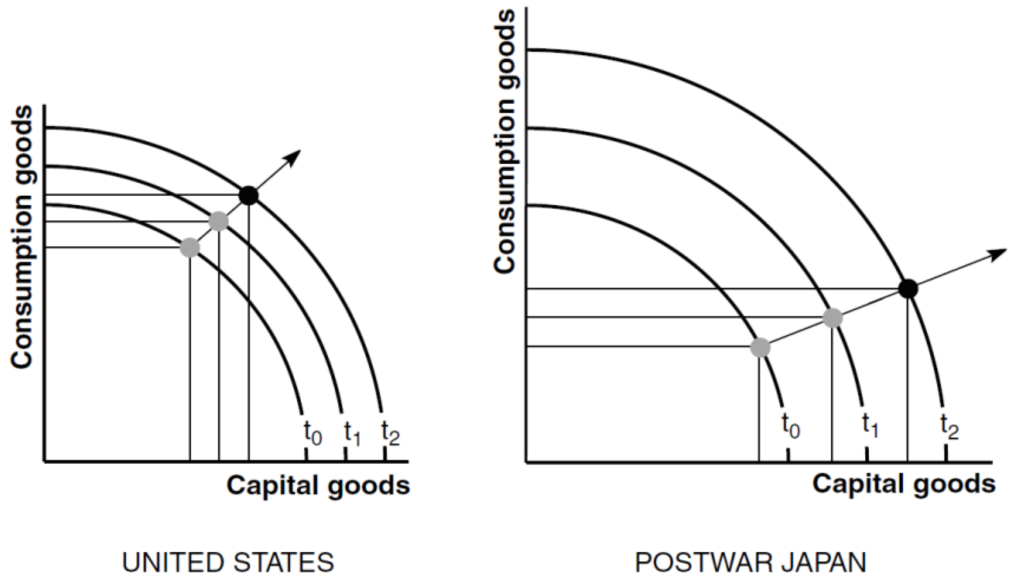
Source: Garrison (2001).

[20] $Y=C+I \rightarrow I=Y-C$

3.3 The Production Possibility Frontier

With the PPF being a fundamental basic of standard orthodox economics and the introductory topic on the vast majority of standard undergraduate macroeconomics, emphasis is only given to the Austrian use of the framework.

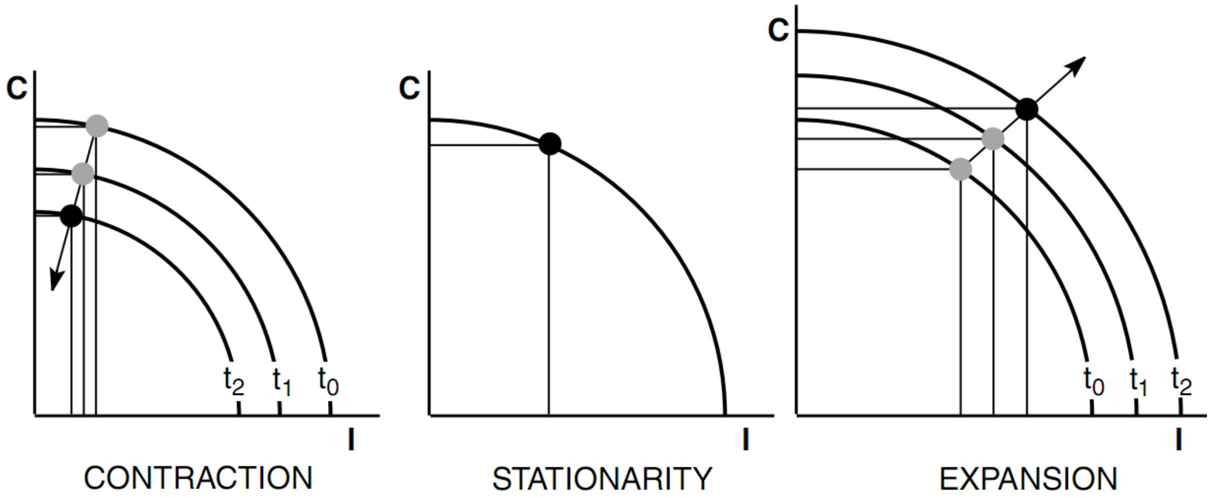
Figure 2: A PPF analysis of the US and Japanese Post War Economies.



Source Garrison (2001).

The PPF framework presented in figure 2, shows the consumption / capital trade off in the post Second World War period. It shows how the Japanese economy forewent a considerable amount of current consumption in favour of capital accumulation. By contrast, the US economy preferred significantly more consumption forgoing capital accumulation. The Austrian School of Economic Thought considers this to account for the comparatively greater Japanese growth in the subsequent time period.

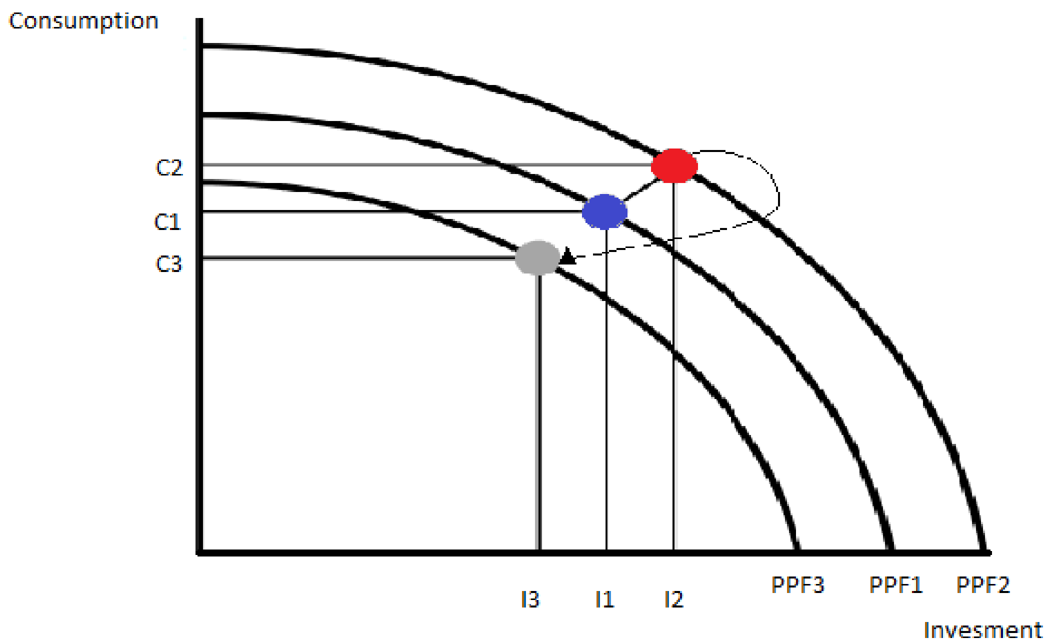
Figure 3: PPF representations of economic states



Source Garrison (2001).

In orthodox theory the expansion of the economy past the PPF occurs when consumption and investment increase together, an increase in one without the other represents a movement along the PPF with consumption increasing at the expense of investment or *vice versa*. Austrian theory however considers investment not financed by real savings (a decrease in consumption) to be unsustainable as it creates a temporary boom of malinvestment and then a contraction *via* the market correction process often to a point within the original PPF. This is due to further market intervention from the state which produces confusing signals, only succeeding in locking the real saved funds which could provide sustainable investment in bail outs of bad debt which without protection would be considerably devalued by the market freeing resources. This is presented via a PPF analysis shown in figure 4 overleaf.

Figure 4: PPF analysis of Malinvestment Theory.



Source Author.

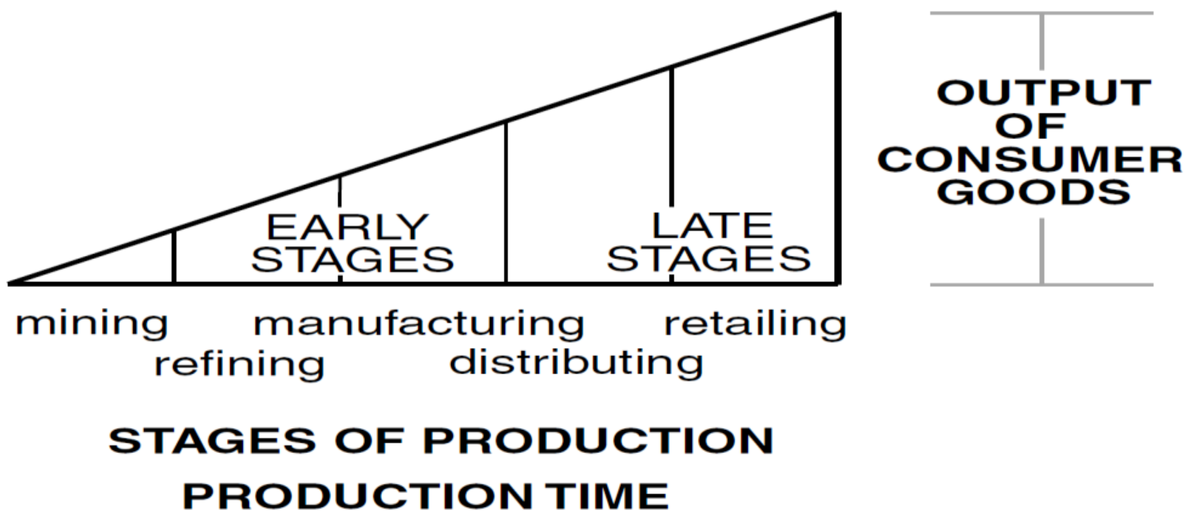
An increase in credit allows for consumption and investment both to increase from C1→C2 and I1→I2 respectively, thus expanding the PPF of the economy from PPF1→PPF2. This unsustainable investment not supported by real savings causes a significant disparity between supply and demand which prompts a market correction process. This market correction hampered by state attempts to maintain the PPF2 situation regresses the economy past the PPF1 stage to an earlier position (PPF3).

3.4 The Hayekian Triangle

As discussed earlier, the Austrians place considerable emphasis on the inter-temporal structure of capital and production (Ekelund & Hebert 1990) and consider both the output of the different stage of production and its temporal dimension.

The Hayekian Triangle (figure 5) is not intended to be a precise mathematical representation, but to provide an understanding of the process (Hayek 1931).

Figure 5: A Hayekian Triangle



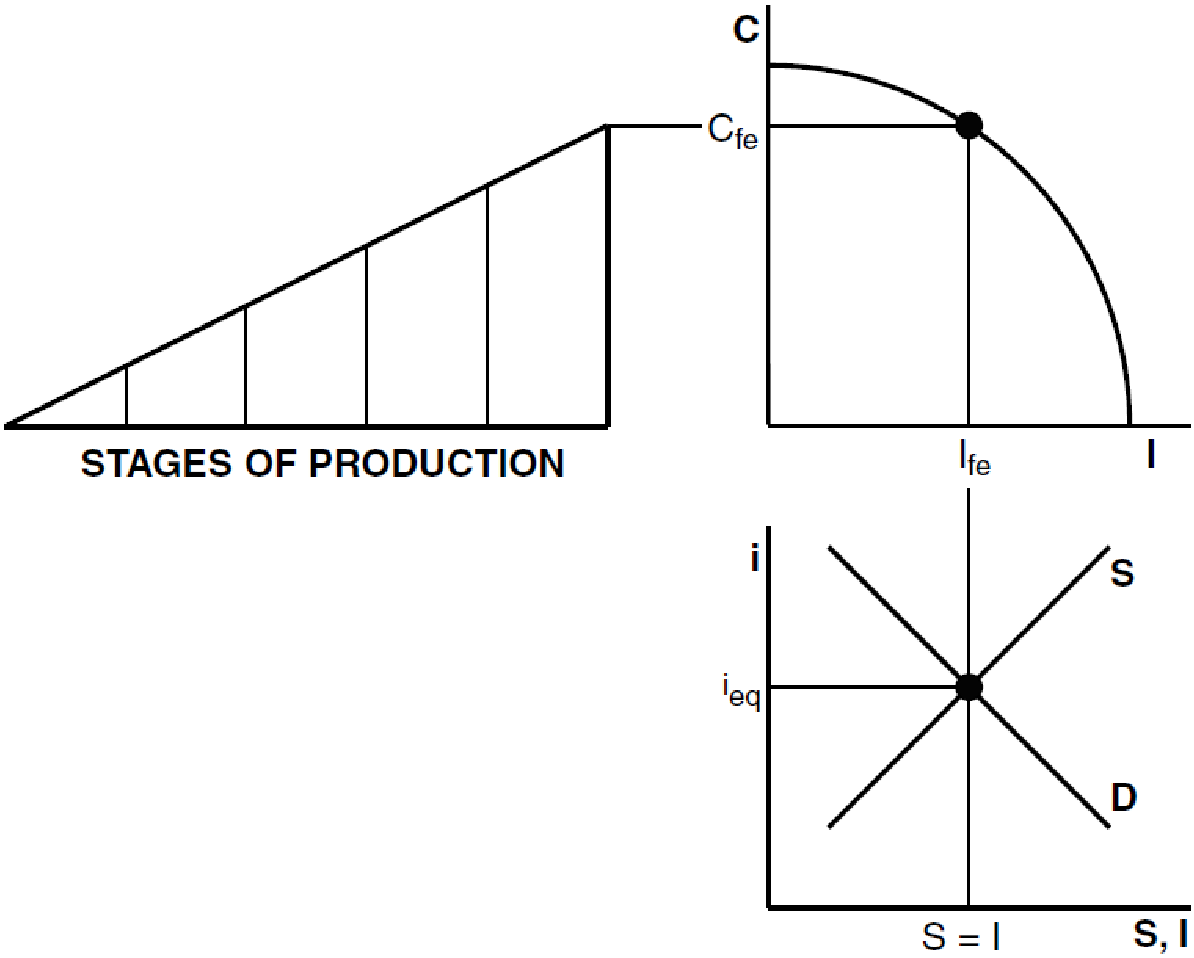
Source Garrison (2001).

The choice of the number of stages is again not mathematically precise and represents visually the temporal productive process. The hypotenuse of the triangle is representative of the product value and the base of the triangle has a twofold significance. Firstly it represents the temporal production structure of the processes between initial production and end stage consumption. Secondly it is the visual representation of the stages of production operating simultaneously in the same time period but servicing different stages of the production process to end stage consumption.

3.5 The New Austrian Macro-Economic Framework

These three fundamentals of Austrian Macro-Economics are combined in figure 6 in order to produce an analytic diagrammatic framework not dissimilar from orthodox economic analysis and a stage in Caldwell’s (1982) bridging the bridgeable gaps between Austrian and orthodox economics.

Figure 6: The New Austrian Macro-Economic Framework



Source Garrison (2001).

Figure 6 demonstrates a simplified Western (Government and Private elements) economy, operating where government spending exactly equals government revenue, thus there is zero government action in the investment process, and with no government action here the market rate of interest reflects the natural rate of interest (i_{eq}). In figure 7, the New Austrian Framework is used to demonstrate Hayek's theory of the trade cycle.

3.6 Austrian theories of Money, Banking and Credit

In this section, the Austrian theories of Money, Banking and Credit are discussed in order to develop Hayek's theory into a testable model appropriate to the Austrian School of Economic Thought.

Rothbard (2001) states that "the economist who sees the free market working splendidly in all other fields should hesitate for a long time before dismissing it in the sphere of money", in the current climate of a clamour for further government involvement in the financial sector[21] it is understandable that this concept is dismissed outright and its theoretical basis forgotten.

This area of review will focus on the limitations of the existing financial system, by this, it is meant the current system which allows, via some form of government intervention, the creation of credit as the banking system is not subject to traditional legal principles (de Soto 2006). In essence the literature reviewed to determine the limitations of the current system is literature concerned with the theoretical and observed flaws of a fractional reserve banking system. A consideration of standard economics textbooks provides a detailed theoretical explanation of how banks create money through the fractional reserve system. Simply put; a bank only needs to keep a calculated fraction of its deposits as reserves against withdrawals, the remainder of the deposits can therefore be lent to the market[22], with the central bank guaranteeing sufficient liquidity in the system to protect against unexpected withdrawals. However the literature suggests that it is precisely this privilege of the banking system to

[21] For example the FSA (2009) Turner Review: A regulatory response to the global banking crisis.
[22] The standard explanation usually comprises of, if A deposited £100 in a bank and the bank had a 10% reserve ratio, then the bank could lend £90 to B, B's account now has a balance of £90, yet the bank only needs to keep £9 (10%) of this as a reserve and can therefore lend £81 to C and so on. A consideration of this process can see its unsustainability; however a casual observation by Murphy (2010) notes how the fractional reserve requirement would allow the bank to create up to £1000 of loanable funds by keeping the original £100 as a reserve and so on, the £1000 creating, £10,000, then £10,000 creating £100,000 *ad infinitum*.

create money seemingly from thin air (de Soto 2010) that is flawed. The literature reviewed[23] considers the creation in this way to be theoretically unsound (Hayek 2007, de Soto 2010). This is as, considering theories of capital and Hayekian Business Cycles, the viewpoint of the reviewed literature is that the credit creation prowess of fractional reserve banking (FRB) leads to severe malinvestment in the boom which eventually and inevitably causes its collapse (Hayek 2007). This concept is derived from the work of Mises (1980) and Hayek and in a very simple form states that investment ultimately built on savings is far more stable and long term than investment built on credit. The limitations of the existing system therefore lie in the examination of a boom created in a fractional reserve environment. It is a frequent feature of the reviewed literature to discuss the popularity of such credit expansions in the short run, both with politicians and the general public (Hayek 2007, de Soto 2010, V. Smith 1936, Van den Hauwe 2006 etc). De Soto (2010) states how in a credit expansion, entrepreneurs are usually pleased as they can obtain cheap finance for virtually any project. As savings are not required to fund the investment, there is no reduction in the demand at final consumption, commodity prices tend to rise and thus their representation on stock markets, at this stage of the boom it appears that an individual's wealth can be raised through no prior sacrifice of consumption (de Soto 2006, 2010). Politicians are usually myopic enough to enjoy being associated with the boom and the perceived increase in national wealth, and as a bonus see government revenues increase year on year (de Soto 2010). Booms based on credit expansion appear to make irrelevant the law of scarcity and encourage investment outside the real abilities of the economy (Muller 2001). The literature emphasises the discord in the market between the individuals who have no wish to increase savings and investors who are relying

[23] The intention is to consider the limitations of the system as a whole, that is the limitations of a fractional reserve banking system, criticisms of this viewpoint are of course numerous from mainstream economics, however to utilise the systematic literature review style and to adhere to the restrictions of this body of work, the flaw of the FRB system is taken as given.

on the credit creation of banks, and describes how the market when unimpeded by government, is a dynamically efficient mechanism which will move to correct this process. A consideration of this correction process[24] further highlights the limitations of the existing FRB system; the material reviewed considers there to be six microeconomic reactions by the market which will occur to correct the bank credit expansion. To summarize, firstly there will be a price rise in labour, natural resources and commodities as saving has not increased reducing resource use at the final stage of consumption and with resources utilised at this stage, production at stages further from competition will compete for more limited labour and resources using the credit gained from the FRB system. Secondly the price of consumer goods will rise more quickly than the rise of the price of labour, natural resources and commodities. This occurs when there is an excess of money at the final stage of consumption at the same time as a reduction in the supply of consumption goods as focus shifts to more distant consumption. This allows for the third effect of a rise in calculable accounting profits of firms in closest proximity to end stage consumption and a stagnation of capital good industries whose costs increase at a greater level than their turnover. Fourthly and crucially the Ricardo effect[25] occurs, with end stage consumption enjoying increasing prices, real wages begin to decrease and firms begin to substitute now relatively cheaper labour for capital, further depressing the capital producing firms. The observed effect is an increase in the loan rate of interest as the credit expansion slows, something that always occurs, due to the increased purchasing power of funds (de Soto 2010). Hayek (1937) notes how people seeking finance at

[24] This review utilises a description of the correction process as provided by de Soto, Money, Bank Credit and Economic Cycles (2009b). This correction process is however the evolution of 'Austrian thought' and not limited to the one author, the works of Hayek and Mises are of particular significance here. De Soto's work is used as he provides a very accessible step by step description of the process. The work of de Soto (2009b) has been widely accepted by the Austrian school, and described by the Mises Institute as "a complete comprehensive treatise on [Austrian] economic theory" www.mises.org/resources/2745/Money-Bank-Credit-and-Economic-Cycles, viewed 09/12/2010.

[25] For an explanation of the Ricardo Effect, please see: Hayek, F.A. (1969) Three Elucidations of the Ricardo Effect. *The Journal of Political Economy*.

this stage begin a ‘fight to the death’ for additional finance, further increasing the price of the loan. The cumulative effect of these discussed events is simply that firms operating in those stages furthest from consumption realise that they are making severe accounting losses, de Soto states that these losses when compared with profits at consumption reveal the error of financing investment with credit and there is now a pressing need for ceasing and liquidating the flawed investment projects. These micro reactions emphasise the limitations of the existing FRB system, a financial crisis, perhaps in this light better termed a financial correction by the market, looms the instant it is realised by the market that the actual worth of the bank credit created is far less than was supposed. In essence the real liabilities (deposits) of the banks are greater than the created assets (loans) and as such the banks are in significant danger of collapse. The literature explains how this financial crisis is not the cause of the recession (correction for the Austrians), but a sign that it has already started. The literature reviewed for this section reveals the Austrian view that government legislative privilege and central bank support allowing for bank credit creation, ensure that financial crisis and thus recession are inevitable (de Soto 2010).

The contemporary nature of the recent financial crisis limits the literature discussing it using Austrian theories as a context, however notable articles by de Soto (2009, 2010), Miller (2009), Evans & Baxendale (2008) and Luther & Cohen (2014) provide Austrian perspectives on this. De Soto argues that the expansionary cycle that precipitated the recent crisis began in misguided efforts to stimulate the American economy from its turmoil in 2001, where state intervention through the central bank[26] began a significant upswing in credit expansion

[26] It is acknowledged that the broad overview provided here cannot delve into every aspect, for an Austrian perspective on the global financial institutions please see – International Institutions: seen from the perspective of Austrian Economics, Socher (2009) and for a less objective view; The dinosaur among us: the World Bank and its path to extinction, Hooke (2007).

completely unsupported by any increase in saving[27]. The argument is continued with an analysis of the speculative bubble in property and commodity prices caused, according to de Soto by the inflation of fiduciary media usually offered to the market at an exceptionally low (or even negative in real terms) rates. Austrian theories of the unsustainability of an artificial credit expansion and an inflation of fiduciary media provide a context for the discussion, with de Soto (2010) stating that the specific factors causing the end of the monetary boom were a rise in commodity prices (particularly oil), the sub-prime mortgage miscalculation and the failure of important banking organisations occurring where the market realised the economic miscalculations they had made. It is emphasised again that due to the fundamental limitations of the current system that the crisis and recession are inevitable consequences of the systems reliance on fractional reserve banking and unsustainable credit expansion. De Soto (2009b) argues that the triggers of the monetary crisis are dependent on the circumstances surrounding it, but the crisis itself will always occur as a result of the systemic flaw of the existing system. Miller (2009) argues that Austrian analysis of trade cycles has relevance for the recent financial crisis stating that future economic historians may assess the recent recession as less deep than the Great Depression, but more Austrian, furthering the research rationale discussed in Chapter 1 and a return to Kuehn's (2013), "is there anything to the theory" question.

3.6.1 Austrian Proposals for Reform

This section discusses the reforms suggested by the Austrian School to address the limitations outlined in the previous review question. An understanding of the reforms suggested helps to position the research presented in this thesis as well as acknowledging that the extreme of the

[27] de Soto (2010) states that for several years the American money supply has been growing at a rate of over 10% a year whereas before the crisis voluntary saving fell to a negative rate over the corresponding period.

proposed reforms are an explanation for the limited success of the Austrian School in penetrating the mainstream.

The reforms discussed are systemic reforms aimed at a complete alteration of the existing system and not simply reforms to the current system; proposals discussed are not minor technicalities of finance (Hayek 2007). In the first instance when considering the literature concerning the structural reform given the acceptance of the unsustainability of fractional reserve banking (*op cit*), the theoretical basis for an investment system based on savings is a frequent feature. The argument summarised for this review is a chronological progression of ideas discussed in the literature, the step by step progression is collected in the work of de Soto (2006, 2009b) and is the culmination of works by noted economists of the Austrian School. De Soto collects the pieces of the Hayekian puzzle and demonstrates that they work together in explaining economic phenomena (van den Hauwe 2006). Broadly speaking the argument for saving based investment is based on Hayek's theories of capital and is contrary to the mainstream paradox of thrift (Hayek 1975). The literature suggests that it is helpful for understanding to consider the temporal nature of the productive process, where in the market most productive factors produce goods not intended to mature immediately and are expected to be demanded at a more distant stage. De Soto (2009b) suggests a dramatic increase in savings to demonstrate the theory, the savings rate increases and therefore the subjective time preference of economic agents must decrease. This forces three microeconomic effects in the market: firstly the profitability of firms closest to consumption will decrease as demand decreases due to the increase in savings. Profitability of firms further from consumption will remain unchanged and thus economic activity within these firms will be more attractive to entrepreneurs and investors, firms will therefore be encouraged to wherever possible, transfer their activities from those near consumption to those further away. Secondly an increase in savings will drive down the interest rate and thus reduce the discounting effect of interest on future profits[28], it becomes even clearer that profitability further from consumption in capital goods industries is greater than that in consumer goods for immediate consumption. The increase in the savings rate has firstly reduced demand at consumption, thus reducing profitability at this end stage and secondly decreased the interest rate, allowing the legitimate calculation of greater profits away from consumption in capital good industries. Thirdly the market experiences what Hayek (1969) terms the Ricardo effect, where assuming that incomes remain constant, an increase in savings will lead to a decrease in demand at consumption, hence a decrease in price of consumer goods, therefore increasing the purchasing power of income *ceteris paribus*. With real wages increased, firms will now substitute the relatively less expensive capital goods for labour, in the unhampered market labour displaced by cheaper capital goods is demanded in their production (*op cit*). The literature suggests that the culmination of these three effects is a longer productive process less focussed on final consumption, this process being sustainable as it is backed by previous saving (de Soto 2006).

The literature for monetary reform based around these ideas of capital theory and sustainable money tends to differ in two areas. Firstly the identity of the money producer is in dispute, some are happy with money being produced by governments (White 1989), whereas others, for instance Hayek (2007), argue that market produced money is more appropriate for the market economy[29]. Mises (1966) would further reduce any state role by only allowing it to perform a conversion function, that is the state would operate a mint converting privately produced pure metal into coin and allow for the conversion of perfectly redeemable money

[28] In accounting the future money received by a firm or individual is discounted using the interest rate to provide an accounting assumption of its value today, this uses the formula PV = $\frac{R_t}{(1+i)^t}$ where PV = the present value, *R* = future money amount, *i* = the rate of interest and *t* = years in the future.
[29] Similarly to Hayek, Sennholz (1985) is in favour of competition in the production of money, but with state issued fiat money as well, competition is ensured here with the abolition of legal tender laws.

substitutes into this coin, Rothbard (1994, 2001) has the only reform of complete private production with the ideal of a pure gold standard. This aspect is somewhat absent from the reviewed literature concerning proposals for financial structural change and the call for a 100% reserve requirement. However due to the financial crisis such idea are becoming less of a 'fringe' argument and meriting contemporary discussion, for instance Hulsman (2008) discusses Mises' gold standard arguments, W.R. White (2008) the head of the Monetary and Economic Department at the Bank for International Settlements has called for a return to a more rule based system by reinstating gold as the reserve currency and de Soto (2010) argues that in response to the recent crisis, what is required is the privatization of fiduciary media then its replacement with a "classic pure gold standard". The fallout from the East Asian Financial Crisis in the late nineties prompted Reisman (2000) to state that "the goal of monetary reform should be a 100% gold standard". From a consideration of the literature, it becomes clear that an explanation for the absence of more discussion on the issue, are the transition difficulties of readopting such a standard which are almost universally accepted as being close to insurmountable, with van den Hauwe (2006) describing the economics of transition to a full gold standard worthy of legitimate research in themselves[30].

The second differentiation in the literature concerns the design of money substitutes, Selgin (1988) states how the issue of fiduciary media is a right of freedom of contract. Mises (1980) has the view that there is no legal right for the issuing of any fiduciary media and only for the issuing of perfectly redeemable money substitutes; this can be seen in the contrast between Sennholz (1985, 1987) and Mises. Sennholz envisaged a natural limit faced by banks when issuing fiduciary media due to reserve and withdrawal requirements, Mises takes the view

[30] A series of essays on this subject are presented in Salerno (2010) *Money: Sound and Unsound*. Ludwig von Mises Institute.

that there are no such limits and the banks would be able to inflate fiduciary media without restriction[31].

Some consideration should be given to the comparison of the Austrian and Monetarist Schools, broadly speaking the two schools agree that monetary disturbances can damage the economy and need to be controlled however, Monetarists tend to favour some form of constant controlled monetary expansion, Austrians tend towards a 100% reserve, also there are significant differences with regard to the Monetarist policy of gradualism for the deceleration of artificial money Vs. the Austrian tendency toward a speedy readjustment (Humphrey 1984).

Austrian proposals for reform seek to alter the structure of the monetary system and not, like the majority of mainstream proposals for reform seek to improve aspects of the existing system[32]. All of the literature reviewed concurs that the aim of the reform to the system is to bring back the primacy of the market into the monetary system, the differences in the author's views regarding the proposed substitutes for money and the control of its production coupled with the author's opinion on aspects within Austrian economic theory result in differing proposals for systemic reform. For instance Hayek's views on private property are contrary to those of Mises, Rothbard[33] differs from both in his view point and this is evident in a consideration of these authors' proposals in the literature.

Rothbard's (2001) proposal involves the dissolution of the Federal Reserve. In the case of the Federal Reserve (FED) its assets will be cashed in to repay its liabilities and its regulatory

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[31] Standard economic analysis terms inflation and deflation as a rise or fall in prices respectively, Austrian analysis and as used in this review refers to inflation as an increase in money and *vice versa*.

[32] Though the mainstream viewpoint is perhaps more accepting of Austrian ideas in the light of current events, please see Evans & Baxendale (2008). Testing times for central banks – is there room for Austrian ideas at the top table.

[33] Mises sees the rights of private property as a result of human action, a means to an end which like any process can be improved upon, by contrast Hayek (1960) sees private property as an end function of human action, the use of which allowed for market society to triumph over alternatives. Rothbard (1994) develops these views and sees private property as a combination of these ideas.

functions absolved, all state issued assets held by the FED will be cancelled and the gold held will be re-valued to allow for 100% redemption of FED issued fiat money. This gold would then be claimed by the fiat holders, banks would therefore have their reserves fully transformed into gold and thus they would be able to provide their own fully backed private money substitute without any state privilege. Mises' (1980) proposal for reform is by contrast less far reaching (Herbener 2002), but in line with the literature surveyed, seeks for the prevention of unsustainable monetary and credit expansion. Mises would freeze the volume of FED notes and prevent the issuing of subsequent fiduciary media, concurrently the gold market would be freed of any state interference, once a natural price of gold had been achieved by the market (Mises allows for a transition period), it is proposed that a conversion agency is created by the state to enable holders of FED notes to convert to gold at parity value, to allow for the usage of gold coin in the monetary process and to prevent state inflation of the monetary supply, Mises proposed the withdrawal of medium sized dollar bills to be replaced directly with gold coin. The state conversion agency could only issue more notes if its gold store increased or as a direct replacement for old or damaged notes. Mises' proposes reform prevents further inflation by preventing the future issue of fiduciary media whilst preventing damage caused to the economy by sudden deflation of the monetary supply. These reforms do not go as far as Rothbard[34], maintaining the level of money in the system does not perform the liquidation of mal-investment described earlier, also the inclusion of the state and the continued existence of the central bank as well as the state conversion agency allow for possible state interference[35]. The proposed reforms of Hayek would abolish any restriction in the production

[34] Rothbard (2001) counters three main arguments against deflation within the Austrian School, those that argue falling prices will be damaging to business, deflationary increase in real debt would be detrimental to production and that contraction of credit would worsen a depression. Rothbard's counter arguments can be traced from Mises and Hayek and are evident in contemporary works such as de Soto's (2010) reform proposals.

[35] Mises (1966) states how any state intervention in the monetary process can be unwise as un-backed expansion of the money supply can occur to aid the state in times of crisis.

of money and end any legal tender laws, a process which would end the state monopoly in the production of money. This according to Hayek (2007) would motivate the private banks to produce their own money, which would have to be stable to provide the users with an acceptable means of exchange, with the users now having a choice in their money use, if any money is not stable and thereby not an adequate means of exchange the market will reject it. When the market accepts a money as secure and stable, this money will take precedent over state produced money if the state produced money does not equal the level of security and stability of the privately produced source. Hayek highlights the main problem of his proposal would be in convincing the public of the suitability of money produced by private enterprise, this of course translates directly into today where public opinion is particularly anti-bank. Sennholz's (1985) proposed reform, similarly to Hayek would end any state monopoly of money production and provide the legal means for private money production and again similar to Hayek recognises that a major problem in this reform would be altering public perception of privately produced money. Sennholz (1985) firmly believes that good money will drive out bad, and that the state could only keep its position as primary money producer in the absence of an enforced monopoly privilege by providing money that is secure and stable and thus accepted by the market, with market free to choose, Sennholz argues that gold will become the most popular means of exchange. De Soto's (2006, 2010) proposed reforms are of particular interest in this review as they develop the discussed reforms in a contemporary context and in the light of the current financial crisis. These reforms are based on the principle of a healthy process of capital accumulation through true savings and seek the complete eradication of the state from the monetary process, de Soto singularly in the reviewed literature places the blame for the recent financial turmoil and thus recession solely on the state in general and central banks in particular (de Soto 2010), The viewpoints of members of the Austrian school of economic thought have been examined, with regard to the limitations of the existing fractional reserve banking system (FRB)[36] within the philosophy of this school, and in their association of distinct ideas within this philosophy[37]. Without exception the literature surveyed provided the same perspective on the end goal of monetary reform, that is to return to the highest stage of money market development as explained by Mises and Menger (Herbener 2002) with the market dominant in the monetary process and a secure and stable currency. The literature displays a variety of proposals for monetary reform from the Austrian authors surveyed, as discussed the end is the same, but the means can vary, dependant on the authors' adherence to branches of thought within the school, for instance Sennholz and Hayek see a competitive role with the state in money production, Mises envisages a state role in monetary conversion and Rothbard seeks for total removal of the state from the entirety of the money process (Gertchev 2004). The authors' views on deflation of the monetary supply against fixing its current level[38], the rights and functions of private property law and the nature or existence of a money substitute differentiate the literature.

The primary aim of the Austrian School requires the elimination or reduction of the role of the state in the monetary process, some thought is given to the likely efforts of the state to restore its involvement and associated benefits, it is acknowledged that the long term success of any reform is dependent on preventing this (Herbener 2002, Hulsmann 2008, de Soto

[36] It is of crucial importance to note that like in other schools of thought, Austrians differ on fundamental as well as technical viewpoints, Selgin and White (1996) voice some support for fiduciary media and fractional reserve banking within a gold based system designed on Austrian theory. Barnett & Block (2005) defend this Austrian FRB approach against criticism within the school.
[37] Selgin (2009) challenges a 100% reserve banking system, this is countered by Thornton (2010b).
[38] For instance, Senhholz in his early works (1955) condemns deflation as an extremely harmful policy, and is a supporter of Mises' anti-deflationary reform proposal, in his later study (1987) he calls for the people to be liberated from inflation and produces a plan for monetary reform that is likely to be severely deflationary (Bagus 2003).

2009b). A criticism levied within the school against the majority of the reform proposals surveyed is the scope they provide for this to occur; Hayek notes that any crisis can be used by the state to justify increasing the money supply, Rothbard proposes a the most complete permanent elimination of the state. The work of de Soto (2009b, 2010), developed in the light of the recent financial crisis and recession, provide a contemporary relevance on this issue, de Soto (2009b) considers that new cycles of artificial credit expansion and thus recession will inevitably occur unless the existing financial system is fundamentally redesigned to prevent artificial credit expansion. Mises' theory of the economic impossibility of socialism is applicable to government intervention in capitalist banking, the theory sets out how the state does not have the required information to succeed over the market, using this de Soto (2009b) argues that the state via central banks indulges in Hayek's fatal conceit in believing itself able to deliver the appropriate monetary policy in a dynamic circumstance for the benefit of the economy, and that central banks are directly responsible for the recent crisis. De Soto's (2009b, 2010) proposed monetary reform includes the complete removal of central banks[39], this will provide two functions in restoring the monetary primacy of the market, it will remove state interference and ensure that a 100% reserve requirement on demand deposits is maintained through the removal of the lender of last resort from the monetary process. Austrian theory is still far from orthodox and not shared by many economists in practice or academia. It is justifiably criticised in many areas and this review is not the medium for a detailed technical critique of the proposed reforms though White's (2007) consideration of whether Austrian philosophy worsened the Great Depression provides significant general as well as technical criticism. It is also worth stating the standpoint of Zimmerman (2003) who

[39] A criticism of the general view of the Austrian school on the removal of the state is that it is simply unrealistic, Zimmerman (2003) states that in the real world there is a high probability that central banks will continue to exist despite Austrian wishes, with the general public perception in light of the recent financial crisis that banking needs in fact closer supervision and state control, this seems extremely likely.

argues in the Journal of Austrian Economics, that Austrian monetary policy is not ignored or the subject of a neo-classical dismissal conspiracy, but is simply often monocausal or too routed in Austrian ideology[40] at the expense of relevant input from other perspectives[41]. Thornton (2010a) however argues for the Austrian perspective concluding that in terms of prediction (the goal of neoclassical economics[42]), standard analysis fails and the Austrian succeeds, citing examples of standard claims of ending boom and bust and paving for perpetual growth against Austrian predictions of a collapse and readjustment, he states (Thornton 2008) that in economics, Austrian realism[43] triumphs over mainstream positivism

3.6.2 Summary of Austrian Reform Proposals

Austrian theories of Money Banking and Credit and their proposals for financial system reform give a strong background to Hayek's theory of the trade cycle as shown below. It should however be noted that the final prescriptions of the Austrian theories, those of zero state involvement are not being considered, this thesis follows Zimmerman's (2003) considerations that the extremes of Austrian Theory distract from the potential value of the foundations and presents an empirical evaluation of the mechanisms of the theory only. The following section (3.7) identifies the economic effects of Hayek's theory of the trade cycle allowing for the construction of the testable model of the theory presented in section 5.8, figure 12.

3.7 What are the principle components of Hayek's theory of the trade cycle?

This section of the thesis isolates the principle components of Hayek's theory of the trade cycle in order to lay the foundations of the construction of the testable model of the theory,

[40] Costabile (2005) argues that in the *Theory of Money and Credit*, Mises (1980) came close to a demonstration that artificial monetary inflation could in fact result in capital accumulation rather than malinvestment but refuses to explore this possibility in light of his ideological views.
[41] Laidler (2003) continues with this thought, but concludes that when all the over generalizations are stripped away from Austrian theory, there still remains a hard core insight perhaps lacking in other approaches.
[42] The motto of the Econometrics Society is in fact "Science is Prediction".
[43] For an extended examination of Austrian differences within the realist approach see Long (2006).

presented in Chapter 5. Within the literature there is a myriad of discussion concerning the various microeconomic effects, de Soto (2006) collects this discussion and weaves the strands into an accessible step by step process within the temporal subjectivism of Austrian Economics. This is summarised in 3.7.1 and is used to develop the testable model of Hayek's theory of the trade cycle presented in Chapter 5 figure 12.

3.7.1 The Microeconomic Effects of Artificial Monetary Expansion

Micro effect 1: with an artificial excess of money at end stage consumption preventing any decrease in demand or prices, resources will initially concentrate here. Quite simply this results in a shortage of supply of resources at production stages away from consumption and thus an increase in price of these resources, financed by artificial excess money.

Micro effect 2: an excess of money at end stage consumption will cause an even greater increase in price at end stage consumption than the scarcity of resources at more distant consumption will cause there, assuming that the time preference of individuals remains unchanged.

Micro effect 3: the accounting profits of end stage consumption firms will greatly exceed those of the firms at distant consumption whose profits will reduce or stagnate due to the rise in the costs of production of effect 1.

Micro effect 4: Hayek's (1975) Ricardo effect where the rise in the price of goods at end stage consumption will drive down real wages. This will encourage firms producing at end stage consumption to substitute where possible labour for capital in the production process. This will further decrease the profitability of capital producing firms away from consumption due to a reduction in demand with a reduction in price of a substitute.

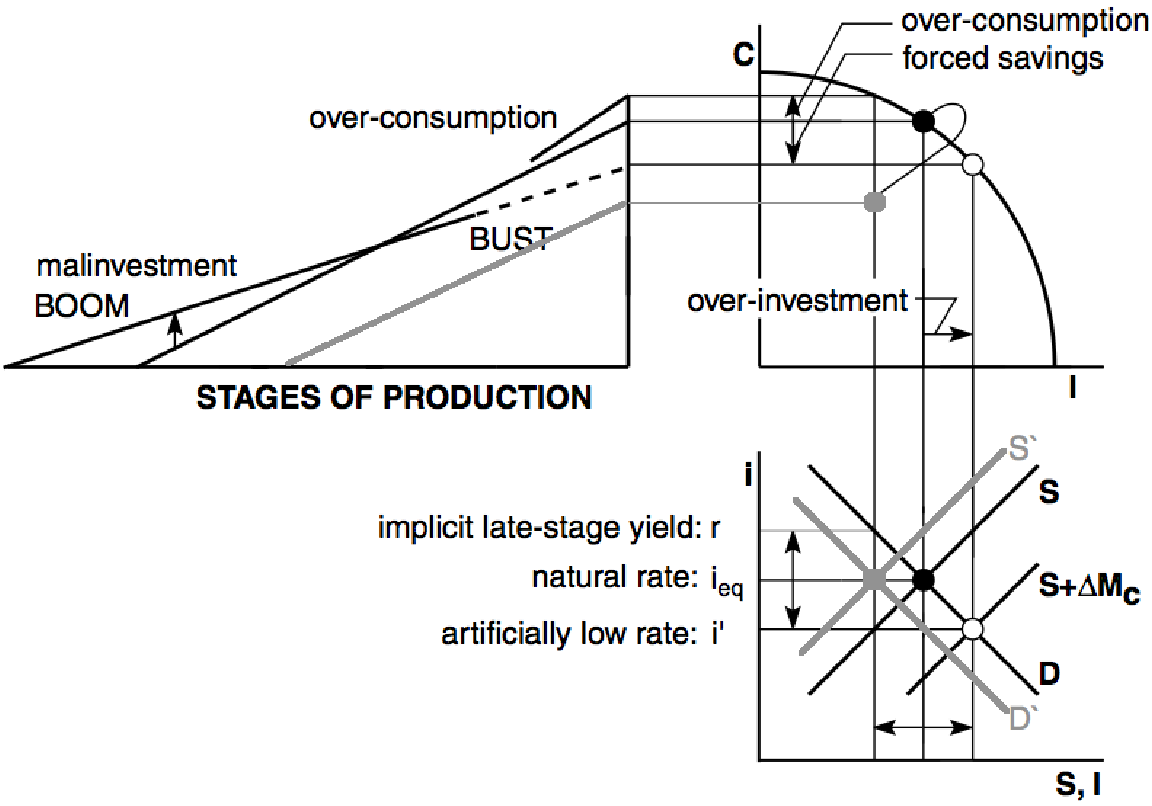
Micro effect 5: Eventually the animal spirit of the market will emerge and in a cyclical nature of the market, will reduce the willingness to lend and result in an increasing interest rate on loaned funds. The rise in the interest rate is self-exacerbating with firms reliant on a supply of loaned funds exhausting that supply.

Micro effect 6: the product of the previous effects; the losses or stagnation of profit faced by firms more distant from consumption demonstrate to the individuals concerned that the market is not mature enough to support widespread activity so far from consumption. In this case the most apt course of action is to correct this *temporal malinvestment* by ceasing activity at the distant stage of consumption.

Given an acceptance of these effects, the market can be seen to be actively correcting the *temporal malinvestment* of the boom of artificial credit rather than to be in crisis. The 'financial crisis' will take effect when the market, which is exceptionally dynamically efficient, realises that the real value of the financial activity of the artificial boom is considerably less than was thought or calculated (de Soto 2010). The banks' assets, (the loans created during the boom) are revalued by the market as a fraction of their initial amount. Whereas the banks' liabilities (the deposits of currency) retain a constant value and now outweigh the assets, the bank resorts to survival mode restricts credit and calls in loans to protect against its increasing liabilities, perhaps in the boom a mere 10% of its capital and after the market revaluation considerably more. Following a severe boom and corresponding significant *temporal malinvestment*, the banks' position may continue to be untenable, and the only resort left is governmental aid; the recent state bailouts of financial institutions 'too big to fail'

This can be demonstrated in the New Austrian Macro-Economic Framework presented in figure 7.

Figure 7: Malinvestment leading to market correction.



Source Garrison (2001) with additions from Bjerkenes *et al* (2010).

An inflation in the money supply provides the malinvestment signal to economic agents, an economy invested in initial stage production cannot meet the increased demand at end stage consumption and thus prices at consumption increase. The increase in prices creates a fall in the real money supply which thus increases the market interest rate (Trautwein 1996, provides a detailed explanation of this process). The increase in the market rate of interest causes a revaluation of investment projects in initial stage production as they face a significantly higher discount rate considerably reducing their accounting profit (de Soto 2010). This precipitates the liquidation process. Liquidation involves reducing labour forces and reducing investment, thus affecting household income and spending, prompting movements within the loanable funds market (S→S', D→D'), as we can see this returns the rate of interest to its true (i_{eq}) level. A movement (as shown) within the PPF at this point is termed Secondary deflation (Hayek 1931) and is not seen as part of the correction process which seeks to return the economy to its PPF from a point outside which it reached via inflation of the money supply allowing for the suspension of the law of scarcity (de Soto 2010). The movement within the PPF is a combination of flawed government policy and reduction in household and business spending due to lack of confidence and is seen as extremely damaging to an economy, in fact Hayek expressed some appreciation of Keynesian expansionary techniques to avoid this situation once the market had corrected itself (de Soto 2009b, 2010, Wapshott 2011).

The Micro-economic effects of artificial monetary expansion.

The Hayekian Theory of the Trade Cycle has rarely been considered via an econometric method, notable exceptions which provide significant insight are Wainhouse (1984), Hughes (1997), Cwik (1998), Keeler (2001), Mulligan (2006), Carilli & Dempster (2008), Bismans & Mouget (2009), Bjerkenes *et al* (2010), Dore & Singh (2012), Lester & Wolff (2013) and Luther & Cohen (2014). For an empirical analysis the HTTC can be further summarised to:

1. An artificial increase in the money supply drives the market interest rate below the true rate of interest.
2. With the interest rate lower than the true rate firms begin projects that they would not do if the interest rate was an actual representation of the economy's time preference.
3. This results in the misallocation of resources to areas of production that would not attract them under the true rate of interest.

4. This misallocation will result in a shortage of supply at end stage consumption, increasing prices. With this increase in prices and money expansion unable to follow suit, the real supply of credit dwindles forcing the market rate of interest back to its true rate position.

5. The market responds by liquidating the malinvestment and reallocating resources appropriately, back to the time preference of the economy. Any perceived financial crisis matches this process, for instance the greater the misallocation and malinvestment the greater the requirement for liquidation and the greater the crisis appears (de Soto 2010).

This step-by-step process highlights the signalling effect of the interest rate in investment decisions and is used to form the testable model of Hayek's theory of the trade cycle presented in section 5.8, figure 12. In Austrian theory there is no need for an exogenous monetary (or otherwise) shock to tip the market into recession (hypotheses 3-5). The boom sows the seeds of its own destruction (Hayek 1944).

The Plucking Model developed by Milton Friedman (Friedman, 1993) has been used to argue against Hayek's theory of the trade cycle (Garrison 1996) as it asserts that economies do not go over trend in the boom, but collapse under trend in a recession, both aspects contrary to Hayek's theory of the trade cycle. Murphy (2015) however considers that the Plucking Model does not hold for the recent financial crisis and that the years preceding the crash fit "many of the stylized predictions of the Austrian Business Cycle" and that "the bust in recent years has not followed the plucking model", (Murphy, 2015 p.40).

3.8 Chapter Summary

This Chapter has reviewed the Literature concerning the Austrian Theories of Money, Banking and Credit as a background to the Micro-Economic effects of Artificial Monetary Expansion and thus the development of Hayek's theory of the trade cycle. The New Austrian Macro-Economic Framework has been used to formalise this, providing a foundation for the approach of this thesis.

This Chapter provides the framework for the construction of the testable model (Chapter 5, figure 12) and the development of the key supporting hypotheses which are used to evaluate the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle.

Chapter 4: Previous Empirical Work on Hayekian Business Cycles

4.1 Introduction

Following the literature review Chapter (2) and the theory review and New Austrian Macro-Economic Framework Chapter (3), the thesis requires a further review to investigate the previous empirical work investigating the Hayekian Theory of the Trade Cycle.

In this Chapter, a similar literature review format to Chapter 2 is used to identify and remove bias from the literature and to ensure a rich depth of material to examine previous empirical research concerning Hayek's Business Cycle Theory. Section 4.3 considers if Hayekian Thought and the Austrian rejection of *scientism* are compatible with empirical examination and section 4.4 considers the previous methodologies and methods for empirical testing of Hayek's theory of the trade cycle. This section is of particular importance to the thesis as it allows the development of an approach to the research presented in Chapter 5, which is justified from the literature as being an empirical examination acceptable to the Austrian School. Key papers in this development and justification are then presented in sections 4.5 and 4.6 with an overview presented in table 8 and a justification of the thesis tests from the literature presented in table 9.

Chapter 4 considers previous empirical research investigating Hayek's theory of the trade cycle providing academic justification and support for the approach of this thesis (Chapter 5). Namely the construction of a testable model and subsequent empirical examination.

4.2 Format of this literature review section

The objective of this section is to examine the literature concerning Hayekian Thought and Empiricism with a focus on the previous research on business cycles and specifically the empirical testing of Hayek's Business Cycle Theory. This allows for the development of a methodology appropriate to the Austrian School and accessible to the wider macroeconomic community and the development of the testable model presented in Chapter 5, figure 12.

Similarly to Chapter two, this second literature review will utilise a critical literature review approach with elements of both a narrative and systematic style. The narrative approach provides a mechanism to deliver an overview of a considerable body of Austrian business cycle research whilst incorporating the critical approach to provide an element of analysis above the narrative approach to support the thesis. The systematic style is utilised in order to provide a navigation tool and gathering system for the large amount of business cycle research present in the economic literature. In order to use this chapter to provide an overview of business cycle research and as a foundation for the empirical study of Hayek's Business Cycle Theory a series of review questions have been formulated and will be answered within this chapter by an examination of the literature.

Each section will be answered with a review of previous literature, this literature will be provided by using a variety of relevant search terms in recognised reliable and valid databases in order to ensure a comprehensive review. The results will be presented in tables similar to those in Chapter Two. Following a selection technique to determine its relevance, the literature will then be synthesised and analysed to provide a clear answer to the questions (1) Is Hayekian Thought compatible with empirical testing and (2) What methodologies, methods and findings are present in the literature for the empirical testing of Hayek's theory of the trade cycle. This chapter will then present an overview and analysis of major papers relevant to this study to demonstrate Austrian acceptance of the thesis approach.

4.3 Is Hayekian thought compatible with empirical testing?

Due to the wealth of post crisis material present and the polarised nature of the Hayekian / Keynesian Debate, a similar literature gathering tool as used in Chapter 2 is used to generate reliable and valid data for this section. The results of various search terms in appropriate databases are shown below:

Table 5: Literature Search Results: Is Hayekian Thought compatible with empirical testing?

Research Objective: Is Hayekian Thought compatible with empirical testing?					
Databases Searched			Econ. Papers.	Science Direct.	Springer Link.
Search Term 1	Hayekian Thought		42	40	46
Variations -	Philosophy		13	7	19
	Research		17	13	16
	Approach		1	1	1
	Theory		12	10	13
		Results	85	71	95
		Relevant Results	6	6	7
Search Term 2	Arguments supporting the empirical testing of Hayekian Theory		2	4	4
Variations -	Research		1	1	2
	Approach		0	1	7
		Results	3	6	13
		Relevant Results	3	6	12
Search Term 3	Limitations of the empirical testing of Hayekian Theory		12	10	15
Variations -	Orthodox Criticisms		14	12	14
	Austrian Criticisms		3	2	6
	Heterodox Criticisms		4	2	3
	Empirical Issues		7	6	8
		Results	40	32	46
		Relevant Results	4	5	8

Academics of the Austrian School of Economic Thought tend toward a firm belief in the explanations and understanding that Austrian Business Cycles can offer to past economic cycles. For instance Mulligan (2006) considers that Hayek's theory of the trade cycle is unmatched in offering persuasive qualitative explanations for economic cycles. It is here that the considerable conflict between Neo-Classical economics with its standard econometric empirical testing approach and the Austrian School with its rejection of *scientism* is highlighted. For the traditional Austrians a qualitative examination based in logic is paramount, any empirical examination is subject to a fundamental epistemological problem, there is little value in direct proof from past observation as human action is not measurable or constant (Mises 1966) and as such conclusions based on past observation of human behaviour alone are non-repeatable and only valid in terms of the understanding they can provide.

It is within this philosophical stance that this thesis is required to justify the empirical approach taken. The Austrian Econometric literature reviewed in this section presents various arguments for the support of this approach.

There are select cases of empirical examination, and these cases are growing with the influence of the New School of Austrian Thought. The long contested Austrian Keynesian sparring ground of the Great Depression[44] provides a starting point for a consideration of previous research. As per the Austrian methodological constraint limiting the empirical testing of hypotheses, Mises (1966) explains the Austrian view of the epistemological problems of Human Action. Burns and Mitchell (1946) consider both short and long term interest rates and find support that long term bond yields are pro-cyclical and have a lag factor, furthermore with a larger sample the long term rates are relatively stable in the boom period and vary considerably in the contraction, as per Hayek's theory of the trade cycle. Rothbard (1962) for instance argues that the considerable expansion of the artificial monetary supply determined

[44] Although Grant (2014) considers that the 1920-21 US Recession provides insight as this was the last recession before widespread government stimulus action.

by the rise of the monetary base above its natural rate resulted in an uncontrollable boom in the 1920s leading to the Great Depression. Furthermore for Rothbard government intervention prevented the natural correction mechanism of the market and resulted in the Hayekian secondary economic contraction. Using a measure similar to the standard MZM monetary aggregate, "MZM is a measure of money that includes assets redeemable at par on demand" (Carlson & Keen 1996), Rothbard (1978) demonstrates that artificial monetary expansion occurred into the 1930s, continuing to prevent the natural market correction required by Hayek's theory of the trade cycle in this scenario and continuing the misallocation of resources and malinvestment predicted by the theory. This was, for Rothbard, further worsened by ineffective and damaging government intervention designed to maintain the artificial price level and prevent the liquidation of malinvested resources. O'Driscoll *et al*. (1976) consider the economic conditions (stagflation) of the 1970s through an Austrian Business Cycle Theory framework with a conclusion that an increase in the artificial money supply can create extra demand at consumption altering the price structure of the economy and thus the allocation of resources, in accordance with Hayek's theory of the trade cycle.

Mishkin (1981) rejects the idea of real interest rates being stable over relatively long periods (1953-1979), finding that technological development or alterations in the time preference of the economy would alter the real rate of interest, as well as a negative relationship between short term nominal interest rates and inflation indicative of a liquidity effect. Wainhouse (1984) provides probably the first econometric analysis of Hayek's theory of the trade cycle using hypothesis testing, now applauded by the New School of Austrian Economic Thought. Wainhouse identifies a series of hypotheses and empirically tests them via Granger Causality tests, he identifies a pattern in accordance with Hayek's theory of the trade cycle starting with monetary shocks and leading to changes in both the interest rate and output levels.

Wainhouse (1984) using econometric techniques concluded finding considerable supporting evidence for Austrian Theory. Le Roux and Levin (1998) use the Wainhouse approach to the South African Economy (1980-1996) with comparable supporting results. Zarnowitz (1992) once again notes the change in the real interest rate over time.

4.3.1 Hayekian Thought and an ACE approach?

In this section, recent developments in computational modelling are discussed as vehicles for the analysis of Hayekian Theory. Agent Based Approaches, in particular Agent Based Computational Economics (ACE) can be seen to link with Hayekian Thought. When considering an ACE approach there are a number of factors which highlight the appropriateness of the technique for this research over a (solely) statistical analysis, these predominantly lie within the aforementioned Hayekian[45] views of economics being an understanding of the process rather than mathematical formalism and prediction. For instance an Agent Based Computational Economic (ACE) approach when compared to statistical analysis can provide a two way interpretation of the process, that is the interaction between micro and macro and *vice versa.* An ACE approach provides a bottom-up perspective, whereas statistical modelling predominantly provides a top-down viewpoint from aggregated data. A simplifying assumption in much statistical modelling within economics is the homogeneity of individuals, as within representative agent modelling. Within an ACE approach agents can be heterogeneous in all their characteristics if needed (Fagiolo & Roventini 2008), formal models are often dynamic and evolve over time whereas statistical modelling tends toward a static form unsuitable for modelling human action (Mises 1977), statistical modelling is perhaps more appropriate for *ceteris paribus* situations than for *mutatis mutandis* ones (Freeman 1998 p.19). Furthermore statistical modelling is clearly appropriate for a linear system, whereas the

[45] Please see Ekelund & Hebert 1990, Chapter 21 – Austrian Economics.

economy treated as a complex system (Liu 1960, Chan & Steiglitz 2008) is decidedly non-linear with the additional possibility of non-linear feedback loops between the micro and macro elements (Fagiolo & Roventini 2008). Goldspink (2002) suggests that an ACE approach is far more appropriate for modelling non-linear scenarios and Richiardi (2003) considers non-linear scenarios resistant to mathematical analysis. However an ACE approach should not be considered a *deus ex machina* in that it like any method is not without its faults. Richardson (2002) considers the problem of *equifinality*, that is an infinite number of different models of complexity each validated by the data could be constructed to provide a solution to a problem however notes that rigorous caution can allow for the selection of appropriate model choices. Richiardi (2003) considers *overfitting* to be a further problem of an ACE approach, that is where a too complicated model does not only fit the patterns and trends of the data but the general noise of the data too. Unlike a statistical approach however, the agents in an ACE method can interact directly, the simplifying assumption of rationality can be relaxed in the computational model, the agents can learn from experience and the system can evolve. Statistical modelling has been widely criticised for being too far removed from reality (Stiglitz 2010, Lawson 2009) and the ability to study economic phenomena from the agent level begins to address this (Tesfatsion & Sun, 2005). The ACE approach is criticised within orthodox economics as failing to provide the proof of statistical analysis as it relies on artificial data produced by the simulation itself (Richiardi 2003). Furthermore the estimation of the parameters and structure of the ACE model may create significant difficulty when comparing with real world empirical data. However the arguments describing the advantages of the ACE approach presented in this work, in particular those supporting the ACE movement toward reality and away from the simplifying assumptions of statistical analysis, could make an ACE approach a viable consideration for economic research within the paradigm of the Austrian School of Economic Thought and are worthy of further consideration outside this thesis.

Though the fact remains that ACE is an output measure of economic analysis creating simulated data, the 'New Generation Austrians' are perhaps more accepting of empirics than the traditional Misean adherents, however the philosophical justification of forecast data built on simulation is outside the set methodological constraints of this thesis[46].

However, Austrians have tended to avoid empirical research, based on Mises (1966, pg 351):

> "It is true the empiricists reject [a priori] theory; they pretend that they aim to learn only from historical experience. However, they contradict their own principles as soon as they pass beyond the unadulterated recording of individual single prices and begin to construct series and to compute averages. A datum of experience and a statistical fact is only a price paid at a definite time and a definite place for a definite quantity of a certain commodity. The arrangement of various price data in groups and the computation of averages are guided by theoretical deliberations which are logically and temporally antecedent. The extent to which certain attending features and circumstantial contingencies of the price data concerned are taken or not taken into consideration depends on theoretical reasoning of the same kind. Nobody is so bold as to maintain that a rise of *a* per cent in the supply of any commodity must always – in every country and at any time – result in a fall of *b* per cent in its price. But as no quantitative economist ever ventured to define precisely on the ground of statistical experience the special conditions producing a definite deviation from the ratio *a*:*b,* the futility of his endeavours is manifest"

However, from the current perspective, this Misean view can appear naïve (Subrick and Beaulier (2010), as previously, noted modern econometricians do not search for exact magnitudes, looking instead for correct signs of coefficients. Modern econometrics recognises measurement error, problems of causation and issues of data, variables and increasingly of autonomous interpretation (Colander *et al* 2009). Subrick and Beaulier (2010) note the example of the recent research regarding common law on economic outcomes. Hayek (1960) first postulated the basic idea discussing the emergence of the rule of law in Great Britain rather than France, however no Austrian adhering to the above Misean view sought to

[46] For further insight into this argument, see Whittle, R. (2011). The Philosophy of The Austrian School of Economic Thought and an Agent Based Computational Method? EDAMBA 20th Annual Summer Academy, Soreze France.

examine this empirically, turning the prepositions into testable hypotheses and collecting data. The idea failed to get traction and was abandoned outside the Austrian School, however Andrei Shleifer and various co-authors (Shleifer *et al* 1998, 2002) performed an empirical examination turning the obscure Austrian idea into a mainstream research project, published in the Journal of Political Economy and the Quarterly Journal of Economics. Empirical examination of Austrian Theory can allow for mainstream acceptance, here Austrian ideas penetrated the mainstream, as their evaluation was empirical and allowed direct comparison with competing theories.

The research presented in this thesis seeks to develop this tradition of empirical examination of Hayekian Theory, namely the evaluation of a testable model of Hayek's theory of the trade cycle.

4.4 What methodologies, methods and findings are present in the literature for the empirical testing of Hayek's theory of the trade cycle?

"To produce acceptable tests of the causal structure contained in Hayek's theory of the trade cycle requires charting a delicate course between the Scylla of theory without measurement and the Charybdis of measurement without theory"

Wainhouse (1984, p55)

This section of the thesis considers the previous empirical research concerning Hayek's theory of the trade cycle. This provides insight into and justification for the approach taken, in particular the evaluation of a testable model with various econometric tests.

As previous, due to the wealth of post crisis material present and the polarised nature of the Hayekian / Keynesian Debate, a similar literature gathering tool as used in Chapter 2 is used to generate reliable and valid data for this section. The results of various search terms in appropriate databases are shown in table 6.

Table: 6 What methodologies, methods and findings are present in the literature for the empirical testing of Hayek's Business Cycle Theory?

Research Objective: What methodologies, methods and findings are present in the literature for the empirical testing of Hayek's Business Cycle Theory?					
Databases Searched			Econ. Papers.	Science Direct.	Springer Link.
Search Term 1	Econometric Testing of Hayekian / Hayek's theory of the trade cycle		84	78	83
Variations -	Empirical		46	42	12
	Mathematical		29	21	16
	Timeseries		45	40	28
	Forecasting		12	8	17
		Results	216	189	156
		Relevant Results	14	17	21
Search Term 2	Methods in Hayekian / Austrian Business Cycle Research		42	23	57
Variations -	Approach		12	25	14
	Methodology		34	27	21
	Data (& variations around sources)		8	14	16
		Results	96	89	108
		Relevant Results	8	9	9
Search Term 3	The New Austrian School of Economic Thought		5	4	7
Variations -	(General) Research		16	74	77
	Method		14	12	21
	Approach		14	11	17
	Business Cycle Research		14	16	19
		Results	63	117	141
		Relevant Results	15	17	15

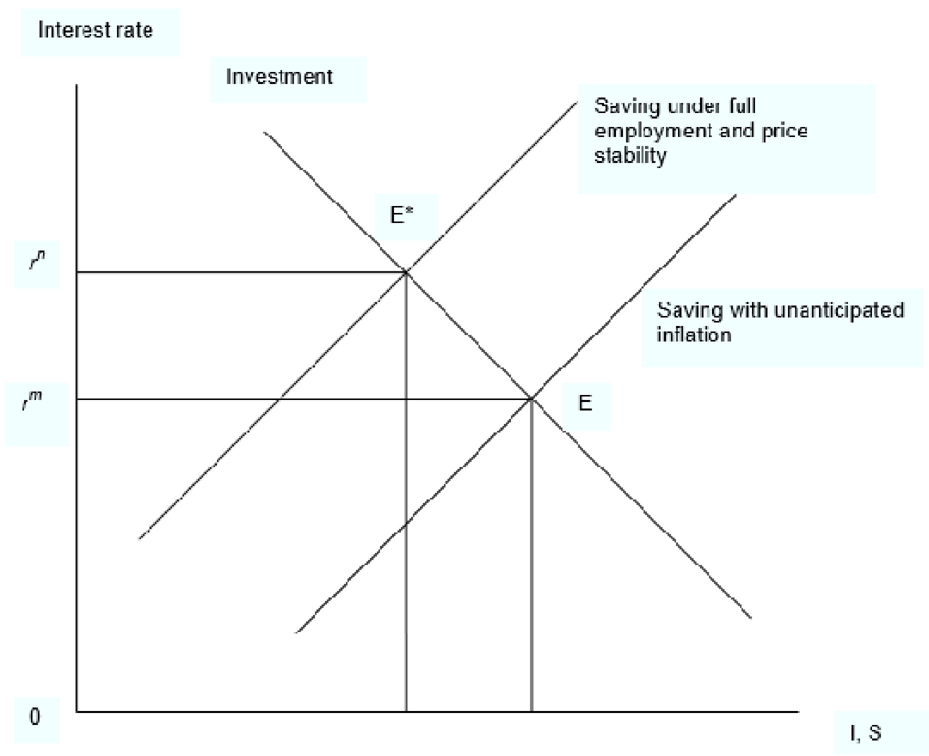
Laidler (2003) considers that whilst Austrian Theory was discredited by its 'nihilistic policy prescriptions' for the Great Depression, its core insights are worthwhile and its relevance is still an open question.

The conference on Monetary Stability, financial stability and the business cycle (Basel 2003) provides an interesting examination of mainstream economic thought on the alternative views of the business cycle. In particular Laidler (2003) and Eichengreen & Mitchener (2003) consider the Austrian (Hayekian) approach as having merit. Whilst Laidler (2003) doubts that Austrian Business Cycle tells the 'whole story'[47], he acknowledges that it is a logical possibility to have inter-temporal coordination issues exacerbated by the money supply and financial system, and more so, that these do seem to occur preceding crises. He argues that Quantity Theory models of the business cycle allow for this when nominal interest rates do not keep pace with inflation, this then creates the HTTC situation of the market rate of interest falling below the true (or natural) rate of interest. It can be seen that most bubbles (Laidler 2003) and following collapses are partnered with price instability, however most is not all, and Laidler is quick to point out considerable inconsistencies in this, particularly when considering the dot-com bubble. Yet, according to Laidler there is validity in some Austrian (Hayekian) business cycle insight (beyond the School's own narrowly drawn and ideological boundaries[48]). Hayek's theory of the trade cycle is also not obviously incompatible with quantity theory analysis and can actually allow for productivity shocks (Blanchard 2004).

[47] Which, as discussed later in this section, is not dissimilar to leading Austrian (Empirical) views.
[48] Though the New School of Austrian Economic Thought are addressing this, as is the increasing (though still rare) use of Empiricism in Austrian Research.

Ultimately Hayek (1931) produced an inter-temporal equilibrium model, Kiyotaki & Moore (2003). In this framework, market rate (r^m) does not actually need to equal the natural rate of interest (r^n) – the rate where investment is equal to saving under the conditions of full employment and accordingly price stability. It can be seen that if the market rate is below the natural rate then inflation will be higher than the natural rate, increasing saving to equal investment. This can be demonstrated in the figure 8, with E representing equilibrium.

Figure 8: Forced Saving



Source: Kiyotaki & Moore (2003)

The above mechanism is known as forced saving – in a Keynesian model incorporating sticky prices, output would change to equate saving to investment. Kiyotaki & Moore (2003) considers that whilst the quantity theory can be useful for monetary policy analysis, standard general equilibrium modelling is not consistent with quantity theory of money. He argues the inter-temporal general equilibrium model with suitable constraints (cash in advance) to be a consistent and convenient framework. However, it is recognised that within this model, money itself acts as a disruption factor preventing the efficient distribution of resources rather than increasing this efficiency. Kiyotaki & Moore (2003) is consistent with the argument in Chapter one of this thesis in his calls for a new model of economic analysis where the allocation disruptions of money are recognised and where money eventually plays a role in improving resource allocation. The development of this new model is not the aim of this thesis, however the empirical analysis and modelling of a system where money has a disruptive effect present in this thesis could provide invaluable data for the formulation of such a model. In principle there are two very contrary views, that of A – money increases the efficiency of resource allocation, and view B – money disrupts the efficiency of resource allocation. This thesis will provide data and understanding concerning resource allocation and the money supply and providing support for the future creation of Kiyotaki & Moore's canonical model.

This thesis however, is primarily concerned with the empirical evaluation of Hayek's (1931) Business Cycle Theory. Whilst Austrian Theory is relatively opposed to empirical examination (as discussed in chapter 2), notable movements toward an empirical aspect of Austrianism have been developed and are discussed philosophically throughout this thesis. It is arguable that Hayek has a greater acceptance of empiricism than Mises (and thus the New Generation Austrians tend toward the Hayekian Approach). Hayek's theory of the trade cycle relies on the Micro-Effects of Expansionary Monetary Policy as discussed in Chapter 3. Malinvestment when the market rate of interest is below the natural rate of interest has to occur for the theory's prescriptions to manifest. Hayek then considers an appropriate policy response to avoid secondary depression depends on the level of malinvestment, clearly an empirical calculation. Furthermore, Hayek headed the New Austrian Institute for Business Cycle Research which quantitatively studied the business cycle and later sought support from the Rockerfeller Foundation for assistance with a technical (econometric) appendix to The Pure Theory of Capital (1941). Several key empirical examinations have been brought to prominence in the literature. With the advent of the New Austrian School of Economic Thought (see Chapter 2) and an increasing imperative to compete with mainstream economics on its own empirical / mathematical battlefield, a need for Hayek's theory of the trade cycle to contribute toward a wider macroeconomics, as well as a move from the heavily criticised ideological constraints of fundamental Austrianism, several prominent Austrians have turned to data and empirics to investigate aspects of the business cycle. As discussed earlier, it can be argued that Hayekian thought is far more data friendly than the Misean approach which can be judged much more opposed to the use of empirics, Blaug (1991) considers Austrianism as anti-empirical and it has been shown in the previous section how this description suits the Misean traditionalists far better than the Hayekian Breakaways and the New Austrian School.

Austrian Empiricism is seen to have two key difficulties:

1. The reduction of Austrian Theory to operational terms (Keeler 2001)
2. The methodological opposition to empirical examination.

This thesis aims to build upon the pioneering work of the New School of Austrian Economic Thought and develop a standard mainstream econometric analysis of Hayek's business cycle. In particular the thesis will build upon the work of Wainhouse (1984), Cwik (1998 & 2008), Garrison (2001), Hughes (1997), Keeler (2001), Mulligan (2002 & 2006), Montgomery (2006) and Bismans & Mougeot (2009), extending these studies with UK timeseries data.

Generally speaking the empirical examinations of Hayek's theory of the trade cycle can be broken down to two types, these are short term analyses which usually consider a particular crisis (usually the traditional sparring ground of The Great Depression, though more recently the East Asian Crisis and the dot com bubble) and long term studies aiming to identify cycle causation in a nation's timeseries (this thesis falls into this second group with added structural examination). Beginning with Rothbard (1962), this study which considers the Great Depression presents evidence that credit expansion, empirically seen as an increase in the monetary base, led to a 1920s boom that was unsustainable. For Rothbard, congruent with Hayek's theory of the trade cycle's artificial extension of resources, this should have been quickly liquidated by the market creating a return to economic normality, however for Rothbard this was prevented by mistaken government action intended to prevent any collapse. Resources which should have been reallocated to support productive sectors were trapped in the sectors which had been artificially extended and were no longer productive (Bismans & Mougeout 2009). Thus for Rothbard a standard reallocation of resources through the HTTC liquidation, a normal recession became the Great Depression (*ibid*). Rothbard however, presents relatively convincing empirical evidence of the first stage of HTTC, the increase in the monetary base, yet then presents a series of (intuitive) leaps supported by limited empirical evidence and guided by the specifications of Hayek's theory for the subsequent stages of the theory. For example there is no empirical evidence presented for the assertion that HTTC unfettered would have resulted in the liquidation process quickly reverting the economy back to normality, for Laidler (2003), Rothbard would be simply advocating the nihilistic policy prescriptions which led to the discrediting of the theory.

Similarly Powell (2002) when considering the 1990s for Japan concludes that government action exacerbated the crisis and like the Great Depression, government action turned a small liquidation into a far more severe and lengthy recession. Again however, Powell supports elements of HTTC with empirical evidence and does no formal modelling to suggest HTTC prescriptions would have been more successful than the labour maintenance policies of the Japanese government. Garrison (2001) delivers an empirical analysis of the stagflation of the 1970s, providing a relatively convincing support of HTTC by analysing new money in the economy and then tracking the effects of the entry of this new money over time. This provides empirical support, not simply that monetary misallocation can be shown to occur preceding a crisis (Laidler 2003), but strong support in the form of a sequence of events that as "misallocated capital cannot be easily reallocated, it has a persistent negative impact on consumerable output. This misallocation increases final goods prices and generates underemployment of resources in early stage output" (Garrison 2001, p67). Hughes (1997) considers the recession of the 1990s through the empirical Austrian lens concluding the Austrian mainstay that deficit spending and monetary expansion do not cure recessions but cause them. In essence Hughes (1997) breaks Austrian Theory into four distinct points:

1. The structure of production
2. Why industries differ in capital needs
3. Why the money supply is expanded
4. The coming of recession

Hughes supports these points with empirical evidence, however as per Rothbard (1962) the stages are linked with a series of intuitive leaps guided by the prescriptions of Hayek's theory of the trade cycle. Evidence is therefore presented in support of the occurrences and not the process. As Cwik (1998) correctly asserts, the theory must be correct prior to mainstream consideration, the theory is not fully supported by evidence presented in support of its components, but by empirical evidence of its process as a whole. Callahan and Garrison (2003) provide an empirical examination of HTTC in the context of the dot com bubble, this like Hughes (1997) gives an overview of operational aspects of Hayek's theory of the trade cycle, in this case:

1. The Boom Begins (1995-1996)
2. A time of crisis (1997-1998)
3. The Height of Madness (1999-2000)
4. The tide turns (Spring 2000)

Callahan and Garrison (2003), however provide a far more convincing flow of events, demonstrating (at least to an extent) the progression from aspect to aspect. The study uses (rare even for an Austrian approach), quantitative and qualitative data to make its point of the value of Austrian Theory. However an aspect which increases its convincingness is the simple admission by the authors that Austrian Theory does not have all the answers. This movement from the often total support of HTTC by Austrian Authors gives hope of the compatibility of Austrian and mainstream economics[49]. Furthermore Callahan and Garrison consider the relevance of behavioural economics and overconfidence to both HTTC and standard mainstream macro theory, this suggests a further acceptance of non-Austrian theory on the Austrian side. Cochran *et al* (2003) take the aspect approach with a largely discursive method, however they do suggest that artificial monetary expansion is a further useful variable in the empirical examination of HTTC. Cwik (2008) raises the useful point that much of the previous (and previously discussed) empirical work focusses on the causes of the downturn and that the liquidation and recovery stages have received little attention, "Since the revival of

[49] Austrians generally see considerable enlightenment in mainstream authors who give credence to HTTC yet are often fully supportive of HTTC and dismissive of mainstream analysis. This movement suggests a possible lessening of rigidity on the Austrian side.

Austrian analysis (in the early 1970s), research on the recessionary stage has remained scant". Cwik (2008, p1).

Cwik (2008), asserts that the singular reason for the fall from grace of Austrian Theory in the great 'business cycle debates' of the 1930s, was that whilst the Keynesians had a plan for recovery, the Austrian prescription of 'do nothing' as the market is working failed to provide confidence. This was particularly relevant politically where inaction is often seen as worse than doing something, even when the something may be wrong[50]. Cwik considers that the Austrian answer should indeed be an action, however before that action can be prescribed, the liquidation and recovery side to HTTC need to be explored. Cwik's (2005) model is useful to explore in this thesis as it demonstrates a formal approach to modelling the HTTC which informs the construction of a reduced form model. Furthermore, the model incorporating a Corporate Finance viewpoint demonstrates the New Austrian acceptance of methodologies outside of the traditional non-empiricism.

Cwik considers The Hayekian Theory of the Trade Cycle from a corporate finance point of view and a hypothetical firms accounting decision making through a central bank's interest rate changes. This moves away from the aspect examination to a process examination, initially HTTC is begun by the lowering of the interest rate in the economy. Cwik supposes a (not unrealistic) twenty percent drop in the base rate from 5% to 4%. This then for the firm affects both the present value of working capital and the present value of fixed capital.

[50] My grateful thanks to a group of HM Gov. Ministerial Advisors for illuminating this point.

For working capital:

$$P_{WK} = P_{INPUT}\left(1 + \frac{i}{t}\right)$$

Where

P_{INPUT} is the cost for labour and materials

i is the rate of interest

t is the turnover rate of working capital

$\therefore$ the %Δ in the present value of working capital when *i* changed by the central bank to i':

$$P_{WK} = \frac{i' - i}{t + i}$$

We can see then that the impact of these changes whilst they do have an effect, is not hugely significant, for instance the change in the discount rate of 20% from 5% to 4% and with a turnover rate of 3 will result in a reduction of the cost of working capital of 0.328%. The effect of this change on fixed capital is however, more noticeable for the firm, if we imagine a firm has a capital investment producing an income stream (R), then the capital investment's discounted cash flow (present value PV) would be:

$$PV_{FK} = \frac{R - P_{WK}}{1 + i} + \frac{R - P_{WK}}{(1 + i)^2} + \cdots + \frac{R - P_{WK}}{(1 + i)^n}$$

OR:

$$PV_{FK} = \sum R\left(\frac{(1 + i)^n - 1}{i(1 + i)^n}\right)$$

$\therefore$ %Δ in the present value of fixed capital is:

$$PV_{FK} = \left(\frac{i}{i'}\right)\left(\frac{(1+i)^n}{(1+i')^n}\right)\left(\frac{(1+i')^n - 1}{(1+i)^n - 1}\right) - 1$$

The change in the discount rate is far more significant for the firm with regard to fixed capital, the impact of this for a ten year income stream is a lessening of income of over 5%. If one considers a firm, then it makes simple accounting sense to (where possible) transfer from short term working capital to long term fixed capital, in fact the longer term the better, for instance a twenty year income stream is improved by over 9%. Cwik (2008) considers firms will expand working capital to further support the investment in long term fixed capital exacerbating the malinvestment. If we imagine a firm is considering a project with a net present value (NPV) which is a near zero negative, then the artificial reduction in the discount factor will push this NPV to above zero, further encouraging long term investment. These malinvestments result in a competition for resources pushing their price up, the central bank is left with a stark choice, end the artificial inflation (increase the interest rate to the natural level) or face increasing price inflation.

Cwik considers that the central bank, generally with an edict toward price stability will eventually choose to end the monetary expansion and will return the interest rate to the pre boom level (in this example 5%). If the interest rate rises now by 25% (4% to 5%) then the effect on the firm's working capital will be a 0.329% increase and a much more significant effect on fixed capital of a reduction in income of 4.798% on a standard ten year discounted cash flow. Cwik notes this impact and suggests the firm will seek to rectify its accounting situation to mitigate these effects. However the change in price differentials between inputs and outputs have a far greater effect on the firm's profitability:

%Δ in the value of working capital when P_{INPUT} changes in line with the new bank rate to P'_{INPUT}:

$$P_{WK} = \frac{P'_{INPUT} - P_{INPUT}}{P_{INPUT}}$$

We can see therefore that if the cost of working capital were to increase by 10% for example, this would equate to a 10% increase in the amount of working capital required to maintain production. This increase is greater than the proportional increase in cost of the interest rate increase, now if we consider the effect on fixed capital (remembering the cost will usually be sunk), the percentage change in the present value of the project would be:

$$PV_{PROJECT} = \frac{P_{WK} - P'_{WK}}{R - P_{WK}}$$

The firm will experience economic (and probable accounting) loss, to halt this the firm must liquidate its long term fixed capital, this capital was, at the reduced interest rate of 4%, an attractive and profitable acquisition which was a sensible and appropriate decision to invest in.

The liquidation phase however has an important redistribution effect, if we consider this from the firm's point of view, standard accounting decision making practice tells us that sunk costs should not factor into future financial decisions. Simply regardless of any spend incurred getting from A to B, the financial position at B is fixed and decisions from that point should be made regardless of sunk cost consideration. That is if a company at point A in its financial year (cash) has a ten million pound surplus and it purchases a five million pound piece of capital, then its position at point B is a five million surplus. If at point B it is discovered the capital can only run at a loss, the decision should be made to liquidate the capital rather than use it as regardless of the cost from A to B, the use of the capita will only worsen the firm's position from point B, regardless of any appeals to hindsight at point A (people are often reluctant to think in these terms, 'throwing good money after bad'[51]). If the firm then takes an accounting view of its return from fixed capital, remembering the decision was made with a discount rate of 4% when input costs were respectively lower, then the standard response will be to liquidate its sale value in a different investment vehicle. A new firm can then purchase the fixed capital at the correct market rate, anticipating less profitability due to the natural discount rate and thus purchasing the fixed capital at a cost commensurate with the true rate of interest and not commensurate with the artificially reduced rate. That is the first firm will have to sell at a loss above the value of any depreciation.

4.4.1 Summary

This analysis provided by Cwik (2008) moves beyond the theory aspect approach toward a process approach. Predating Cwik is Wainhouse (1984), one of the first econometric considerations of HTTC. In this paper Granger Causality Testing is used to consider Hayek's theory of the trade cycle as a process starting with changes to the money supply Granger causing interest rate and output level movements in accordance with HTTC. This technique is used by Leroux and Levin (1998) who find evidence supporting the monetary origin of business cycles. Sechrest (2004) regresses time series data to examine HTTC, Keeler (2001) uses time series analysis considering Austrian Theory staples; the relationships between money and interest rates and hypothesis testing of monetary shock as a cause of business

[51] Perhaps this 'sunk-cost fallacy' is another behavioural consideration for Austrian economic theory as per Callahan & Garrison (2003).

cycles in accordance with Hayek's theory of the trade cycle. Mulligan (2002) uses error correction and vector error correction (2006) to test the principle component of HTTC, the lowering of the interest rate below the natural rate increases output and investment in the short run and lowers output and investment in the long run.

The following section (4.5) presents a review of the major papers relevant to this thesis in order to further refine and support an empirical examination of Hayek's theory of the trade cycle.

4.5 Review of major papers relevant to this thesis

"Does Austrian Business Cycle Theory actually describe phenomena with any observable correspondence to those of modern-day economic fluctuations?"

Carilli & Dempster (2008, p272)

This thesis builds on the burgeoning tradition of the empirical study of Hayek's theory of the trade cycle, as there is a reasonably limited body of practical literature in this area, and as it predominantly emanates from the Austrian literature (generally the Quarterly Journal of Austrian Economics, the Review of Austrian Economics and the Atlantic Economic Journal), it is further reviewed below and collated in table 8. This allows for a positioning of this thesis within the literature as well as identifying justification for the methodology and approach taken in this thesis.

The foundation paper of Empirical Examination of Hayek's theory of the trade cycle, Wainhouse (1984) begins with an introduction to Hayek's work and the Hayekian Theory of the Trade Cycle (similar to that found in previous sections of this thesis), and from this derives a series of testable hypotheses:

1. Changes in the supply of savings are independent of changes in the supply of bank credit.
2. Changes in the supply of credit lead changes in rates of interest. Furthermore, changes in credit and interest rates are inversely related.
3. Changes in the rate of change of credit lead changes in the output of producer goods.
4. The ratio of producer goods prices to consumer goods prices tends to rise after the initiation of a credit expansion.
5. The prices of producer goods closest to final consumption tend to decline relative to the prices of producer goods further away from the consumer good in the production scheme.
6. The prices of consumer goods rise relative to the prices of producer goods, reversing the initial shift in relative prices.
7. Toward the end of a Hayekian trade cycle, unemployment should increase first in producer goods industries and then, with some lag, in consumer goods industries.
8. Employment will expand in consumer goods industries as relatively more labor (sic) resources are applied both in response to the fall in real wages and in an effort to satisfy consumer demand.
9. Around the cycle peak, inflation in raw materials prices will exceed that in consumer goods prices.

Wainhouse (1984) states that despite Hayek's confidence in the nature of these relationships, they should be verified statistically. The statistical verification is accomplished by Granger Causality Testing, hypotheses 1-3 are tested for G*-causal relationships, 4-6 are examined *via* the identification of patterns in the time series according to Hayekian Theory, hypotheses 7-9 focus on the results of the Ricardo Effect and are not formally tested in the paper, though Wainhouse states that the testing of 4-6 suggest support for 7-9. The empirical testing finds support for Hayek’s Business Cycle Theory and suggests an alternative to the quantity theory as a guide to monetary policy.

Keeler (2001) presents an account of why there have been only limited numbers of empirical studies of Hayek’s Business Cycle Theory, stating that the limited ability to express Austrian concepts in operational terms and the methodological opposition to the empirical testing of hypotheses result in few examples of empirical Austrianism. Mises (1966, p56) considered that “the impracticality of measurement is not due to the lack of technical methods for the establishment of measure. It is due to the absence of constant relations”, however Keeler argues there is a clear need to consider how well the Austrian Theory can explain observed cyclical behaviour. Keeler considers that with an awareness of these (from the point of view of the Austrian School) methodological issues, empirical evaluation can provide evidence on the magnitude and validity of Austrian explanations of the characteristics of business cycles. Keeler is concerned not only with evidence supporting Austrian explanations, but the strength of this evidence, asking, “Are the responses large enough to explain business cycle behaviour?”.

The Hayek’s theory of the trade cycle is then discussed (similarly to Wainhouse 1984), with the cycle broken down to the following propositions:

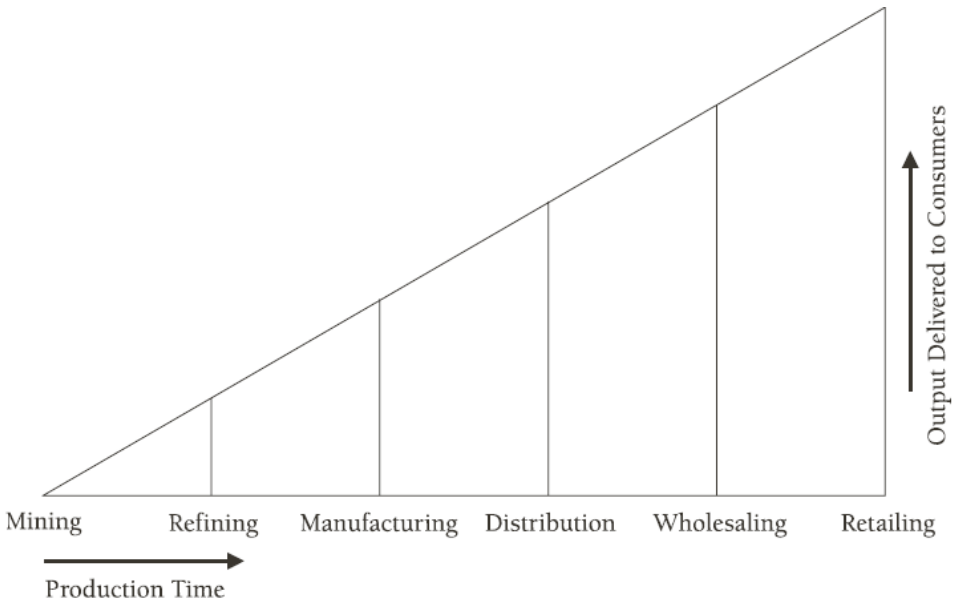
1. The liquidity effect lowers market interest rates below the natural interest rate, and creates a steeper yield curve at a lower position.
2. Investment flows and capacity utilisation are systematically increased for more capitalistic production processes in the expansion.
3. Short term interest rates adjust to long term interest rates with a mechanism related to the cycle.

4. The expansion phase entails the contraction phase as resource allocations are reversed.

Keeler considers that these propositions reflect the role of price signals; the cycle begins through a distortion of relative prices in the economy, the cycle continues *via* human responses to the distortion of prices and is ended *via* a price adjustment mechanism. A review is presented of previous Austrian Empiricism and the GDP data are examined and displayed visually to guide the reader through the possibly alien Hayekian concepts. The definition of variables and the reasoning behind the proxies are discussed and clearly presented data cleaning increases the reliability of the study. Keeler (2001) uses the Augmented Dicky Fuller test to check for any unit root in the data and removes any issue of non-stationarity. An Error Correction model is used to confirm a relationship between the interest rate differential and the business cycle in accordance with Hayek's Business Cycle Theory. The study provides empirical evidence for Hayek's Business Cycle Theory, reducing the theory to operational terms and addressing the epistemological concerns of the empirical study of human action by agreeing the historical nature (non-repeatability) of the data, but seeking constant patterns in previous data and seeking to provide evidence and understanding to the theory.

Mulligan (2006) begins with a Hayekian Triangle explanation of the inter temporal of the economy (The workings of the Hayekian Triangle are discussed in Chapter Three), are shown in figure 9.

Figure 9: Hayekian Triangle: Production and Capital Structure



Source Garrison (2001) displayed in Mulligan (2006)

Mulligan then explores the theoretical basis for the paper followed by a discussion of previous Hayek's theory of the trade cycle in the literature, this discussion is similar to that in the previous papers and in the previous research section earlier. The methodological approach of the paper is covered in detail and an error correction model of real output as measured by real consumption expenditures testing for co-integration with estimates of the error correction model. The paper presents a standard discussion of Hayek's theory of the trade cycle, though discusses the recession aspect of the theory in considerable detail. For Mulligan (2006) Hayek's theory of the trade cycle can result in a recession in 3 distinct ways:

1. A reduction of the money supply. The monetary authority recognise that the interest rate is 'too low' and tighten the money supply. Contractionary policy can be seen preceding the Great Depression, the Volker Recession (1981-1982) and the 2001 recession, Mulligan (2001).

2. A maintenance of the money supply as the monetary authorities remain unaware of the ‘too low’ interest rate environment. Due to the momentum effect of too ‘too low’ interest rates eventually demand for credit outstrips supply driving interest rates up further. Mulligan (2006) considers most postwar recessions have started this way including the Gulf Crisis Recession (1990-1991).
3. Preventative increase of the money supply (reduction in market rate of interest). The monetary authority attempts to prolong a boom or forestall a recession, altering the production structure totally and fully committing the economy to malinvestment projects. Mulligan (2006) considers that this process results in the most severe recession and is clearly demonstrated in the oil shock recession (1969-1970 and 1973-1974). Evans and Baxendale (2008) and de Soto (2010) consider the recent financial and economic crisis to take this form.

Mulligan then presents a brief explanation of the Great Depression from the Keynesian, Monetarist and Austrian viewpoints summarised in table 7.

Table: 7 Views of the Great Depression

Keynesian	**Monetarist**	**Austrian**
Liquidity trap created once nominal interest rates become low enough; bank demand for excess reserves became perfectly elastic. Monetary base doubled between 1929-38: monetary policy was expansionary but excess reserves accumulated in banks. Demand for loans depressed due to unfavourable business outlook. Banks did not buy securities because nominal yields were so low.	Real interest rates extremely high due to a price deflation: e,g., CPI fell 10% in 1931 and 1932. Indicates a contractionary policy. Growth in monetary base mostly attributable to currency held by public unavailable to be loaned out rather than bank reserves. “Flight to quality” greatly increased demand for short term Treasury securities, depressing their yield. Fed tightened discount lending	Expansionary monetary policy depressed interest rates and created an unsustainable boom throughout the late 1920s. Monetary policy was intermittently both expansionary and contractionary at different times throughout the1930s. Government intervention initiated under the Hoover administration between 1930-32 delayed the liquidation of malinvested

	policy in 1931, and doubled the reserve requirement between 1936-37, triggering a secondary recession.	capital. Price fixing, fiscal stimulus, and inconsistent monetary activism, continued and extended under the Roosevelt administration, preventing liquidation of malinvested capital prolonging the contraction.
Keynes (1936), Hicks (1939), Modigliani (1944)	Friedman and Schwartz (1963), pp. 411-41	Rothbard (1962),Garrison (2001)

Source Mulligan (2006)

The Data are described and obtained from reliable sources, for instance annualised personal consumption data are obtained from the US Department of Commerce Bureau of Economic Analysis and interest rate data is provided by the Federal Reserve Bank of St Louis. An error correction methodology is assessed and proposed by Mulligan (2006) as an econometric methodology 'especially amenable to interpretation by the Austrian School'.

The error correction model provides an estimation of any structural or equilibrium process and crucially the error correction or dis equilibrium process by which adjustment is made toward any equilibrium. Even though the Austrian School may reject the notion of such an equilibrium, the disequilibrium adjustment process is still a valid insight.

Mulligan (2006) then presents a vector error correction model, Ordinary Least Squares Analysis and in accordance with Wainhouse (1984), a Granger Causality test. The paper shows evidence of cointegration between consumerable output and the interest rate term spread. The vector error correction model is shown to have considerable explanatory power over the presented data.

Mulligan (2006) presents an empirical model as especially suited to the New Austrian School, this VECM generates considerable empirical support for the HTTC using US timeseries data. A replication of this model using the thesis data is presented in Chapter (9), interpreted in Chapter (10) and discussed in Chapter (11) to determine the evidence this accepted Austrian Econometric method provides for a determination of the validity of the HTTC for the UK economy.

Carilli & Dempster (2008) begins with a key question: “Does Austrian Business Cycle Theory actually describe phenomena with any observable correspondence to those of modern-day economic fluctuations?” arguing that “the true measure of any business cycle theory in any historical period is the extent to which the economic phenomena predicted by the theory correspond to those actually observed”. The paper argues that Austrian Empiricism is a response to the methodological critics of the Austrian School (Yeager 1997, Wagner 1999), and that whilst the eventual form of Austrian analysis of theory is still in development, empirical examinations are a step toward a final methodology, it is to this progression, that this thesis also contributes.

The paper considers econometric techniques appropriate for the study of Hayek’s theory of the trade cycle as:

1. The correct application of time series techniques can help the researcher to avoid spurious correlation, which can be present in other forms of historical analysis.
2. The use of time series techniques can provide distinctive evidence on Hayek’s theory of the trade cycle relative to competing theories.

The paper then provides a now familiar review of the econometric literature concerning Hayek’s theory of the trade cycle before progressing to a simple model of the Austrian money-interest rate-output relationship:

$$\Delta\text{Reserves} \rightarrow \Delta(\text{Natural Rate} - \text{Market Interest Rate}) \rightarrow \Delta\text{GDP}$$

Carilli & Dempster (2008) consider Granger Causality testing to be appropriate for the confirmation of an inter-temporal relationship between variables. As per the previous papers data are gathered from tried and tested reliable sources (in this case the Federal Reserve Bank of St Louis) and is tested for non-stationarity. Tests are developed for the below aspects of the simple model:

1. Reserves $\rightarrow$ Interest Rate Gap
2. Interest Rate Gap $\rightarrow$ GDP

Vector-Autoregression (VAR) and Granger causality are then applied to determine that "Hayek's theory of the trade cycle is more than a collection of ad hoc observations … [and] … offers a very clear set of propositions about the transmission mechanism behind the 'artificial' boom and the impulse behind the downturn".

Carilli & Dempster (2008) use empirical methods and find supporting evidence for the relevance of the HTTC for the US economy, as such, considerable guidance is taken from this paper in determining the testable model of the HTTC (Chapter 5), the endogenous turning point evaluation (Chapter 7), VAR construction (Chapter 8) and the subsequent interpretations and discussions in Chapters 10 & 11.

4.6 Summary of Key Austrian Empirical Papers

"Engaging in sophisticated empirical analysis is a necessary (though not sufficient) condition for Austrian Business Cycle Theorists to be taken seriously by the broader macroeconomic community."

Luther & Cohen (2014)

Following the discussion of the relatively rare Austrian empirical literature in section 4.5, literature relevant to the approach of this thesis is presented in table 8. This table presents the key papers which have informed the methodology, their methods and their arguments for an empirical evaluation of Austrian Business Cycle Theory.

Table 8: Summary of Key Austrian Empirical Papers

Article	Source	Method	Arguments for Empiricism
Wainhouse (1984)	Siegel, B. (ed.) *Money in Crisis*	A series of propositions tested for empirical validity. Furthermore the Hayekian Business Cycle is tested as a sequence of events via Granger Causality Testing.	Hayek's confidence in the propositions, should be tested empirically.
Keeler (2001)	*The Review of Austrian Economics*	1.Descriptive statistics to visually evaluate and explain the theory. 2.An error correction model.	1.A need to consider how well Austrian Theory can explain observed cyclical behaviour. 2.Empirics give a magnitude of the effect, so it is possible to see whether Hayek's propositions are strong enough to actually affect the business cycle.
Mulligan (2006)	*Quarterly Journal of Austrian Economics*	1.An error correction model (which is especially amenable to the Austrian School). 2.Ordinary Least Squares. 3. A vector error correction model. 4. A Granger Causality test.	1.Make Hayekian Theory accessible to other Schools of Economics. 2.Evaluate Hayek's theory of the trade cycle through observed behaviour
Carilli, A & Dempster, G. (2008).	*Review of Austrian Economics*	1.A Vector-Autoregression (VAR). 2.A Granger Causality test. 3.Distributed Lag Model.	1.The correct application of time series techniques can help the researcher to avoid spurious correlation, which can be present in other forms of historical analysis. 2.The use of time series techniques can provide distinctive evidence on Hayek's theory of the trade cycle relative to competing theories.
Dore, M & Singh, R. (2012)	*Atlantic Economic Journal*	1.A Vector-Error Correction Model and associated	Emphasis on no *a priori* economic assumptions to better allow

		Impulse / Response Functions. 2.Granger Causality Testing.	Hayekian methodological acceptance.
Fisher, E. (2013)	*Quarterly Journal of Austrian Economics*	1.A Vector-Error Correction Model and associated Impulse / Response Functions	The paper seeks to extend earlier empirical work on capital based macroeconomics, and especially Austrian Business Cycle Theory.
Lester, R & Wolff, J. (2013)	*Review of Austrian Economics*	1.Vector-Auto Regression Models and associated Impulse / Response Functions.	ABCT emphasises a sequential nature of production and resource allocation (hence the IRF analysis). As such an empirical study is beneficial to establishing the overall validity of the theory.
Luther, W & Cohen, M. (2014)	*Atlantic Economic Journal*	1.Vector-Auto Regression Models and associated Impulse / Response Functions.	This paper is in essence a re-working of Lester & Wolff (2013) using a term spread (equivalent to YGAP) variable as the expansionary monetary policy proxy to 'correct' their negative findings. As such the arguments for empiricism are as above.
[52]Russell, L & Langemeier, M. (2015)	*Quarterly Journal of Austrian Economics*	1.Vector-Auto Regression Model and associated Impulse / Response Functions. 2.Granger Causality Tests. 3.Distributed Lag Model.	Due to the increasing popularity of the Austrian Business Cycle Theory in the popular press and the mainstream economics profession it is increasingly subjected to conventional empirical analysis. Russell & Langemeier consider this is testament to the theory's intuitive appeal.

The above table generates considerable insight for the methodology of this thesis, it is clear that particular techniques are appropriate to use within the philosophical constraints of the New Austrian School. The Vector-Auto Regression, Ordinary Least Squares, Vector Error Correction Models and Granger Causality Tests used by this thesis have support and

[52] This paper's recent publication date means it wasn't available to shape the methodology presented in this thesis, however it is included in table 8 and 9 as it provides considerable support for the approach of the thesis in determining the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle.

justification from the Empirical Austrian literature. The empirical tests used in this thesis and their corresponding 'pedigree' in the New Austrian literature is shown below:

Table 9: Thesis Tests and justifying articles

Tests Used in This Thesis	**Supporting Article(s) using similar approaches**
Vector-Auto Regression	Carilli & Dempster (2008), Lester & Wolff (2013), Luther & Cohen (2014). Russell & Langemeier (2015).
Ordinary Least Squares	Mulligan (2006)
Vector Error Correction	Keeler (2001), Mulligan (2006), Dore, M & Singh, R. (2012), Fisher (2013).
Correlation Matrix	Keeler (2001)
Distributed Lag Models	Carilli & Dempster (2008), Russell & Langemeier (2015).
Granger Causality Testing	Wainhouse (1984), Mulligan (2006), Carilli & Dempster (2008). Russell & Langemeier (2015).

Furthermore, the papers reviewed suggest considerable support for the methodology of this thesis, that of the construction of a testable model of Hayekian Theory and subsequent empirical evaluation of said model.

4.7 Chapter Summary

Chapter 4 presents an overview of the Austrian Empirical body of literature and discusses the potential empirical nature of Hayek's theory of the trade cycle. Hayek applied for support from the Rockerfeller Centre for a technical (econometric) appendix for the Pure Theory of Capital (1941) and from the literature discussed in the preceding chapter it is arguable that Hayekian Austrians (New Generation) have a greater acceptance of empiricism than traditional Misean Austrians. Given this the New Austrian empirical works are examined and a number of econometric tests are considered as appropriate for this thesis as they have previous academic justification in the Austrian Empirical Literature.

The Austrian Acceptance of the methodology of this thesis, namely the construction of a testable model of the HTTC and its empirical testing is seen to have justification and acceptance in the Austrian Empirical Literature.

Chapter 4 identifies the previous empirical literature evaluating Austrian theory and provides support and justification for the methodology of this thesis presented in Chapter 5.

Chapter 5: An empirical evaluation of Hayek's theory of the trade cycle: Methodology Chapter

5.1 Introduction

In this Chapter the arguments for empirical examination of Hayek's theory of the trade cycle are examined in section 5.2, building on the work presented in Chapter 4. The relevance of the wider Austrian empiricism debate for the thesis is explored in sections 5.2 and 5.3. The aim of this thesis to provide an empirical examination acceptable to the Austrians and accessible to the wider macroeconomic community is further discussed in section 5.3 in order to better position this thesis in the literature. Methodological Pluralism is discussed as the wider approach and aim of this thesis in section 5.4 and a summary table of the approach of this thesis is presented in section 5.5 (table 10).

The research methods of the thesis and the econometric tests identified in chapter 4 (table 9) are discussed in 5.6 and 5.7 to demonstrate their acceptability to the Austrians and accessibility to the wider macroeconomic community.

Building on section 3.7.1, section 5.8 generates Second Order Predictions of Hayek's theory of the trade cycle, which in turn lead to the construction of the testable model demonstrated in figure 12. Coupled with this additional supporting hypotheses are developed to provide reduced form analysis and examination of the singularly Austrian endogenous turning point in the effect of expansionary monetary policy on output. This combination of structural and reduced form analysis addresses a clear gap in the literature and criticism of Austrian empirics, that studies only address one aspect or the other (Kuehn 2013). The dual analysis presents a novel contribution of this thesis to the literature and is discussed in section 5.9.

Section 5.10 explains how each Second Order Prediction (the testable model) will be evaluated and how each hypothesis will be tested, all the testing is in accordance with the

Austrian empirical literature and is justified as being acceptable to the Austrian School both in Chapter 4, in particular tables 8 and 9 and in section 5.2.

Chapter 5 explains the approach of the thesis, building on the material presented in Chapters 2, 3 and 4. The Chapter then discusses the research methods and the tests used in this thesis as acceptable to the Austrian School and develops a testable model and key supporting hypotheses for evaluation of Hayek's theory of the trade cycle.

5.2 An empirical examination of Hayek's theory of the trade cycle

"Economists are apparently in disagreement over a variety of issues – over policy prescriptions, over the methods they use, over the criteria they employ to judge or to choose their theories (e.g. testability or falsifiability), over the legitimate scope of their work (positive or normative), as well as over general philosophical questions, such as whether or not economics is a science"

Woo (1994)

This thesis in providing an empirical examination of the Hayek's theory of the trade cycle aims to contribute into the above debate described by Woo (1994). Policy Prescriptions being the 'public face' and tangible outcome of the economics profession are in need of re-examination and new input following the 2007 economic and financial crisis (Colander 2009). The contribution the Austrian School alone can make to policy prescription and the design of an effective strategy within the economic infrastructure as it stands today is limited. However, whilst the end prescriptions of the Austrian School as an ideology can be questioned, an understanding of the mechanisms which provide the foundations for the Hayek's theory of the trade cycle can, if isolated, from the ideological prescriptions of the Austrian School, and viewed as an aspect of the economic process, contribute to the debate. The foundations of the Hayek's theory of the trade cycle can provide alternative and valid explanations for observed events. Austrian Economists adhere to valuing understanding over prediction and rejection of *scientism*, yet the far reaching prescriptive nature of the School's prescriptions devalue the understanding generated through Austrian Enquiry.

McCloskey (1994) considers persuasiveness to be key in economic arguments, as noted elsewhere in this thesis Zimmerman (2003) considers the unrealistic nature of Austrian Prescriptions to be a crucial aspect in the heterodox status. Central Banks are key figures of crucial importance in the present economy, likewise the Basel Regulations, theories that advocate a total shift away from this and ignore the cost, fail to be persuasive. This is not even simply within academia where the Austrian opposition to the mainstream fails to find common ground, but throughout our present economic system. The political infrastructure is integrated with the Central Bank, monetary (and fiscal) policy and the entire global financial system, even if it were 'irrefutably demonstrated' that the Austrian Prescriptions for the removal of central banks had considerable merit, then the policy decision to do so would be unrealistic and exceptionally unlikely. The immediate and future costs of changing the global financial infrastructure so dramatically would call for much debate, and likewise the nature of this 'irrefutable demonstration'. Mainstream economics is perhaps more open to debate and discussion post crisis than before, however in the absence of natural science testing and method (Solow 1985), no demonstration will be irrefutable and given the costs, dangers and uncertainties of the removal of the Central Bank System, it will, despite Austrian Theory, continue to exist. Simply the end prescriptions of Austrian Theory discredit the potential value of the foundations (or understandings) of the theory.

Colander (1994) reports that Thomas Mayer (1993) and Edward Leamer et al (1978, 1991) have convincingly argued, that given the nature of observation in economics, empirical tests at this level are inevitably indecisive stating that numerous theories and judgements can be interpreted as consistent with the data. Nevertheless, it is considered that the process of empirical examination has considerable value in the policy prescription debate, particularly at this time of new observed data following the 2007 crisis; empirical examination can suggest value or importance of economic mechanisms or processes. The mechanisms of the Hayek's theory of the trade cycle outside of their ideological theory and away from their end prescriptions have use or offer explanation or understanding of economic phenomena.

> "Econometric tests rarely lead, on their own to decisive tests of economic theories. Such testing is not however without importance …econometrics gives you, 'suggestive results"
>
> Backhouse (1994)

As per Backhouse above, this thesis provides an empirical examination of the Hayek's theory of the trade cycle, not with the overall objective of providing an irrefutable demonstration of the validity of the theory, but to demonstrate the potential value of the mechanisms (or understandings) of the theory to contribute to the policy debate. Hayek's theory of the trade cycle may have value in explaining economic phenomena, predicting the drivers and mechanisms of the boom and providing understanding for the business cycle, yet this potential value is often lost within the extreme ideological prescriptions of Austrianism. For McCloskey (1994, 2010), persuasiveness is key, Austrianism cannot persuade due to its end prescriptions, as it cannot persuade, the value of its foundations is thus diminished. This empirical examination, considering the mechanisms of Hayek's theory of the trade cycle outside its end prescriptions, aims to provide a persuasive analysis of the Austrian mechanisms which may be of use to the policy debate.

5.3 The mainstream and Austrian Economics: Bridging the gap.

A key objective of this thesis is to produce an evaluation of Hayek's theory of the trade cycle which is acceptable to the Austrian School of Economic Thought and accessible to the wider macroeconomic community. A consideration of Austrian Economics is crucial to understanding the development of modern economics (Rosen 1997, Lewin 2001), however the Neo-classical ideology is solely dominant. Lewin (2001), Basse (2006) and Keeler (2001), amongst many others from the Austrian side, and crucially Rosen (1997) and McCloskey (2006) from the non-Austrian position consider that Austrian (or indeed the majority of heterodox) economics and Neo-classical (or mainstream) economics are not mutually exclusive. No branch of economics represents the whole field, the spectrum of economic thinking is spread between extremes; extremes of ideology, extremes of policy and extremes of methodology and method. So too are the majority of fields of thought and academic endeavour, sociology is far more fragmented with a far less secure and dominant mainstream and continuously competing theories not settling to allow the development of a definite orthodoxy.

Physics currently camps in two major loop or string groups, the curative or preventative debate (medical vs social models) continues in medicine and public health and political action remains the preserve of two competing dichotomies. Yet unlike in many fields, the dialogue in economics between the mainstream and Austrians is severely limited (Rosen 1997). Perhaps this is simply due to the dominance of Neo-classical economics, it is after all rare for one field for so long to have such a powerful and relatively unchallenged orthodoxy (Lawson 2006). However, this thesis considers the views expressed by the New School of Austrian Economic Thought and the econometric or empirical Austrians such as Keeler (2001), Mulligan (2006), Garrison (2006), Carilli & Dempster (2008), Fisher (2013) and Russell & Langemeier (2015)[53] for the need to present Hayekian Theory for empirical testing in order to facilitate wider acceptance. This can only occur with comparability of analysis and results i.e. empirical examination presenting unambiguous results of the success (or otherwise) of Austrian Theory. This thesis shares the view of the New Austrian School that for dialogue to begin, even on a

[53] See table 8.

rudimentary level, a common language must be used. For Austrian Theory to be introduced to, and considered by the mainstream and other heterodox Schools of Economic Thought, empirics must be used. If they are not, and traditional Austrian methodology and methods are used, then the results are only accessible to economists who already accept the Austrian Theory.

Austrians often fail to present their work to the mainstream in a common form which allows comparison or even interpretation without acquiring proficiency in at least two paradigms (Lewin, 2001). Simply put, to interpret Austrian writings, the orthodox economist must learn another (obscure) process, this additional cost prohibits appropriate consideration by the mainstream. If the Austrian writer expects the mainstream to become fluent in their language, then surely help must be provided in terms of common or shared linguistic components. Empirics does this, providing a common ground for comparison of theories without altering the theory itself. It is the view of this thesis that the recent economic crisis increases the mainstream interest in Hayek's theory of the trade cycle as expounded by Evans and Baxendale (2008), Douglas Carswell's motion for an Austrian inspired Finance Bill (2010), Stiglitz's (2010) call for a Pluralist Economic Paradigm and Neck's (2014, p122) view that "Austrian Economics is blossoming in the US with its own scientific journals, series of books and some influence on the political discourse there".

However first and foremost, assessment of Austrian Theory needs to be *via* a common approach, namely empirics. There is a clear need to at least widen mainstream acceptance of heterodox ideas and to (re)integrate economics with the wider social sciences (Haldene 2014, Brown & Spencer 2014).

The Misean (traditional anti-empirical) Austrians are mostly concerned with the study of human action. Simply individual agents act and the interaction of these agents form a complex system or economy (Basse 2006). This bottom up approach is contrary to the top down approach of neoclassical economics, but that in itself is not an insurmountable obstacle to communication or dialogue. Behavioural, neuro and experimental economics take a similar approach and are increasingly accepted into the mainstream. Agent Based Computational Economics can be considered to have a strong methodological comparability to the Austrian approach (Whittle 2011) and yet has penetrated the mainstream. However Austrian academics tend toward a far less formal methodology, “Austrian economists tell stories of events” (Subrick and Beaulier 2010) and whilst they can be persuasive, they lack the comparability of language required to communicate with the mainstream.

Without a clearly stated hypothesis Austrian ‘stories’ leave the mainstream reader lacking common denominator language or points of comparability and raise a series of questions from the mainstream reader:

1. How does the theory relate to the evidence?
2. What assumptions underpin the Theory?
3. How does the market respond? (i.e. what is the outcome?)
4. What are the institutional foundations of the Theory? (Subrick and Beaulier 2010)

Empirics as a common denominator language would provide reference points addressing these questions and allowing dialogue to commence.

This thesis considers that there are mutual benefits of dialogue, though would take pains to point out that dialogue does not equal acceptance. It is the aim of this thesis to provide an empirical evaluation of the relevance of Hayek’s theory of the trade cycle for understanding the UK business cycle acceptable to the Austrian School and accessible to the wider macroeconomic community. Austrian economics can provide a valuable perspective on the economic process, as behavioural, neuro, experimental and evolutionary economics do.

However the approach of these non-mainstream approaches invites dialogue and the contributions of these approaches to mainstream economics are valued and accepted or at least acknowledged, debated and discussed.

5.4 Methodological Pluralism

Mthodological pluralism is of key relevance to this thesis as it allows for an approach acceptable to the Austrian School and accessible to the wider macroeconomic community (discussed further in 5.5 and displayed in table 10).

A full description of this methodological position can be found in Caldwell (1982), however for the purposes of this thesis, a brief consideration of the methodological pluralist approach combining Austrian and wider macroeconomic ideas is justifiable for discussion. Roy (1991) considers that a Humean epistemology would conclude that the differences between the Neoclassical and Austrian Schools may be so irreconcilable that the only option is to pick a side; this implies that there is no bridgeable gap required by Caldwell's pluralism. Roy (1991) further considers that the conflict is exceptionally bitter, Hoppe (2004) considers the academic atomic bomb of sarcasm to be a common weapon in this argument, the legitimacy of each side is questioned by the other and the academic researcher in economics could find their career severely hampered by crossing the lines (*ibid*). However, credible attempts have been made; Garrison (2001) attempts to provide a mutually compatible growth model and Mulligan (2006) successfully explores Austrian ideas *via* econometric analysis. Furthermore there have been several calls, and not just from the heterodoxy, for a pluralist economics closer aligned to reality (Stiglitz 2010). Writing for the post-crash economic movement, Andy Haldane (Director of Financial Stability for the Bank of England) calls for a change in economic methodology stating:

“Some of this is discovery of the new – for example, in the area of evolutionary, neuro and behavioural economics. But a large part is rediscovery of the old – or, in some cases, dusting down of the neglected – for example, in the area of institutional economics, economic history and money and banking. The proposed methodology is pluralist. It is also cross-disciplinary. It combines deductive and inductive methods.”

Haldene (2014)

In this environment perhaps Roy’s (1991) consideration of the economic approaches to be unbridgeable may be out-dated and the Austrian epistemological position with its logical rigour and link to reality, not so far removed from Neoclassical mathematical formalism to make co-operation if not compatibility a very real prospect[54]. The current crisis in academic economics (see Chapter 1) has prompted the mainstream to review the pre-crisis orthodoxy. This thesis does not argue for the rejection of this orthodoxy, but aims to provide evidence for the evaluation of the Hayek’s theory of the trade cycle by the mainstream in a manner accessible to orthodox economics and the wider macroeconomic community.

5.5 The Philosophy (approach) of this thesis

The approach of this thesis developed through a consideration of the New Austrian Macro-Economic Framework presented in Chapter (3), the Empirical Austrian literature presented in Chapter (4) and the discussion on methodological pluralism above is an empirical examination of a testable model of Hayek’s theory of the trade cycle within the philosophical stance of methodological pluralism. This approach, which supports the overall aim of the thesis to evaluate the HTTC in an approach acceptable to the Austrians and the mainstream, is supported by the Austrian empirical studies discussed in Chapter (4). The below table (table

[54] Claude Mouchot (2007) considers what he terms a realistic epistemology of economics along pluralist lines, by considering that each branch of economics has a particular view of reality, and their workable combination through finding a common structure for discourse, presents a greater picture of reality as a whole.

10) demonstrates the approach of this thesis compared to the traditional Austrian and mainstream approaches:

Table 10: The approach of the thesis

Issue	Mainstream approach	Austrian approach	**This Thesis**
Concept of economics	Theory of decision, that is human action is rational and based on utility maximization.	Praxeology – human action is a dynamic process.	**Human action is dynamic, but the empirical study of phenomena can provide valuable insight.**
Methodological origin	Positivist approach to human action via mathematical formalism.	Subjectivist approach via verbal formalism.	**Methodological Pluralism seeking a symbiosis of the positivist and subjectivist approach.**
Information within the analysis	Complete, objective and constant information on the economic process is a given in analysis. There is no acknowledgement of different types of knowledge within the process.	Information and knowledge is subjective and dynamic, there is an acknowledgement of different types of knowledge in analysis of the economic process.	**Humans are not fully rational but tend toward patterns in behaviour, an understanding of these patterns can provide insight.**
Basis of analysis	One of equilibrium and given constants, micro and macro effects are considered separate.	The economic process is considered in its entirety.	**Aspects of theory building a dynamic process.**
Empiricism within the analysis	Rejection of null hypothesises.	Shared view that history (collected past data) cannot prove theories.	**Past data can provide understanding and insight as well as measures of magnitude.**
Prediction as a goal of analysis	The end goal of the analysis.	Prediction is impossible as it lies within future human action which has not yet occurred and is	**Prediction is not the goal of the analysis, but the understanding gained through**

		thus impossible to measure.	**empirical examination can be useful.**
Formalism within the analysis	Mathematical Formalism.	Verbal Formalism.	**Mathematical Formalism (less prediction)**

Source de Soto (1998) plus Author additions

5.6 Research Methods

This section discusses the evaluation process used in this thesis to determine the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle. For Carilli and Dempster (2008) the true measure of any business cycle theory is the extent that the economic phenomena predicted by the theory correspond to those actually observed. Austrian economists are beginning to employ (see section 2.4) econometric techniques to consider and evaluate Hayek's theory of the trade cycle. The literature reveals a small selection of standard econometric tests that are both acceptable to the mainstream economic orthodoxy and the (New) Austrian Economic School. This thesis uses empirical testing of UK timeseries data to evaluate the validity of HTTC for the UK by measuring the extent to which the predictions of the theory as described by de Soto (2010) correspond to those actually observed.

Empirical examination is an appropriate evaluation measure, providing it stays within the 'bounds of acceptable use' for the Austrian School. Econometric tests can provide results to allow Hayek's theory of the trade cycle to stand or fall on an Austrian evaluation position of comparing the predictions of the Theory against observed data for the UK, and presenting the results in a form accessible to mainstream economics to measure against the literature of econometric evaluation of other Business Cycle Theories. Simply an econometric evaluation of

HTTC presents the results in a comparable form to mainstream evaluations. However, it should be noted that the Austrian School will generally only consider second order predictions as valid, that is the value of the econometric analysis is in comparison of the theory to observed data and not the generation of future forecasts. Here the philosophies and ideologies of the mainstream and the Austrian approach differ, yet an econometric output from this thesis will produce an empirical evaluation which can be compared against other business cycle theory while adhering to the Austrian view of second order predictions.

The literature suggests a small range of econometric tests beyond standard tests of description and inference. Vector-Auto Regression, Granger Causality and Vector Error Correction modelling as econometric analysis tools have been suggested as being an appropriate methodology for the consideration of Austrian theory from a mathematically formalist perspective (tables 8 & 9). This methodology will provide an estimate of a structural or equilibrium process and the Error Correction or dis-equilibrium process which provides adjustment toward the hypothesised equilibrium. An Austrian rejection of the existence of any equilibrium due to human action, does not discount an interest in the disequilibrium process, indeed Austrian philosophy seeks an understanding of the process and not necessarily of its conclusions (Mises 1980).

5.7 Austrian 'friendly' tests

This section lists the tests which are used in this thesis for the empirical evaluation of the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle. Austrian empirics are in their infancy with a limited (though growing) number of papers using empirical examination justifying this within Austrian methodological constraints and the Hayekian rejection of *Scientism*. The tests below are seen to be appropriate for evaluating Hayek's theory in sections 4.4 and 4.5 and their acceptance in the literature is displayed in table 9.

5.7.1 Vector-Auto Regression

In keeping with the reviewed Austrian literature, a reduced form Vector-Auto Regression (VAR) model will be used; as its name suggests, a reduced form VAR incorporates the fewest maintained hypotheses and represents the VAR in its purest form (Becketti 2013). This helps maintain the Austrian rejection of s*cientism* as this VAR retains the information of the jointly endogenous variables without relying on strong identifying assumptions, yet still provides a mainstream standard, accepted and accessible test. The aim of this thesis to provide an evaluation of the Hayek's theory of the trade cycle, with a methodology acceptable to both mainstream and Austrian economists, is supported by the use of a reduced form VAR[55].

Christopher Sims (1980) suggested the VAR to counter what he stated where "incredible" *a priori* assumptions used in the estimation of large scale macro-econometric models, considering that VARs retain the value of multiple information models without relying on 'overly strong identifying assumptions', Becketti (2013). Sims (1980) also considered that the forecasting accuracy of VARs is often superior to structural simultaneous equation models. The development of the VAR, countering and avoiding considerable assumptions, allows for some Austrian acceptance of the power of econometric and empirical testing.

5.7.2 Vector Error Correction Modelling

Vector Error Correction modelling as an econometric analysis tool has been suggested as being an appropriate methodology for the consideration of Austrian theory from a mathematically formalist perspective (Mulligan 2006, Fisher 2013[56]). This methodology will provide an estimate of a structural or equilibrium process and the Error Correction or dis-equilibrium process which provides adjustment toward the hypothesised equilibrium. An

[55] All references to VARs used in this thesis refer to the reduced form VAR as described by Becketti (2013).
[56] Fisher (2013, p45), states the Error-Correction Model to be "an econometric method considered a tractable model for Austrian-inspired research".

Austrian rejection of the existence of any equilibrium due to human action, does not discount an interest in the disequilibrium process, indeed Austrian philosophy seeks an understanding of the process and not necessarily of its conclusions (Mises 1980). The proposed model consists of two aspects; firstly a structural equation analysis of the long term equilibrium process and the residual of this demonstrating the disequilibrium in a set time period.

Vector Error Correction Models are a test of several time series models simultaneously which calculate the returning to equilibrium[57] speed of the dependant variable following an alteration in the independent variable. Vector Error Correction Models are particularly appropriate for estimating both the long and short-term effects of a first time series on a second.

5.7.3 The Granger Causality Test

It is noted that regression deals with correlation and not causation (Gujarati 2003). Simply put, a discovered relationship between variables does not confirm any causality. However with regression calculations involving time series datasets the causality scenario may be more calculable.

"Time does not run backward. That is, if event A happens before event B, then it is possible that A is causing B. However it is not possible that B is causing A. In other words, events in the past can cause events to happen today. Future events cannot." (Koop 2000. p. 175)

Quite simply this is the basic principle of the Granger Causality Test. It is worth noting at this point that causality itself is a contentious philosophical issue of which there are many extreme viewpoints, from those who consider causality to be fundamental to everything, that is everything is caused by something to those who view causality as non-existent.

[57] The notion of equilibrium may cause query from some Austrian perspectives, however it is worth noting that Hayek's theory relies on a natural interest rate, this rate of interest delivers a 'steady state economy' which a boom / bust scenario returns to.

In response to criticisms (mostly raised by Zellner 1979), Granger (1980) reviewed his definition of causality presented in Granger (1969). This thesis uses the 1980 definition of causality which takes a specific time series perspective for three central axioms as the foundation for the definition of causality:

Axiom A	The past and present may cause the future, but the future cannot cause the past.
Axiom B.	$\mathbf{\Omega}_n$ (the 'universal' information set) contains no redundant information, so that if some variable $\boldsymbol{Z}_n$ is functionally related to one or more other variables, in a deterministic fashion, then $\boldsymbol{Z}_n$ should be excluded from $\mathbf{\Omega}_n$.
Axiom C.	All causal relationships remain constant in direction through time.

In a standard Multivariate Linear Regression Model, the dependant variable (y) can be seen as a function of a series of independent explanatory variables and is modelled as:

yt = β0 + β1xi1 + β2xi2 + β3xi3 + ….. + βnxin + ei

The coefficients β0, β1xi1, β2xi2, β3xi3 etc represent the marginal effects on y.

Granger (1969, further developed in 1980) formulated a technique built upon time series data to determine causality which in this thesis will be referred to as Granger Causality to accommodate the philosophical concerns of causality testing.

5.8 Second Order Predictions of Hayek's theory of the trade cycle and additional supporting hypotheses.

This section provides a discussion of the Second Order Predictions of Hayek's theory of the trade cycle. Carilli & Dempster (2008) consider that an empirical evaluation of Hayek's theory should be an evaluation of how closely the drivers and mechanisms of the theory (which they call Second Order Predictions to differentiate from prediction or forecasting in the orthodox sense) correspond to observations.

The Second Order Predictions (SOPs) generated below provide a mechanism to test if Hayek's theory of the trade cycle can provide understanding of the UK economy 1980-2010, building from the derived summary framework of Hayek's theory of the trade cycle. In accordance with Bjerkenes *et al* (2010) these predictions will be divided into mechanisms of the business cycle. For this thesis three distinct mechanisms will be used:

1. The trigger or tipping point of the business cycle.
2. The propagation or continuation stage of the business cycle.
3. The correction stage of the business cycle.

The second order predictions are formulated from the key aspects and step-by-step summary (de Soto) of Hayek's theory of the trade cycle (HTTC) and are in accordance with the hypothesis testing ethos of the New Austrian School of Economics.

Trigger Stage Second Order Predictions:

SOP 1 – Expansionary monetary policy increases the volume of 'Artificial Money' (here M4) in the economy. **Expansionary Monetary Policy→M4↑**

SOP 2 – An increase in M4 leads to the economy moving to a consumption focus. **M4↑→INVCON↓**

SOP 3 – An increase in M4 leads to movement toward initial stage production. **M4↑→RESOURCES↑**

Continuation Stage Second Order Predictions:

SOP 4 – The economy moving to initial stage production leads to an increase in economic activity. **RESOURCES↑→↑ln(GDP)**

SOP 5 – The economy moving to a consumption focus leads to an increase in economic activity. **INVCON↓→↑ln(GDP)**

Correction Stage Second Order Predictions:

SOP 6 – The increase in economic activity leads to the economy (further) focussing on initial stage production. **↑ln(GDP) → RESOURCES↑**

SOP 7 – The increase in economic activity leads to the economy (further) focussing on initial stage production. **↑ln(GDP) → INVCON↓**

SOP 8 – The focus on initial stage production leads to contractionary monetary policy. **RESOURCES↑→Contractionary Monetary Policy**

SOP 9 – The focus on consumption leads to Contractionary monetary policy. **INVCON↓→ Contractionary Monetary Policy**

SOP 10 – Contractionary Monetary Policy leads to a reduction in economic activity. **Contractionary Policy Correction → GDP↓**

Additional supporting hypotheses:

The thesis will also test 5 key hypotheses to further evaluate the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle. Similarly to the above Second Order Predictions, these hypotheses are developed from the literature with hypotheses 1 & 2 concerning the overall relationship between expansionary monetary policy (e.g. Mulligan

2006) and hypotheses 3 – 5 examining the endogenous turning points required for Hayek's theory of the trade cycle (*as per* Carilli & Dempster 2008).

Hypothesis 1 - There is a long-term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy.

Hypothesis 1_0 - There is not a long-term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy.

Hypothesis 2 – There is a long-term inverse relationship between an increase in M4 and the output proxy.

Hypothesis 2_0 – There is not a long-term inverse relationship between an increase in M4 and the output proxy.

Hypothesis 3 – There is an endogenous turning point consistent with Hayek's theory in the effect of YIELD on GDP.

Hypothesis 3_0 – There is not an endogenous turning point consistent with Hayek's theory in the effect of YIELD on GDP.

Hypothesis 4 – There is an endogenous turning point consistent with Hayek's theory in the effect of YGAP on GDP.

Hypothesis 4_0 – There is not an endogenous turning point consistent with Hayek's theory in the effect of YGAP on GDP.

Hypothesis 5 - There is an endogenous turning point consistent with Hayek's theory in the effect of M4 on GDP.

Hypothesis 5_0 - There is not an endogenous turning point consistent with Hayek's theory in the effect of M4 on GDP.

The Second Order Predictions of Hayek's theory of the trade cycle can be seen in the context of a typical business cycle in figures 10 & 11. A formal testable model of Hayek's theory built from Second Order Predictions is presented in figure 12.

Figure 10: Diagram of SOPs in according stages of a business cycle

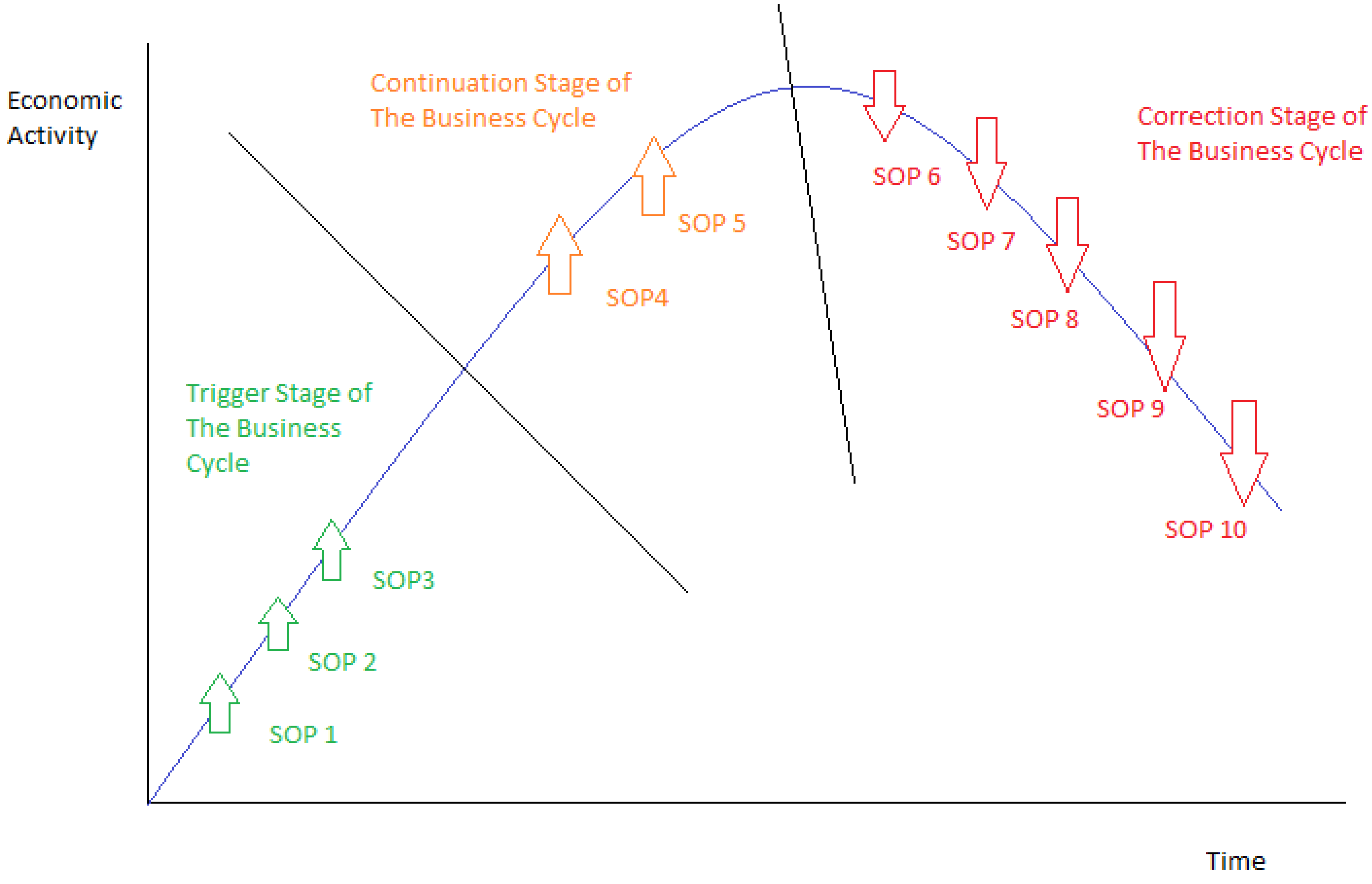
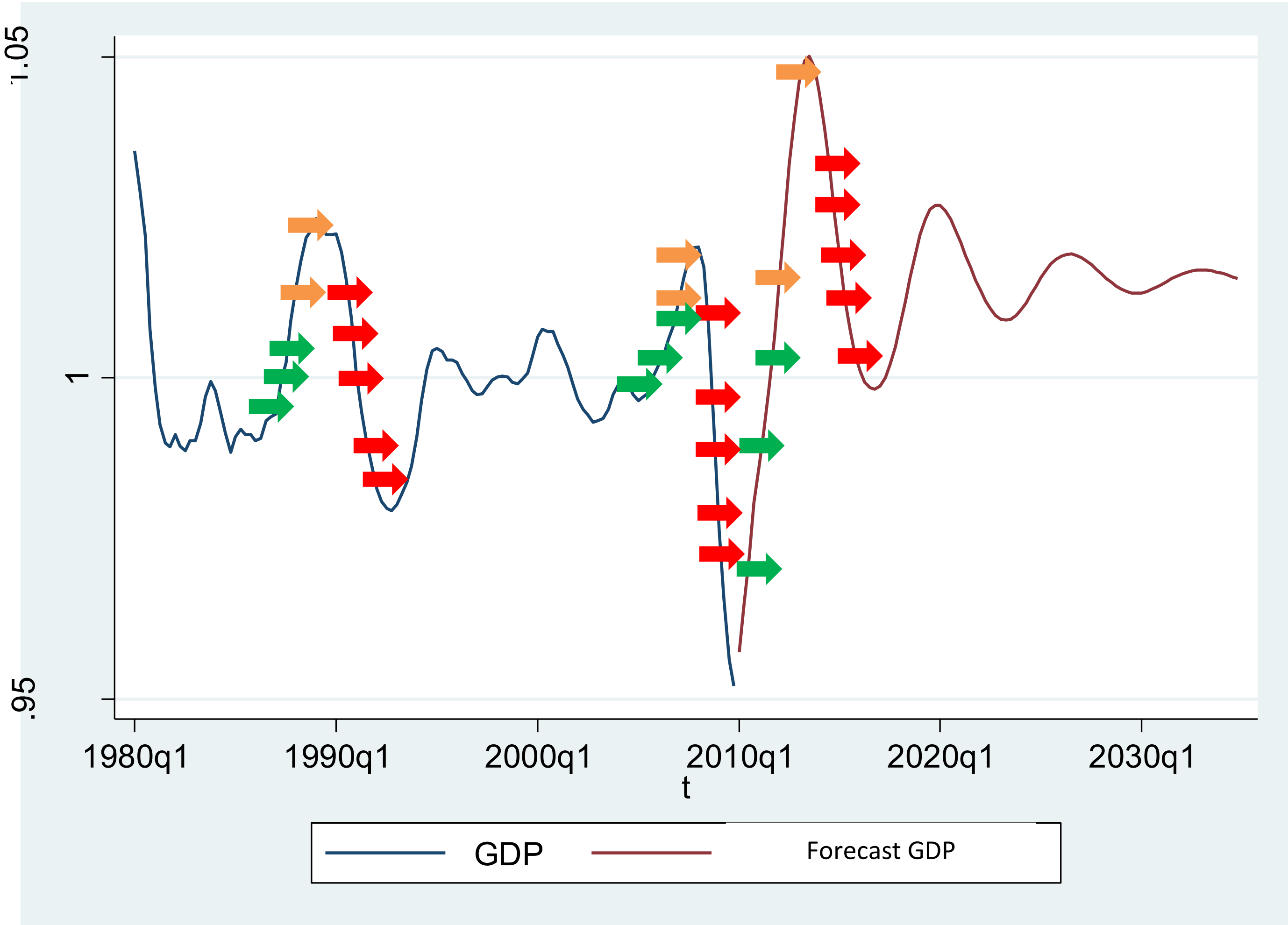


Figure 11: Observed and forecast GDP with SOP stages:

Economic Activity



This leads to a testable model, a development on, but similar to that presented in Carilli & Dempster (2008):

Figure 12: The testable model of Second Order Predictions of Hayek's theory of the trade cycle

EMP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→CMP →(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

Where[58]:

EMP = Expansionary Monetary Policy

CMP = Contractionary Monetary Policy

M4 = The Money Supply

GDP = The Output Proxy

RESOURCES[59] = The movement in economic focus between initial and end stage consumption.

INVCON[60] = The Investment / Consumption Ratio in the economy.

[58] The construction of the variables discussed in chapter 6 (additional variables for the VECM are constructed in chapter 9). All variables are summarised before the interpretation of results in chapter 10 (section 10.2.1, tables 78 & 79).

[59] ↑ = ↑ initial stage production
↓ = ↑ end stage production

[60] ↑ = ↑ investment
↓ = ↑ consumption

5.9 Reduced Form and Structural Models of Hayek's theory

Kuehn's (2013) clear criticism of the Austrian empirical literature is that it generally takes two distinct approaches, each lacking a complete evaluation of Hayek's theory of the trade cycle. Those of Reduced Form or Structural approaches; a reduced form approach tests for macroeconomic outcomes consistent with Hayek's theory of the trade cycle, whereas the structural studies explicitly model the Hayekian processes affecting the business cycle. Kuehn's criticism is that studies adopting one of these approaches produce a necessary step in evaluating the validity of Hayek's theory but miss an aspect, either the driving mechanism is missed in a reduced form study or the macro picture is missed in a structural study.

However the testable model of Hayek's theory of the trade cycle (figure 12) combines a reduced form analysis of Hayek's theory with a structural analysis. Macroeconomic outcomes consistent with Hayek's theory are tested for, as are the structural drivers of the Theory. Thus the model presented in this thesis represents a reduced form structural analysis of Hayek's theory of the trade cycle answering Kuehn's (2013) criticism and presenting a novel contribution to the Hayekian empirical literature.

5.10 SOP testing (I-X) How are these going to be tested?

Based on the model (presented in figure 12), this thesis in accordance with the approach of Carilli & Dempster (2008), will develop tests for the key linkages, the Austrian Theory is for Garrison (1989) "a recognition that an extra-market force (expansionary monetary policy) can initiate an artificial or unsustainable boom … [which] contains the seeds of its own undoing: the upturn must, by the logic of the market forces set in motion, be followed by a downturn".

The sequence of linkages presented is closely aligned to the Hayek's theory of the trade cycle to allow for distinction away from other business cycle theories, e.g. Real Business Cycle

Theory and the Neoclassical Model, discussed earlier. Carilli & Dempster (2008) also consider that such a sequence of linkages avoids the imposition of the structural parameters which would expose this thesis to the Lucas critique. It is imperative for the common denominator approach and contribution of this thesis that the econometric approach taken be in the 'middle ground' of comparability to mainstream publications without allowing for Austrian criticisms of method. Evans & Honkapohja (2003) demonstrate that monetary policy remains exposed to the Lucas critique despite alternative forms of expectations.

In accordance with Carilli & Dempster (2008) the actual prescriptions of the HTTC will be tested. These prescriptions (discussed further in Chapter 10) can be expressed as:

Table 11: Second Order Predictions of Hayek's theory of the trade cycle

Link	Second order predictions of the HTTC
ΔMR→ ΔM4	**Loose Monetary Policy→M4↑**
ΔM4→ ΔRESOURCES	**M4↑→INVCON↓**
ΔM4→ ΔINVCON	**M4↑→RESOURCES↑**
ΔRESOURCES →ΔGDP	**RESOURCES↑→↑ln(GDP)**
ΔINVCON→ΔGDP	**INVCON↓→↑ln(GDP)**
ΔGDP→ΔRESOURCES	**↑ln(GDP) → RESOURCES↑**
ΔGDP→ ΔINVCON	**↑ln(GDP) → INVCON↓**
ΔRESOURCES→ΔMR	**RESOURCES↑→Tighter Monetary Policy**

ΔINVCON →ΔMR	**INVCON↓→ Tighter Monetary Policy**
ΔMR→Δ(↓)GDP	**Tighter Monetary Policy → GDP↓**

This thesis will test the above second order prescriptions in order to determine the validity of the Hayekian Theory of the Trade Cycle for the UK Economy (1980-2010). The SOPs form a reduced form model of the HTTC as per Carilli & Dempster (2008) which will empirically examined using tests acceptable to the New Austrian School. The specific approach for the evaluation of the Second Order Predictions and Hypothesis Testing is shown below:

Evaluation of each SOP:

1. Examination of Orthogonalized Impulse Response Functions derived from a Vector-Auto Regression Model, as per Carilli & Dempster (2008).
2. Examination of Granger Causality Tests derived from a Vector-Auto Regression Model, as per Carilli & Dempster (2008).
3. Examination of Orthogonalized Impulse Response Functions derived from a Vector Error Correction Model, as per Mulligan (2006).
4. Examination of Granger Causality Tests derived from a Vector Error Correction Model, as per Mulligan (2006).

Additional supporting hypotheses:

Hypothesis 1 - There is a long-term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy.

Hypothesis 1_0 - There is not a long-term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy.

1. Examination of Long Term Orthogonalized Impulse Response Functions derived from a Vector-Auto Regression Model, as per Carilli & Dempster (2008).
2. Examination of Orthogonalized Impulse Response Functions derived from a Vector Error Correction Model, as per Mulligan (2006).

Hypothesis 2 – There is a long-term inverse relationship between an increase in M4 and the output proxy.

Hypothesis 2_0 – There is not a long-term inverse relationship between an increase in M4 and the output proxy.

1. Examination of Long Term Orthogonalized Impulse Response Functions derived from a Vector-Auto Regression Model, as per Carilli & Dempster (2008).
2. Examination of Orthogonalized Impulse Response Functions derived from a Vector Error Correction Model, as per Mulligan (2006).

Hypothesis 3 – There is an endogenous turning point consistent with Hayek's theory in the effect of YIELD on GDP.

Hypothesis 3_0 – There is not an endogenous turning point consistent with Hayek's theory in the effect of YIELD on GDP.

1. Examination of a finite distributed lag model of the effect of YIELD on GDP, as per Carilli & Dempster (2008) and Russell & Langemeier (2015).

Hypothesis 4 – There is an endogenous turning point consistent with Hayek's theory in the effect of YGAP on GDP.

Hypothesis 4_0 – There is not an endogenous turning point consistent with Hayek's theory in the effect of YGAP on GDP.

2. Examination of a finite distributed lag model of the effect of YIELD on GDP, as per Carilli & Dempster (2008) and Russell & Langemeier (2015).

Hypothesis 5 - There is an endogenous turning point consistent with Hayek's theory in the effect of M4 on GDP.

Hypothesis 5_0 - There is not an endogenous turning point consistent with Hayek's theory in the effect of M4 on GDP.

3. Examination of a finite distributed lag model of the effect of YIELD on GDP, as per Carilli & Dempster (2008) and Russell & Langemeier (2015).

Furthermore, Mulligan (2006) presents a Vector Error Correction Model of the Hayekian Theory of the Trade Cycle using US time series data, this paper is widely considered in the Austrian Literature (e.g. de Soto 2009, Lester & Wolf 2013, Fisher 2013) as providing considerable support for the Austrian Business Cycle Theory using empirics. As such, this thesis presents a replication of Mulligan (2006) in order to determine if the support provided for the validity of the Austrian Business Cycle Theory for the US is present in the UK time series data (1980-2010).

5.11 Chapter Summary

Methodological Pluralism is discussed as an appropriate philosophical position for research into the validity of Hayek's theory of the trade cycle and for an Austrian Empirical approach. Vector-Auto Regression Models, Vector Error Correction Models and Granger Causality Tests are examined as being acceptable to the Austrian Empirical approach and will be used to test the Second Order Predictions of the HTTC. Previous Austrian Econometric research is used to provide the basis of a testable model, which will be examined to determine the overall validity of the HTTC for the UK Economy (1980-2010). The Chapter also identifies Mulligan (2006) as an Austrian Empirical Study, which generates considerable support for the Austrian Business Cycle Theory using timeseries data from the US economy. This thesis will present a replication of Mulligan (2006) using the UK timeseries data to determine if similar relationships are present, thus providing a further test of the validity of the HTTC for the UK Economy.

This chapter presents the methodology of the thesis, supporting this as acceptable to the Austrian School using the literature presented in Chapter 4. Chapter 5 presents the arguments for an empirical evaluation of the theory and develops the testable model (based on Second Order Predictions) and the key supporting hypotheses. The methodology of a dual reduced form and structural analysis addresses the gap in the literature identified by Kuehn (2013) of single analysis studies.

Chapter 6: The Data

6.1 Introduction

The data for this thesis were obtained from the Bank of England Statistical Service discussed in section 6.2. These data are highly reliable and data obtained from this source have been used for several leading journal articles as well as to research and inform government policy.

In accordance with Hayekian Theory, economic activity is determined from generally reported GDP, components of the Hayekian Temporal view of the economy are determined from relevant sector figures, the investment consumption ratio is determined following guidance from the Austrian-Econometric literature, the money supply from reported M4 and proxies for the market and natural rates of interest are determined in accordance with Wainhouse (1984), Keeler (2001) and Mulligan (2006).

The data required to be stationary for the construction of the Regression Models (Chapter 7), Finite Distributed Lag Models (Chapter 7) and Vector-Auto Regression Models (Chapter 8) are de-trended in a process acceptable to Hayekian Thought. Section 6.5 uses a Hodrick-Prescott Filter to determine the trend of the data and thus to de-trend, dependant on the results of a Modified Dicky-Fuller Test. The variables for the thesis were then created and displayed in table 14, with GDP representing economic activity, M4 representing new money creation. YIELD, YGAP representing the divergence of the market rate of interest from the natural rate. INVCON representing the investment / consumption ratio within the UK Economy and RESOURCES demonstrating the movement of spending in the economy within the Hayekian Temporal view of production (explained in Chapters 2 & 3).

Following the advice of Keeler (2001), section 6.6 presents a correlation matrix of the variables in order to determine initial relationships in the data.

Chapter 6, discusses the source of the data, its treatment and the creation of the variables for empirical evaluation of the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle. The UK data used for the empirical evaluation does not feature in any of the reviewed literature and thus its use represents a further contribution to the Austrian Econometric Literature.

6.2 Data Sourcing

Numerous tried, tested and reliable data sources exist for gathering timeseries data, particularly for the UK which has a tangible history in the collection of statistics on its population as a whole and its economy. The data for this study has been sourced from the Bank of England Statistical Service, utilising a standard data revision date of quarter 1, 2010. The length of the timeseries is in keeping with Mulligan (2006) to provide the richness of data encompassing 'Boom & Bust' in order to best analyse Hayek's theory of the trade cycle. This has ensured equal treatment of all data by the statistical service before its use in this thesis. A visual representation of all data is presented in the appendices (A1.0).

6.2.1 Measuring The Business Cycle

Burns & Mitchell (1946) consider a business cycle to be an increase in economic activity in many areas around the same time period, followed by a contraction of economic activity which in turn leads to the expansion phase of the next cycle. With economic activity generally measured in GDP, this is itself an appropriate measure of business cycles and the standard measure in the aforementioned Austrian econometric studies.

6.2.2 The Money Supply

For Austrian Theory the money supply most closely aligned to the activity of the central bank should be used (Bjerkenes *et al* 2010). The UK M4 measure is thus considered and obtained from the Bank of England Statistical Service.

6.2.3 Interest Rates

A key component of Hayek's theory of the trade cycle is that the movement of the market rate of interest below the natural rate of interest in the economy. For Hayek and the Austrian School this represents Expansionary Monetary Policy[61].

For the purposes of this thesis and in accordance with Keeler (2001), the natural rate of interest is assumed to be the long term rate on government bonds (here 10 years). For the market rate a proxy is taken using the 3 month interbank loan rate, this is an accordance with Bernanke (1990). Following the advice of Bjerkenes *et al* (2010) the slope of the yield curve will serve as the relationship between the market and the natural rate of interest.

Therefore the variable YIELD[62] is calculated:

$$\text{YIELD}_t = \left(\frac{1+3mthRate_t}{1+10yrRate_t}\right)$$

And in accordance with Mulligan (2006) YGAP[63] is calculated:

$$\text{YGAP}_t = (10yrRate_t\text{-}3mthRate_t)$$

6.2.4 Investment and Consumption

Private consumption figures for the relevant time periods were obtained from the Office of National Statistics.

In accordance with the Austrian view that all income not used for consumption comprises the loanable funds market and is thus investment (Garrison 2001). Rather than taking investment

[61] Note that low interest rates themselves do not necessarily mean expansionary monetary policy for the Austrian School, but the divergence of the market rate under the natural. Likewise high market interest rates do not mean contractionary monetary policy, if the natural rate of interest is higher.
[62] Please see footnote 10.
[63] Further discussion of this variable (for VECM purposes) are present in Chapter 9, section 9.2.2.

figures calculated with various saving / hording caveats, a simple calculation of I_t=GDP_t-C_t was used.

Furthermore for this study the changing pattern between investment and consumption is of key importance, this variable, termed INVCON is calculated as:

$$INVCON_t=\left(\frac{INVESTMENT_t}{CONSUMPTION_t}\right)$$

6.2.5 Resources

As discussed in the first research question a key component of the Austrian malinvestment theory is the effect that the market rate of interest below the true rate has on the allocation of resources. For the theory a below true rate of interest leads to a production process centred on end stage consumption.

In accordance with Mulligan (2002) the distribution of resources will be measured by the output of initial production and end stage consumption. Using data obtained from the Economic and Social Data Service, a ratio of output at end stage consumption over output at initial stage production is constructed. At end stage consumption is retail and services whereas at initial stage production is mining and extracting and the variable (termed RESOURCES) is calculated as:

$$RESOURCES_t = \frac{output_t^{Initial}}{output_t^{end}}$$

The descriptive statistics of the data are shown in table 12.

Table 12: Descriptive Statistics

Data	Observations	Mean	Std. Dev.	Min.	Max.
GDP	118	247461.9	55163.1	166052	344809
NPISH consumption	118	6038.466	1874.357	2505	8424
Government Consumption	118	58250.55	7733.077	48683	74553
Investment	118	3809.11	11767.26	20381	62738
M4	118	16492.37	16679.74	11325	109457
Natural Rate	118	8.04783	3.119294	3.5295	14.9
Market Rate	118	7.767542	3.573386	0.56	16.05
Initial Stage Output	118	120.9424	16.2888	85.2	150.2
End Stage Output	118	69.63475	19.07512	44.3	104.9

6.3 Data treatment and the Stationary Variables

This section of the thesis discusses the variables that are used in the thesis for the empirical evaluation of the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle. The variables are developed informed by the literature discussed in sections 4.5 and 4.6. In particular the interest rate proxies which are informed by Keeler (2001), Mulligan (2006) and Carilli & Dempster (2008) to address the Austrian concerns raised in Keeler (2001) concerning the subjectivity of measurement of the interest rate.

6.4 Data Cleaning

Prior to the statistical testing of the time series data, the data itself and its properties must be considered carefully. Statistical tests performed on initial data can produce misleading results and falsely identify patterns and relationships as significant.

6.4.1 Stationarity in the data

Establishing the stationarity of the data is crucial in time series analysis, for instance there may be significant policy implications if output is actually dependant on output from several time periods past; current decisions therefore can have far reaching consequences (Bjerkenes *et al* 2010). The Vector-Auto Regression models (VAR YIELD and VAR YGAP) presented in chapter 8 require stationary data, whereas the Vector-Error Correction models presented in chapter 9 require the data to be non-stationary.

A stationary time series has a constant variance, covariance and mean, thus if:

$E(y_t)=\mu$

$Var(y_t)=\sigma^2$

$Cov(y_t - y_{t-s}) = \gamma_s$

Then the time series is said to be stationary.

Whilst the sample mean is a quick and initial test of the variable properties, for the purposes of this thesis a comprehensive mathematical test of non-stationarity is required. A number of different unit root tests could perform this function, the Phillips-Perron is a popular choice in the econometric literature, however in accordance with Bjerkenes *et al* (2010) an Augmented Dicky-Fuller Test will first be considered. This test is a standard econometric test, recommended Dougherty (2002) as appropriate for quarterly time series data, Greene (2003).

6.4.2 The Dicky Fuller Test

The test is built upon a first order autoregressive model and checks if the data contains a unit root.

The autoregressive model:

$y_t = p y_{t-1} + \varepsilon_t$

subtracting y_{t-1} from both sides gives:

$y_t - y_{t-1} = (p-1) y_{t-1} + \varepsilon_t$

simplifying this gives the three different Dicky-Fuller (DF) tests:

DF1: $\Delta y_t = \gamma y_{t-1} + \varepsilon_t$

DF2: $\Delta y_t = \alpha + \gamma y_{t-1} + \varepsilon_t$

DF3: $\Delta y_t = \alpha + \theta_t + \gamma y_{t-1} + \varepsilon_t$

With $\gamma = (p-1)$ and $\Delta y = y_t - y_{t-1}$, the test for non-stationarity concerns testing the null hypothesis $p=1$ against the alternative hypothesis $p<1$.

Bjerkenes *et al* (2010) consider that there is no fixed framework concerning which of the Dicky-Fuller Tests to use, though a visual examination of the data can provide an indication. If on a visual examination the data appears to have an average fluctuating around zero then DF1 is the appropriate choice, if the data appears to have an average fluctuating around a non-zero value, then DF2 should be used. If the data appears to have a linear trend then DF3 is an appropriate option.

The Modified Dicky-Fuller is an expansion of the Dicky Fuller test allowing any error-term to be autocorrelated. The MDF takes the form:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{S=1}^{M} \alpha \Delta\, y_{t-S} + \varepsilon_t$$

With $\Delta y_{t-1} = (y_{t-1} - y_{t-2})$, $\Delta y_{t-2} = (y_{t-2} - y_{t-3})$. As this takes autocorrelation error into account, this paper will use this Modified Dicky-Fuller test in preparing the data as recommended by Beketti (2013). This test first proposed by Elliott, Rothenburg and Stock (1996). Within this modified test the timeseries undergoes a GLS transformation before the Dicky-Fuller Regression. Numerous studies (Beketti 2013) have demonstrated this test's greater power over the traditional ADF test. The tests are presented in the appendices (A2.0) and are summarised in table 13.

Table 13: Unit Root Test Table

Variable	**MDF** **Accept H_0 of a unit root**
GDP	y
Household Consumption	y
NPISH Consumption	y

Government Consumption	y
Investment	y
M4	y
Natural Rate of Interest	y
Market Rate of Interest	y
Initial Stage Output	y
End Stage Output	y

The existence of a unit root in all the data is no surprise following the review of several macroeconomic timeseries papers presented in Becketti 2013 and will be dealt with by the use of a Hodrick-Prescott filter for the tests requiring stationary data, as recommended by Bjerkenes et al (2010) and throughout the Austrian Literature.

6.5 The Hodrick-Prescott Filter

The influential paper by Nelson & Plosser (1982) suggested that macroeconomic time series are better characterised by stochastic rather than linear trends and following the paper, a variety of methods of stochastic detrending have been developed. Berjenkenes et al (2010) recommend the application of a Hodrick-Prescott (HP) (1980) Filter to enable the detrending of timeseries data for the evaluation of Austrian Theory, Guay and St-Amet (1996) consider the HP Filter to be the most popular approach, though note its criticisms. King and Rebelo (1993) show how it can alter measures of persistence and variability when applied to observed timeseries and Harvey and Jager (1993) and Cogley and Nason (1995) demonstrate the potential introduction of spurious cyclicality by the HP Filter when applied to a random walk process. Kaiser and Maravall (1999) argue that this spurious cyclicality criticism is unwarranted and provide considerable support for the HP Filter, the Real Business Cycle literature is strongly in favour of the technique (particularly the Minnesota School, Kaiser and Maravall 1999). Jakeman and Young (1984) and Young and Pedregal (1996) demonstrate that exactly equivalent smoothing results from much more advanced smoothers and next generation HP variants can be obtained from the original HP approach (Kaiser and Maravall 1999). Guy and St-Amat (1997) demonstrate that the HP Filter performs well (assuming correct application) in a variety of timeseries scenarios through rigorous scenario testing and a review of Austrian Econometric Literature reveals a preference for the HP Filter. Bjerkenes (2010), Carilli and Dempster (2008) and Chen (2013) amongst others use the Hodrick Prescott Filter for analysis of timeseries data and Austrian or Hayek's theory of the trade cycle. One of the aims and contributions of this thesis is to provide an empricial examination of UK Timeseries data to assess the Hayek's theory of the trade cycle as described by de Soto (2010) in a manner which provides mainstream economic acceptance as well as being appropriate to the ideology of the (New) School of Austrian Economic Thought and Hayekian Authors. The Hodrick Prescott Filter, whilst like any empirical method can be refined and criticised, is a clear choice as it is appropriate to all the target audience of this work. The HP filter is a standard approach to the non-stationarity problem (Dougherty 2002) and is advantageous over other approaches due to its two-sided nature (Schlicht 2004).

The HP filter chooses the smoothed values of a time series and is shown as:

$$\min \sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$$

With λ determining the smoothness of the trend.

The HP Filter relies on a constant parameter signified by λ; this parameter is determined by the frequency (monthly, annually, quarterly etc) of the data and the primary period of the timeseries cycle being assessed (Maravall and del Rio, 2001). The choice of λ determines the smoothness of the trend and reflects the 'cost' to the analysis of incorporating cyclical fluctuations in the overall trend. We can see that as the value of λ rises, the change in trend becomes more constant resulting in a linear time trend to the observed values. Conversely the lower the value of λ, the closer the trend to the observed values. For quarterly data there is a consensus of a λ value of 1600 as proposed by Hodrick and Prescott (1979). This value of lambda has been deemed appropriate by the OECD and the European Central Bank (Boissay et al 2013), and is suggested by Berjenkenes et al (2010) as appropriate for the quarterly time series data presented in this thesis.

The original data and the Hodrick-Prescott Trend of that data are presented in the appendices (A2.11-A2.20).

The stationary variables for the construction of VAR YIELD and VAR YGAP are further discussed in the appendices (A3.0) and are presented in table 14. The development of variables for the Vector-Error Correction Model follows advice from Mulligan (2006) and Fisher (2013) and is discussed in Chapter 9 (sections 9.2.1 and 9.2.2).

Table 14: Variables for the construction of the VAR models (Chapter 8)

Variables				
Variable Description	Variable Name	Construction	Source	Movement
Measure of economic activity.	GDP	GDP/TrendGDP	Bank of England	↑ = ↑ economic activity ↓ = ↓ economic activity
Measure of the monetary base closely linked to government action.	M4	M4/TrendM4	Bank of England	↑ = ↑ M4 ↓ = ↓ M4
The ratio of end stage to initial stage output.	RESOURCES	Stationary Initial Stage Output / Stationary End Stage Output	Bank of England	↑ = ↑ initial stage production ↓ = ↓ end stage production
A proxy for the measurement of the relationship between true and artificial interest rates.	YIELD YGAP	Stationary Market Rate of Interest / Stationary Natural Rate of Interest Stationary Natural Rate of Interest – Stationary Market Rate of Interest.	Bank of England	↑ = ↑ contractionary monetary policy ↓ = ↓ expansionary monetary policy ↑ = ↓ expansionary monetary policy ↓ = ↑ contractionary monetary policy
A measure for the relationship between investment and consumption in the economy.	INVCON	(Investment / Consumption)/Trend,	Bank of England	↑ = ↑ investment ↓ = ↑ consumption

6.6 Descriptive Statistics

In accordance with Keeler (2001), the thesis conducted a correlation matrix of the variables to begin an initial empirical evaluation. The following correlation Matrix of the variables presented in figure 23, gives weight to the Hayekian view of money supply growing above trend being positively correlated with the interest rate as predicted by Hayek's theory of the trade cycle, however the findings are not consistent with Keeler's (2001) demonstration with a negative correlation with expansionary monetary policy. This correlation of 0.4519 is both strong (Pallant 2005) and significant at the 1% level. The correlation of YIELD and RESOURCES -0.433 is likewise strong and highly significant. This glimpse into the relationships between the variables is suggestive of support for Hayek's Business Cycle Theory and invites further consideration. The thesis presents a detailed empirical evaluation in Chapters 7, 8 and 9, interpreting the results from this evaluation in Chapter 10 and discussing the implications of these in Chapter 11.

Figure 13: Correlation Matrix of the Variables

	GDP	**M4**	**INVCON**	**YIELD**
M4	0.5921***			
INVCON	0.8191***	0.4275***		
YIELD	0.5903***	0.4519***	0.672***	
RESOURCES	-0.3656***	-0.2705**	-0.511***	-0.433***

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

6.7 Chapter Summary

Chapter 6 of the thesis presents the data used for the empirical evaluation of Hayek's theory of the trade cycle. The data is obtained from the Bank of England Statistical Service and can be judged to be highly reliable.

When required the data is made stationary in a manner acceptable to Hayekian Thought by using a Hodrick-Prescott Filter to de-trend data containing a unit root, which is identified using a Modified Dicky-Fuller Test.

Variables are then created in line with the Austrian-Econometric Literature and an initial correlation matrix examination as per Keeler (2001) suggests some support for Hayek's theory of the trade cycle.

This data chapter identifies the data as reliable and demonstrates its preparation for the thesis evaluation. The data used in the thesis itself represents a contribution to knowledge as it has not been analysed in any of the reviewed Austrian econometric literature.

Chapter 7: Initial statistical analysis

7.1 Introduction

This Chapter presents an initial statistical analysis of the data in order to begin to determine the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle. This initial statistical analysis fully addresses hypotheses 3-5 and provides further insight for the remaining Second Order Prediction evaluation and hypothesis testing.

Ordinary Least Squares Regression is used to examine relationships in the data and is conducted with output as the dependant variable, summarised in section 7.5. Univariate Regressions are used to examine each Second Order Prediction of the HTTC in section 7.6, and in section 7.8, Finite Distributed Lag Models are used to investigate the existence of endogenous turning points in the effects of YIELD, m4 and YGAP on Economic Activity in accordance with Carilli & Dempster (2008).

This chapter provides tests of hypotheses 3-5, by constructing a finite distributed lag model (in accordance with Carilli & Dempster 2008) to investigate the existence of 'singularly Austrian' endogenous turning points required by Hayek's theory of the Trade Cycle whilst furthering understanding of the relationships between the variables.

7.2 Initial Statistical Analysis

This thesis provides an empirical evaluation of the following second order predictions (SOPs) and hypotheses in order to examine the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle.

The following regression models examine the relationships expressed in the SOPs and the Finite Distributed Lag Models address Hypotheses 3-5 (The Second Order Predictions and Hypotheses are presented in Chapter 5, section 5.8).

7.3 OLS Regression (Model 1)

Table 15: OLS Model 1

Source	SS	df	MS	Number of obs	=	120
				F(4, 115)	=	85.71
Model	0.015779	4	0.00394	Prob > F	=	0.0000
Residual	0.005292	115	0.00004	R2	=	0.7488
				Adj R2	=	0.7401
Total	0.021071	119	0.000177	Root MSE	=	0.00678
GDP	Coef.	Std. Err.	t		P>t	
RESOURCES	0.0337738	0.020044	1.68		0.095	
INVCON	0.2749652	0.0252262	10.90		0.000	
M4	0.0163038	0.0028766	5.67		0.000	
YIELD	-0.00021	0.005058	-0.04		0.966	
_cons	0.6754427	0.035502	19.03		0.000	.

In the above model (table 15), GDP is regressed on four independent variables; RESOURCES, INVCON, M4 and YIELD. To recap GDP is the measure of economic activity for the UK economy, RESOURCES is the shift from initial stage to end stage production, INVCON is the ratio of investment to consumption in the economy, M4 is the amount of new deposits created in the economy (used as the Austrian proxy for money as M0 would be too restrictive not capturing the ‘fiduciary media’ created through the Fractional Reserve Banking System) and YIELD represents the movement of the market rate of interest from the natural rate. For the Austrian School of Economic Thought, the ‘true’ value of economic activity is not simply the observed exchange value captured through the GDP measure, but is the aggregated subjective measure of perceived value per individual per unit of economic action. This is however fundamentally unobservable (Mulligan 2006) and prevents empirical analysis of Austrian Theory. As such the traditional GDP measure will be used to allow comparison, this will be acceptable to the Austrians as in essence the subjective view must be able to be reduced to (GDP + Subjective Premium) as any actor when making the decision of economic activity must value the subjective activity at least equal to the measurable cost or it would not occur. Therefore the traditional GDP measure for the Austrian School must be at worst less than (but possibly equal too) the subjective measure of activity. Mulligan (2006), Keeler (2001), Wainhouse (1984) and every reviewed piece of Austrian Econometric Literature consider the traditional measure of GDP at least an appropriate proxy measurement.

Beginning with the calculated F-TEST, the output confirms that the null hypothesis that all model coefficients are 0 can be rejected with high confidence ($F_{3,116}$: Prob>F=0.0000), with the rejection of this null hypothesis the coefficients of the regression equation can be examined, the coefficients are the beta estimates or the slope coefficients in a regression line.

Firstly the coefficient on the constant term (_cons) can be considered, this coefficient is large and highly significant and is the intercept for the regression line, that is the value of the dependant variable (GDP) if all independent variables were set to zero in the model. However the variables RESOURCES, INVCON and YIELD are ratios, representing movements in economic activity or rates and as such cannot be zero, thus the value of the constant in a regression investigating Hayek's theory of the trade cycle is limited.

However the magnitude and significance of the other coefficients is of far more value in the investigation of the relevance of Hayek's theory of the trade cycle for the UK economy. The coefficients for the independent variables are shown below in table 16:

Table 16: Variable Coefficients (OLS Model 1)

Variable	Coefficient
RESOURCES	0.0337738
INVCON	0.2749652
M4	0.0163038
YIELD	-0.00021

In terms of magnitude, what is the importance of these coefficients? Whilst the importance of the magnitude is at least ‘partly a judgement call’ (Becketti 2013), it will be useful to see how the independent variables each effect the dependant as they are increased (or decreased) by their own standard deviation and if they have a proportionally greater affect. The standard deviation of the dependant variable GDP is 0.133069 and the standard deviation of the independent variables is shown below in table 17:

Table 17: Variable Standard Deviations (OLS Model 1)

Variable	Standard Deviation
RESOURCES	0.0364771
INVCON	0.0357612
M4	0.246865
YIELD	0.1727185

Thus, if the independent variable were increased by one of its own standard deviations, it will Effect the dependant variable (GDP), displayed in table 18:

Table 18: Variable effect on GDP (OLS Model 1)

Variable	Standard Deviation	Coefficient	Effect on GDP
RESOURCES	0.0364771	0.0337738	0.00123197
INVCON	0.0357612	0.2749652	0.009833086
M4	0.246865	0.0163038	0.004024838
YIELD	0.1727185	-0.00021	-0.000036

It can clearly be seen that the magnitude of the coefficient of the independent variable YIELD has a negligible effect on GDP, which will be discussed further later in this section, however the negligible magnitude of this independent variable is noted and the variable YIELD appears at this stage to have a very small effect on GDP querying the relevance of the Hayek's theory of the trade cycle for the UK economy. The remaining independent variables (RESOURCES, INVCON and M4) can be seen above to have an effect on GDP, this effect can be seen below in table 19, as a percentage of a standard deviation of the variable GDP.

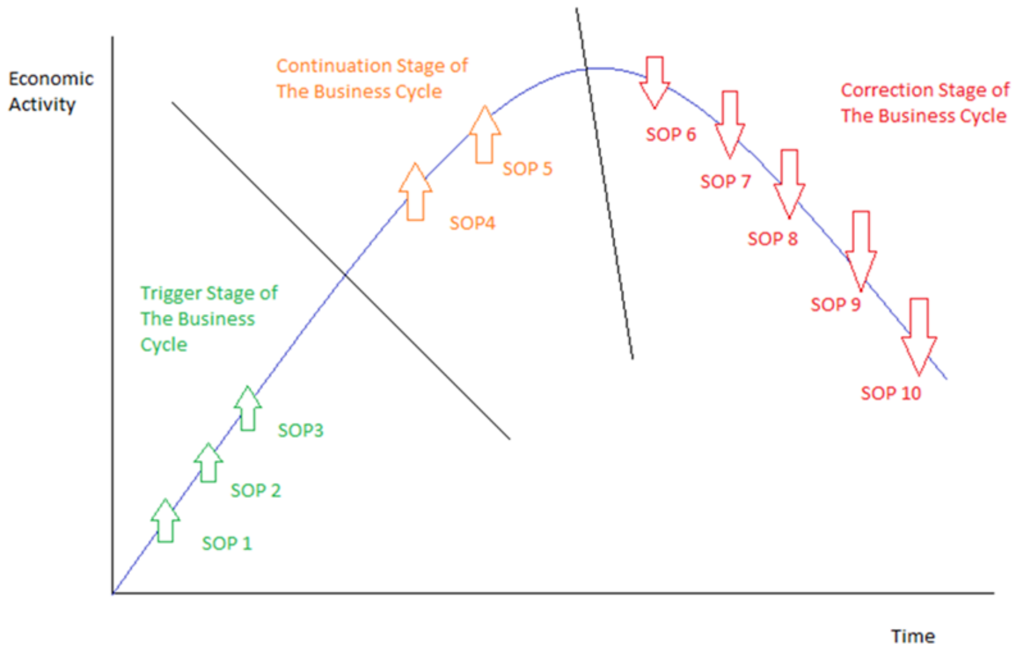
Table 19: Variable effect (%) on GDP (Model 1)

Variable	Standard Deviation	Coefficient	Effect on GDP	% of GDP SD
RESOURCES	0.0364771	0.0337738	0.00123197	0.925812924
INVCON	0.0357612	0.2749652	0.009833086	7.389464113
M4	0.246865	0.0163038	0.004024838	3.024624819
YIELD	0.1727185	-0.00021	-0.000036	-0.027053634

An increase in the independent variable RESOURCES by one standard deviation results in an increase in GDP by close to 1% of a standard deviation, an increase in INVCON by one standard deviation results in an increase in GDP by close to 7.5% of a standard deviation and a one standard deviation increase in M4 results in an increase in GDP by 3% of a standard deviation. An increase in the independent variable YIELD by one standard deviation results in a negligible decrease in GDP by 0.03% of a standard deviation.

However in terms of magnitude of coefficient, the nature of the variables themselves, suggest caution in making far reaching conclusions from the descriptive statistics. Hayek's theory of the trade cycle suggests a chain reaction and a combination of factors explaining the change in GDP, rather than individual components and the ratio nature of the variables tend to maintain GDP up to a tipping point within Hayek's theory of the trade cycle. This can be seen below in figure 14:

Figure 14: SOPs at stages of the trade cycle



The statistical significance of the estimated coefficient is in effect the 'precision of the estimate' (Pallant 2005), the p values reported in the output for model 1 is the statistical significance of the coefficient estimates. The constant is reported as being highly significant at the 0.000 level, however as mentioned earlier the value of the constant is limited with the nature of the independent variables. The YIELD coefficient is reported as being highly non-significant, that is a p value of 0.966, the implications of which for Hayek's theory of the trade cycle, are discussed in Chapter 11. The remainder of the independent variable coefficients are reported with various strengths of significance, shown below in table 20:

Table 20: Significance of Coefficients (OLS Model 1)

Variable	Coefficient	p Value
RESOURCES	0.0337738	0.095
INVCON	0.2749652	0.000
M4	0.0163038	0.000
YIELD	-0.00021	0.966

The coefficient of the independent variable, RESOURCES is significant at the 90% level with P<0.01 and the coefficients of the independent variables INVCON and M4 are significant at the 99.99% level with P<0.000.

The R2 of the model is generally summarised to the percentage of variance explained (Pallant 2005), that is how much of the variance of the dependant variable is explained by the model i.e. how much of the variance of GDP is explained by the model. For the above model, 74.88% of the variance of GDP is explained by the independent variables. This is quite a high value, within the social sciences, approx. 50% is considered fairly high[64] (Becketti 2013) with above 60% being classes as a strong result (Pallant 2005). An Adjusted R2 has also been calculated, which is a reassessment of the 'goodness of fit' penalising the model for extra independent variables, the AR2 is 74.01% which is only slightly different from the R2. This is not unexpected as the model has a robust number of observations (120) and standard advice (Dougherty 2002,Becketti 2013) suggesting the AR2 figure for models with observations less than 30.

To summarize, a regression with the dependant variable GDP and independent variables RESOURCES, INVCON,M4, YIELD (Remembering all variables have been made stationary and checked to ensure a robust model) explains approximately 75% of the variance of GDP. The variables RESOURCES, INVCON and M4 all have a statistically significant effect on GDP in terms of magnitude of coefficient. The independent variable YIELD, both in terms of statistical significance and magnitude of coefficient appears to have little effect on GDP. The implications of this for the relevance of Hayek's theory of the trade cycle will be discussed in a following section, however it would be prudent to run the model without the variable YIELD to examine the effect of RESOURCES, INVCON and M4 on GDP with the higher degree of freedom

[64] For de-trended data.

resulting from the removal of an independent variable. This regression model is shown below in table 21.

7.4 OLS Model 2:

Table 21: OLS Model of Hayek's theory of the trade cycle (2)

Source	SS	df	MS	Number of obs	=	120
				F(3, 116)	=	115.27
Model	0.015779	3	0.00526	Prob > F	=	0.0000
Residual	0.005293	116	4.56E-05	R2	=	0.7488
				Adj R2	=	0.7423
Total	0.021072	119	0.000177	Root MSE	=	0.00675
GDP	Coef.	Std. Err.	t		P>t	
RESOURCES	0.033884	0.019793	1.71		0.090	
INVCON	0.274408	0.021501	12.76		0.000	
M4	0.016274	0.002781	5.85		0.000	
_cons	0.675705	0.034817	19.41		0.000	.

Immediately it can be seen that the AR2 is negligibly improved from 74.01% in model 1 to 74.23% in model 2.

In the above model, GDP is regressed on three independent variables; RESOURCES, INVCON, M4 and M4. Returning to the calculated F-TEST, the output confirms that the null hypothesis that all model coefficients are 0 can be rejected with high confidence (F3,116: Prob>F=0.0000).

As per model 1 the coefficient on the constant term (_cons) can be considered, this coefficient is large and highly significant and is the intercept for the regression line, that is the value of the dependant variable (GDP) if all independent variables were set to zero in the model. However as in model 1, the variables RESOURCES and INVCON are ratios, representing movements in economic activity or rates and as such cannot be zero, thus the value of the constant in a regression investigating Hayek's theory of the trade cycle is limited.

In terms of the magnitude:

Table 22: Variable Coefficients (Model 2)

Variable	Coefficient
RESOURCES	0.033884
INVCON	0.274408
M4	0.016274

Remembering it is useful to assess these magnitudes in terms of their standard deviation. The standard deviation of the dependant variable GDP is 0.133069 and the standard deviation of the independent variables is shown below:

Table 23: Variable Standard Deviations (Model 2)

Variable	Standard Deviation
RESOURCES	0.0364771
INVCON	0.0357612
M4	0.246865

As before, if the independent variable were increased by one of its own standard deviations, it will affect the dependant variable (GDP), by:

Table 24: Effect on GDP (Model 2)

Variable	Standard Deviation	Coefficient	Effect on GDP
RESOURCES	0.0364771	0.033884	0.00123599
INVCON	0.0357612	0.274408	0.009813159
M4	0.246865	0.016274	0.004017481

And, as previously, the effect on a standard deviation of the dependant variable can be seen as a percentage:

Table 25: % Effect on GDP (Model 2)

Variable	Standard Deviation	Coefficient	Effect on GDP	% of GDP SD
RESOURCES	0.0364771	0.033884	0.00123599	0.928833913
INVCON	0.0357612	0.274408	0.009813159	7.374489175
M4	0.246865	0.016274	0.004017481	3.019096108

An increase in the independent variable RESOURCES by one standard deviation results in an increase in GDP by close to 1% of a standard deviation, an increase in INVCON by one standard deviation results in an increase in GDP by close to 7.5% of a standard deviation and a one standard deviation increase in M4 results in an increase in GDP by 3% of a standard deviation. An increase in the independent variable YIELD by one standard deviation results in a negligible decrease in GDP by 0.03% of a standard deviation. These percentages are very similar to model 1, remembering that in terms of magnitude of coefficient, the nature of the variables themselves, suggest caution in making far reaching conclusions from the descriptive statistics.

In terms of statistical significance, the picture is again very similar to model 1, however the significance of the RESOURCES variable has increased slightly:

Table 26: Significance of Coefficients (Model 2)

Variable	Coefficient	p Value
RESOURCES	0.033884	0.090
INVCON	0.274408	0.000
M4	0.016274	0.000

The coefficient of the independent variable, RESOURCES is significant at the 90% level with $P<0.01$ and the coefficients of the independent variables INVCON and M4 are significant at the 99.99% level with $P<0.000$. In essence the statistical significance of the variables RESOURCES, INVCON and M4 is maintained with the removal of YIELD as an independent variable.

7.5 Summary of the Models:

Table 27: Summary of the OLS Models of HTTC

	Model 1	Model 2
R2	0.7488	0.7488
AR2	0.7401	0.7423
P>F statistic	0.0000	0.0000

Variable	Model 1		Model 2	
	Coefficient	P Value	Coefficient	P Value
RESOURCES	0.0337738	0.095	0.033884	0.090
INVCON	0.2749652	0.000	0.274408	0.000
M4	0.0163038	0.000	0.016274	0.000
YIELD	-0.00021	0.966	n/a	n/a

It is clear from the above that the above that the variable YIELD has little impact on the dependant variable GDP within the multi-variate linear regression model, however given its importance in Hayek's theory of the trade cycle, this variable should be explored further:

To recap the variable YIELD represents the divergence of the market rate of interest from the natural or 'true' rate of interest and is constructed as the Stationary Market Rate of Interest / Stationary Natural Rate of Interest smoothed with a moving average of two lags, current observation and one lead observation.

The literature (Keeler 2001,Mulligan 2006 etc) would suggest that the YIELD variable may have an effect on GDP and as such can be considered in a univariate linear regression model, displayed in table 28.

Table 28: Univariate Regression GDP dependant, YIELD independent

Source	SS	df	MS	Number of obs	=	120
				F(1, 118)	=	63.12
Model	0.0073437	1	0.00734	Prob > F	=	0.0000

Residual	0.0137281	118	0.00011	R2	=	0.3485
				Adj R2	=	0.3430
Total	0.0210719	119	0.000177	Root MSE	=	0.01079
GDP	Coef.	Std. Err.	t		P>t	
YIELD	0.0454828	0.005724	7.95		0.000	
_cons	0.9546751	0.005722	166.83		0.000	.

The first observation from this simple test is that the independent variable YIELD alone explains around 35% of the variance of the dependant variable, GDP. Secondly the F statistic allows for rejection of the null hypothesis that the coefficient is zero and that the coefficient estimate for YIELD is highly statistically significant at the 99.9% level with the magnitude of the coefficient increasing considerably from model 1:

Table 29: YIELD effect on GDP

Variable	Standard Deviation	Coefficient	Effect on GDP	% of GDP SD
YIELD	0.1727185	0.0454828	0.007855721	5.903494

When considering the variable YIELD, the function of this variable in Hayek's theory of the trade cycle is as a trigger mechanism, in essence the change in YIELD in the theory acts as a trigger to effect INVCON and RESOURCES which in turn effects GDP in accordance with Hayek's theory of the trade cycle. It would therefore be appropriate to create a simple univariate regression of YIELD on INVCON and a univariate regression of YIELD on RESOURCES to further explore the impact of this variable considered key in Hayek's theory of the trade cycle, shown below in tables 30, 32 and 34.

7.6 Univariate Regressions

Table 30: INVCON dependant YIELD independent

Source	SS	df	MS	Number of obs	=	120

				F(1, 118)	=	97.16
Model	0.0687228	1	0.06872	Prob > F	=	0.0000
Residual	0.083462	118	0.0007	R2	=	0.4516
				Adj R2	=	0.4469
Total	0.1521848	119	0.00127	Root MSE	=	0.0266
INVCON	Coef.	Std. Err.	t		P>t	
YIELD	0.1391356	0.014115	9.86		0.000	
_cons	0.8614463	0.01411	61.05		0.000	.

The first observation from this simple test is that the independent variable YIELD alone explains around 45% of the variance of the dependant variable, INVCON. Secondly the F statistic allows for rejection of the null hypothesis that the coefficient is zero and that the coefficient estimate for YIELD is highly statistically significant at the 99.9% level. In terms of magnitude of coefficient, the standard deviation comparison can provide some insight (The standard deviation of INVCON is 0.0357612) :

Table 31: effect of YIELD on INVCON

Variable	Standard Deviation	Coefficient	Effect on INVCON	%INVCON SD
YIELD	0.1727185	0.1391356	0.024031292	67.19934

The magnitude of coefficient of YIELD in the univariate linear regression model suggests that this variable has a relatively considerable effect on RESOURCES. An increase in YIELD of one standard deviation results in an increase in RESOURCES of 67% of 1 standard deviation.

Table 32: RESOURCES dependant YIELD independent

Source	SS	df	MS		Number of obs	=	120
					F(1, 118)	=	27.23
Model	0.029685	1	0.02968		Prob > F	=	0.0000
Residual	0.128653	118	0.00109		R2	=	0.1875
					Adj R2	=	0.1806
Total	0.158338	119	0.00133		Root MSE	=	0.03302

RESOURCES	Coef.	Std. Err.	t			P>t	
YIELD	-0.091444	0.017525	-5.22			0.000	
_cons	1.089562	0.017518	62.20			0.000	.

The first observation from this simple test is that the independent variable YIELD alone explains around 19% of the variance of the dependant variable, RESOURCES. The F statistic allows for rejection of the null hypothesis that the coefficient is zero and that the coefficient estimate for YIELD is highly statistically significant at the 99.9% level. In terms of magnitude of coefficient, the standard deviation comparison can provide some insight (The standard deviation of RESOURCES is 0.0364771):

Table 33: effect of YIELD on RESOURCES

Variable	Standard Deviation	Coefficient	Effect on RESOURCES	%RESOURCES SD
YIELD	0.1727185	-0.091444	-0.01579	-43.2986

Here we can see, that in accordance with Hayek's theory of the trade cycle, the magnitude of the coefficient of Yield is negative supporting the inverse relationship between RESOURCES and YIELD expected from the work of de Soto (2006), Keeler (2001), Wainhouse (1984) and Mulligan (2006). The magnitude here is relatively considerable, with an increase in YIELD of one standard deviation resulting in a decrease of 43% of one standard deviation of resources.

Furthermore, within Hayek's theory of the trade cycle, one would expect YIELD to be related to M4:

Table 34: M4 dependant, YIELD independent

Source	SS	df	MS	Number of obs	=	120
				F(1, 118)	=	30.28
Model	0.498441117	1	1.48081	Prob > F	=	0.0000
Residual	5.16721228	118	0.0489	R2	=	0.2042

				Adj R2	=	0.1974
Total	5.6656534	119	0.0609	Root MSE	=	0.22116
M4	Coef.	Std. Err.	t		P>t	
YIELD	0.6458586	0.1173775	5.50		0.000	
_cons	0.3413925	0.1173338	2.91		0.004	.

With the magnitude of effect as:

Table 35: Effect of YIELD on RESOURCES

Variable	Standard Deviation	Coefficient	Effect on RESOURCES	%M4 SD
YIELD	0.1727185	0.1173775	0.02027	8.21%

7.6.1 Univariate Models of the Key Linkages in Hayek's theory of the trade cycle:

Hayek's theory of the trade cycle has several key linkages between the micro-effects (de Soto 2010), these are explored in further detail in Chapter 4 and are expressed in table 36 below.

Table 36: Linkages of Variables in Hayek's theory of the trade cycle

ΔM4→ΔYIELD	ΔGDP → ΔINVCON
ΔYIELD → ΔRESOURCES	ΔGDP → ΔRESOURCES
ΔYIELD → ΔINVCON	ΔRESOURCES→ΔYIELD
ΔRESOURCES → ΔGDP	ΔINVCON→ΔYIELD
ΔINVCON → ΔGDP	ΔYIELD→ Δ(↓)GDP

In order to begin to evaluate these linkages, a series of univariate linear regression models examining the relationships can be constructed and are summarised in table 37.

Table 37: Univariate Linear Regression Relationships of the derived Austrian Business Cycle Linkages.

Univariate Linear Regression Relationships of the derived Austrian Business Cycle Linkages.					
Dependant Variable	Independent Variable	P(F-test)	R^2	AR^2	Coefficient
YIELD	M4	0.000	0.2042	0.1974	0.3161519***
RESOURCES	YIELD	0.000	0.1875	0.1806	-0.0914442***
INVCON	YIELD	0.000	0.4516	0.4469	0.1391356***
GDP	RESOURCES	0.000	0.1337	0.1263	-0.1333699***
INVCON	GDP	0.000	0.6709	0.6681	0.3047792***
RESOURCES	GDP	0.000	0.1337	0.1263	-1.002169***
YIELD	RESOURCES	0.000	0.1875	0.1806	-2.050187***
YIELD	INVCON	0.000	0.4516	0.4469	3.245573***
GDP	YIELD	0.000	0.3485	0.3430	0.0454828***

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

However the HTTC suggests more than a simple combination of independent variables acting on GDP, it is clear in its prediction that both a market rate below the natural rate (YIELD) and an increase in fiduciary media (M4) will lead to two definite stages in GDP. Firstly through malinvestment these variables will create the boom and secondly the correction or liquidation stage, this can be seen through the coefficients in a finite distributed lag model of GDP as a function of YIELD and as a function of M4.

7.7 Endogenous Turning Points in the Data (Hypotheses 3-5)

This further consideration is, termed by Carilli & Dempster (2008), not only finding results which are consistent with Hayek's theory of the trade cycle but finding results which actually favour it above other interpretations of the business cycle. For instance the Keeler (2001) study finds evidence consistent with HTTC, however it is noted by Carilli & Dempster (2008) that the findings are also consistent with the Monetarist view and considering what ACBT has to add to Monetarist and other mainstream theories, and that an investigation into endogenous turning points, as below, into the relationship between the interest rate gap

(YGAP or YIELD) and output (GDP) would indicate a self-perpetuating cycle that is more analogous to HTTC than competing theories.

7.8 Finite Distributed Lag Models:

Thus for model 1:

$$GDP_t = \alpha + \beta_0(i_n - i_m)_t + \beta_1(i_n = i_m)_{t-1} + \cdots + \beta_p(i_n - i_m)_{t-p} + \beta_{p+1}(i_n - i_m)_{t-p-1} + \cdots + \beta_k(i_n - i_m)_{t-k} + \varepsilon_t$$

Where β_i is the coefficient on YIELD *i* periods prior to the GDP observation. If a reduction in the market rate below the natural rate of interest (YIELD) leads to an artificial expansion followed by contraction, for HTTC to hold, one would expect a definite set of interim or intermediate multipliers to be positive ($\sum_{i=0}^{p} \beta_1 > 0$) and another to be negative ($\sum_{i=0}^{p} \beta_1 < 0$).

For model 2:

$$GDP_t = \alpha + \delta_0(i_n - i_m)_t + \delta_1(i_n = i_m)_{t-1} + \cdots + \delta_p(i_n - i_m)_{t-p} + \delta_{p+1}(i_n - i_m)_{t-p-1} + \cdots + \delta_k(i_n - i_m)_{t-k} + \varepsilon_t$$

Where δ_i is the coefficient on M4 *i* periods prior to the GDP observation. If the creation of 'fiduciary media' (M4) leads to an artificial expansion followed by contraction. For HTTC to hold, one would expect a definite set of interim or intermediate multipliers to be positive ($\sum_{i=0}^{p} \delta_1 > 0$) and another to be negative ($\sum_{i=0}^{p} \delta_1 < 0$).

And for model 3:

$$GDP_t = \alpha + \gamma_0(i_n - i_m)_t + \gamma_1(i_n = i_m)_{t-1} + \cdots + \gamma_p(i_n - i_m)_{t-p} + \gamma_{p+1}(i_n - i_m)_{t-p-1} + \cdots + \gamma_k(i_n - i_m)_{t-k} + \varepsilon_t$$

Where γ_i is the coefficient on YGAP *i* periods prior to the GDP observation. If a reduction in the market rate below the natural rate of interest (YGAP) leads to an artificial expansion followed by contraction, For HTTC to hold, one would expect a definite set of interim or intermediate multipliers to be positive ($\sum_{i=0}^{p} \beta_1 > 0$) and another to be negative ($\sum_{i=0}^{p} \beta_1 < 0$).

Hayek's theory of the trade cycle suggests that the form of the finite distributed lag model would be quadratic (Carilli & Dempster 2008) and we should see more recent YIELD, m4 and YGAP alterations in accordance with HTTC increasing GDP and more distant YIELD, m4 and YGAP alterations decreasing it. Carilli & Dempster (2008) consider that "we cannot know the interval ex ante, but HTTC does predict it". (Underlining added for emphasis).

7.8.1 Lagged Effects of YIELD, YGAP and M4 on GDP:

Table 38 shows the lagged effects of YIELD, M4 and YGAP on GDP. This 'effect per lag' allows investigation into the existence of endogenous turning points in the data as per Carilli & Dempster (2008). The Term Spread column in the table presents Carilli & Dempster's (2008) results. They consider the definite positive and then negative effect periods to be evidence of an endogenous turning point in the effect of Term Spread on GDP and strong support for Hayek's theory of the trade cycle.

Table 38: Lagged effects of variables on GDP

Lag	YIELD Coefficient***	M4 Coefficient***	YGAP Coefficient***	Term Spread[65]
t	0.101605	0.976534	-0.0037994	0.00399
t-1	-0.1047058	-0.1050004	-0.0000848	0.00283
t-2	0.19823	0.0314258	-0.0004202	0.00184
t-3	-0.0109924	0.0108487	0.000448	0.00102
t-4	0.0784046	0.0418213	0.0004718	0.00036

[65] Carilli & Dempster (2008).

t-5	-0.619775	-0.61872	-0.0001443	-0.00014
t-6	-0.0064765	-0.0036186	0.0009551	-0.00047
t-7	0.0151947	0.425775	0.0007024	-0.00063
t-8	0.712036	0.0249355	-0.0001307	-0.00047
t-9	-0.0224519	-0.0085594	0.0004585	-0.00014
t-10	-0.178262	-0.0437193	0.0002134	0.00036
t-11	-0.211168	0.316596	0.0000509	0.00102
t-12	0.473678	0.219191	0.0001745	0.00017
R-Squared	56%	61%	27%	55%

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively (NB. This is the joint significance of the coefficients as per Russell & Langemeier (2015) and guidance from the STATA manual)

These results are discussed in the interpretation of findings chapter (Chapter 10), however they do suggest at least some support for the existence of the endogenous turning points predicted by Hayek's theory of the trade cycle and stated to be a unique feature of the HTTC by Carilli & Dempster (2008).

The results of all the statistical analysis presented in this chapter are interpreted in Chapter 10 and their implications discussed in Chapter 11.

7.9 Chapter Summary

This chapter presents a comprehensive initial statistical examination of the data, Ordinary Least Squares Regression Models are conducted to examine the overall relationships between the variables present in the data. The Second Order Predictions of Hayek's theory of the trade cycle are initially investigated with a series of Univariate Linear Regression Models. This examination provides an initial foundation for the approach used in Chapters 8 and 9 for the evaluation of the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle.

Hypotheses 3-5, that there are endogenous turning points in the relationship between: (H3) YIELD and GDP, (H4) YGAP and GDP and (H5) M4 and GDP are investigated using Finite Distributed Lag Models, the results of these models are interpreted further in Chapter 10 and discussed in Chapter 11, however there is clear evidence for the existence of the endogenous turning points required for the Hayek's theory of the trade cycle.

Chapter 7 presents an initial statistical evaluation of the relationships between the variables and tests hypotheses 3-5. The initial statistical evaluation reveals relationships which offer some support for the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle and leads to the more sophisticated analysis presented in Chapters 8 and 9.

Chapter 8: An empirical evaluation of Hayek's theory of the trade cycle: Vector-Auto Regression Modelling.

"The true measure of any business cycle theory in any historical period is the extent to which the economic phenomena predicted by the theory correspond to those actually observed. Note that we are talking exclusively about second order prediction here: we are not saying the value of a theory is determined by its ability to produce "true" forecasts of the future, but by its ability to produce explanations of history that correspond to observable data"

Carilli & Dempster (2008, p272)

8.1 Introduction

In this chapter, econometric evidence is compiled from recent UK data on gross domestic product (GDP), interest rates, the investment / consumption distribution of the economy, resource use in the economy and the amount of money created, to test the Second Order Prediction models of Hayek's theory of the trade cycle:

(↓)YIELD→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↑)YIELD→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

(↑)YGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)YIELD→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

The interest rate is considered both in the form of movement of market rate below (and above) the natural rate and the construction of the gap between the natural rate and the market rate of interest. The movement of the interest rate is used as a proxy for expansionary policy. Vector-Auto Regression Models (reduced form for Austrian acceptance) one incorporating the interest rate proxy YIELD (section 8.2) and one the proxy YGAP (section 8.4) and their derived Orthogonalized Impulse Response Functions (sections 8.2.2 & 8.4.2) and Granger Causality Tests (section 8.6) are used to evaluate the data against the prescriptions of the model above.

Chapter 8 presents two Vector-Auto Regression models developed in accordance with the literature to evaluate the Second Order Predictions of Hayek's theory of the trade cycle and determine its relevance for understanding the UK business cycle.

8.2 VAR Model 1 (VAR YIELD):

This section considers the validity of the Hayek's theory of the trade cycle for the UK economy via the construction of a Vector-Auto Regression Model following the guidance of Carilli and Dempster (2008), Lester & Wolf (2012) and Luther & Cohen (2014) who use similar tests on US timeseries data to evaluate Hayek's theory. Furthermore Granger Causality tests will be used *as per* much of the Austrian Literature (Wainhouse 1984 through to Dore & Singh 2012) to examine the temporal relationships of the interaction of the variables and evaluate the linkages in HTTC. The selection of variables follows the advice of Carilli & Dempster (2008), Mulligan (2006), Berjenkenes *et al*. (2010), Keeler (2001) and Wainhouse (1984) and model construction primarily follows the guidance of Carilli & Dempster (2008) with standard econometric guidance from Becketti (2013), thus having input from both sides of the Austrian / Neoclassical methodological debate.

The variables (demonstrated as stationary in Chapter 6) used to construct the VAR models in this thesis are shown in table 39.

Table 39: variables for VAR Construction

Variables				
Variable Description	Variable Name	Construction	Source	Movement
Measure of economic activity.	GDP	GDP/TrendGDP	Bank of England	↑ = ↑ economic activity ↓ = ↓ economic activity
Measure of the monetary base closely linked to government action.	M4	M4/TrendM4	Bank of England	↑ = ↑ M4 ↓ = ↓ M4
The ratio of end stage to initial stage output.	RESOURCES	Stationary Initial Stage Output / Stationary End Stage Output	Bank of England	↑ = ↑ initial stage production ↓ = ↓ end stage production
A proxy for the measurement of the relationship between true and artificial interest rates.	YIELD YGAP	Stationary Market Rate of Interest / Stationary Natural Rate of Interest Stationary Natural Rate of Interest – Stationary Market Rate of Interest.	Bank of England	↑ = ↑ contractionary monetary policy ↓ = ↓ expansionary monetary policy ↑ = ↓ expansionary monetary policy ↓ = ↑ contractionary monetary policy
A measure for the relationship between investment and consumption in the economy.	INVCON	(Investment / Consumption)/Trend,	Bank of England	↑ = ↑ investment ↓ = ↑ consumption

In order to evaluate the validity of Hayek's theory of the trade cycle for the UK economy and determine the relationship between GDP, YIELD, M4, INVCON and RESOURCES this thesis will specify the following Vector-Auto Regression Model:

$$\alpha(t) = A(L)\alpha(t-1) + B(L)\beta(t-1) + C(L)\gamma(t-1) + D(L)\delta(t-1) + E(L)\theta(t-1) + u(t)$$

$$\beta(t) = F(L)\alpha(t-1) + G(L)\beta(t-1) + H(L)\gamma(t-1) + I(L)\delta(t-1) + J(L)\theta(t-1) + v(t)$$

$$\gamma(t) = K(L)\alpha(t-1) + Z(L)\beta(t-1) + M(L)\gamma(t-1) + N(L)\delta(t-1) + O(L)\theta(t-1) + w(t)$$

$$\delta(t) = P(L)\alpha(t-1) + Q(L)\beta(t-1) + R(L)\gamma(t-1) + S(L)\delta(t-1) + T(L)\theta(t-1) + y(t)$$

$$\theta(t) = U(L)\alpha(t-1) + V(L)\beta(t-1) + W(L)\gamma(t-1) + X(L)\delta(t-1) + Y(L)\theta(t-1) + z(t)$$

Where *α(t)* represents the change in GDP at time t, *β(t)* the change in YIELD at time t, *γ(t)* the change in M4 at time t, *δ(t)* the change in INVCON at time t, and *ϑ(t)* the change in RESOURCES at time t. *A(L), B(L), C(L), D(L), E(L), F(L), G(L), H(L), I(L), J(L), K(L), Z(L), M(L), N(L), O(L), P(L), Q(L), R(L), S(L), T(L), U(L), V(L), W(L), X(L),* and, *Y(L)* are lag operators and *u(t), v(t), w(t), y(t)* and, *z(t)* are random (white noise) error terms.

The first step in the construction of the Vector-Auto Regression Model is the calculation of the number of lags to include in the model. Becketti (2013) considers it is standard to calculate four different information criteria, confirmed from the Austrian perspective by Carilli & Dempster (2008), these are:

1. Akaike's final prediction error (FPE).
2. Akaike's information criterion (AIC).
3. Hannan and Quinn's information criterion (HQIC).
4. Schwarz's Bayesian information criterion (SBIC).

These information criteria are based on information theory and demonstrate the information lost with different specifications of fit, Stock and Watson (2001), provide a guide to VAR specification which is used for advice throughout this section and in particular include an intuitive description of the various information criteria.

The information criteria for the UK timeseries variables are shown in table 40:

Table 40: Information Criteria VAR (YIELD)

lag	Degree of Freedom	p	FPE	AIC	HQIC	SBIC
0	25	0.000	3.3e-14	-16.8382	-16.7773	-16.686
1	25	0.000	2.0e-18	-26.5755	-26.2102	-25.6623
2	25	0.000	2.1e-19*	-28.8369	-28.1673*	-27.1628*
3	25	0.000	2.1e-19	-28.8511	-27.877	-26.416
4	25	0.000	2.2e-19	-28.858*	-27.5796	-25.6619

*preferred value

The lag length which produces the minimum value of the information statistic is the preferred solution, for the UK timeseries variables Akaike's final prediction error, Hannan and Quinn's information criterion and Schwarz's Bayesian information criterion prefer 2 lags whilst Akaike's information criterion prefers 4 lags. Becketti (2013) states that it is common to for the various information criteria to produce differing results and that a decision must be made informed by theory and previous research. Lütkepohl (2005) considers that Schwarz's Bayesian information criterion and Hannan and Quinn's information criterion provide consistent estimates of the true lag order whilst the Akaike's final prediction error and Akaike's information criterion can overestimate the lag order suggesting that 2 lags is appropriate. The 2 lags choice is also supported by the literature with Carilli and Dempster suggesting it appropriate for a similar Vector-Auto Regression model with comparable variables evaluating Hayek's theory of the trade cycle in US Timeseries data. Thus using the selected lag order, having previously made the variables stationary, a Vector-Auto Regression (VAR) model specifying 2 lags can be constructed. The output is summarised in table 41.

Table 41: VAR (YIELD) Model of Hayek's theory of the trade cycle

Equation	R-Square	Chi-Square		
GDP	0.9790	0.3676137***		
Coefficients				
GDP	RESOURCES	YIELD	M4	INVCON
0.967918**	-0.0609	0.05418**	-0.0077**	0.007893
Equation	R-Square	Chi-Square		
RESOURCES	0.9251	975.7678***		
Coefficients				
GDP	RESOURCES	YIELD	M4	INVCON
-1.05764**	0.025316	0.74897***	-0.01278	0.135985
Equation	R-Square	Chi-Square		
YIELD	0.9396	1228.15***		
Coefficients				
GDP	RESOURCES	YIELD	M4	INVCON
2.695254*	0.744851***	-0.30977	-0.02938	0.049086
Equation	R-Square	Chi-Square		
M4	0.8946	670.4864***		
Coefficients				
GDP	RESOURCES	YIELD	M4	INVCON
15.8445***	0.131375	0.9655**	0.346041***	-2.37461**
Equation	R-Square	Chi-Square		
INVCON	0.9554	1691.419***		
Coefficients				
GDP	RESOURCES	YIELD	M4	INVCON
0.734**	0.064335	-0.00315	0.00981	0.603099***

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

The R-Square is relatively high for each equation, though the M4 equation at 89% is slightly lower than the others. The information criteria are shown below in table 42.

Table 42: Information Criterion VAR (YIELD)

Information Criterion	Value
AIC	5.413556
HQIC	5.711566
SBIC	6.147689

8.2.1 Testing the Constructed VAR model:

A univariate autoregressive process is stationary if all the roots of $\phi(z)=0$ lie outside the unit circle. For a VAR the process is similar, it is stationary of all the roots of:

$$|\phi(z)|=0$$

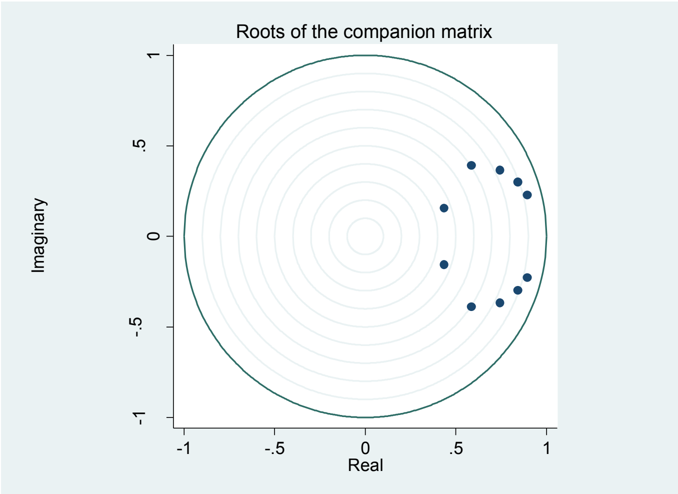
Lie outside the unit circle (Becketti 2013, Hamilton 1994), this must mean that a VAR is stationary if all the eigenvalues of the companion matrix must lie inside the unit circle, shown below in table 43 and figure 15.

Table 43: Eigenvalue Stability Conditions

Eigenvalue	Modulus
0.8938774+0.2279731i	0.92249
0.8938774-0.2279731i	0.92249
0.8426053+0.2993211i	0.894191
0.8426053-0.2993211i	0.894191
0.7453366-0.3664219i	0.830537
0.7453366+0.3664219i	0.830537
0.5847108+0.3903178i	0.703018
0.5847108-0.3903178i	0.703018
0.435488+0.155825i	0.462527
0.435488-0.155825i	0.462527

All the eigenvalues lie inside the unit circle demonstrating that the VAR model satisfies the stability condition, this is easily seen in figure 15:

Figure 15: Roots of the Companion Matrix (VAR YIELD)



In the VAR model there are five variables (n=5) and two lags (p=2) resulting in ten (np) eigenvalues, in actuality there are five pairs of eigenvalues as complex roots always come as a pair of complex complements (Becketti 2013). Whilst it is clear that all the eigenvalues lie inside the unit circle, on pair is relatively close to the limit indicating that some shocks within the model may not die out quickly potentially supporting the Austrian view of cumulative progress or links of micro effects resulting in long term impact.

The lag decision for the model was estimated pre-construction, informed by a variety of information criterion and the similar model in Carilli & Dempster (2008), however a formal test of the significance of the lag in each VAR equation are performed after construction of the model and detailed below in table 44.

Table 44: Lag Significance in each VAR equation (VAR YIELD)

Equation GDP	
Lag	Chi^2
1	549.2625***
2	119.641***
Equation RESOURCES	
Lag	Chi^2

1 2	208.8973*** 33.46573***
Equation YIELD	
Lag 1 2	Chi^2 369.744*** 83.293**
Equation M4	
Lag 1 2	Chi^2 111.7072*** 14.59844**
Equation INVCON	
Lag 1 2	Chi^2 568.6521*** 136.2854***
Equation All	
Lag 1 2	Chi^2 1752.706*** 367.639***

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

It can be seen that in agreement with the original information criterion tests, that both lags are highly significant (usually at the 1% level) for all individual equations and both lags are considered highly significant at the 1% level when the VAR as a whole is considered.

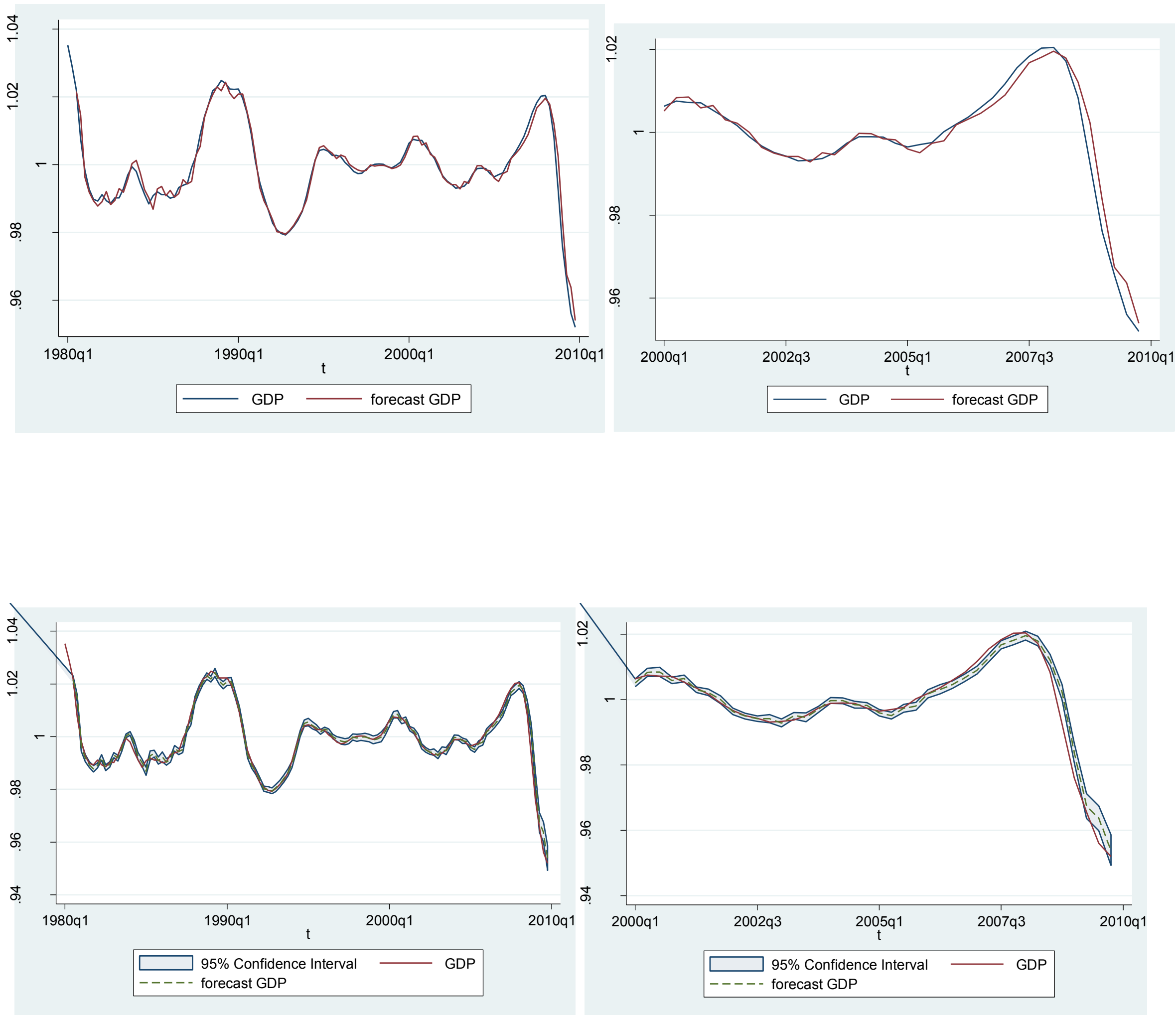
A strength of the VAR model is in forecasting, however as this would be considered anathema from the Misean Austrian perspective, the forecasts generated will be used to create historical forecasts for evaluation of the model as shown in table 45.

Table 45: One step ahead forecasts (VAR YIELD)

Variable	Mean	Standard Deviation
Observed GDP Forecast GDP	0.9994629 0.9990814	0.0133069 0.0121289
Observed YIELD Forecast YIELD	0.9847196 0.9863671	0.1727185 0.1548441
Observed M4 Forecast M4	0.9773822 0.9850581	0.246865 0.2107624
Observed RESOURCES Forecast RESOURCES	0.9995151 0.9998867	0.0364771 0.0344337
Observed INVCON Forecast INVCON	0.9984559 0.9978756	0.0357612 0.0334788

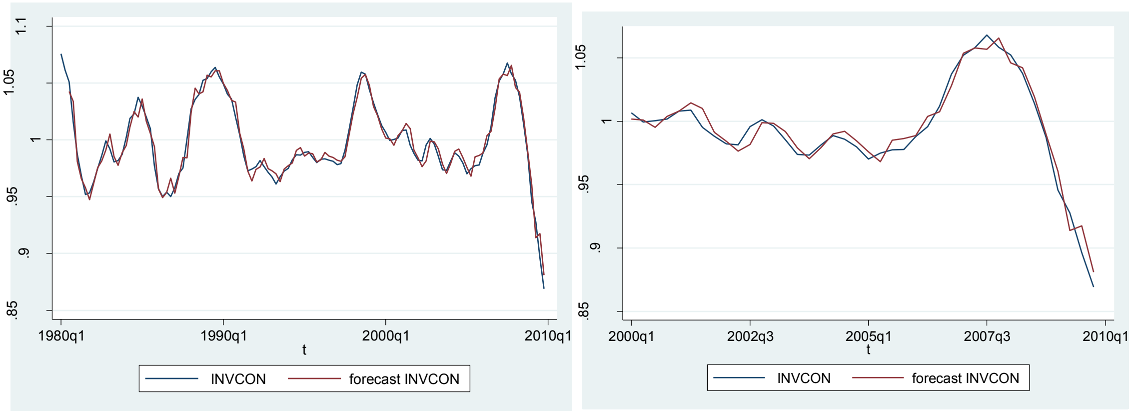
In terms of GDP and forecast GDP, qualitatively it can be seen that the generated forecast is reasonably matched to observed GDP over the period. It can also be seen, in accordance with Evans and Baxendale (2008), the Austrian Variable VAR forecast GDP is consistent with the turbulent crisis period in the UK time series shown in figure 16.

Figure 16: Forecast GDP (VAR YIELD)



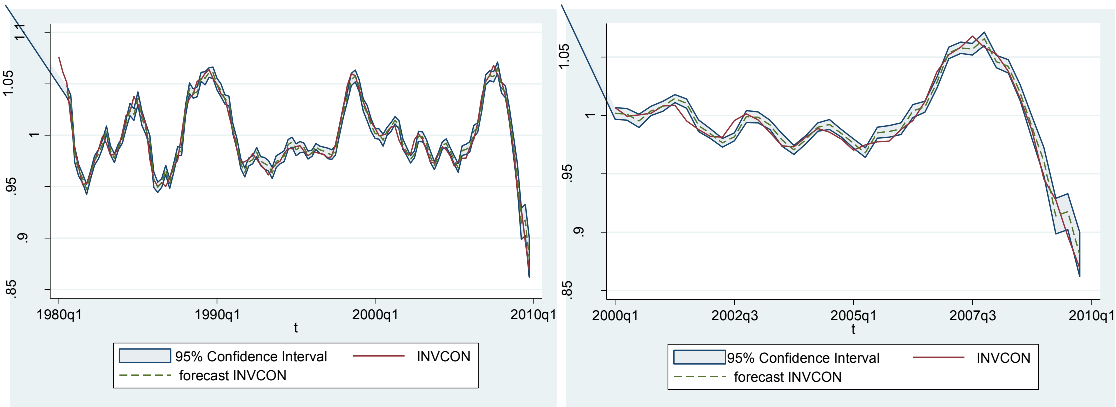
Consistent with the expectations of Becketti (2013), the uncertainty around the forecasts increases (the confidence interval widens) with the onset of the global financial crisis, however the forecasts are more consistent than the non-Austrian variable VAR reported in the Chapter 10.

Figure 17: Forecast INVCON (VAR YIELD)



The forecasts for INVCON (shown in figure 17 & 18) are again relatively consistent with the observations, though of consideration for Austrian evaluation, the lag difference of prediction to observation increases in the crisis period.

Figure 18: Forecast INVCON 95% Confidence Interval (VAR YIELD)



The uncertainty noticeably increases in the crisis period, and the potential link of HTTC of a sudden shift in the investment / consumption ratio appears valid.

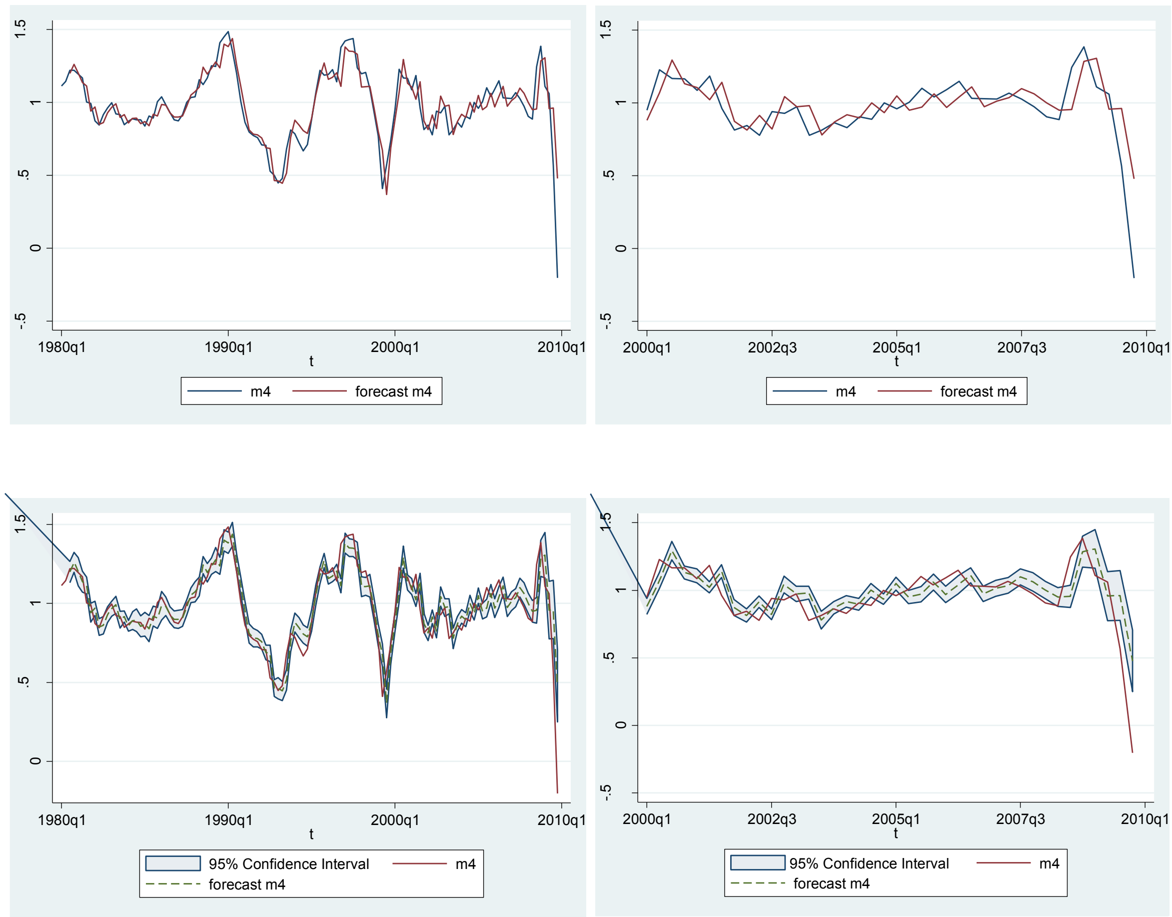
Figure 19: Forecast YIELD (VAR YIELD)

YIELD forecasts (shown in figures 19 &20) are again relatively consistent, though it must be noted that in sample forecasts rarely diverge too far from the observations, as they are informed by the previous observation.

Figure 20 Forecast YIELD 95% Confidence Interval (VAR YIELD)

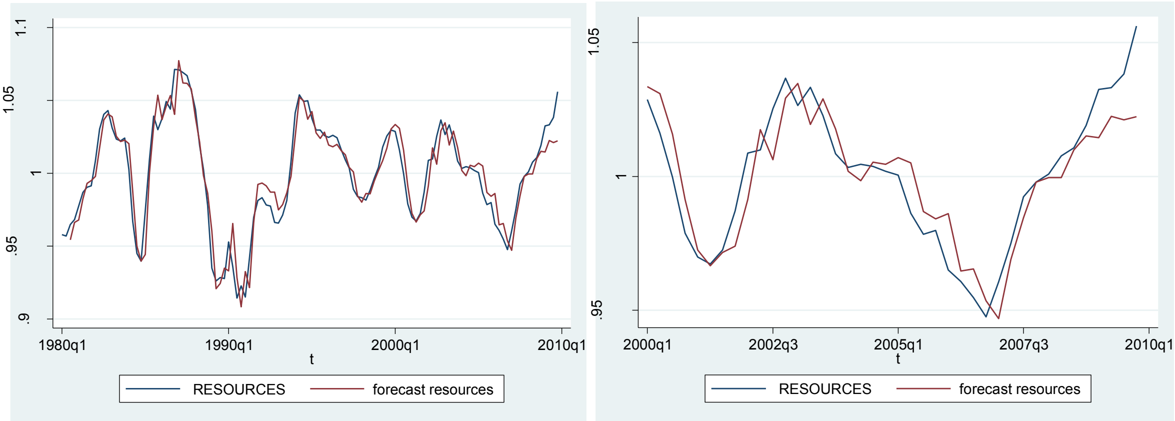
Again the forecast uncertainty increases in the crisis period, however the model produces relatively consistent forecasts throughout the timeseries.

Figure 21: Forecast M4 (VAR YIELD)



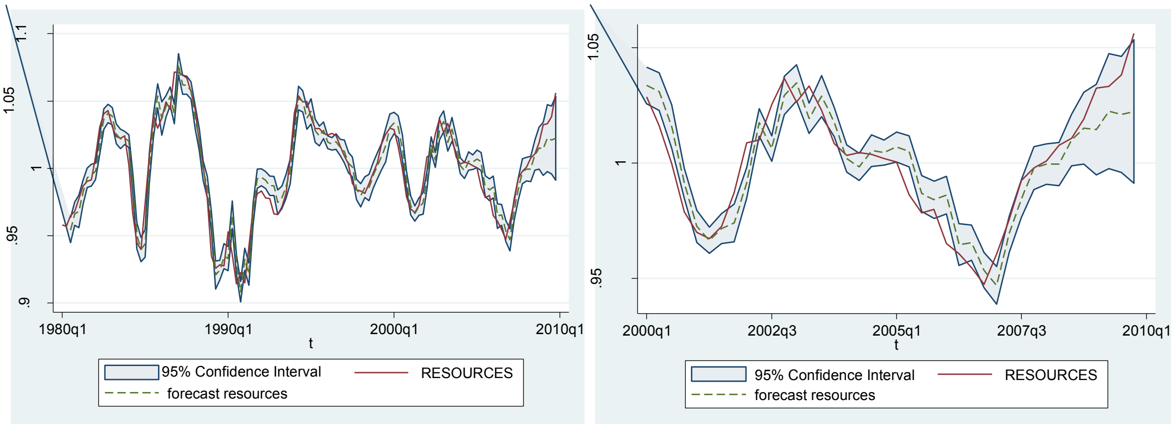
M4 produces a noticeably poorer forecast throughout (shown in figure 21), though it should be noted that these forecasts are far more consistent with actual M4, than the VAR using a standard interest rate variable reported in Chapter 10.

Figure 22 Forecast RESOURCES (VAR YIELD)



The RESOURCES forecasts (figures 22 &23) tend to be less consistent with the actual observations toward the end of the period. Whilst this VAR appears an improvement on a standard interest rate variable VAR, the Austrian Econometric literature (e.g. Keeler 2001, Wainhouse 1984, Mulligan 2006) consider the Austrian interest rate proxy variable a contentious choice. Within the VAR model the choice of variable YIELD could affect the RESOURCE forecasts and a second suggested variable for Austrian interest rate (YGAP) will be used to construct a similar VAR for comparison and further evaluation.

Figure 23: Forecast RESOURCES 95% Confidence interval (VAR YIELD)



As expected the uncertainty around the RESOURCES forecasts increases with the onset of the global financial crisis, HTTC suggests that the interest rate variable will have a large effect here and the following YGAP VAR will provide further illumination on this variable.

This is a qualitative view of the efficacy of this VAR, however it is also useful to see the Root Mean Square Error (RMSE) of these forecasts compared to other simpler tests, in particular calculating the RMSE for each forecast horizon of the VAR and forecasts produced by the mean, random walk and a univariate autoregression. These results are shown in table 46

Table 46 RMSE Comparison (VAR 1):

Equation	Method				% improvement		
GDP							
Horizon	Mean (M)	Random Walk (RW)	Univariate Autoregression (AR)	Vector-Autoregression	M	RW	AR
2	0.01	0.00	0.01	0.00	69	24	67
4	0.01	0.01	0.01	0.01	19	14	15
8	0.02	0.02	0.02	0.02	-4	23	-2
YIELD							
Horizon	Mean (M)	Random Walk (RW)	Univariate Autoregression (AR)	Vector-Autoregression	M	RW	AR
2	0.13	008	0.13	0.06	52	20	51
4	0.13	0.14	0.13	0.11	14	20	13
8	0.26	0.33	0.27	0.26	3	22	3
RESOURCES							
Horizon	Mean (M)	Random Walk (RW)	Univariate Autoregression (AR)	Vector-Autoregression	M	RW	AR
2	0.02	0.02	0.02	0.02	28	8	25
4	0.02	0.03	0.02	0.03	-13	11	-16
8	0.03	0.04	0.03	0.04	-28	18	-26
M4							
Horizon	Mean (M)	Random Walk (RW)	Univariate Autoregression (AR)	Vector-Autoregression	M	RW	AR
2	0.12	0.11	0.11	0.12	1	-2	-2
4	0.14	0.17	0.14	0.15	-6	14	-7
8	0.26	0.29	0.26	0.29	-12	2	-11
INVCON							

Horizon	Mean (M)	Random Walk (RW)	Univariate Autoregression (AR)	Vector-Autoregression	M	RW	AR
2	0.03	0.02	0.03	0.01	58	26	57
4	0.03	0.03	0.03	0.02	31	33	30
8	0.04	0.07	0.05	0.04	2	33	3

The VAR can be seen to have a measurable improvement over simpler measures and has some predictive power, in essence a VAR based on HTTC appears to have some validity and suggests some strength in the power of HTTC to explain the UK Business Cycle 1980-2010. The VAR can also be seen to perform relatively well in explaining variation in the UK economy in the 'crisis period' 2007-2010.

8.2.2 Orthogonalized Impulse Response Functions derived from VAR (YIELD)

As Hayek's theory of the trade cycle is a cumulative sequence of micro events (as discussed in de Soto 2009 and described in Chapters 2&3), a common feature of its evaluation in the Austrian Econometric literature is the examination of Orthogonalized Impulse Response Functions (OIRFs) derived from robust models (e.g. Mulligan 2006, Fisher 2013, Russell & Langemeier 2015). OIRFs are the dynamic response of one variable in the model to the change in another (Lütkepohl 2013) and as such are useful to explore the Second Order Predictions of Hayek's theory of the trade cycle.

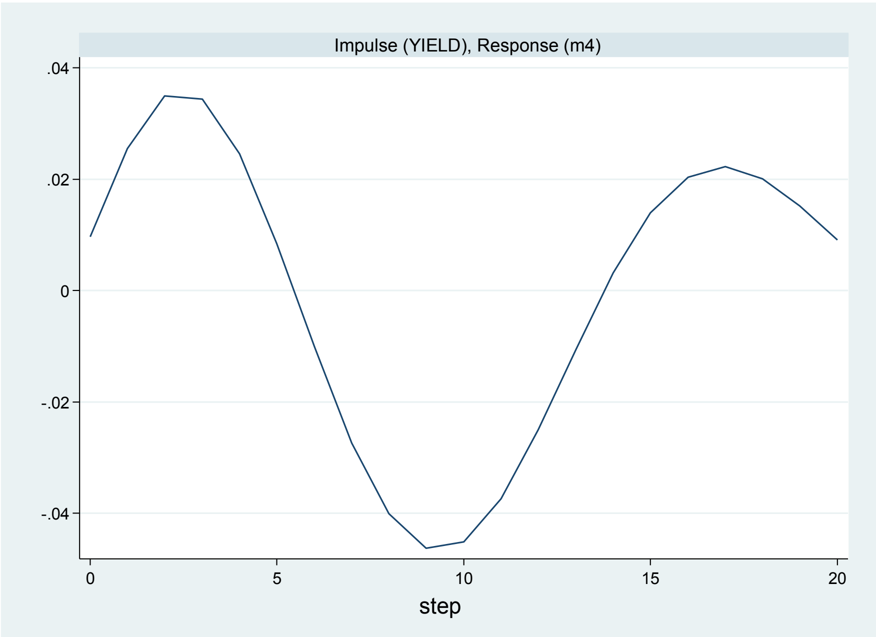
The full report of the optimum ordering of the OIRFs is displayed in the appendices (A6.1), discussed qualitatively and further interpreted in Chapter 10.

In accordance with Mulligan (2006) and Russell & Langemeier (2015) it is possible to assess the OIRFs against the Second Order Predictions of Hayek's theory in the testable model model:

(↓)YIELD→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↑)YIELD→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

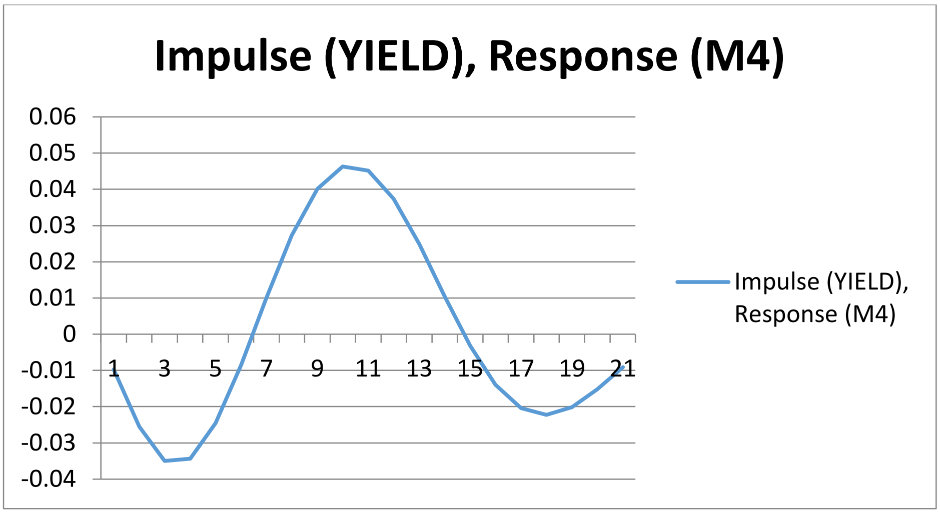
Below the Impulse from a 1% increase in the variable YIELD is shown in figure 24. This represents an increase in the market rate toward the natural rate of interest (a tighter monetary policy). This rise in the market interest rate generates an immediate increase in m4 followed by a circular decrease and return to base level over the period, however the qualitative view below suggests a further decrease in following time periods.

Figure 24: Impulse YIELD, Response M4 (VAR YIELD)



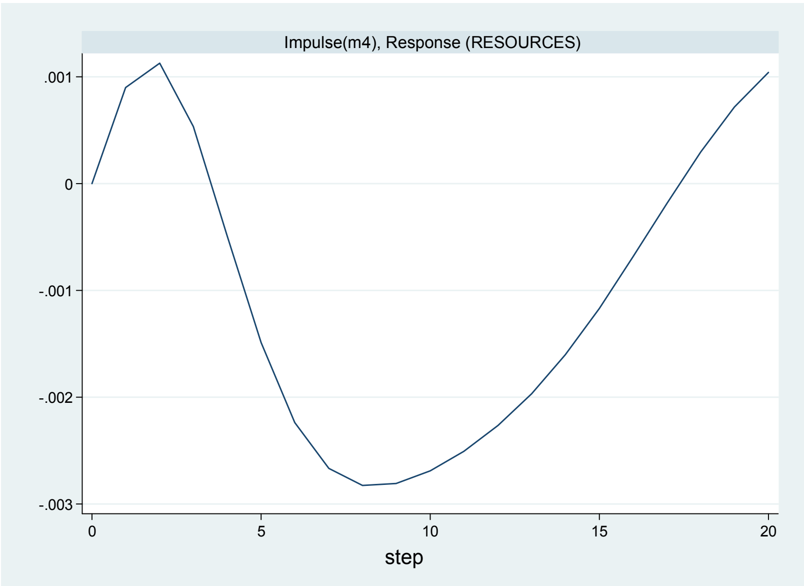
Conversely when assessing against the SOPs, Hayek's theory of the trade cycle suggests that a decrease in YIELD (expansionary monetary policy) will generate a steady increase in m4. This can be seen as:

Figure 25: Impulse YIELD (NEGATIVE), Response M4 (VAR YIELD)



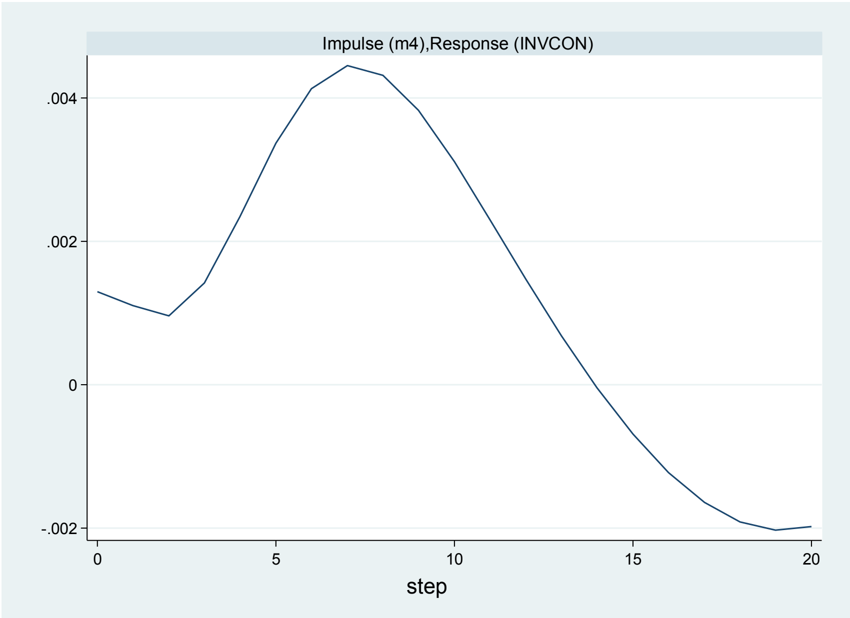
With the pattern demonstrating a general increase in m4 over the period, however it is certainly not a unique feature of Hayek's theory that expansionary monetary policy causes a general increase in m4 and this result is interpreted in Chapter 10.

Figure 26: Impulse M4, Response RESOURCES (VAR YIELD)



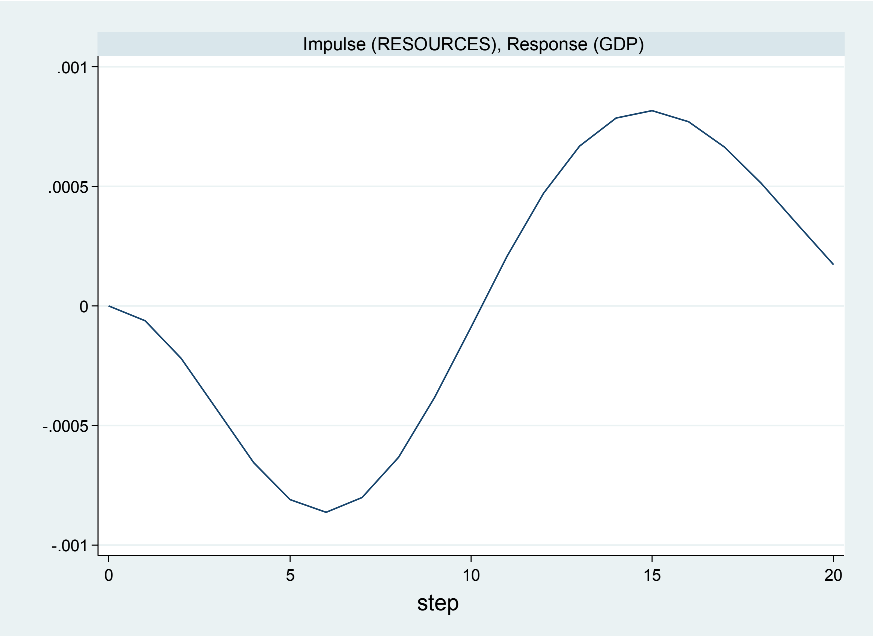
A 1% increase in the variable m4 causes an immediate increase in RESOURCES (shown in figure 26) translating to a shift to initial stage production, there is a marked secondary shift to end stage production followed by a seemingly long term shift to initial stage production potentially supportive of HTTC.

Figure 27: Impulse M4, Response INVCON (VAR YIELD)



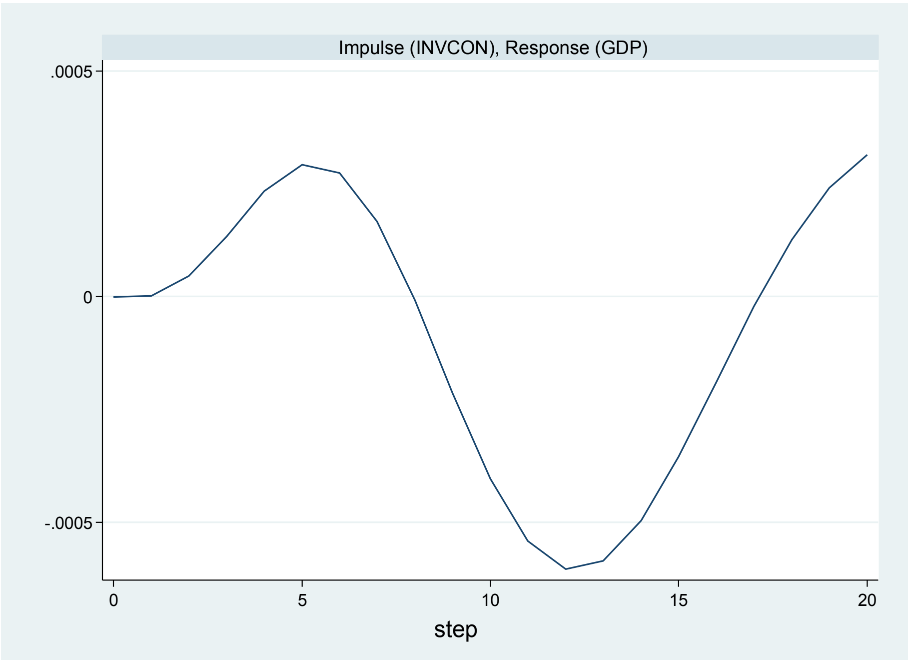
The 1% increase in the variable m4 (demonstrated in figure 27) can be seen to generate a slight decrease in INVCON followed by a rise and then a steady decline. This is reasonably consistent with the Second Order Predictions of Hayek's theory and again its implications are discussed in Chapter 10.

Figure 28: Impulse RESOURCES, Response GDP (VAR YIELD)



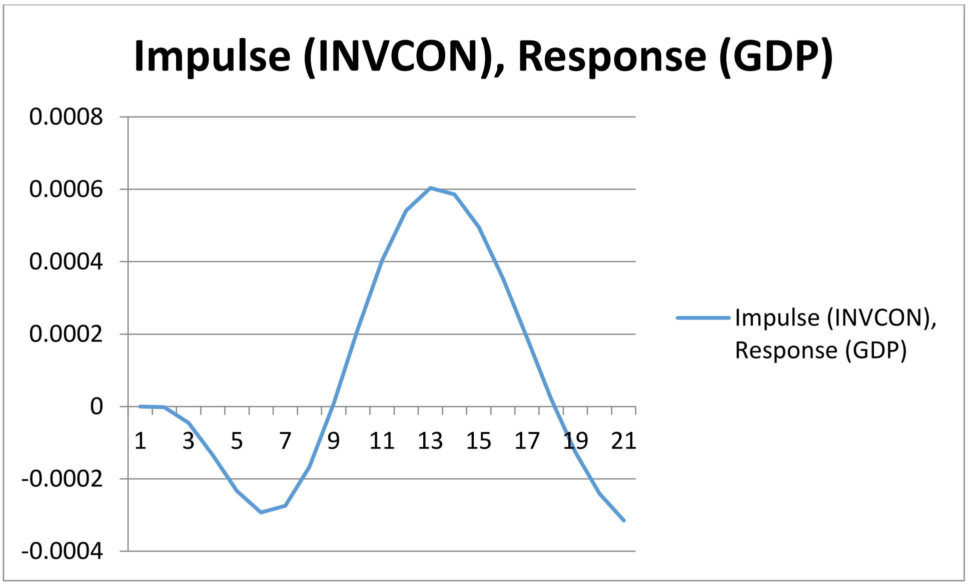
A 1% rise in RESOURCES (figure 28) generates an immediate decline in GDP which is reversed at 10 steps, the 1% impulse then generates an increase in GDP which appears relatively short lived outside the sample steps.

Figure 29 Impulse INVCON, Response GDP (VAR YIELD)



A 1% increase in INVCON shown in figure 29, representing a shift toward investment in the economy causes an immediate increase in GDP with a decline immediately preceding step 10 which slows around step 12 and reverses around step 17. Hayek's theory predicts that a shift toward consumption (a decrease in INVCON) will generate an increase in GDP. The results from a 1% decrease in INVCON's effect on GDP can be seen below in figure 30:

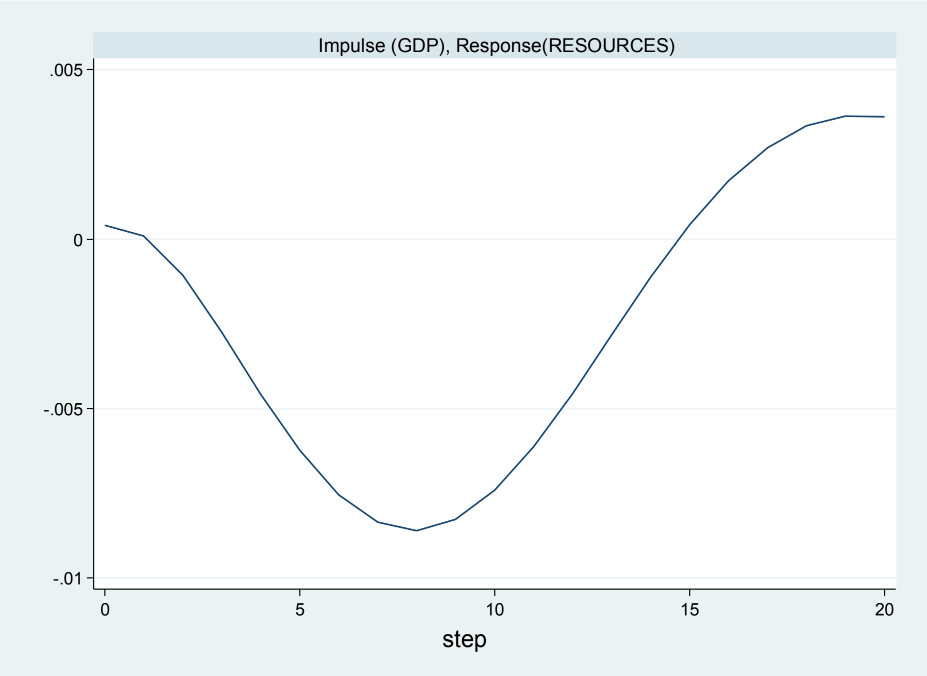
Figure 30: Impulse INVCON (Negative), Response GDP (VAR YIELD)



This is further interpreted in Chapter 10.

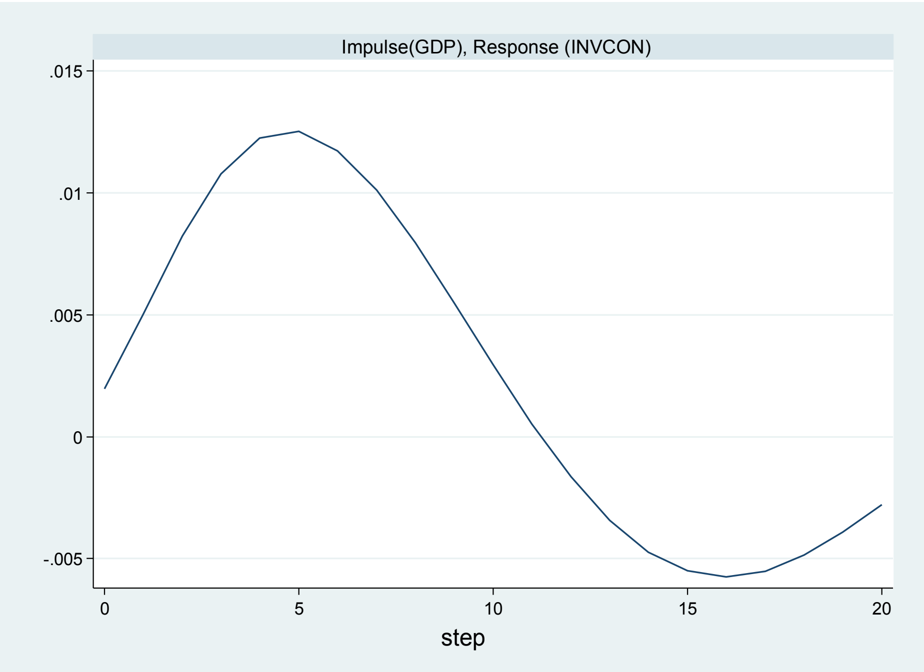
It can be seen in figure 31, that a 1% increase in GDP leads to a shift in the economy toward end stage production which slows around step 7 and reverses to a shift to initial stage production around step 15.

Figure 31: Impulse GDP, Response RESOURCES (VAR YIELD)



The response of INVCON to a 1% rise in GDP can be seen below in figure 32, in short a rise in GDP results in a positive shift in INVCON which reverses around step 11.

Figure 32: Impulse GDP, Response INVCON (VAR YIELD)



The response of YIELD to an increase in RESOURCES can be seen below in figure 33, where the increase in RESOURCES leads to an expansionary monetary policy until around step 10, a subsequent tighter monetary policy with the beginnings of an expansionary policy at the end of the shown steps.

Figure 33: Impulse RESOURCES, Response YIELD (VAR YIELD)

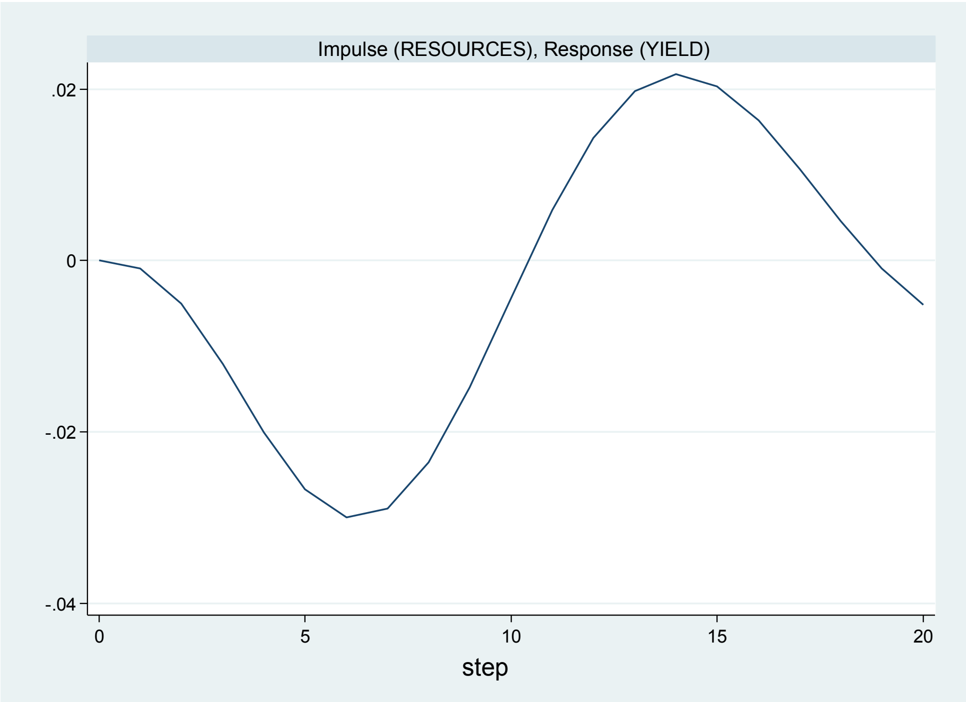
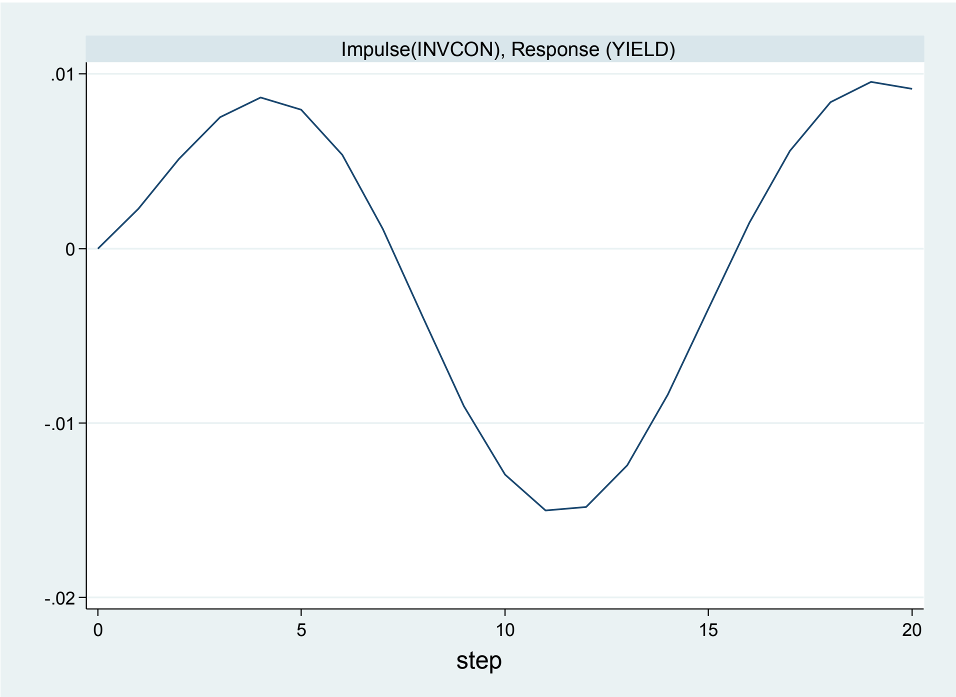
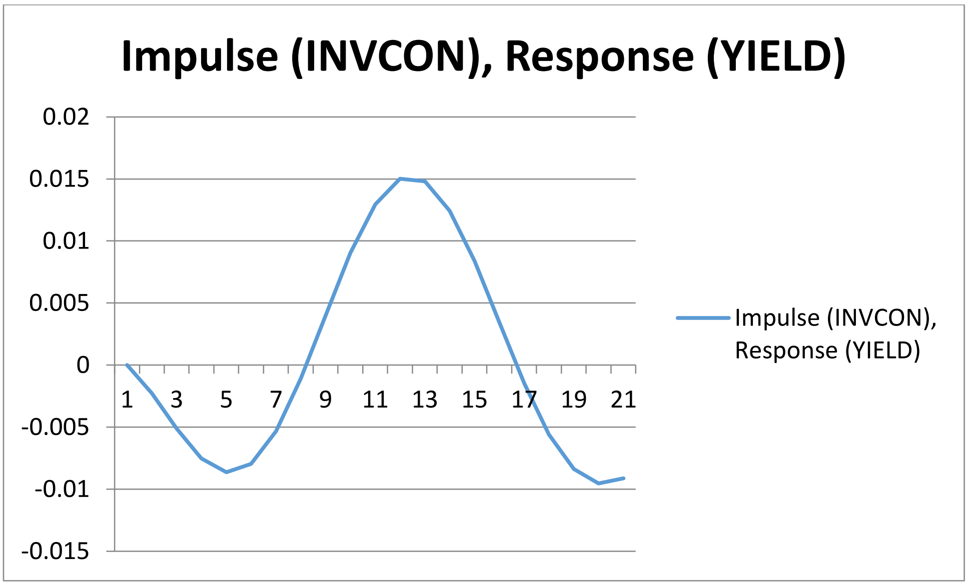


Figure 34: Impulse INVCON, Response YIELD (VAR YIELD)



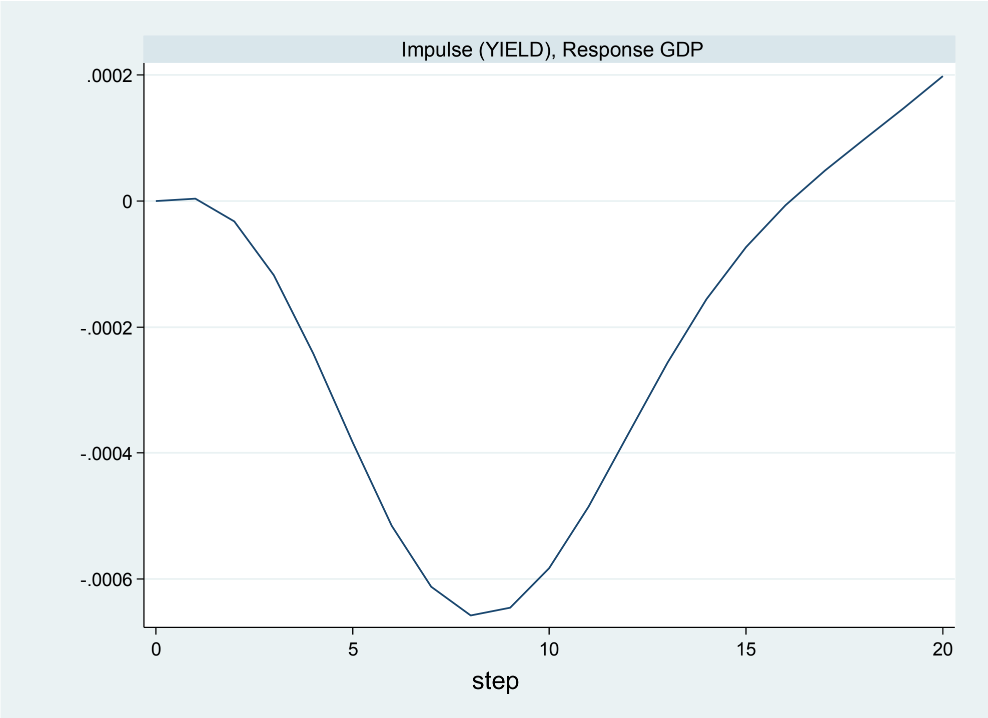
The response of YIELD to an increase in INVCON can be seen above in figure 34. Hayek's theory predicts a tighter monetary policy (YIELD↑) following a shift in the economy toward consumption (INVCON ↓). This can be seen below in figure 35, and is further discussed in Chapter 10.

Figure 35: Impulse INVCON (Negative), Response YIELD (VAR YIELD)



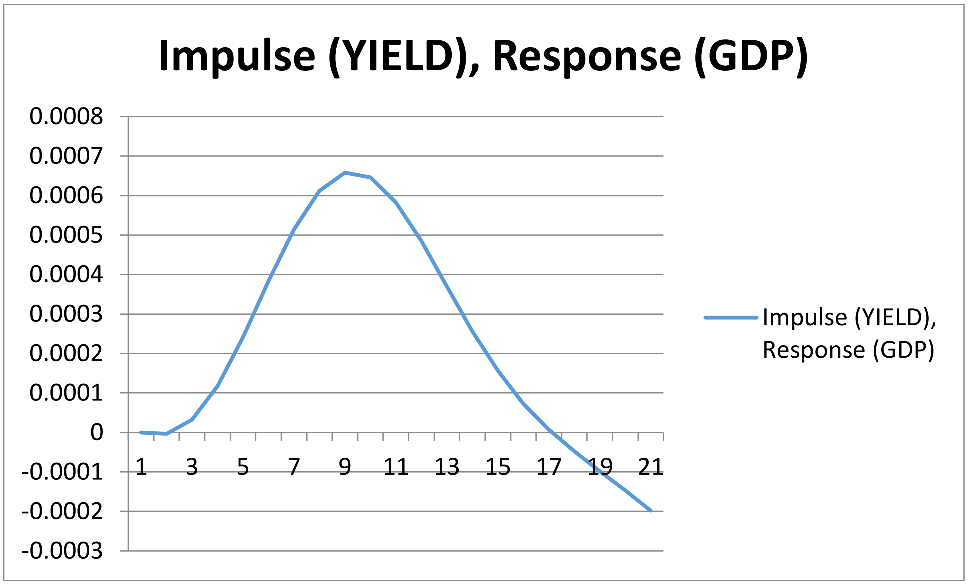
The response of GDP to a 1% increase in YIELD can be seen in figure 36, the immediate decline in GDP and the subsequent longer term increase is consistent with Hayek's theory of the trade cycle and further discussed in Chapter 10.

Figure 36: Impulse YIELD, Response GDP (VAR YIELD)



A key feature of Hayek's theory of the trade cycle is the long term relationship between expansionary monetary policy (YIELD ↓) and GDP. HTTC predicts that expansionary monetary policy will ultimately result in a lowering of GDP, the response of GDP to a 1% decrease in YIELD is shown in figure 37, and further discussed in Chapter 10.

Figure 37: Impulse YIELD (Negative), Response GDP (VAR VIELD)

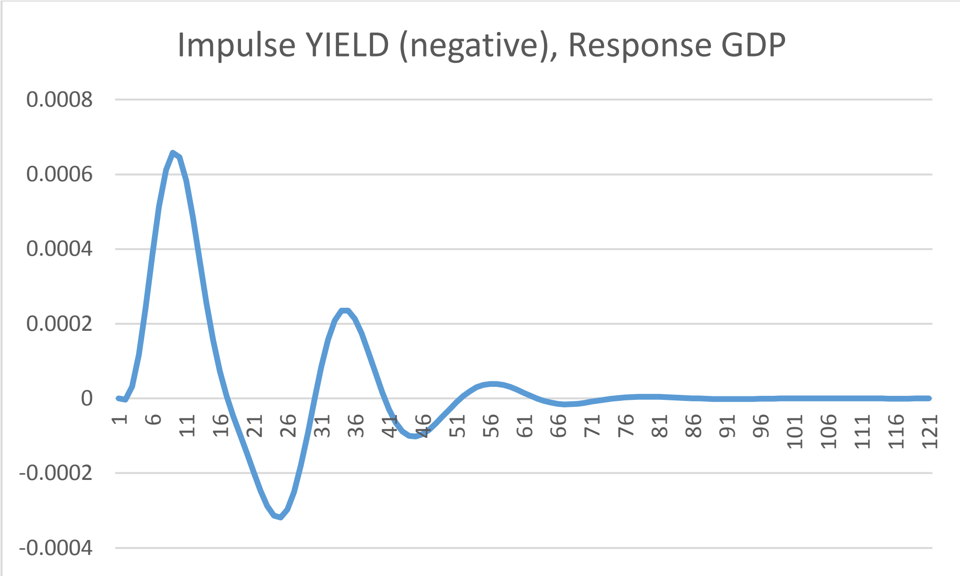


8.3 The Long Term Relationship Between Expansionary Monetary Policy (YIELD) and GDP

Hayek's theory of the trade cycle suggests a long term inverse relationship between Expansionary Monetary Policy and GDP. For Mulligan (2006), Hayek's theory is characterised by expansionary monetary policy (here a decrease in the variable YIELD) resulting in a long term decrease in GDP.

Hypothesis 1 of this thesis, that there is a long term inverse relationship between expansionary monetary policy and the output proxy can be addressed through an evaluation of the long term Orthogonalized Impulse (YGAP), Response (GDP) Function which is shown in figure 38.

Figure 38: Long term Expansionary Monetary Policy (YIELD) and GDP Response



With a 1% decrease in YIELD impulse leading to a 0.003655 GDP response. The implications of this are further discussed in Chapters 9 and 10.

8.4 VAR Model 2 (VAR YGAP):

In accordance with Mulligan (2006) and Carilli & Dempster (2008) and advised by Keeler (2001), a similar VAR incorporating the variable YGAP can be constructed with the specification:

$$\alpha(t) = A(L)\alpha(t-1) + B(L)\mu(t-1) + C(L)\gamma(t-1) + D(L)\delta(t-1) + E(L)\theta(t-1) + u(t)$$

$$\mu(t) = F(L)\alpha(t-1) + G(L)\mu(t-1) + H(L)\gamma(t-1) + I(L)\delta(t-1) + J(L)\theta(t-1) + v(t)$$

$$\gamma(t) = K(L)\alpha(t-1) + Z(L)\mu(t-1) + M(L)\gamma(t-1) + N(L)\delta(t-1) + O(L)\theta(t-1) + w(t)$$

$$\delta(t) = P(L)\alpha(t-1) + Q(L)\mu(t-1) + R(L)\gamma(t-1) + S(L)\delta(t-1) + T(L)\theta(t-1) + y(t)$$

$$\theta(t) = U(L)\alpha(t-1) + V(L)\mu(t-1) + W(L)\gamma(t-1) + X(L)\delta(t-1) + Y(L)\theta(t-1) + z(t)$$

Where $\alpha(t)$ represents the change in GDP at time t, $\mu(t)$ the change in YGAP at time t, $\gamma(t)$ the change in M4 at time t, $\delta(t)$ the change in INVCON at time t, and $\vartheta(t)$ the change in RESOURCES at time t. *A(L), B(L), C(L), D(L), E(L), F(L), G(L), H(L), I(L), J(L), K(L), Z(L), M(L), N(L), O(L), P(L), Q(L), R(L), S(L), T(L), U(L), V(L), W(L), X(L),* and, *Y(L)* remain lag operators and *u(t), v(t), w(t), y(t)* and, *z(t)* are still random (white noise) error terms.

The information criteria for this VAR model are shown below in table 47.

Table 47: Information Criteria for VAR YGAP

lag	Degree of Freedom	p	FPE	AIC	HQIC	SBIC
0			6.5e-12	-11.5672	-11.5063	-11.415
1	25	0.000	1.4e-15	-20.0465	-19.6812	-19.1333
2	25	0.000	2.3e-16*	-21.8326*	-21.163*	-20.1585*
3	25	0.000	3.2e-16	-21.5067	-20.5327	-19.0716
4	25	0.000	3.4e-16	-21.4916	-20.2132	-18.2955

*preferred value

The lag length which produces the minimum value of the information statistic is the preferred solution, for the UK timeseries variables Akaike's final prediction error, Akaike's information criterion, Hannan and Quinn's information criterion and Schwarz's Bayesian information criterion all prefer 2 lags in the VAR.

The output of VAR YGAP is shown in table 48.

Table 48: VAR Model of Hayek's theory of the trade cycle (VAR YGAP)

Equation	R-Square		Chi-Square	
GDP	0.9780		3517.911***	
Coefficients				
GDP	RESOURCES	YGAP	M4	INVCON
-0.7928407***	0.0161459	-0.0024999	-0.0024999	0.0143715
Equation	R-Square		Chi-Square	
RESOURCES	0.9236		955.4574***	
Coefficients				
GDP	RESOURCES	YGAP	M4	INVCON
-0.7775133	-0.4550149	-0.001325	-0.0185179	-0.001325
Equation	R-Square		Chi-Square	
YGAP	0.7259		209.2113***	
Coefficients				
GDP	RESOURCES	YGAP	M4	INVCON
92.78336**	-12.31487	-0.62	0.5246939	-11.93916
Equation	R-Square		Chi-Square	
M4	0.8953		675.5456***	
Coefficients				
GDP	RESOURCES	YGAP	M4	INVCON
3.387012	-0.7699581	0.0221048**	-0.3483989***	-0.6835483

Equation	R-Square		Chi-Square	
INVCON	0.9579		1798.078***	
Coefficients				
GDP	RESOURCES	YGAP	M4	INVCON
-0.6619061**	0.0371254	0.0017847**	0.0126968	-0.6653302***

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

The R-Square is relatively high for each equation, though the YGAP equation at 73% is noticeably poorer than the others. The information criteria are shown in table 49.

Table 49: VAR YGAP Information Criterion

Information Criterion	Value
AIC	-21.56089
HQIC	-20.9
SBIC	-19.91127

8.4.1 Testing the Constructed VAR model:

As previously, the VAR satisfies the stability criteria shown in table 51, all the eigenvalues lie inside the unit circle shown in figure 39.

Figure 39: Roots of the Companion Matrix (VAR YGAP)

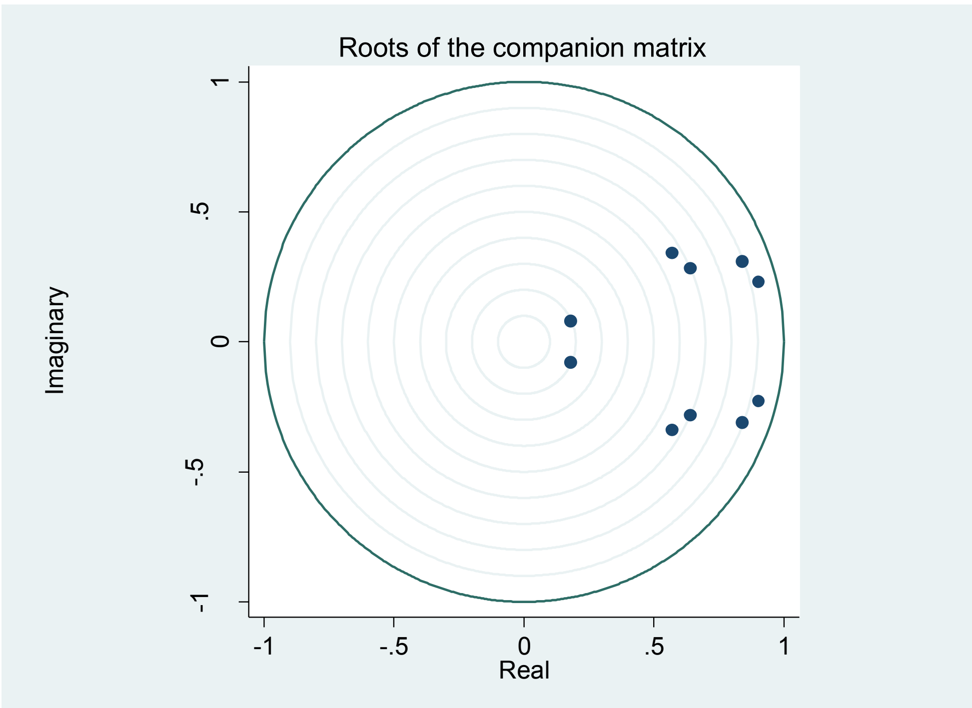


Table 50: Eigenvalues (VAR YGAP)

Eigenvalue	Modulus
0.9035296+0.2296424i	0.932256
0.9035296-0.2296424i	0.932256
0.840039+0.3100659i	0.895436
0.840039-0.3100659i	0.895436
0.6400973+0.2822235i	0.699553
0.6400973-0.2822235i	0.699553
0.5691181+0.3404729i	0.663187
0.5691181-0.3404729i	0.663187
0.1795585+0.7947335i	0.19636
0.1795585-0.7947335i	0.19636

As per VAR model 1, one step forecasts will be generated for evaluation purposes and are shown in table 51.

Table 51: One Step Forecasts VAR YIELD & VAR YGAP

Variable	Mean	Standard Deviation
Observed GDP Forecast GDP (Model 1) Forecast GDP (Model 2)	0.9994629 0.9990814 0.9994479	0.0133069 0.0121289 0.0116458
Observed YIELD Forecast YIELD	0.9847196 0.9863671	0.1727185 0.1548441
Observed YGAP Forecast YGAP	0.2802873 0.351055	1.612801 1.390701
Observed M4 Forecast M4 (Model 1) Forecast M4 (Model 2)	0.9773822 0.9850581 0.9905678	0.246865 0.2107624 0.2093229
Observed RESOURCES Forecast RESOURCES (Model 1) Forecast RESOURCES (Model 2)	0.9995151 0.9998867 0.9997267	0.0364771 0.0344337 0.0348767
Observed INVCON Forecast INVCON (Model 1) Forecast INVCON (Model 2)	0.9984559 0.9978756 0.9988143	0.0357612 0.0334788 0.0319831

The visual representation of these is not dissimilar to those for the first VAR containing the variable VAR and as such they are presented in the appendices (A3.0). As per the first VAR model it is also useful to see the Root Mean Square Error (RMSE) of these forecasts compared to other simpler tests, in particular calculating the RMSE for each forecast horizon of the VAR and forecasts produced by the mean (**M**), random walk (**RW**) and a univariate autoregression (**AR**), shown in table 52.

Table 52: RMSE VAR Comparison

Equation	% improvement for Model 1			% improvement for Model 2		
GDP						
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	69	24	67	70	26	68
4	19	14	15	18	13	14
8	-4	23	-2	-6	22	-4
YIELD				**YGAP**		
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	52	20	51	5	28	58
4	14	20	13	-17	29	26
8	3	22	3	2	33	3
RESOURCES						
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	28	8	25	32	14	30
4	-13	11	-16	-5	17	-7
8	-28	18	-26	-26	20	-24
M4						
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	1	-2	-2	7	4	4
4	-6	14	-7	10	27	9
8	-12	2	-11	-15	-2	-15
INVCON						
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	58	26	57	59	28	58
4	31	33	30	27	29	26
8	2	33	3	2	33	3

Both Model 1 (VAR YIELD) and Model 2 (VAR YGAP) can generally be seen to have a measurable improvement over simpler measures, this coupled with the rigorous and successful post estimation tests is supportive of the overall validity of the VAR models and the subsequent Orthogonalized Impulse Response Functions and Granger Causality Tests.

As per VAR YIELD, the Orthogonalized Impulse Response Functions can be used to examine the second order predictions of Hayek’s theory of the trade cycle and are discussed in section 8.4.2.

8.4.2 Orthogonalized Impulse Response Functions derived from VAR (YGAP)

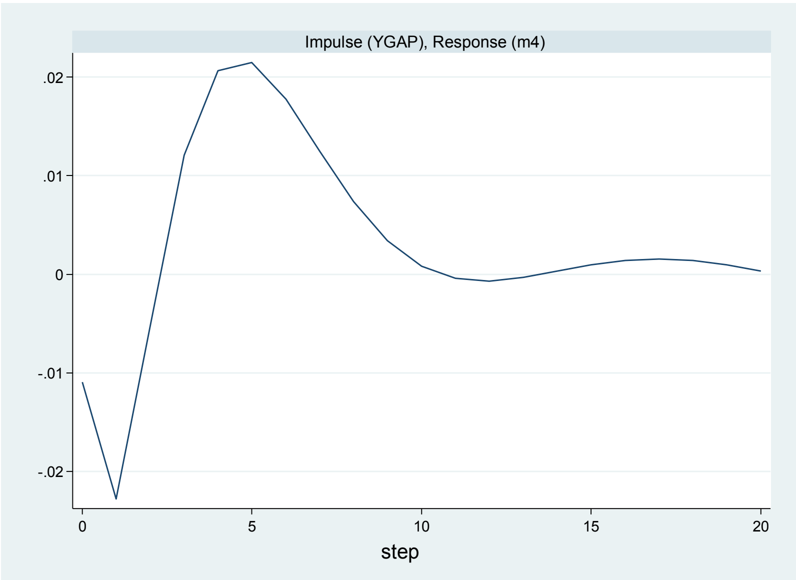
The Orthogonalized Impulse Response Function Analysis of the relationships between the variables in VAR YGAP are displayed in the appendices (A.2). An examination of these Impulse Response Functions provides an evaluation of the second order predictions of Hayek’s theory of the trade cycle as per Mulligan (2006) and Dore & Singh (2012).

As per the VAR YIELD model of HTTC it is possible to evaluate the Second Order Predictions of Hayek's theory of the trade cycle:

(↑)YGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)YGAP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

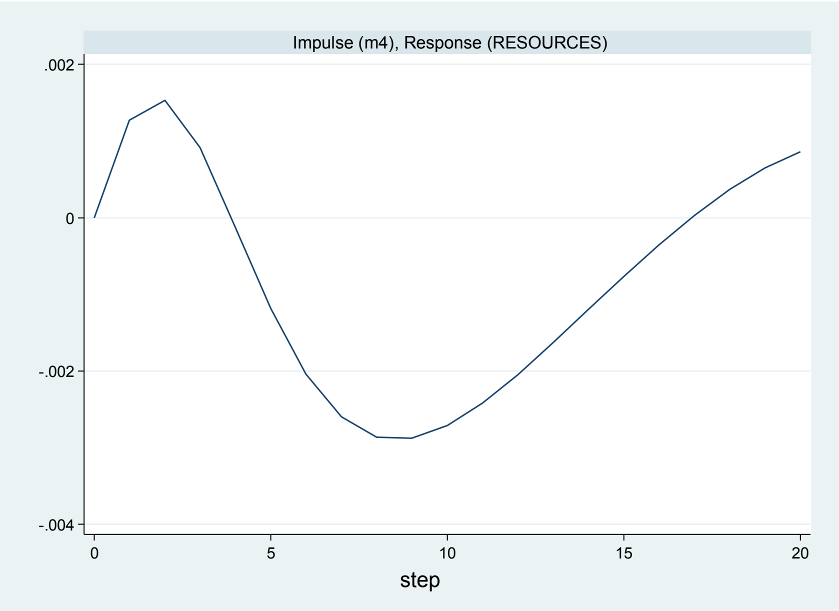
The **(↑)YGAP→ (↑)M4** SOP can be seen in figure 40, where in accordance with Hayek's theory, over the period a rise in YGAP (expansionary monetary policy) results in an increase in M4.

Figure 40: Impulse YGAP, Response M4 (VAR YGAP)



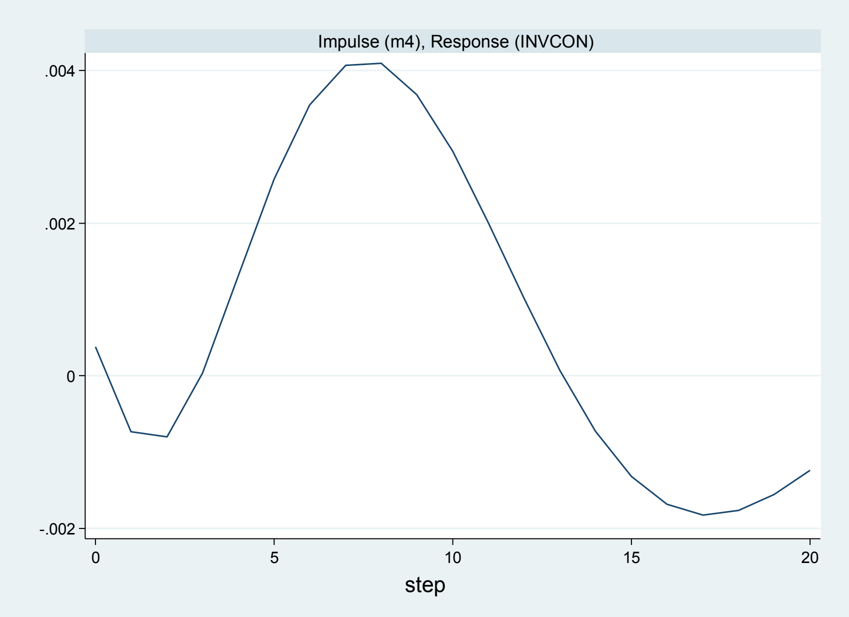
The Orthogonalized Impulse Response Function of the effect of a 1% increase in M4 on the RESOURCES variable within the Vector-Auto Regression Model of Hayek's theory of the trade cycle can be seen below. The **(↑)M4→ (↑)RESOURCES** SOP of Hayek's theory predicts that the RESOURCES variable will increase as a response to an increase impulse of M4, whereas in figure 41, it can be seen that there is a negative response of RESOURCES to a positive impulse in M4.

Figure 41: Impulse M4, Response RESOURCES (VAR YGAP)



However, qualitatively the view above suggests an increase in RESOURCES in subsequent periods, potentially suggesting support for the **(↑)M4→ (↑)RESOURCES** SOP. The Orthogonalized Impulse Response Function of the effect of a 1% increase in M4 on the INVCON variable within the Vector-Auto Regression Model of Hayek's theory of the trade cycle can be seen in figure 42. The **(↑)M4→ (↓)INVCON** SOP of Hayek's theory predicts that the INVCON variable will decrease as a response to an increase impulse in M4, whereas in figure 42 it can be seen that there is a positive response of INVCON to a positive impulse in M4.

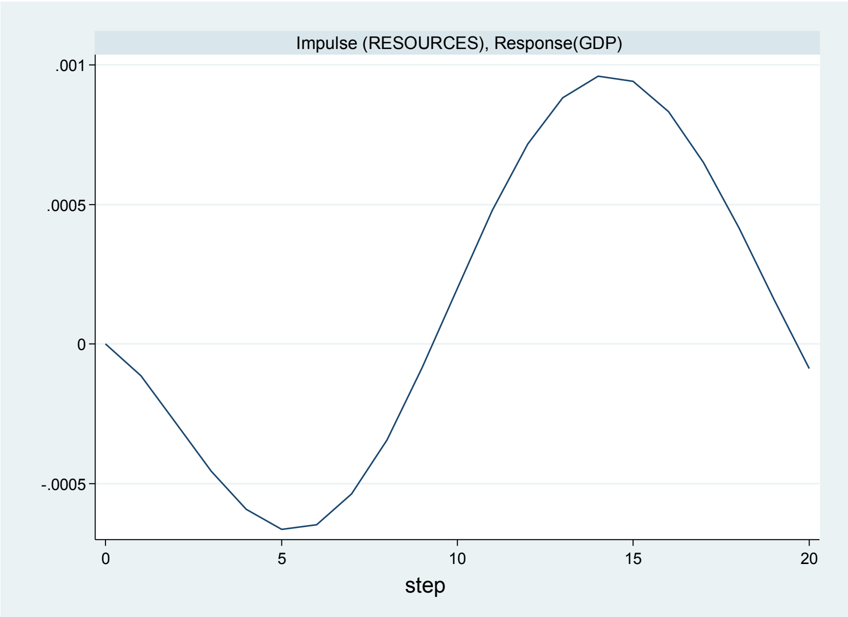
Figure 42: Impulse M4, Response INVCON (VAR YGAP)



Unlike the **(↑)M4→ (↑)RESOURCES** SOP where the VAR YGAP OIRF qualitatively suggested some potential support for the SOP in future periods, qualitatively the M4 INVCON OIRF above suggests a future pattern not supportive of the **(↑)M4→ (↓)INVCON** SOP of Hayek's theory.

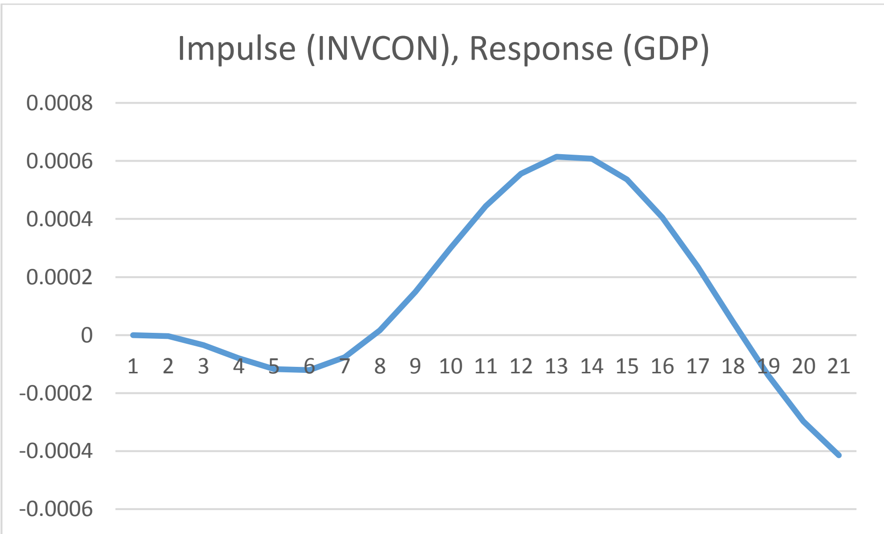
The Orthogonalized Impulse Response Function of the effect of a 1% increase in RESOURCES on the GDP variable within the Vector-Auto Regression Model of Hayek's theory of the trade cycle can be seen in figure 43. The **(↑)RESOURCES→(↑)GDP** SOP of Hayek's theory predicts that the GDP variable will increase as a response to an increase impulse in RESOURCES, below it can be seen that there is a positive response of GDP to a positive impulse in RESOURCES.

Figure 43: Impulse Resources, Response GDP (VAR YGAP)



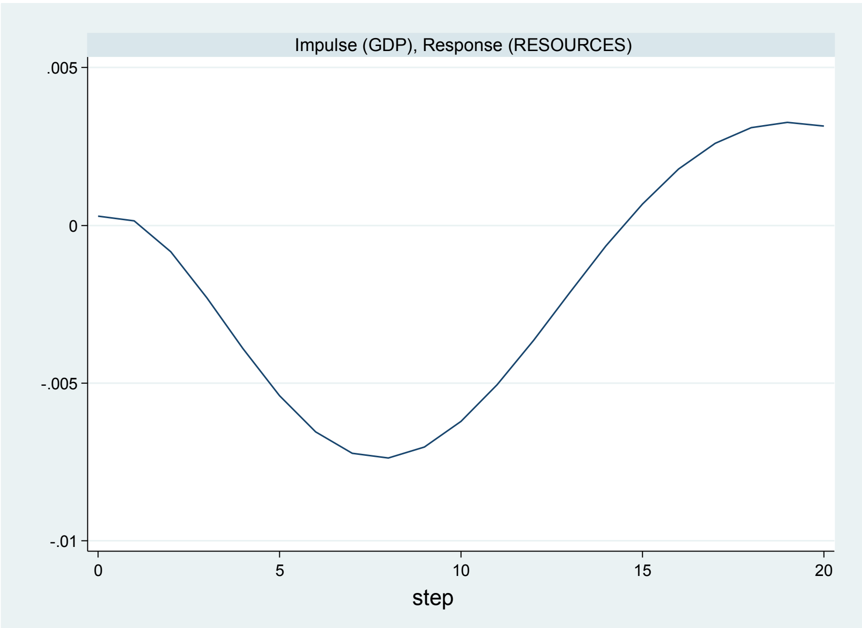
The Orthogonalized Impulse Response Function of the effect of a 1% decrease in INVCON on the GDP variable within the Vector-Auto Regression Model of Hayek's theory of the trade cycle can be seen in figure 44. The **(↓)INVCON→(↑)GDP** SOP of Hayek's theory predicts that the GDP variable will increase as a response to a decrease impulse in RESOURCES. The OIRF demonstrates that in accordance with Hayek's theory a negative impulse of INVCON generates a positive response of GDP.

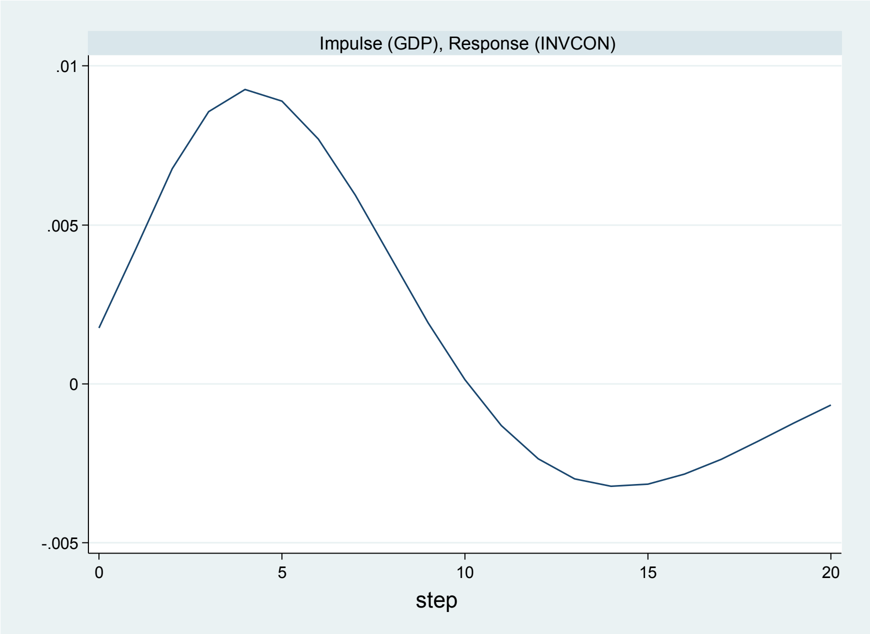
Figure 44: Impulse INVCON (Negative), Response GDP (VAR YGAP)

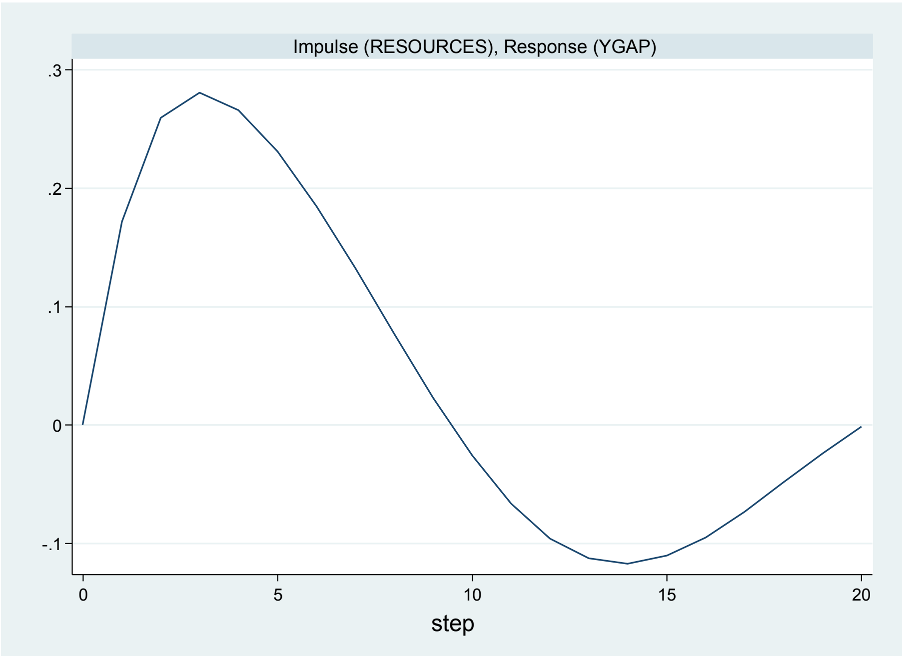


Orthogonalized Impulse Response Functions of variable responses within the Vector-Auto Regression (YGAP) Model for the response of the variable RESOURCES to a positive impulse of GDP, the response of the variable INVCON to a positive impulse of GDP and the response of the variable YGAP to a positive impulse of RESOURCES can be seen below in figure 45. These three OIRF evaluations do not support their corresponding SOP within Hayek's theory of the trade cycle.

Figure 45: OIRF relationships (VAR YGAP)

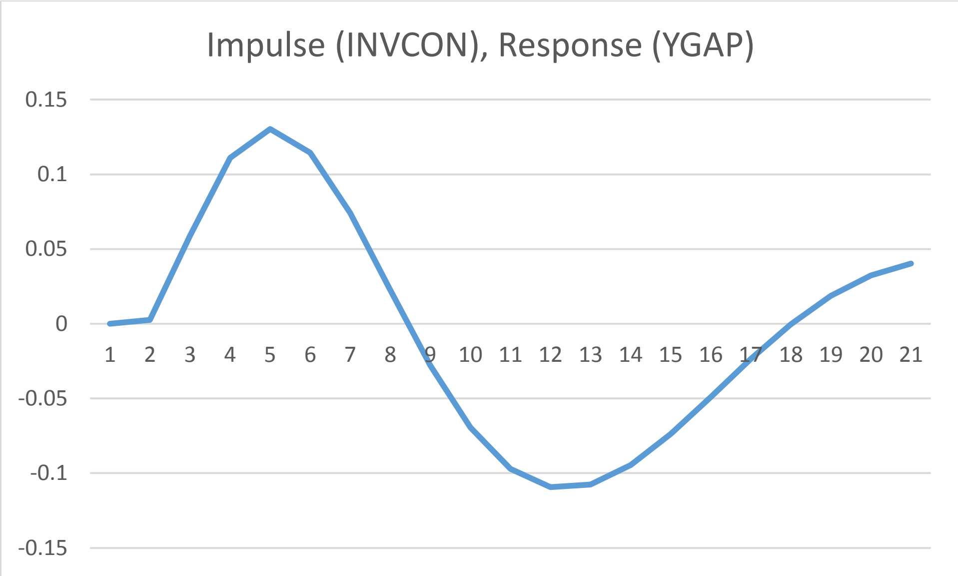






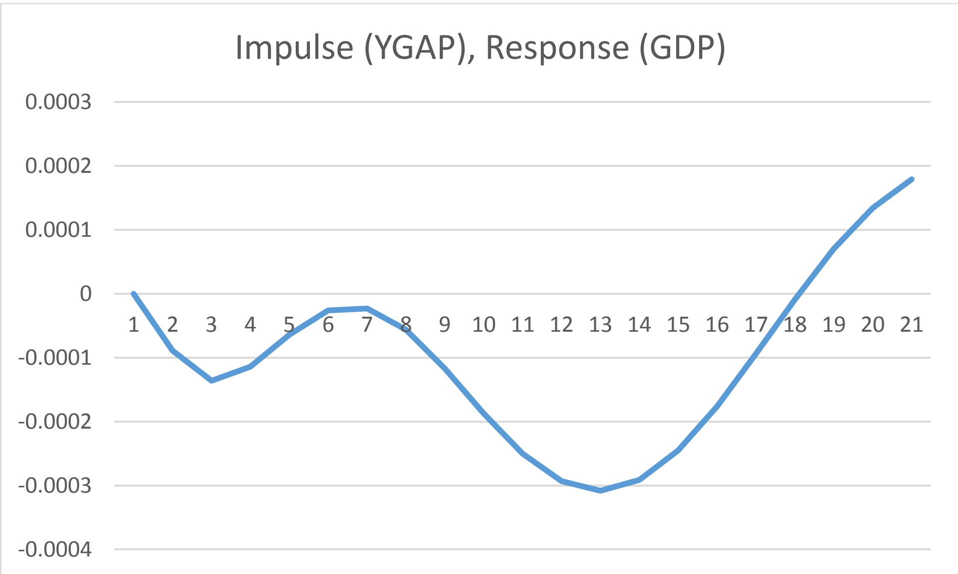
The OIRF showing the YGAP response to a negative impulse of INVCON. Hayek's theory of the trade cycle can be seen in figure 46. Whilst this supports the **(↓)INVCON→(↓)YGAP** SOP the qualitative view suggests less support for this SOP in future periods.

Figure 46: Impulse INVCON (Negative), Response YGAP (VAR YGAP)



The OIRF of the response of GDP to a negative impulse of YGAP can be seen in figure 47. The **(↓)YGAP→(↓)GDP** SOP that the response of the GDP variable to reduction in YGAP will be negative is supported by the YGAP GDP OIRF present in the Vector-Auto Regression Model of Hayek's theory of the trade cycle.

Figure 47: Impulse YGAP (Negative), Response GDP (VAR YGAP)

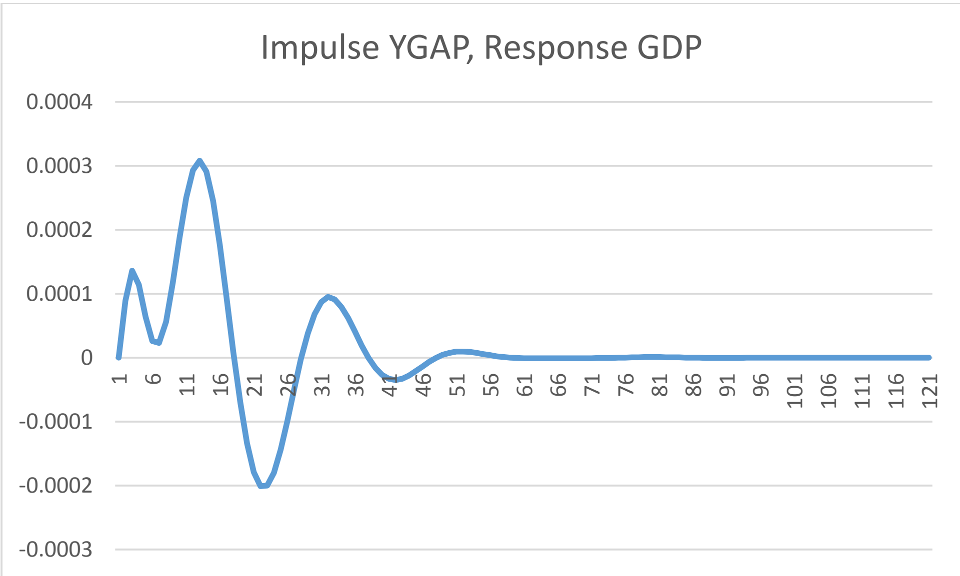


8.5 The Long Term Relationship Between Expansionary Monetary Policy (YGAP) and GDP

Hayek's theory of the trade cycle suggests a long term inverse relationship between Expansionary Monetary Policy and GDP. For Mulligan (2006), Hayek's theory is characterised by expansionary monetary policy (here an increase in the variable YGAP) resulting in a long term decrease in GDP.

Hypothesis 1 of this thesis, that there is a long term inverse relationship between expansionary monetary policy and the output proxy can be addressed through an evaluation of the long term Orthogonalized Impulse (YGAP), Response (GDP) Function shown in figure 48.

Figure 48: Long term Expansionary Monetary Policy (YGAP) and GDP Response



With a 1% increase in YGAP impulse leading to a 0.001635 GDP response. The implications of this are further discussed in Chapters 9 and 10.

8.6 Granger Causality Tests:

Following the specification of a robust Vector-Auto Regression Model, in accordance with Wainhouse (1984), Mulligan (2006) and Carilli & Dempster (2008), Granger Causality Tests can be performed to determine if the temporal relationship and causality in a Granger sense supports the prescriptions of Hayek's theory of the trade cycle for the UK economy 1980-2010. The results of the Granger Causality Tests derived from the variable relationships in both VAR YIELD and VAR YGAP are presented in table 53.

Table 53:Granger Causality Results (VAR YIELD & VAR YGAP):

Equation	G* Variable	Chi^2 (Model 1)	Chi^2 (Model 2)
GDP	YIELD (1) / YGAP (2)	0.02394	0.33079
GDP	RESOURCES	6.496**	0.80469
GDP	M4	4.7079**	3.7165
GDP	INVCON	0.04411	0.12613
GDP	ALL	14.095**	5.3123
YIELD	GDP	2.7806*	-
YIELD	RESOURCES	0.78091	-
YIELD	M4	0.25197	-
YIELD	INVCON	0.00627	-
YIELD	ALL	8.3742*	-
YGAP	GDP	-	6.5502**
YGAP	RESOURCES	-	8.5869**
YGAP	M4	-	4.0248
YGAP	INVCON	-	3.5516
YGAP	ALL	-	28.676***
RESOURCES	GDP	14.135***	4.6925*
RESOURCES	YIELD (1) / YGAP (2)	2.3101	0.9945
RESOURCES	M4	1.5726	2.8681
RESOURCES	INVCON	1.5897	1.7276
RESOURCES	ALL	32.397***	12.091
M4	GDP	52.438***	22.183***
M4	YIELD (1) / YGAP (2)	1.0283	8.7984
M4	RESOURCES	4.1582**	1.5228
M4	INVCON	8.0126**	4.12
M4	ALL	71.905***	33.299***

INVCON	GDP	5.6237**	17.892***
INVCON	YIELD (1) / YGAP (2)	0.05595	8.2493**
INVCON	RESOURCES	0.00221	5.2268*
INVCON	M4	0.7651	9.3704**
INVCON	ALL	5.797	43.007***

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

8.7 Chapter Summary

This Chapter presents a series of Vector-Auto Regression Models of Hayek's theory of the trade cycle as acceptable to the Austrian Econometric Literature (e.g. Carilli & Dempster 2008). The first VAR model uses the variable YIELD as the interest rate proxy and the second uses the variable YGAP. For both models Orthogonalized Impulse Response Functions are used to examine the relationships between the variables within the models against the Second Order Predictions of Hayek's theory and Granger Causality Tests are used *as per* the Austrian Econometric Literature to examine the causation directions predicted by Hayek's theory of the trade cycle.

Chapter 8 constructs two robust Vector-Auto Regression models informed by the literature to ensure Austrian acceptance. These models are used to investigate the relationships between the variables via an examination of their Orthogonalized Impulse Response Functions and Granger Causality Testing. These results are then compared against the Second Order Predictions of Hayek's theory in Chapter 10 and discussed in Chapter 11 to determine the relevance of Hayek's theory for understanding the UK business cycle.

Chapter 9: An empirical evaluation of Hayek's theory of the trade cycle: Vector-Error Correction Modelling.

"The Austrian economists Ludwig von Mises and Friedrich A. Hayek developed a unique theory of the business cycle. In their view, an unsustainable boom ensues when the rate of interest in the market falls below the natural rate. The boom is characterized not only by an increase in aggregate production but also by a distortion of the structure of production"

Luther & Cohen (2014, p153)

9.1 Introduction

A Vector-Error Correction Model is seen as being amenable to empirical evaluation within Austrian methodological constraints (Mulligan 2006, Dore & Singh 2012). In Chapter 9 the thesis develops a Vector-Error Correction Model using guidance from Keeler (2001), Mulligan (2006) and Dore & Singh (2012). A new variable CYGAP is developed in section 9.2.2 in order to develop an interest rate proxy with the required unit root. This variable is developed informed by Mulligan (2006). Post estimation tests suggested by Becketti (2013) are conducted in section 9.2.3 to ensure a reliable and valid model. Orthogonalized Impulse Response Function (OIRF) and Granger Causality relationships between the variables within the model are used to assess the Second Order Predictions of Hayek's theory of the trade cycle in sections 9.2.4 and 9.3 respectively.

Mulligan's (2006) Vector-Error Correction (OIRF and Granger Causality) evaluation of Hayek's theory of the trade cycle finds strong support for Hayek's theory using US timeseries data, as such the thesis presents a replication of this study presented in section 9.4. This uses UK data to further contribute to the discussion of the relevance of Hayek's theory for understanding the UK Business Cycle.

Chapter 9 presents a Vector-Error Correction analysis developed in accordance with the literature to evaluate the Second Order Predictions of Hayek's theory of the trade cycle and determine its relevance for understanding the UK business cycle.

9.2 The Vector-Error Correction Model

From the perspective of Austrian Theory, it must be remembered that the business cycle is not caused by changes in the interest rate resulting from a change in entrepreneurial time preference but caused *via* policy created 'easy credit' or monetary expansion. The boom which is always proceeded by the bust from the Austrian perspective is generated through a reduction of the market interest rate below the natural rate, the rate that "would prevail in the absence of monetary expansion" Mulligan (2006). Whilst the rate is 'too low', the production process can take more time to produce the same amount of real output (as the discount rate is reduced, Cwik 2008) and can invest heavily in physical capital. The 'too low' interest rate discourages saving and thus increases consumption, the credit created through the low interest rate environment allows for further investment in early stage and late stage production as well as facilitating extra consumption.

Simply, the 'too low' interest rate environment creates an economy which takes longer to produce the real consumerable output, but concurrently creates a high consumption scenario fuelled by easy credit. As such the production structure is unsustainable and eventually will be liquidated, exacerbated by a higher interest rate environment driven by inflation of nominal prices in the 'boom'. Higher interest rates cause for a re-evaluation of decisions taken in the 'too low' interest rate environment and disrupt plans of producers and consumers who are reduce their time preference to natural interest rate levels.

The Vector-Auto Regression and Finite Distribution Lag models found some evidence supporting the Hayek's theory of the trade cycle, much of the Austrian econometric literature (shown in table 54) which has informed the approach of this thesis suggests a Vector Error Correction Model as an appropriate test from the Austrian perspective as well as the orthodox.

Table 54: Vector-Error Correction Austrian-Empirical Papers

Keeler	2001
Mulligan	2006
Dore & Singh	2012
Fisher	2013

9.2.1 Construction of the Vector-Error Correction Model

Becketti (2013) reports a simple step by step process in the estimation of a Vector Error Correction Model (it is worth noting for Austrian acceptance, that Mulligan 2006, follows a similar procedure), to demonstrate the transparent nature of this econometric evaluation to accommodate the rejection of *scientism*, these steps are shown below:

1. Confirm the presence of a unit root.
2. Identify the number of lags of the Vector Error Correction Model.
3. Identify the number of cointegrating relationships.
4. Fit the Vector Error Correction Model.
5. Test for stability and white-noise residuals.

It is clear from step one that the variables made stationary for the Vector-Auto Regression Model are not appropriate for the Vector Error Correction Model (VECM). Previously the variables had been made stationary due to the presence of a unit root and thus the unit root was removed, however for a VECM the presence of a unit root is required. It has been previously noted that the VECM is a model especially attuned to the Austrian perspective, partially due to its acceptance of variables in their natural state before trends etc. are removed.

The initial VECM variables for consideration are shown in table 57, with their confirmation of a unit root shown in table 55.

Table 55: initial VECM Variables

Variables			
Variable Description	Variable Name	Construction	Source
Measure of economic activity.	lnGDP	ln(GDP data)	Bank of England
Measure of the monetary base closely linked to government action.	M4	M4 data	Bank of England
The ratio of end stage to initial stage output.	RESOURCES	Initial Stage Output / End Stage Output	Bank of England
A proxy for the measurement of the relationship between true and artificial interest rates.	YIELD	Market Rate of Interest / Natural Rate of Interest.	Bank of England
	YGAP	Natural Rate of Interest – Market Rate of Interest	
A measure for the relationship between investment and consumption in the economy.	INVCON	Investment / Consumption.	Bank of England

Table 56: Confirmation of a Unit Root in VECM variables

Variable	MDF Accept H_0 of a unit root
lnGDP	y
M4	y
YIELD	n
YGAP	n
RESOURCES	y
INVCON	y

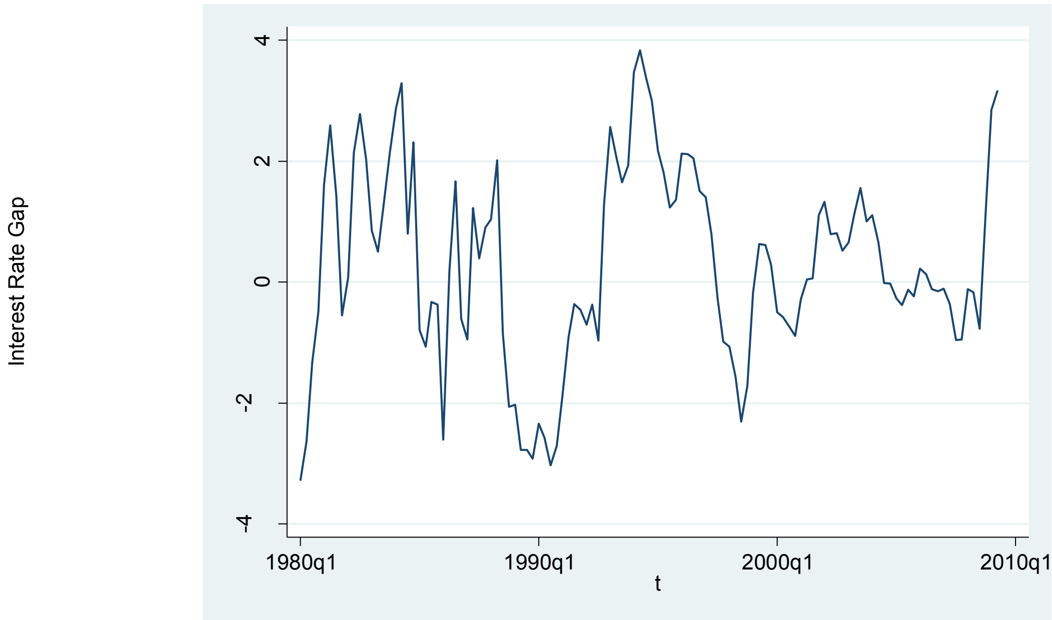
Due to the stationary nature of the variable YIELD and YGAP the cumulative sum of YGAP will be used and labelled CYGAP. If YGAP represented the spread of natural and artificial rate, then CYGAP could be interpreted as the real return over time (Mulligan 2006).

9.2.2 The Variable CYGAP:

In 9.2.2 the variable CYGAP is discussed, the creation of the Cumulative Term Spread (CYGAP) Variable is to produce an interest rate proxy for the construction of a Vector-Error Correction Model of Hayek's theory of the trade cycle. Previously in this thesis the variables YIELD and YGAP have been used to model Hayek's theory in Vector-Auto Regression Models, however the VECM presented in this chapter requires an interest rate variable containing a unit root. In accordance with key Austrian econometric papers (Keeler 2001, Mulligan 2006, Carilli & Dempster 2008) the variable YGAP represents the spread between the natural rate of interest and the market rate of interest and is calculated as 10yr UK gov bond yield – 3month UK gov bond yield using reliable central bank (Bank of England) data as recommended by Mulligan (2006) who uses The Federal Reserve and Berjenkenes *et al* (2010) who use the Norwegian Central Bank.

YGAP provides a proxy for the movement of the market rate away from the natural rate based on accepted Austrian approaches. The variable has 118 observations, a mean of 0.2802873 and a standard deviation of 1.612801.

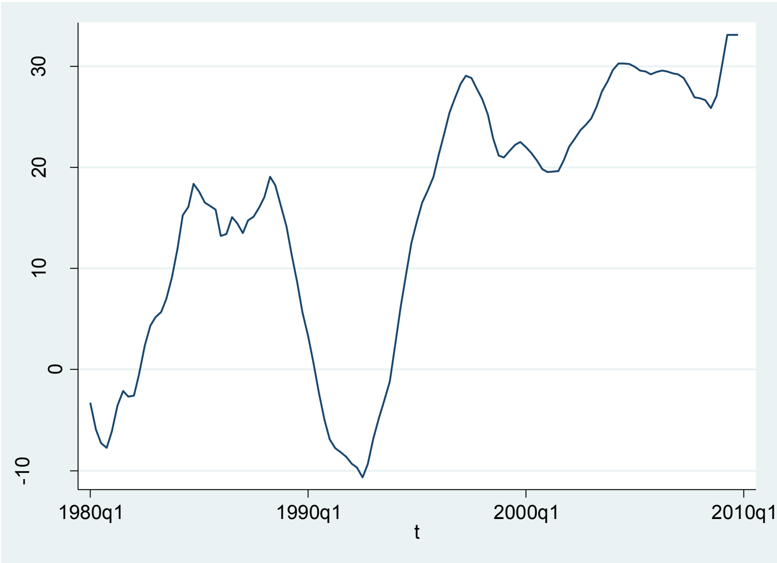
On a visual inspection (below) the variable shows the UK Central Bank Policy response to the financial crisis with a clear divergence of the market rate from the natural rate with the interest rate stimulus toward the end of the last decade.



For the purposes of the VECM, the variable YGAP is stationary (See chapter 6) and as such unable to form a stable cointegrating relationship with the other variables in the model. Mulligan (2006) likewise does not find a unit root in the similar term spread variable used in that paper, the term spread variable is calculated as the US 10year constant rate – 3month secondary market rate using Federal Reserve Data and suggests the cumulative sum of the term spread variable as an appropriate solution. Thus this thesis will create the cumulative sum of YGAP as the proxy for the divergence of the market interest rate from the natural rate.

The cumulative sum of YGAP has 119 observations (starting with the initial YGAP observation, and ending 1 quarter after YGAP), it has a mean of 15.13345 and a standard deviation of 12.8185.

Shown below, visually the variable (termed CYGAP) clearly shows the long term increasing trend of a positive difference between the natural rate of interest and the market rate of interest. The upward trend implies that the market rate of interest is frequently below the natural rate with the slope of increase demonstrating the magnitude of the gap.



The variable CYGAP is confirmed to contain a unit root at the 1% level and the final variables for construction of the Vector-Error Correction Model are shown in table 57.

Table 57: Final VECM variables

Variable	MDF Accept H_0 of a unit root	Implications of Variable Movement
lnGDP	y	↑ = ↑ economic activity ↓ = ↓ economic activity
M4	y	↑ = ↑ M4 ↓ = ↓ M4
CYGAP	y	↑ = Expansionary Monetary Policy ↓ = Contractionary Monetary Policy

RESOURCES	y	↑ = ↑ initial stage production ↓ = ↑ end stage production
INVCON	y	↑ = ↑ investment ↓ = ↑ consumption

Following the confirmation of a unit root, Becketti (2013) suggests the estimation of the number of lags for the VECM, in a similar approach to the previous Vector-Auto Regression Section. The information criteria for the UK timeseries variables is shown in table 58.

Table 58: Information Criteria for the Vector-Error Correction Model of HTTC

lag	Degree of Freedom	p	FPE	AIC	HQIC	SBIC
0	25	0.000	2.1e+12	42.578	42.6267	42.698
1	25	0.000	2.8e+07	31.3293	31.6215	32.0493*
2	25	0.000	2.0e+07*	30.9978	31.5336*	32.3179
3	25	0.000	2.3e+07	31.1331	31.9123	33.0532
4	25	0.000	2.0e+07	30.9899*	32.0127	33.5101

*preferred value

The lag length which produces the minimum value of the information statistic is the preferred solution, for the UK (timeseries now including CYGAP) variables. Akaike's final prediction error and Hannan and Quinn's information criterion prefer 2 lags whilst Akaike's information criterion prefers 4 lags and Schwarz's Bayesian information criterion prefers 1 lag. As previously it must be considered that Becketti (2013) states that it is common to for the various information criteria to produce differing results and that a decision must be made informed by theory and previous research. The 2 lags choice is supported by the literature with Mulligan and Keeler considering it appropriate and the post estimation testing of the Vector-Auto Regression model suggesting the significance of 2 lags in models of Hayek's theory of the trade cycle.

Conventional inference is valid in the VECM with non stationary variables, as although previously for the Vector-Auto Regression Models the stationarity of the variables was crucial it is generally assumed that calculating the appropriate number of lags is always sufficient to guarantee the residuals are white noise errors with no serial correlation, Becketti (2013), Mulligan (2006).

Secondly, the number of cointegrating relationships must be estimated, In accordance with Mulligan (2006) Johansen tests for cointegration are used and presented in table 59.

Table 59: Johansen Tests for cointegration

Rank	Eigenvalue	Trace Statistic	5% Critical Value
0	-	101.1491	68.52
1	0.30039	59.7102	47.21
2	0.25670	25.2988*	29.68
3	0.13977	7.8348	15.41
4	0.06530	0.0010	3.76
5	0.00001	-	-

*indicates specified number of cointegrating relationships

Within this specification, the Johansen tests for cointegration accept the null hypothesis that r ≤ 2.

Thus using the selected lag order, having previously confirmed the presence of a unit root in the variables, a Vector Error Correction (VECM) model specifying 2 lags and 2 cointegrating relationships can be constructed with the form:

$$\begin{aligned}\Delta\ln(GDP)_t = {} & \Theta(e_{t-1}) + \Delta\ln(GDP)_{t-1} + \Delta\ln(GDP)_{t-2} + \Delta\ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} \\ & + \Delta YGAP_{t-2} + \Delta YGAP_{t-3} + \cdots + \Delta m4_{t-1} + \Delta m4_{t-2} + \Delta m4_{t-3} + \cdots \\ & + \Delta RESOURCES_{t-1} + \Delta RESOURCES_{t-2} + \Delta RESOURCES_{t-3} + \cdots \\ & + \Delta INVCON_{t-1} + \Delta INVCON_{t-3} + \Delta INVCON_{t-3} + \cdots + u_t\end{aligned}$$

$$\begin{aligned}\Delta YGAP_t = {} & \Psi(e_{t-1}) + \Delta\ln(GDP)_{t-1} + \Delta\ln(GDP)_{t-2} + \Delta\ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} \\ & + \Delta YGAP_{t-2} + \Delta YGAP_{t-3} + \cdots + \Delta m4_{t-1} + \Delta m4_{t-2} + \Delta m4_{t-3} + \cdots \\ & + \Delta RESOURCES_{t-1} + \Delta RESOURCES_{t-2} + \Delta RESOURCES_{t-3} + \cdots \\ & + \Delta INVCON_{t-1} + \Delta INVCON_{t-3} + \Delta INVCON_{t-3} + \cdots + u_t\end{aligned}$$

$$
\begin{aligned}
\Delta \mathrm{M4}_t = \Phi(e_{t-1}) &+ \Delta \ln(GDP)_{t-1} + \Delta \ln(GDP)_{t-2} + \Delta \ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} \\
&+ \Delta YGAP_{t-2} + \Delta YGAP_{t-3} + \cdots + \Delta m4_{t-1} + \Delta m4_{t-2} + \Delta m4_{t-3} + \cdots \\
&+ \Delta RESOURCES_{t-1} + \Delta RESOURCES_{t-2} + \Delta RESOURCES_{t-3} + \cdots \\
&+ \Delta INVCON_{t-1} + \Delta INVCON_{t-3} + \Delta INVCON_{t-3} + \cdots + u_t
\end{aligned}
$$

$$
\begin{aligned}
\Delta RESOURCE_t = \Pi(e_{t-1}) &+ \Delta \ln(GDP)_{t-1} + \Delta \ln(GDP)_{t-2} + \Delta \ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} \\
&+ \Delta YGAP_{t-2} + \Delta YGAP_{t-3} + \cdots + \Delta m4_{t-1} + \Delta m4_{t-2} + \Delta m4_{t-3} + \cdots \\
&+ \Delta RESOURCES_{t-1} + \Delta RESOURCES_{t-2} + \Delta RESOURCES_{t-3} + \cdots \\
&+ \Delta INVCON_{t-1} + \Delta INVCON_{t-3} + \Delta INVCON_{t-3} + \cdots + u_t
\end{aligned}
$$

$$
\begin{aligned}
\Delta \mathrm{INVCON}_t = \Upsilon(e_{t-1}) &+ \Delta \ln(GDP)_{t-1} + \Delta \ln(GDP)_{t-2} + \Delta \ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} \\
&+ \Delta YGAP_{t-2} + \Delta YGAP_{t-3} + \cdots + \Delta m4_{t-1} + \Delta m4_{t-2} + \Delta m4_{t-3} + \cdots \\
&+ \Delta RESOURCES_{t-1} + \Delta RESOURCES_{t-2} + \Delta RESOURCES_{t-3} + \cdots \\
&+ \Delta INVCON_{t-1} + \Delta INVCON_{t-3} + \Delta INVCON_{t-3} + \cdots + u_t
\end{aligned}
$$

Where e_{t-1} represents the error which the disequilibrium adjustment of the VECM attempts to explain. Θ,Ψ,ϕ,Π and Υ represent the structural adjustment or disequilibrium terms. Whenever the system is in disequilibrium the non zero residual in period t results in an adjustment back toward equilibrium in period t_{+1} represented by the error correction process.

The specification of the VECM considers the relationship between the natural log of GDP [ln(GDP)], the cumulative interest rate gap [YGAP], the creation of new money in the economy [M4], the change in the temporal production process [RESOURCES] and the change in the investment / consumption process [INVCON]. In Hayek’s theory of the trade cycle manipulation of the interest rate below the natural level increases the money supply, creates malinvestment signified by a rapid increase in investment and consumption and a production process focussed on longer term production. This malinvestment is eventually ‘corrected’ by the market liquidating investment past the entrepreneur’s time preference and the consumer re-evaluating future consumption decisions.

As previously the HTTC can be summarised in a series of Second Order Predictions, shown in table 60.

Table 60: Second Order Predictions of Hayek’s theory

(↓)YIELD→ (↑)M4	**(↑)GDP→(↑)RESOURCES**
(↑)M4→ (↑)RESOURCES	**(↑)GDP→(↓) INVCON**
(↑)M4→(↓) INVCON	**(↑)RESOURCES→(↑)YIELD**
(↑)RESOURCES→(↑)GDP	**(↓) INVCON →(↑)YIELD**
(↓) INVCON → (↑)GDP	**(↑)YIELD→(↓)GDP**

Shown as:

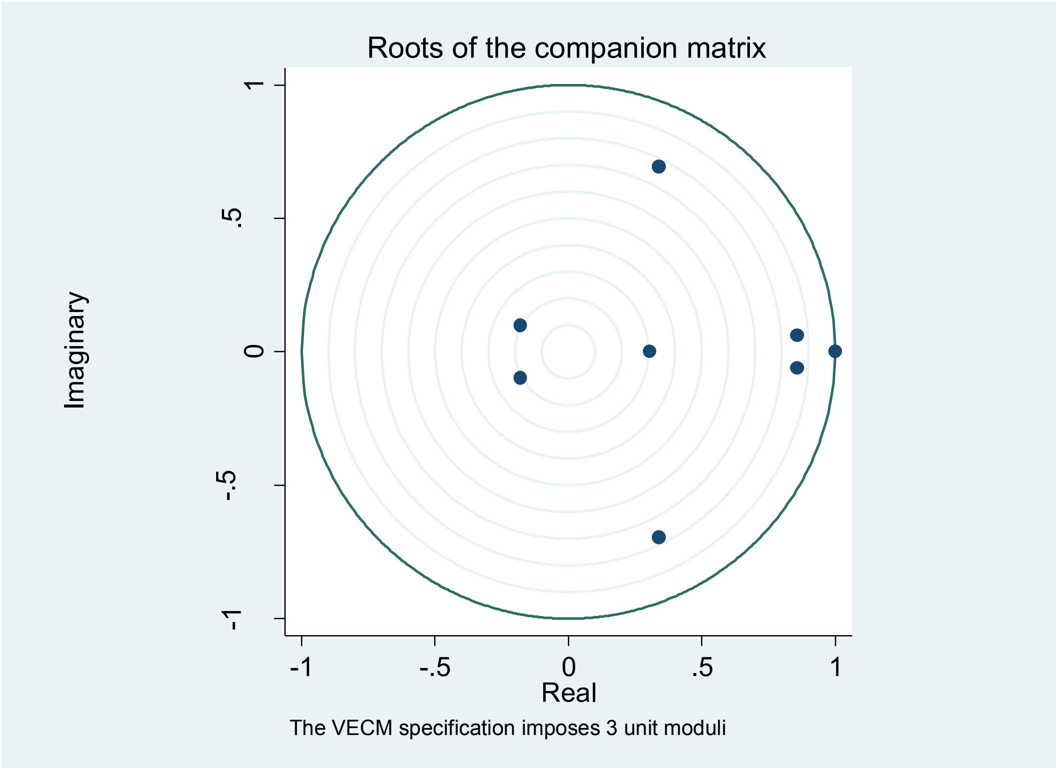
(↑)YGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)YGAP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

The VECM model built to examine these relationships is displayed in the appendices (A6.5).

9.2.3 Testing the VECM

As expected the VECM imposes 3 unit roots, shown in figure 49, which lie within the unit circle, though one lies on the edge indicating some shocks may not die out quickly.

Figure 49: Roots of the Companion Matrix (VECM)



There is no evidence of instability nor of autocorrelated errors. Non-normality which is considered through a Jarque-Bera Test for Multivariate Normality of Residuals with all null hypotheses of normality accepted[66].

[66] Whilst all test presented have received and been refined according to robustness checks and post estimation review, the interpretation of long run coefficients in the co-integrating vectors is subject to discussion and contention in the discussion of the literature (e.g. Mulligan 20016), this should be remembered when reviewing the discussion of the Vector Error Correction Model. However the overall finding of this model, that of limited, but far from holistic support of Hayek's Theory of the Trade Cycle is supported by the results of the Vector Auto-Regression Models.

The Cointegrating relationships[67] present in the VECM can be written as:

CR1:

lnGDPt+0.0702253RESOURCESt+0.1693787INVCONt-0.0000055CYGAPt-0.0055382-12.2349t

CR2:

CYGAPt-0.001139M4t-34.66767RESOURCESt-106.1492INVCONt-0.0344+107.2249t

With the coefficients of mixed significance, shown in table 61.

Table 61: Coefficients of the variables within the cointegrating relationships

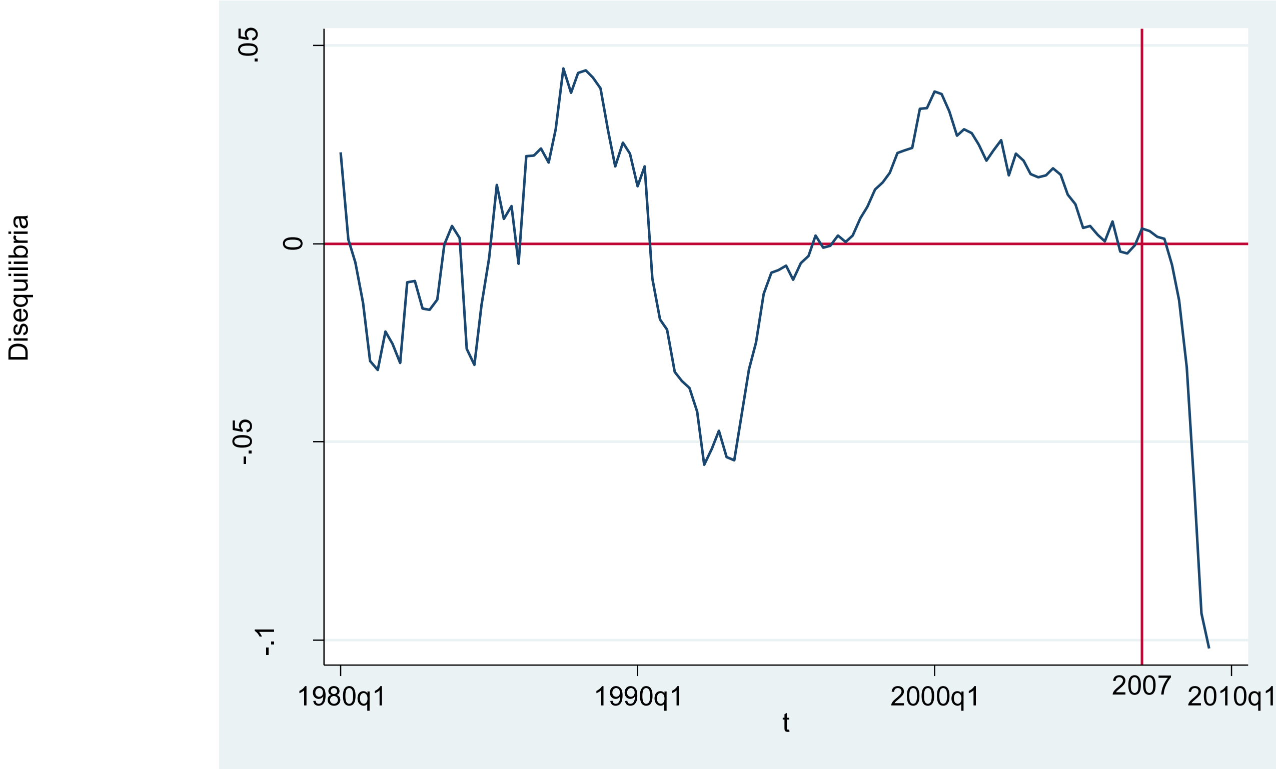
CE1**	Coefficient
RESOURCES INVCON CYGAP	0.0702253** 0.34 0.912
CE2***	
RESOURCES INVCON CYGAP	-9.59*** -4.82*** -0.67

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

The cointegrating relationships can be better seen qualitatively in figures 50 & 51.

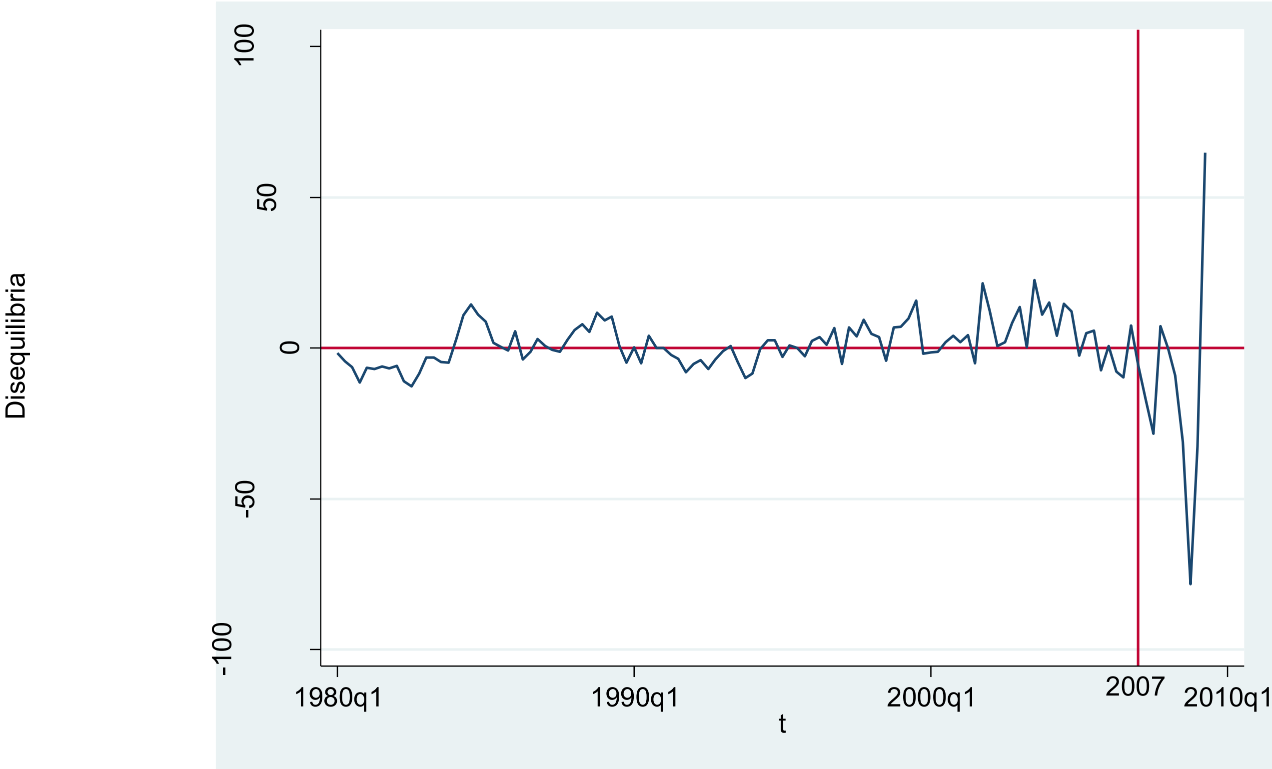
[67] In accordance with Becketi (2013), the derived cointegrating relationship ($\beta' w_{t-1} + v + p^t$) is used. In equilibrium $0 = \beta' w_{t-1} + v + p^t$.

Figure 50: Cointegrating Relationships 1: GDP, M4, RESOURCES, INVCON



This cointegrating relationship, significant at the 5% level demonstrates a disequilibrium process relatively consistent with Hayek's theory of the trade cycle, the relationship between the variables can be seen to oscillate widely above equilibrium before financial or economic crisis and move under equilibrium levels. This process can clearly be seen in the lead up to and the activity below equilibrium following the 2007 financial crisis (correction).

Figure 51: Cointegrating Relationship 2



This cointegrating relationship, significant at the 1% level again demonstrates a disequilibrium process relatively consistent with Hayek's theory of the trade cycle, the relationship between the variables can be seen to oscillate widely above equilibrium before financial or economic crisis and move under equilibrium levels. This process can clearly be seen in the lead up to and the activity below equilibrium following the 2007 financial crisis (correction).

A consideration of the R-Square for the disequilibrium process reveals some support of the HTTC, Δ(lnGDP) at 0.6860 suggests that unsurprisingly much of the adjustment process is related to ln(GDP). The R-Square for Δ(YGAP) is 0.7158, this could be read as a compelling vote for HTTC as a considerable amount of the adjustment process appears to work through the interest rate. In a VECM containing a measure of GDP it is consistent with HTTC that the measure of the interest rate has the largest R^2.

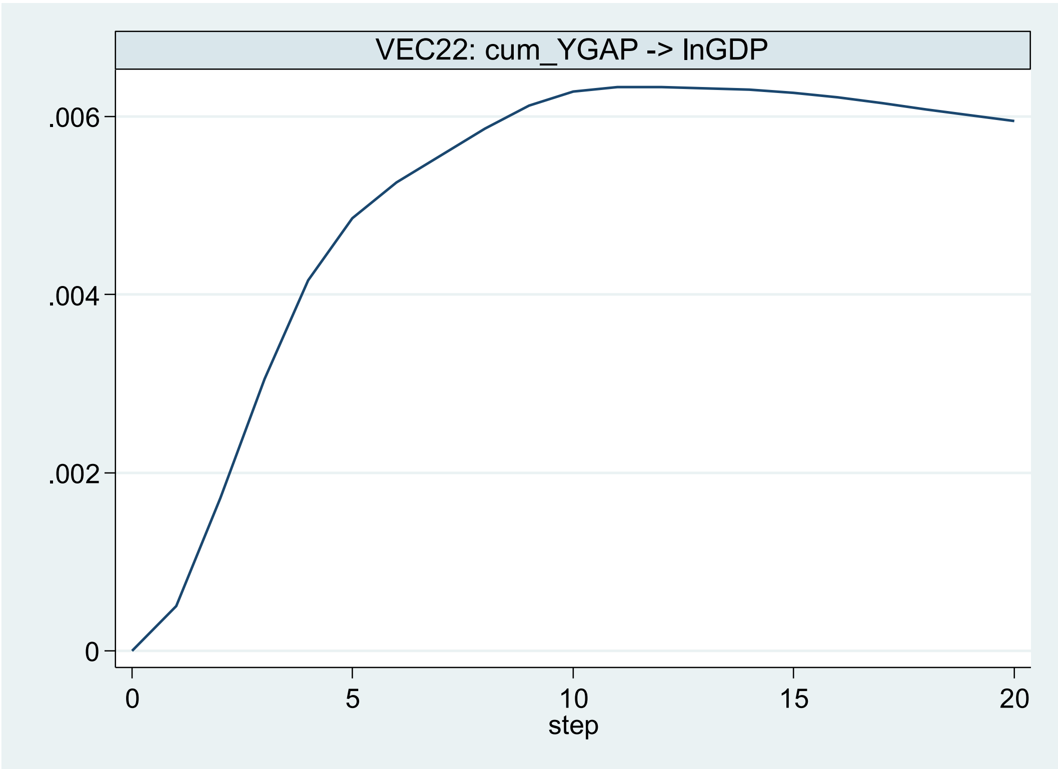
Much of the HTTC relies on the temporal impact of a change in variables, and as demonstrated through the earlier Finite Distributed Lag Models, many of the variables have a dual nature. That is a positive effect on output (lnGDP) in the first instance and then a negative effect in the second. For example, for Hayek's theory of the trade cycle, it would be expected that a reduction in the variable CYGAP would cause a positive effect initially with the increase in malinvestment generating increased activity, but ultimately a negative effect as the liquidation effect of HTTC occurs. Likewise the M4 variable, an increase would first of all boost economic activity, however as it becomes apparent (for the Austrians) that the increase in economic activity is malinvestment, this will be corrected and liquidated in accordance with HTTC.

9.2.4 Orthogonalized Impulse Response Functions Derived From The VECM.

A 20 step (5 year) calculation of the Orthogonalized Impulse Response Function of one variable of the VECM on another is shown as appendix A6.3. For an overall view of the temporal relationships in the economy modelled on HTTC principles all the combinations of impulse and response are shown. This snapshot of the impulse response of a five year period is recommended by Mulligan (2006) though acknowledged that often the expansionary stage (not encompassing the endogenous turning point of the variable) generally lasts longer than 5years. Graphs demonstrating the key linkages in HTTC demonstrating evidence of the slowdown anticipated prior to the endogenous turning point are shown following the tables.

One expects *a priori*, that a GDP impulse will have a response throughout the model variables which can be seen throughout the first five Orthogonalized Impulse Response Functions. Beginning then with a random one percentage point increase in the cumulative term spread, the effects mirror those reported by Mulligan (2006) demonstrating a steady increase in GDP over the period following the positive CYGAP shock. However the beginnings of a slowdown are apparent on the qualitative view in figure 52.

Figure 52: Impulse YGAP, Response GDP (VECM)



With this model suggesting a stronger positive (negative) effect than Mulligan (2006), the finding of the VECM in this respect is consistent with the Austrian Econometric and Empirical Literature and thus from the Austrian perspective, evidence for the HTTC being valid for the UK economy (1980-2010). However it is important to state that the data to test the prescription of the Hayek's theory of the trade cycle that monetary policy works symmetrically is not possible as the data is asymmetric toward low interest rates being used as monetary policy and judgements based on the inverse of relationships must be used.

Evidence for the relevance of HTTC for the UK economy could be found within the response of M4 to CYGAP. In the expansionary monetary policy which is anathema to the Austrians, Mulligan (2006) suggests that CYGAP should decrease with activity to raise the ST bond yield as money at this stage of the economy is primarily being used for consumption, which in fact forms the basis of his compelling arguments for the relevance of HTTC, as the interest rate decreases, a stimulation of M4 should occur thus an inverse relationship which is not observed above. However, de Soto (2010) suggests that at least for a while in the expansionary stage the 'easy credit' decision gains initial momentum from a low interest rate and then actor credit decision are made on expectation of activity continuing rather than a simple interest rate decision which could explain the observation in figure 53.

Figure 53: Impulse(CYGAP) Response (M4)

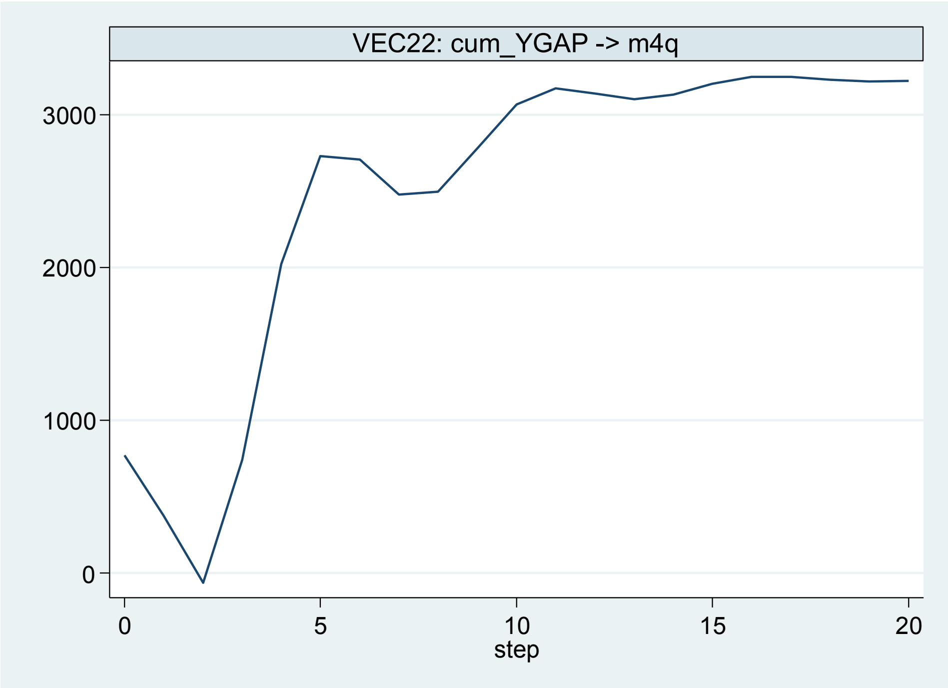
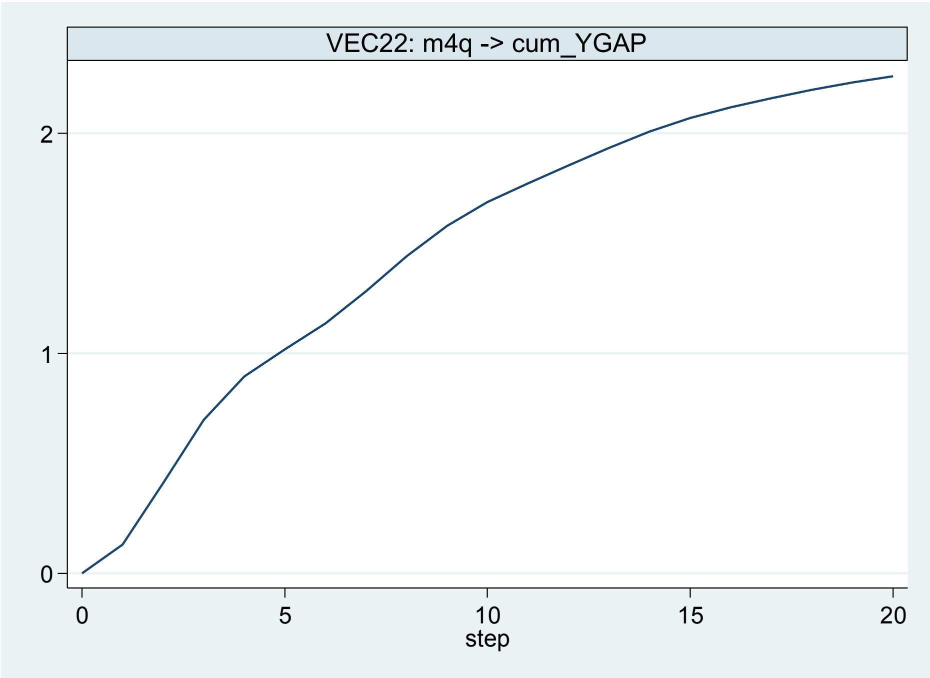


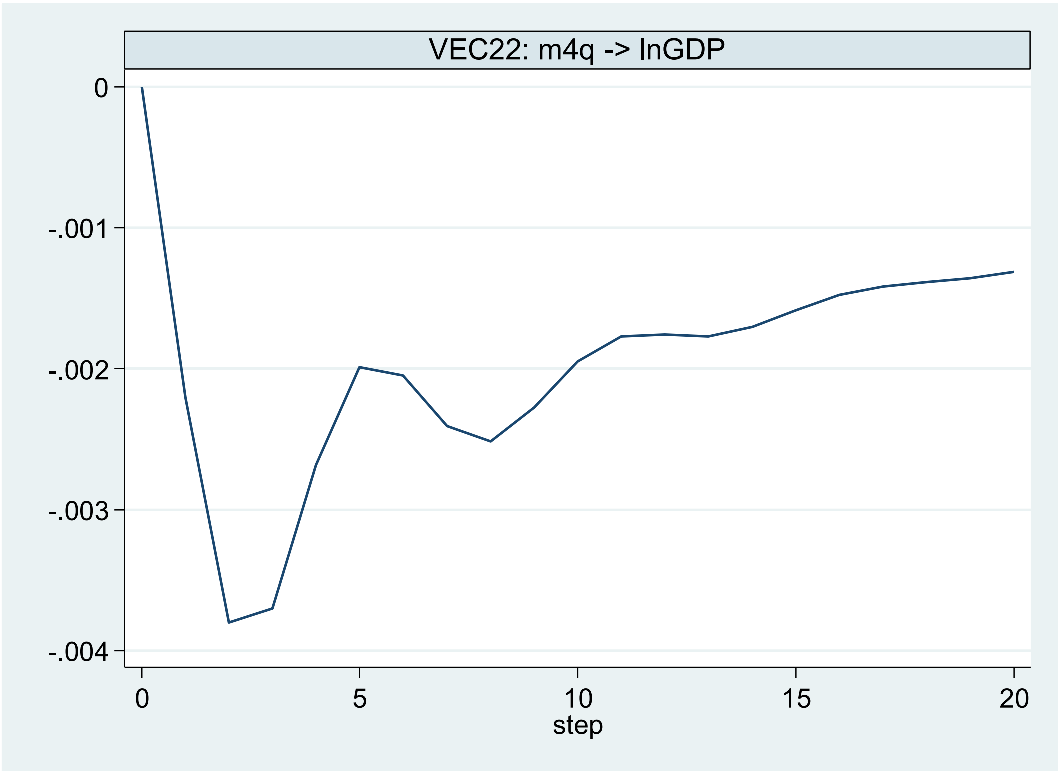
Figure 54: Impulse (M4) Response (CYGAP)



We could however expect CYGAP to increase as the market rate of interest decreases and M4 to increase. This is as 'too low' interest rates increase the demand and thus price of ST bonds, thus forcing down ST bond yields. Both of these being components of what is for the Austrians the Central Bank's expansionary monetary policy, thus an inverse relationship between CYGAP and M4. In figure 54, the relationship appears positive with random positive 1% shocks to each impulse variable creating positive responses. However there is a rational reason in the UK economy for this process. If the loanable funds rate (market rate of interest) falls, there comes a time where 3month UK government bond yields are higher than the cost of funds. It makes economic sense to borrow easy credit to invest in ST government bonds, thus creating a positive relationship between CYGAP and M4.

It is supportive of the relevance of Hayek's theory of the trade cycle for the UK economy that the response of ln(GDP) to a random 1% increase in M4 is inverse. HTTC would suggest that the artificial inflation of the money supply would have a permanent lowering effect on GDP:

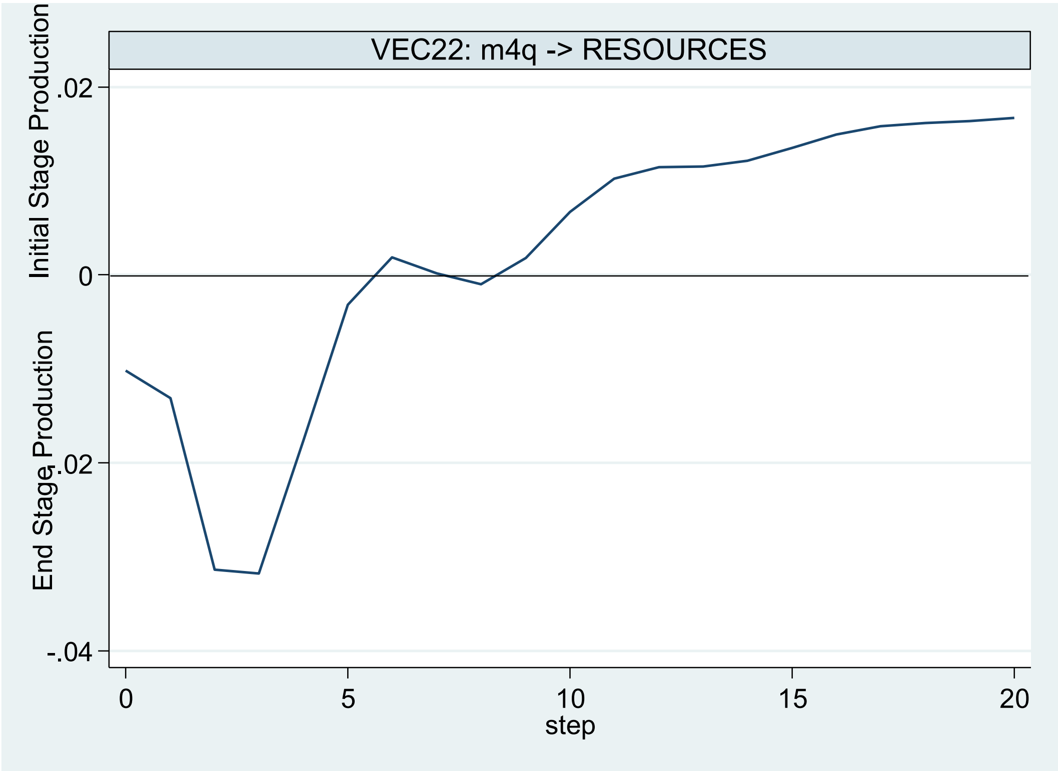
Figure 55: Impulse M4, Response GDP (VECM)



The OIRF for impulse (M4) response(lnGDP) demonstrates in figure 55, clear support for the HTTC, however the previous relationships between M4 and the interest rate, require far more support before the response of ln(GDP) to M4 can be heralded as a triumph for HTTC as per Mulligan (2006).

The OIRF of RESOURCES response to a positive 1% random shock on M4 appears to be supportive of Hayek's theory of the trade cycle. The HTTC suggests that an increase in M4 will increase initially resource use at end stage production (signified by the negative response of the first five quarters) then a shift toward longer production processes (initial stage consumption) will occur, signified here by the positive response of the majority of the remaining quarters. This can be seen in figure 56.

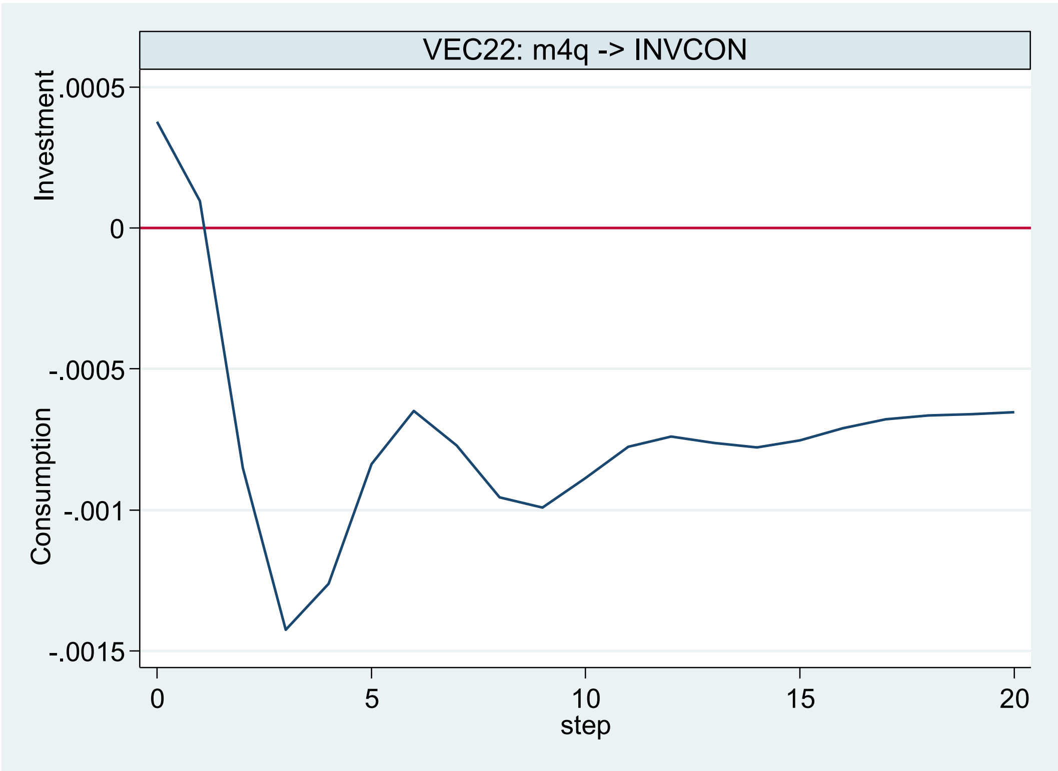
Figure 56: Impulse M4, Response RESOURCES (VECM)



Where the shift from end stage production to initial stage production is consistent with HTTC predictions and suggestive of its relevance for the UK economy. However for HTTC to hold, one would expect the predicted vice versa effect on the investment / consumption ratio (INVCON). Simply HTTC relies on this to create the economy's focus on consumption (end stage production) creating the situation where the "economy takes longer to produce real consumerable output, but also ensures consumers are less willing to wait for their wants to be satisfied" (Mulligan, 2006). The unsustainable production structure of the economy arising from an increase in artificial credit relies on an increase in credit (+M4) leading to the economy shifting to initial stage production (+RESOURCES) and a shift toward consumption (-INVCON).

This shift can be seen in figure 57.

Figure 57: Impulse M4, Response INVCON (VECM)



A consideration of some of the more relevant impulse response functions for HTTC calls for a questioning of the function of the interest rate in HTTC, the Austrian interpretation provided by Mulligan (2006) provides relatively strong evidence in support of HTTC, an orthodox view of CYGAP suggests an opposite relationship and thus little support for HTTC in this regard. Carilli & Dempster (2008) explore this phenomena in greater depth, using Austrian interpretations of variables generates results in favour of HTTC, using orthodox interpretations of the variables, less so.

A consideration of the OIRFs generated through the VECM suggest some support for HTTC, although the key interest rate linkage remains less convincing.

However, in terms of the testable model:

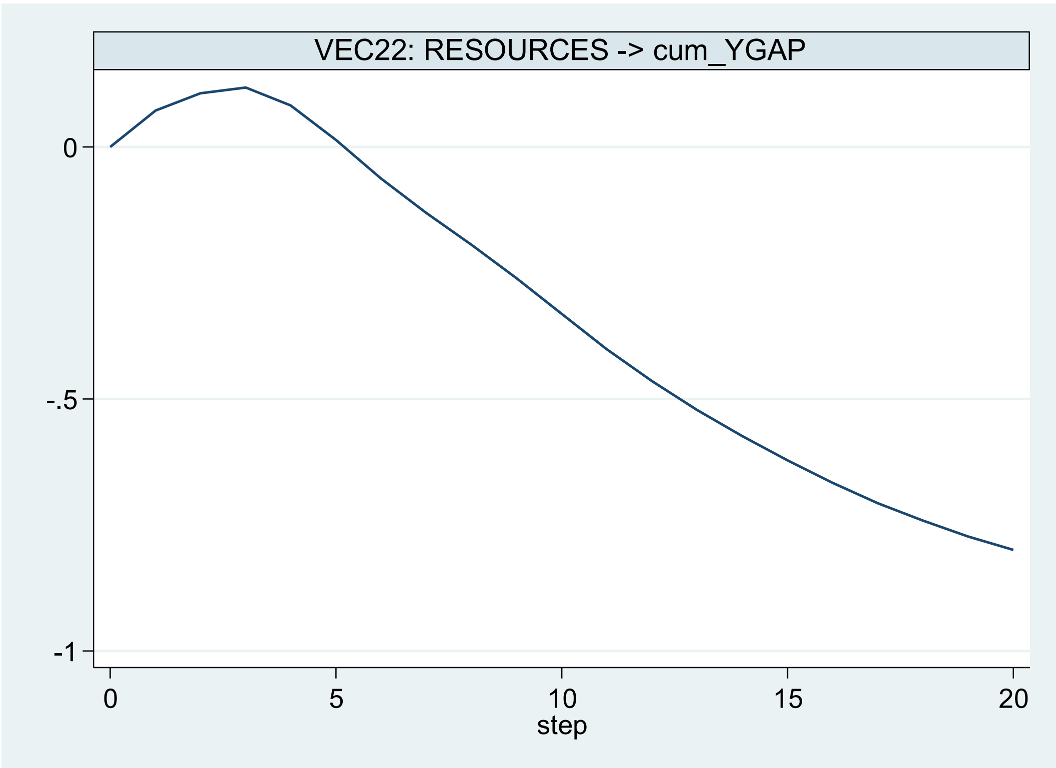
(↑)CYGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)CYGAP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

The **(↑)M4→ (↑)RESOURCES** link can be seen within the UK timeseries data
↘ (↓)INVCON

The orthodox interpretation of the variable CYGAP provides support for the **(↑)CYGAP→ (↑)M4→** link, however does not provide the strong support for the Austrian view of a decrease in the market rate of interest below the natural rate of interest creating a long term negative reduction in GDP that Mulligan (2006) and Carilli & Dempster (2008) find.

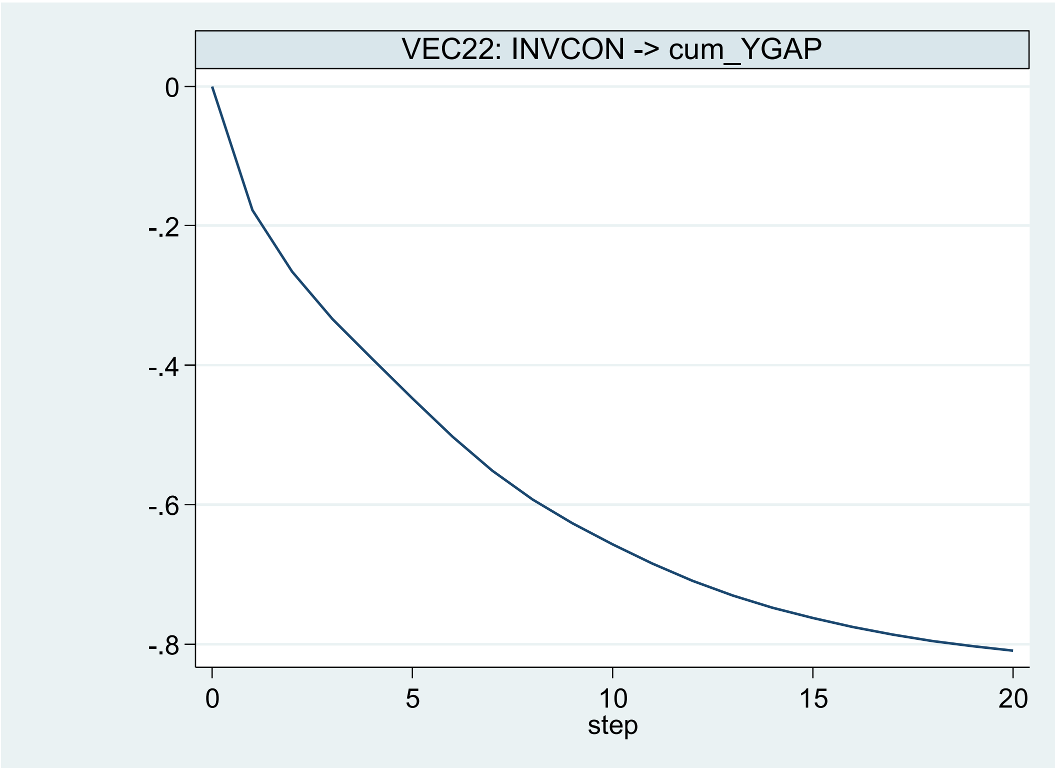
Adhering to Hayek's theory of the trade cycle, one would expect that a positive increase in RESOURCES, that is a movement toward initial stage production and thus a longer production process would generate a negative response in CYGAP as the market rate of interest would increase as the malinvestment became apparent, the OIRF is shown in figure 58.

Figure 58: Impulse RESOURCES, response CYGAP (VECM)



Using an orthodox view of CYGAP and assessing its response to a positive shock of 1%, it can be seen that in accordance with HTTC, following an initial increase of YGAP (and thus decrease of the market rate below equilibrium), the market rate rises in accordance with HTTC decreasing YGAP. In terms of the Investment / Consumption ratio, HTTC would suggest that with the realisation of extra consumer demand, the instability of the production process becomes apparent to the market. There is a clear entrepreneurial opportunity for sudden investment in the end stage production the economy has moved away from, HTTC therefore would expect to see an inverse relationship between a 1% positive INVCON shock and CYGAP demonstrated in figure 59.

Figure 59: Impulse INVCON, Response CYGAP (VECM)

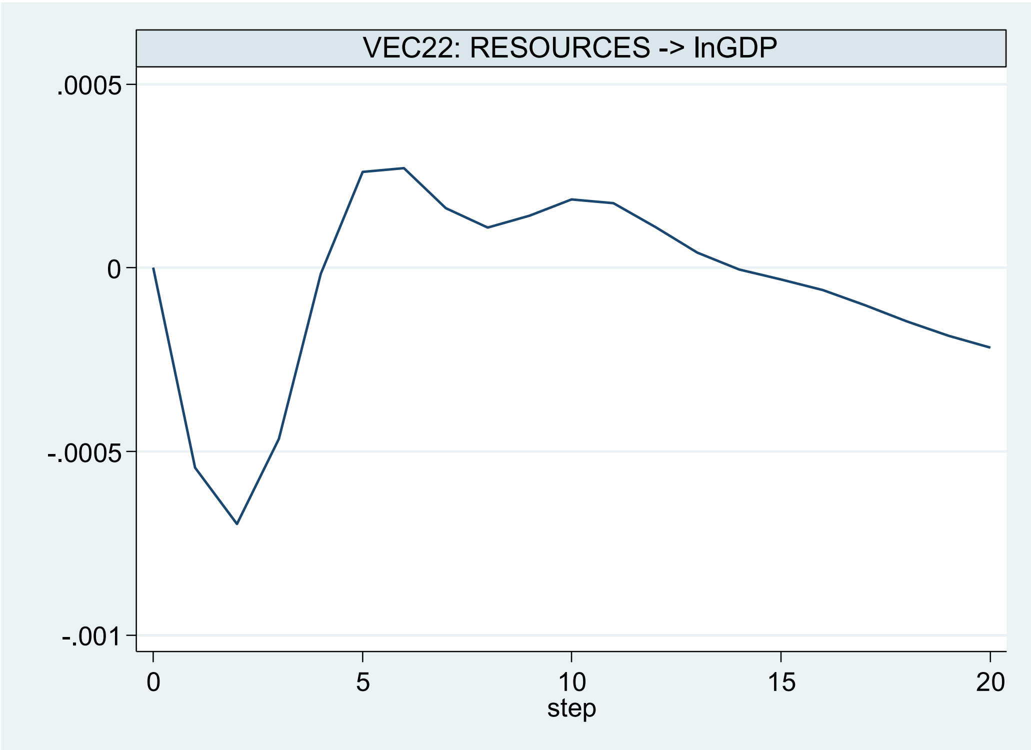


The (↑)**RESOURCES→(↓)CYGAP** link can be seen to be supported by the VECM.
(↓) INVCON ↗

The **(↑)RESOURCES→(↑)GDP** link can be examined as above, Austrian Business Cycle
(↓)INVCON ↗

theory which worked relatively well in explaining the effects of M4 on RESOURCES and INVCON suggests that a positive shock to RESOURCES should result in a positive response to ln(GDP). A negative shock to INVCON (the economy shifting to a consumption focus) should for HTTC have a positive effect on ln(GDP). In terms of RESOURCES, following an initial decline of ln(GDP) presumably due to the transfer in the economy from end stage to initial stage production, there is a small positive effect followed by a continuation of the negative, this finding shown in figure 60, is not wholly consistent with HTTC.

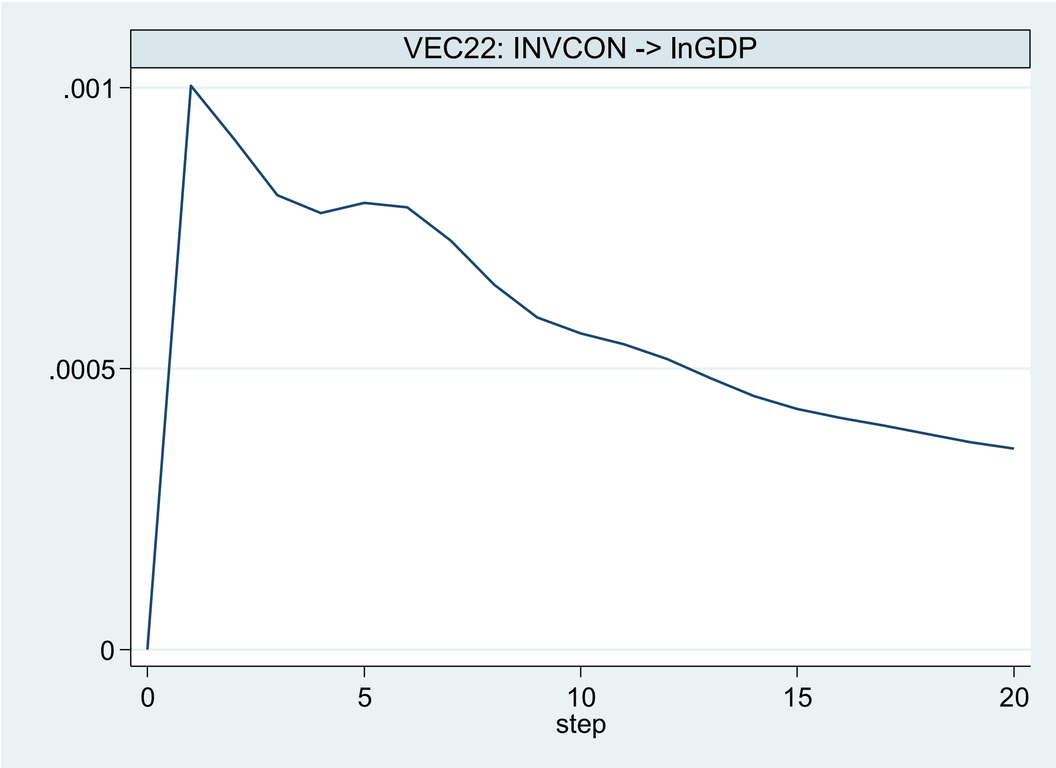
Figure 60: Impulse RESOURCES, Response GDP (VECM)



The positive INVCON impulse on ln(GDP) shown in figure 61 does not follow HTTC predictions which consider that there will be an inverse relationship below, however there is a noticeable decline in the response of ln(GDP) over time. Fundamentally any economic activity will have a positive relationship with ln(GDP) and whilst a switch toward consumption away from investment may in the long term act within the prescriptions of HTTC, the Orthagonalized

Impulse Response Function may simply be acknowledging any potential dissaving which occurs with the switch toward a consumption focussed economy.

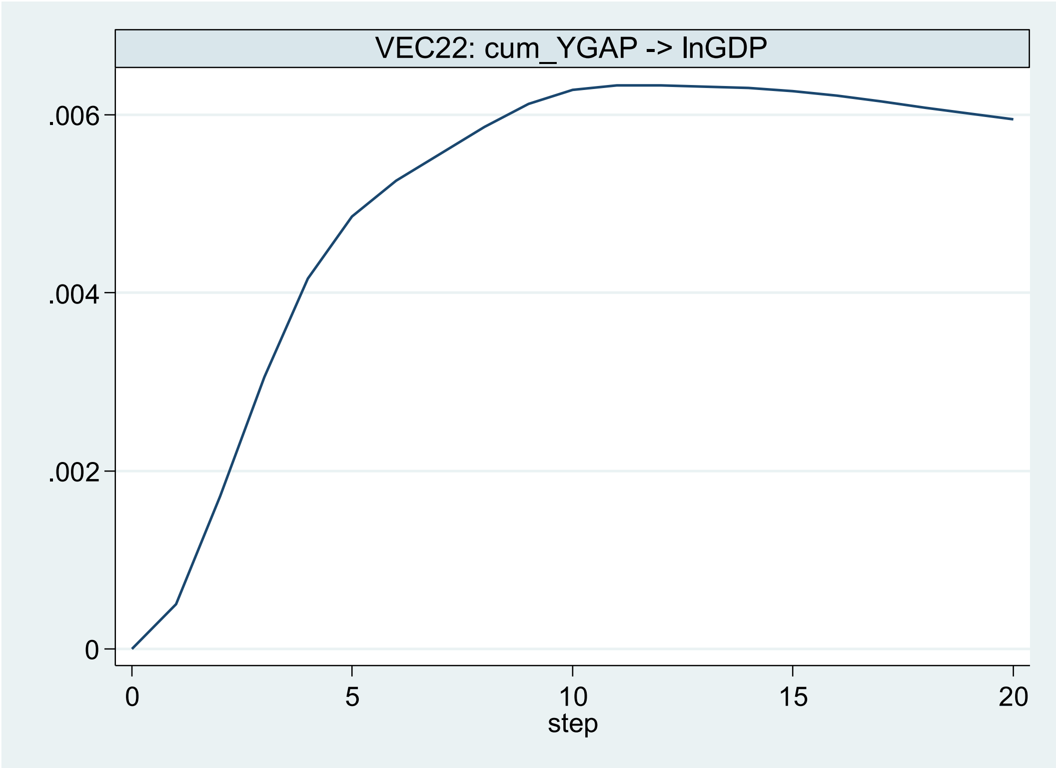
Figure 61: Impulse INVCON, Response GDP (VECM)



The high immediate positive response to the +1% INVCON impulse shown in figure 61 could be explained by an increase in credit or dissaving action within the market.

Finally the **(↓)CYGAP→(↓)GDP** link of the HTTC can be examined. Using CYGAP as a proxy (in the orthodox sense and not in the Austrian as per Mulligan, 2006) for the market rate (we would expect CYGAP to have an inverse relationship with the market rate). Therefore a 1% positive random shock to CYGAP would be expected to result in a positive response from ln(GDP):

Figure 62: Impulse CYGAP, Response GDP (VECM)



In accordance with Hayek's theory of the trade cycle (and of course expected from an Orthodox perspective), the increase in the market rate of interest would be expected to lead to a decrease in ln(GDP), a summary of the OIRF analysis of the HTTC model below is presented in table 62.

HTTC model:

(↑)CYGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)CYGAP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

Table 62: Impulse Response evaluation of the SOPs of HTTC

Link	Impulse / Response Relationship predicted by HTTC	Observed Impulse / Response Relationship
ΔMR→ ΔM4	**CYGAP↑→M4↑**	**CYGAP↑→M4↑**
ΔM4→ ΔRESOURCES	**M4↑→INVCON↓**	**M4↑→INVCON↓**
ΔM4→ ΔINVCON	**M4↑→RESOURCES↑**	**M4↑→RESOURCES↑**
ΔRESOURCES →ΔGDP	**RESOURCES↑→↑ln(GDP)**	**RESOURCES↑→↓ln(GDP)**
ΔINVCON→ΔGDP	**INVCON↓→↑ln(GDP)**	**INVCON↑→↓ln(GDP)**
ΔGDP→ΔRESOURCES	**↑ln(GDP) → RESOURCES↑**	**↑ln(GDP) → RESOURCES↓**[ϕ]
ΔGDP→ ΔINVCON	**↑ln(GDP) → INVCON↓**	**↑ln(GDP) → INVCON↑**[Ψ]
ΔRESOURCES→ΔMR	**RESOURCES↑→CYGAP↓**	**RESOURCES↑→CYGAP↓**
ΔINVCON →ΔMR	**INVCON↓→ CYGAP↓**	**INVCON↓→ CYGAP↓**
ΔMR→Δ(↓)GDP	**CYGAP↓→ GDP↓**	**CYGAP↓→ GDP↓**

ϕThe non-correspondence of this observation with the HTTC predicted, may not be a refutation of Hayek's theory of the trade cycle , Carilli & Dempster (2008) suggest an endogenous turning point and these observations are consistent with this and the HTTC as outlined by Mulligan (2006).

Ψ The non-correspondence of this observation with the HTTC predicted, may not be a refutation of Hayek's theory of the trade cycle , Carilli & Dempster (2008) suggest an endogenous turning point and these observations are consistent with this and the HTTC as outlined by Mulligan (2006).

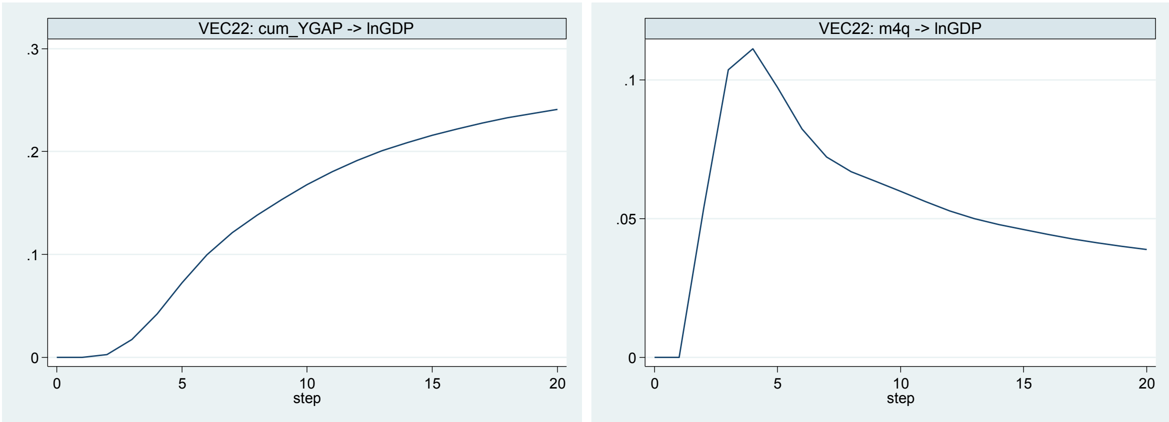
The analysis of the links above demonstrate some consistency with HTTC predictions for the UK economy 1980-2010 with reasonable explanations for the missed observations. The missed observations flowing from the cycle midpoint change in GDP could be earlier movements toward predicted relationships, remembering that the location of the temporal shift is unknown but for HTTC sure to happen, as previously noted, Carilli & Dempster (2008) consider that “we cannot know the interval ex ante, but Austrian (Hayekian) Business Cycle Theory <u>does</u> predict it”

In accordance with Mulligan (2006), the Variance Decomposition of the relationships within the VECM can enable the evaluation of Hayek’s theory of the trade cycle and are presented in appendix A6.4.

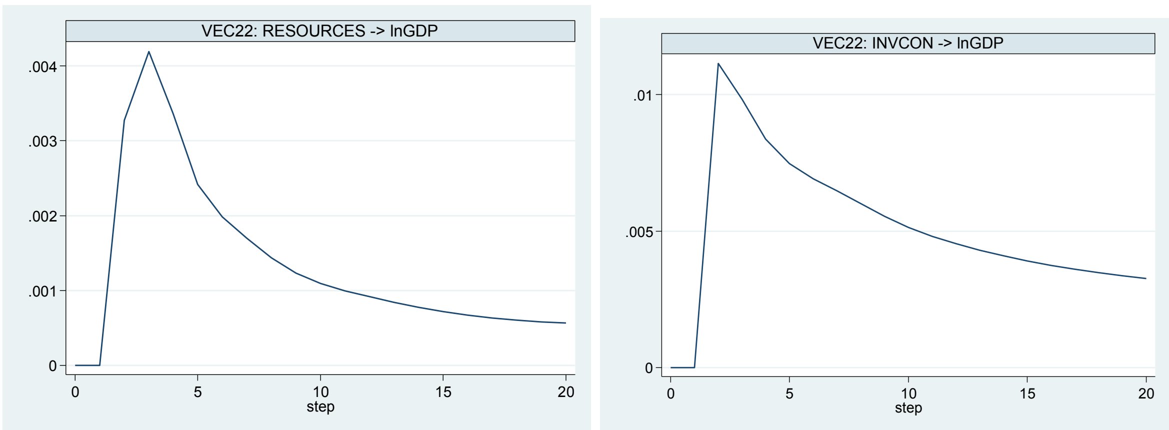
A consideration of the OIRFs generated through the VECM suggest some support for HTTC, although the key interest rate linkage remains less convincing.

The Fixed Effect Vector Decompositions are calculated above and generally show, relationships in variance decomposition consistent with the estimated cointegrating relationships. When considering the variance of ln(GDP) it can be seen in figure 63, that after 20 quarters or 5 years:

Figure 63: the variance of GDP relationships within the VECM



(1) CYGAP on ln(GDP) (3) M4 on ln(GDP)



(2) RESOURCES on ln(GDP) (4) INVCON on ln(GDP)

The interest rate proxy steadily grows in its explanatory power, whereas the further variables reduce their explanatory power over the time period:

Table 63: the variance of GDP relationships within the VECM

Horizon	Impulse (lnGDP), Response (lnGDP)	Impulse (CYGAP), Response (lnGDP)	Impulse (M4), Response (lnGDP)	Impulse (RES), Response (lnGDP)	Impulse (INVCON), Response (lnGDP)
1	1	0	0	0	0
2	0.929006	0.002811	0.053759	0.003273	0.011151
3	0.865176	0.017201	0.103602	0.004193	0.009829
4	0.834768	0.042235	0.111261	0.003362	0.008374
5	0.820427	0.072312	0.097371	0.002416	0.007474
6	0.809262	0.099565	0.082264	0.001985	0.006924
7	0.798546	0.12107	0.072208	0.001701	0.006475
8	0.78739	0.138305	0.06686	0.001439	0.006007
9	0.776275	0.153524	0.063424	0.001234	0.005543
10	0.766241	0.167666	0.059863	0.001092	0.005139
11	0.757657	0.18043	0.056109	0.000996	0.004809
12	0.750402	0.191398	0.052744	0.000918	0.004538
13	0.744156	0.200652	0.050043	0.000843	0.004306
14	0.738618	0.208617	0.04789	0.000776	0.004099
15	0.733662	0.215683	0.046023	0.000719	0.003913
16	0.729268	0.222023	0.044288	0.000672	0.003749
17	0.725417	0.227662	0.042681	0.000633	0.003606
18	0.722047	0.23263	0.041241	0.000603	0.003479
19	0.71907	0.237011	0.039972	0.000581	0.003365
20	0.716412	0.240919	0.038839	0.000568	0.003262
. . .					
120	0.679916	0.29886	0.000838	0.000957	0.19429

Though it can be seen, if the entire series (120 quarters) is estimated shown in table 63, the growth in the explanatory power of the interest rate proxy over the variance of ln(GDP) plateaus, moving from explaining approx. 24% of the variance in ln(GDP) in quarter 20 to explaining approx.. 30% of the variance in ln(GDP) in quarter 120. However Mulligan (2006) considers that the interest rate proxy being the strongest explanatory variable is in itself a triumph for HTTC.

9.3 Granger Causality Tests Derived from VECM:

In accordance with the Austrian Econometric Literature (e.g. Wainhouse 1984, Mulligan 2006, Carilli & Dempster 2008), Granger Causality Tests on the non-stationary variables can be conducted to examine the causal SOPs of Hayek's theory of the trade cycle. These results are presented in table 64.

Table 64: Granger Causality Results (VECM)

Equation	G* Variable	Chi^2
Ln(GDP)	CYGAP	6.72**
Ln(GDP)	RESOURCES	0.06
Ln(GDP)	M4	0.98
Ln(GDP)	INVCON	4.95**
CYGAP	Ln(GDP)	1.04
CYGAP	RESOURCES	0.12
CYGAP	M4	0.68
CYGAP	INVCON	4.93**
RESOURCES	Ln(GDP)	3.86**
RESOURCES	CYGAP	10.41***
RESOURCES	M4	2.60*
RESOURCES	INVCON	0.17
M4	Ln(GDP)	0.20
M4	CYGAP	1.43
M4	RESOURCES	4.95**
M4	INVCON	0.67
INVCON	Ln(GDP)	3.51**
INVCON	CYGAP	3.59**
INVCON	RESOURCES	1.16
INVCON	M4	0.55

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

9.4 Replication of Mulligan (2006) for UK timeseries data:

A key paper arguing for the validity of the Hayek's theory of the trade cycle (HTTC) is Mulligan (2006) which constructs a Vector Error Correction Model (VECM) using timeseries variables for output and the term spread of interest rates from the American Economy. A replication of this study for the UK economy should provide:

1. A further test of validity for Hayek's theory of the trade cycle.
2. An econometric approach to testing HTTC which uses a standard and accepted orthodox method, which has been embraced by the Austrian School of Economic Thought. The Mulligan (2006) paper is published in the Quarterly Journal of Austrian Economics, regarded as a leading Austrian Economic Journal.

The study constructs a VECM with the form:

$$\Delta C_t = \Theta(C_{t-1} - a - br_{t-1}) + \Delta C_{t-1} + \Delta C_{t-2} + \Delta C_{t-3} + \cdots + \Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3+\cdots+}u_t$$

$$\Delta \mathrm{r}_t = \Psi(C_{t-1} - a - br_{t-1}) + \Delta C_{t-1} + \Delta C_{t-2} + \Delta C_{t-3} + \cdots + \Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3+\cdots+}u_t$$

Where Θ and Ψ are the structural adjustment or disequilibrium terms and indicate the importance of the past changes in the explanatory variables in adjustment toward the hypothesised equilibrium.

Thus this replication study will construct a similar VECM with the form:

$$\Delta \ln(GDP)_t = \Theta(Ln(GDP)_{t-1} - a - bYGAP_{t-1}) + \Delta \ln(GDP)_{t-1} + \Delta \ln(GDP)_{t-2} + \Delta \ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} + \Delta YGAP_{t-2} + \Delta YGAP_{t-3+\cdots+}u_t$$

$$\Delta \mathrm{YGAP}_t = \Psi(Ln(GDP)_{t-1} - a - bYGAP_{t-1}) + \Delta \ln(GDP)_{t-1} + \Delta \ln(GDP)_{t-2} + \Delta \ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} + \Delta YGAP_{t-2} + \Delta YGAP_{t-3+\cdots+}u_t$$

To recap, the equilibrium represented by $\Theta(Ln(GDP)_{t-1} - a - bYGAP_{t-1})$ or $\Psi(Ln(GDP)_{t-1} - a - bYGAP_{t-1})$ is generally never reached and if ever achieved is not long term. Should it ever be reached it is represented by a zero residual in the cointegrating equation for that observation and when it is non-zero it represents the system in disequilibrium. Whenever the system is in disequilibrium the non zero residual in period t results in an adjustment back toward equilibrium in period t_{+1} represented by the error correction process.

The Mulligan (2006) study uses constructed monthly data from annualised figures for the period 1959-2003, in replicating the study for the UK economy this thesis will use variables from the previous VECM which have been observed quarterly from 1980-2010. In constructing the data from annualised figures the Mulligan Study potentially loses some of the richness of the data, in essence constructing 12 identical data point for every recorded observation. The variables used in the original study and the variables used in this thesis' replication are shown in table 65.

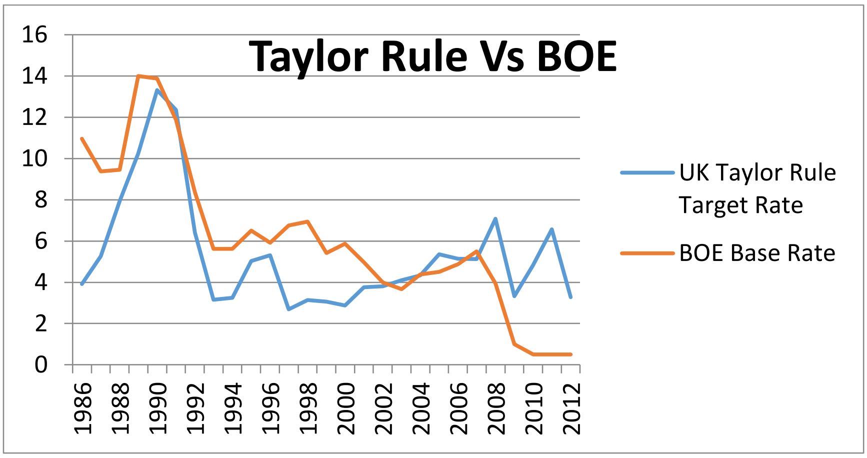
Table 65: Comparison of Mulligan and Replication Variables

Economic Phenomena	Mulligan Proxy	Thesis Proxy
Output	Ln(Consumerable Output)	Ln(GDP)
Interest rate divergence from 'natural rate'	Cumulative FED 10year constant rate – 3month secondary market rate (Term Spread)	Cumulative BoE 10yr UK gov bond yield – 3month UK gov bond yield. (CYGAP).

Both ln(GDP) and CYGAP have previously been tested and confirmed to be non-stationary and as such appropriate for use in this VECM.

The selection of these two variables is advantageous for Mulligan as it allows the isolation of influences due to credit expansion on output. However it has been noted throughout this thesis of the Behavioural Economics consideration required for HTTC, HTTC relies on a behavioural mechanism or an assumption that the lowering of interest rates below their natural rate will result in credit expansion, similar to the neoclassical criticisms it raises, HTTC does not deal well with exogenous events and it has a mono-causal foundation for individual's behaviour. The Hayek's theory of the trade cycle also falls down on the behaviour of the UK economy in the present post-crash low interest rate environment, a Taylor rule[68] estimation of the UK interest rate Vs the Bank of England Base Rate is shown in figure 64.

Figure 64: Taylor Rule rate for the UK Vs BoE rate for the UK



Source: Author's own calculations

The post crisis period is a clear demonstration of interest rates being below their (Taylor Rule Proxy) natural level, and yet the economic activity of the time period is at best a slow rise contrary to the Hayek's theory of the trade cycle. However the run up to crisis (from 2002) demonstrates a base rate below its natural rate, potentially in accordance with Austrian Theory.

Yet, for Garrison (1985) the interest rate directs the intertemporal coordination of productive resources by clearing the loanable funds market, as such Kirzner (1984) considers

[68] $i_t = \pi_t + r_t^* + a_\pi(\pi_t - \pi_t^*) + a_y(y_t - \bar{y}_t)$

disequilibrium interest rates to act the same as prices, highlighting opportunity for profit and the market of entrepreneurs reallocate resources accordingly.

Becketti (2013) states that a adding a sufficient number of lagged terms in the adjustment process is sufficient to guarantee that the residuals are white noise processes with no serial correlation, Mulligan (2006) finds that two lags are appropriate for similar variables and information criterion calculation as per the previous VAR tests reveal likewise. These are shown in table 66.

Table 66: Information Criterion for Replication VECM

Lag	FPE	AIC	HQIC	SBIC
0	0.008162	0.867467	0.890438	0.924545
1	1.1e-06	-8.06921	-8.0003	-7.89798
2	3.5e-07*	-9.18347*	-9.06861*	-8.89808*
3	3.8e-07	-9.11822	-8.95742	8.71868
4	4.1e-07	-9.03467	-8.82793	-8.52097

*indicates preferred lag for each information criterion.

The lag length which produces the minimum value of the information statistic is the preferred solution, for the UK timeseries variables Akaike's final prediction error, Hannan and Quinn's information criterion, Akaike's information criterion and Schwarz's Bayesian information criterion all prefer 2 lags, giving unanimous direction for this VECM.

The selection of the number of cointegrating relationships is performed as per Mulligan (2006) using Johansen-Juselius tests for cointegration (shown in table 67), remembering the maximum number of cointegrating relationships is 1 when examining 2 variables:

Table 67: Johansen-Juselius Tests for cointegration (Replication VECM)

Hypothesised # CE(s)	Maximum Eigenvalue	Trace Statistic	5% Critical Value
0*	0.30039	59.7102	47.21
At most 1	0.18698	0.0704	3.76

*(**) denotes rejection of the hypotheses at the 5% (1%) level

As the two variables in the model are cointegated, the ordinary least squares estimate of the structural relationship has the property of superconsistency (Mulligan 2006), the OLS estimate is presented in table 68 below:

Table 68: Superconsistent OLS

Variable	Coefficient	Standard Error	t-Statistic	Probability
CYGAP	0.2089348	0.262002	7.97	0.0000
Constant	11.84864	0.0767457	154.39	0.0000

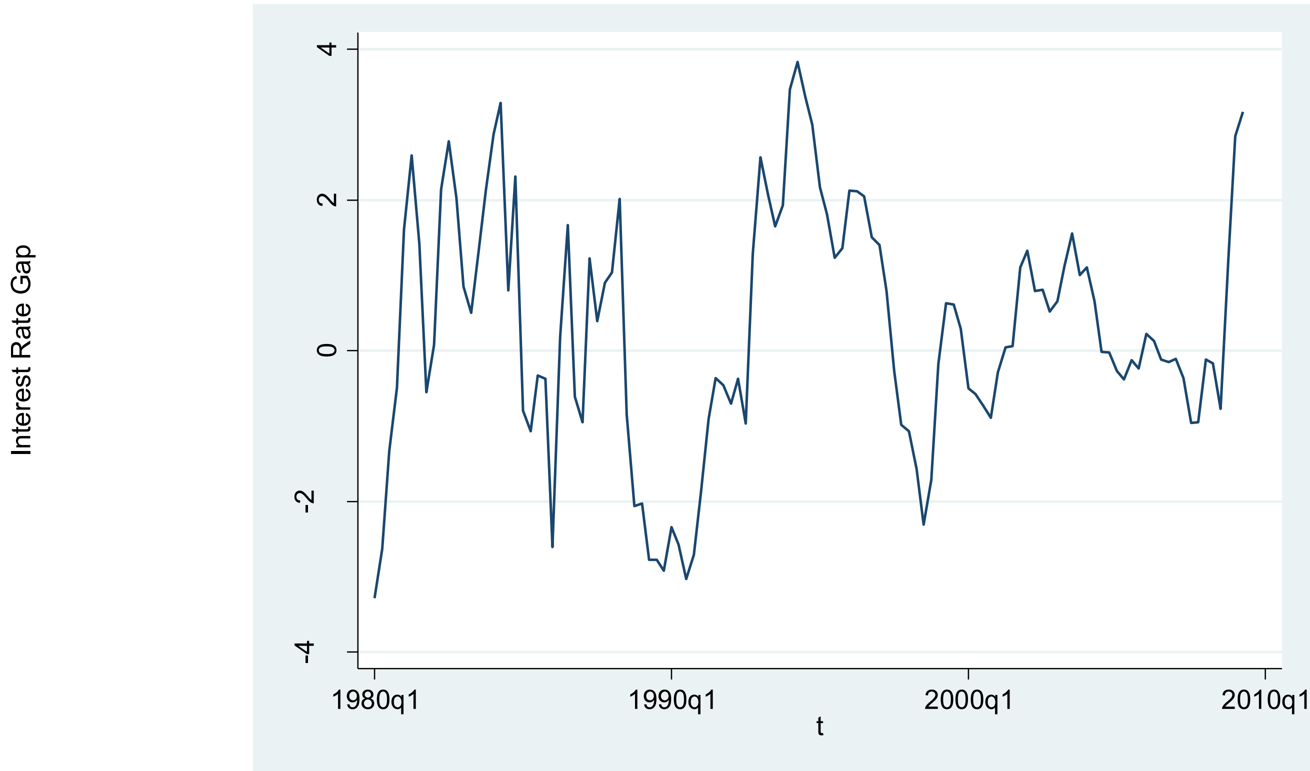
R-Squared	0.4087
Adjusted R-Squared	0.4023
F-Statistic	63.59
Probability (F-Statistic)	0.0000
Mean of dependant variable	12.39417
S.D. of dependant variable	0.2245884

It can be seen that the OLS provides an estimate of the cointegrating equation which whilst not inconsstent with the VECM in terms of primacy of the constant, demonstrates a stronger relationship between CYGAP and ln(GDP) than is found in the VECM (shown toward the end of this chapter). The OLS estimates allows for a test (as per Mulligan 2006) that a lower interest rate accompanies a permanent lowering of output (A key component of HTTC). Assuming that interest rates fall (and thus YGAP increases) only due to expansionary monetary policy and not due to an overall lowering of time preference, so in terms of YGAP assuming that it increases as the market rate falls due to government action and not general acceptance of lower returns over time. The R-Squared and the Adjusted R-Square of the model are approximately 40% , less than half of Mulligan's reported 97% , it may be argued that the data of the replication study contains the recent financial and economic crisis where the fall of interest rate may have a component of a lowering of the economy's time preference due to an overall drop of confidence, re-running the model dropping the crisis years results only in a moderate improvement of 8% in R^2 and A-R^2, still not coming close to Mulligan's exceptionally strong result. However the intercept and coefficient on CYGAP are positive and highly significant (at the 1% level).

The Austrian view is summarised clearly by Bismans & Mougeot (2009) who consider that long term rates are equal to the weighted average of short term rates plus a risk premium,the expansionary monetary policy lowers short term rates more than the long term rate. Hence YGAP is expected to rise at the beginning of the (artificial) boom, then gradually decrease and become negative just preceding the recession.

Qualitatively this can be seen in figure 65.

Figure 65:Time series of YGAP



With larger interest rate gaps corresponding to the times of Austrian malinvestment and smaller or negative interest rate gaps corresponding to times of 'correction' or recession.

Interestingly in the UK, the 2007 crisis can clearly be following a decline in the interest rate gap and the subsequent policy response for the Austrians makes further recessions inevitable.

YGAP therefore marks a turning point in economic activity, as it decreases the economy allocates resources from initial to end stage production, a negative YGAP indicates for the Austrian's the beginning of the inevitable correction process.

Thus the impact of lowering the interest rate on consumption can be referred to via a link process:

1. A large price premium dominates short term interest rates as the central bank pursues expansionary monetary policy.
2. CYGAP (↓)
3. The coefficient of CYGAP is positive ∴ ln(GDP)(↓)

In the superconsistent OLS model of ln(GDP) regressed on CYGAP, the coefficient of CYGAP is 0.2089348, thus multiplying this slope coefficient by 1.0 (-1.0) representing an increase (decrease) in the market rate by 1 percent for one quarter and taking the antilog of 0.2089348, it can be seen that the effect on ln(GDP) is a gain (loss) of £1.62bn (chained at 2010 Pound Stirling). The longer the market interest rate is kept below the natural interest rate the greater the impact on cumulative term spread and thus on output.

The VECM is characterised below and reported in table 69.

$$\Delta\ln(GDP)_t = \Theta(Ln(GDP)_{t-1} - a - bYGAP_{t-1}) + \Delta\ln(GDP)_{t-1} + \Delta\ln(GDP)_{t-2} + \Delta\ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} + \Delta YGAP_{t-2} + \Delta YGAP_{t-3+\cdots+}u_t$$

$$\Delta\mathrm{YGAP}_t = \Psi(Ln(GDP)_{t-1} - a - bYGAP_{t-1}) + \Delta\ln(GDP)_{t-1} + \Delta\ln(GDP)_{t-2} + \Delta\ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} + \Delta YGAP_{t-2} + \Delta YGAP_{t-3+\cdots+}u_t$$

- Number of Cointegrating Relationships: 1
- Number of lags: 2

Table 69: Mulligan VECM Replication Results

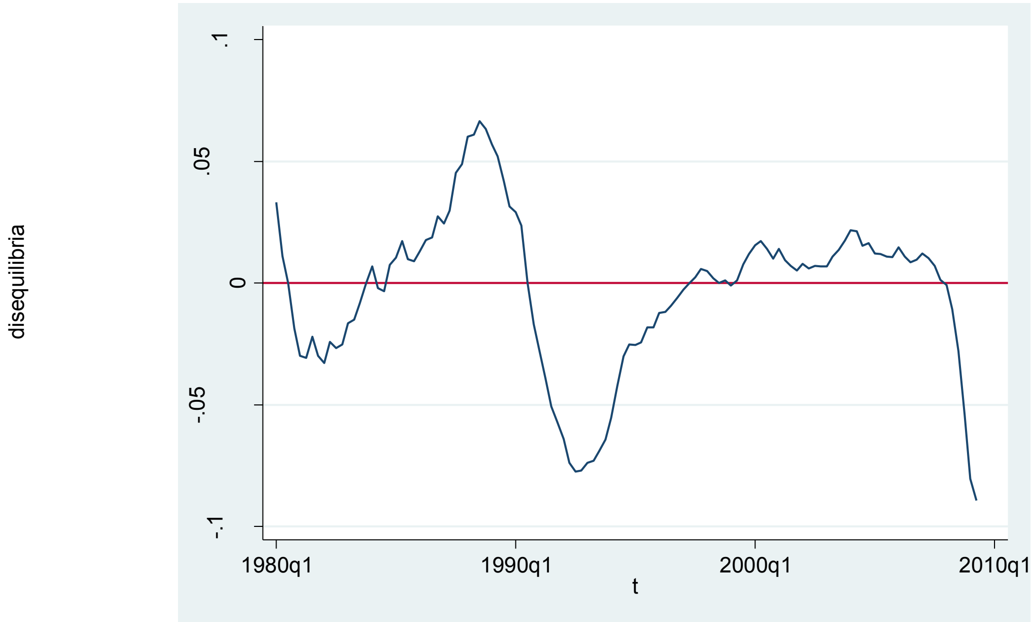
Cointegrating Equation: $\ln(GDP)_t$+0.0015CYGAP-0.007-12.02			
	Coefficient	Standard Error	z-statistic
Constant	-12.01962	-	-
Cumulative YGAP	0.0015408	0.0008	1.87*
Error correction process Summary Statistics			
		∆(ln GDP)	∆(Cumulative YGAP)
Disequilibrium adjustment terms		0.0227213	-12.16767
Standard Error		0.0199231	3.168237
z-statistics		1.14	-3.84***
RMSE		0.005569	0.885643
Chi^2		182.4657***	266.199***
R-Square		0.6218	0.7057
Mean of Dependant Variable		12.39417	15.13345
Standard Deviation of Dependant Variable		0.2245884	12.8185
Logarithm of Likelihood Function			293.3072
Akaike Information Criterion			-4.867366
Schwarz criterion			-4.60625

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

Unlike Mulligan, here the estimated coefficients of CYGAP (the interest rate term spread) are far weaker both in terms of magnitude and in terms of statistical significance. The VECM slope coefficient of CYGAP is 0.0015408 indicating a 1% decrease in the term spread in a quarter decreased GDP by £1.004bn (chained 2010 Pounds Stirling). Like the OLS estimates the effect is cumulative, the longer that CYGAP is reduced, the greater the long term decrease in GDP. This is less than the OLS estimate, however the two are reasonably consistent.

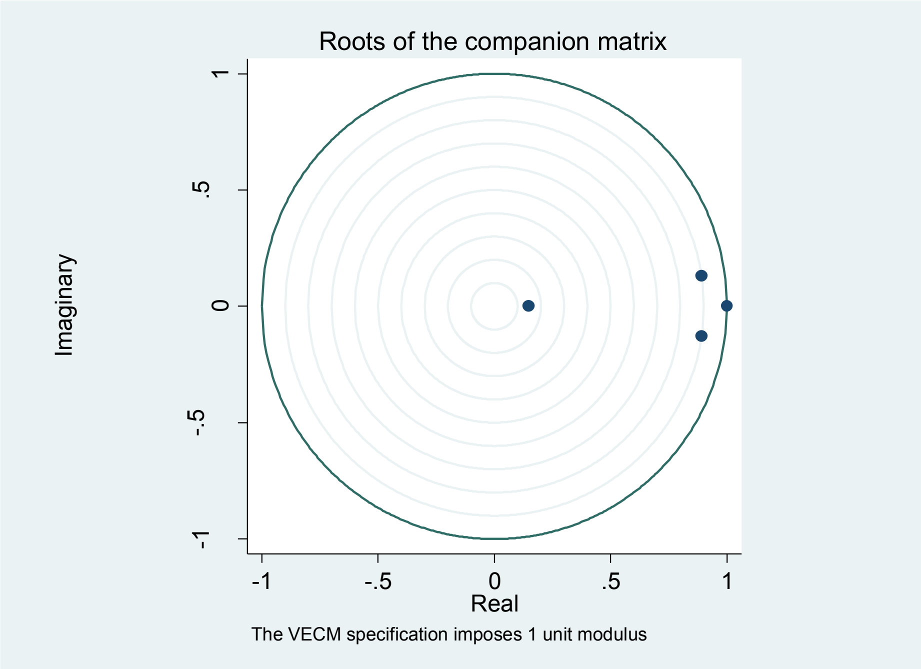
The R-Square for the disequilibrium process is reasonably high at 70% for the CYGAP disequilibrium adjustment process and likewise (62%) for the ln(GDP) output process. It is indicative of the robustness of the model that the adjustment processes of both variables are reasonably explained. Mulligan (2006) considers it a triumph for HTTC that the adjustment process appears to work reasonably well through the interest rate, however the adjustment process here appears to also work well through GDP. The disequilibrium term for ln(GDP) represented in the model equation by Θ is positive and non-significant, possibly indicating that ln(GDP) adjusts upward whenever ln(GDP) exceeded the equilibrium fitted value however the non-significance of this result queries the confidence in it. However the disequilibrium term for CYGAP represented in the model by Ψ is negative and highly significant at the 1% level. This indicates that in accordance with Hayek's theory of the trade cycle CYGAP adjusts downward whenever CYGAP exceeded the equilibrium value. The literal implications of the model is that in accordance with HTTC whenever CYGAP is lowered ln(GDP) is lowered considerably, GDP is lowered by the corresponding antilog.

Figure 66: Cointegrating Equation and equilibrium



The estimated cointegrating relationship is shown in figure 66, with large oscillations seen around the 1985-1995 region and the clear movement below equilibrium around the recent financial crisis. Mulligan's (2006) model suffers from non-normality of the residual series, it is stated in the paper that firstly normality is a sufficient rather than a necessary condition for valid VECM estimates and the similarity between the VECM model coefficients and the superconsistent OLS coefficients. However it remains that this would raise concerns within standard econometric modelling, for the above VECM, whilst the specification naturally imposes a unit root shown in figure 67.

Figure 67: Unit Roots of the Companion Matrix (Replication VECM)



Aside from this one unit root, there is no evidence of instability nor of autocorrelated errors. The non-normality which plagues Mulligan (2006) is considered through a Jarque-Bera Test for Multivariate Normality of Residuals with all null hypotheses of normality accepted.

Granger Causality Tests (results shown in table 70) can be derived from the VECM and provide some further support for the Hayek's theory of the trade cycle:

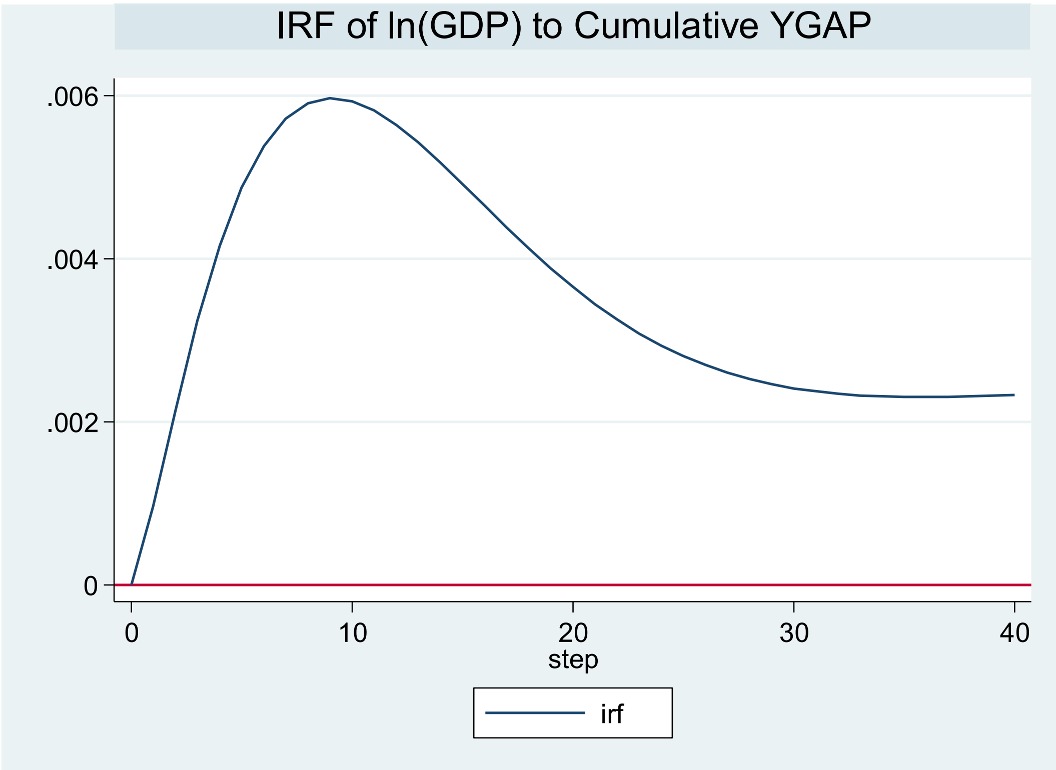
Table 70: Granger Causality Tests (Replication VECM)

Equation	G*Variable	Chi^2
ln(GDP)	Cumulative YGAP	5.98**
Cumulative YGAP	ln(GDP)	0.04

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

From the Granger Causality test it appears that in accordance with HTTC the cumulative interest rate gap does indeed cause ln(GDP) in the Granger Sense significant at the 5% level, however Granger Tests rely on the acceptance of the hypothesis that all relevant variables are contained in the VECM (Davidson & MacKinnon 1993). Previously in this thesis a larger VECM (5 variables) has been constructed and the Granger results from that should be considered primary.

Figure 68: Impulse Response Function: Effect of Cumulative YGAP on GDP



Mulligan (2006) considers that the impulse response function of ln(GDP) to CYGAP (shown in figure 68) is of key importance for HTTC. This indicates that over the time period examined a one standard increase in CYGAP has resulted in, on average, an upward adjustment of approximately 0.0023 in the logarithm of GDP equivalent to £1.005bn, likewise the sudden decrease in CYGAP resulting for the Austrians at the end of expansionary monetary policy, decreased GDP by an equivalent amount.

This replication study is compared to Mulligan (2006) in table 71 and further discussed in Chapter 11.

Table 71: Comparison with Mulligan (2006)

Cointegrating Equation							
REPLICATION				MULLIGAN			
	Coefficient	Standard Error	z-statistic		Coefficient	Standard Error	z-statistic
Constant	-12.01962	-	-	Constant	7.120293	-	-
Cumulative YGAP	0.0015408	0.0008	1.87*	Cumulative Term Spread	0.135673	0.0088	15.3553***
Error correction process Summary Statistics							
		Δ(ln GDP)	Δ(Cumulative YGAP)			Δ(ln consumption)	Δ(Cumulative Term Spread)
Disequilibrium adjustment terms		0.0227213	-12.16767	Disequilibrium adjustment terms		-0.017780	0.004338
Standard Error		0.0199231	3.168237	Standard Error		0.00589	0.00447
z-statistics		1.14	-3.84***	z-statistics		-3.02***	0.967
RMSE		0.005569	0.885643	RMSE		Not Reported	Not Reported
Chi^2		182.4657***	266.199***	Chi2		Not Reported	Not Reported
R-Square		0.6218	0.7057	R-Square		0.5334	0.97
Mean of Dependant Variable		12.39417	15.13345	Mean of Dependant Variable		0.002726	0.016250
Standard Deviation of Dependant Variable		0.2245884	12.8185			0.005639	0.013855
Logarithm of Likelihood Function			293.3072	Logarithm of Likelihood Function			3714.176
Akaike Information Criterion			-4.867366	Akaike Information Criterion			-14.13397
Schwarz criterion			-4.60625	Schwarz criterion			-10.47386

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

9.5 Chapter Summary

In accordance with the Austrian Econometric Literature, a Vector Error Correction Model of Hayek's theory of the trade cycle is created to explore the relationships present in the variables. Orthogonalized Impulse Response Functions are used to evaluate the Second Order Predictions of Hayek's theory and Granger Causality Testing is used as per Wainhouse (1984), Mulligan (2006) and Dore and Singh (2012) to explore the causal links specified by HTTC. The results of this battery of tests are presented throughout the chapter along with the cointegrating equations present within the Vector-Error Correction Models to determine the understanding Hayek's theory of the trade cycle can provide for the UK Business Cycle.

Furthermore a replication of Mulligan's (2006) study, which found strong evidence for HTTC using a VECM and US time series data, is presented using UK time series data to evaluate if the same support is present. This replication whilst does find some support for Hayek's theory within the UK data, however the results (discussed further in Chapters 10 and 11) are not as supportive as the original Mulligan study.

Chapter 9 constructs a robust Vector-Error Correction model informed by the literature to ensure Austrian acceptance. This model is used to investigate the relationships between the variables *via* an examination of their Orthogonalized Impulse Response Functions and Granger Causality Testing. These results are then compared against the Second Order Predictions of Hayek's theory in Chapter 10 and discussed in Chapter 11 to determine the relevance of Hayek's theory for understanding the UK business cycle.

Chapter 10: Interpretation of Findings

"As Thomas Mayer (1993) and Edward Leamer (1978, 1991) have convincingly argued, given the nature of observation in economics, empirical tests at this level are inevitably indecisive. Numerous theories and judgements can be interpreted as consistent with the data"

Colander (1994)

10.1 Introduction

In this chapter the test results are assessed against a framework of outcome or process predicted by the Hayek's theory of the trade cycle against observations from the data. This will be used to judge the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle. The expected observations derive from the work of de Soto (2006, 2010) and are displayed in a testable model acceptable to the Austrian School of Economic Thought *as per* Carilli & Dempster (2008).

The model can be seen in terms of the Second Order Predictions as:

EMP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→CMP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

EMP = Expansionary Monetary Policy

CMP = Contractionary Monetary Policy

This Chapter evaluates the results of VAR YIELD, VAR YGAP and the Vector-Error Correction model against the Second Order Predictions of Hayek's theory of the trade cycle as well as evaluating the results of the hypothesis tests.

10.2 Interpretation of results

The relationships in table 72, provide clear testable (second order) predictions of economic phenomena deriving from Hayek's theory of the trade cycle. Carilli & Dempster (2008) consider that the true measure of any business cycle theory is the extent to which the economic phenomena predicted by the theory correspond to those actually observed. In this thesis results from tests of progressive sophistication are used to compare the observed data against Austrian Business Cycle second order predictions.

Table 72: Relationship predicted by HTTC

Link	Relationship predicted by HTTC
ΔMR→ ΔM4	**Expansionary Monetary Policy →M4↑**
ΔM4→ ΔRESOURCES	**M4↑→INVCON↓**
ΔM4→ ΔINVCON	**M4↑→RESOURCES↑**
ΔRESOURCES →ΔGDP	**RESOURCES↑→↑ln(GDP)**
ΔINVCON→ΔGDP	**INVCON↓→↑ln(GDP)**
ΔGDP→ΔRESOURCES	**↑ln(GDP) → RESOURCES↑**
ΔGDP→ ΔINVCON	**↑ln(GDP) → INVCON↓**
ΔRESOURCES→ΔMR	**RESOURCES↑→CYGAP↓**
ΔINVCON →ΔMR	**INVCON↓→ CYGAP↓**
ΔMR→Δ(↓)GDP	**Contractionary Monetary Policy→ GDP↓**

A correlation matrix (*as per* Keeler, 2001), Univariate and Multivariate OLS Regressions (*as per* Subrick & Beaulier 2010), Finite Distributed Lag Models and a Vector-Auto Regression Model (*as per* Carilli & Dempster 2008), Granger Causality Tests (*as per* Wainhouse 1984 and Mulligan 2006), Vector Error Correction Models (*as per* Keeler 2001 and Mulligan 2006) and a replication of Mulligan (2006) are used to evaluate the predictions of Hayek's theory of the trade cycle within the data for the UK economy 1980-2010.

These Austrian acceptable economic tests are expanded from the overview of relationships found in the earlier Austrian econometric literature (Wainhouse 1984, Keeler 2006) to an evaluation of the direction and magnitude of the relationships explored in Mulligan (2006) and Carilli & Dempster (2008). This brings in further sophisticated analysis, however the New Austrian School and selected Austrian Econometric works support this approach as making Hayek's theory of the trade cycle more accessible by the orthodoxy.

10.2.1 The Variables and the implications of their movements

All the variables used in this thesis in the empirical evaluation to determine the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle are presented in table 73 and the implications of their movements for the structural analysis are presented in table 74.

Table 73: Comprehensive Variable Summary

Variables				
Variable Description	Variable Name	Construction	Source	Movement
Stationary Measure of economic activity.	GDP	GDP/TrendGDP smoothed with a moving average of two lags, current observation and one lead observation.	Bank of England	Increase = increase in economic activity and *vice versa*.
Non stationary Measure of economic activity.	Ln(GDP)	Natural log of GDP.	Bank of England	Increase = increase in economic activity and vice versa.
Measure of the monetary base closely linked to government action.	M4	M4/TrendM4 smoothed with a moving average of two lags, current observation and one lead observation.	Bank of England	Increase = increase in M4 and vice versa.
Non-stationary measure of the monetary base closely linked to government action.	(M4)	Original state Quarterly M4.	Bank of England	Increase = increase in (M4) and vice versa.
The ratio of end stage to initial stage output.	RESOURCES	Stationary Initial Stage Output / Stationary End Stage Output smoothed with a moving average of two lags, current observation and one lead observation.	Bank of England	An increase in RESOURCES suggests a movement toward initial stage production. A decrease in RESOURCES suggests a movement

				toward end stage production.
Non Stationary ratio of end stage to initial stage output.	(RESOURCES)	Initial Stage Output / End Stage Output	Bank of England	An increase in (RESOURCES) suggests a movement toward initial stage production. A decrease in (RESOURCES) suggests a movement toward end stage production.
A stationary proxy for the measurement of the relationship between true and artificial interest rates.	YIELD	Stationary Artificial Rate of Interest / Stationary True Rate of Interest smoothed with a moving average of two lags, current observation and one lead observation.	Bank of England	An increase in YIELD suggests an increase in the market rate if the time preference of the economy remains fixed. A decrease in YIELD suggests a decrease in the market rate of interest if the time preference of the economy remains fixed.
A stationary proxy for the measurement of the relationship between true and artificial interest rates.	YGAP	True rate of interest – Market Rate of interest.	Bank of England	An increase in YGAP suggests a decrease in the market rate of interest if the time preference of the economy remains fixed. A decrease in YGAP suggests an increase in the market rate of interest if

				the time preference of the economy remains fixed.
A non-stationary proxy for the measurement of the relationship between true and artificial interest rates	CYGAP	Cumulative YGAP	Bank of England	An increase in CYGAP suggests the market rate of interest is below the natural rate. No change in CYGAP suggests that the market rate of interest equals the natural rate of interest. A decrease in CYGAP suggests that the market rate of interest is above the natural rate of interest.
A measure for the relationship between investment and consumption in the economy.	INVCON	(Investment / Consumption)/Trend, smoothed with a moving average of two lags, current observation and one lead observation.	Bank of England	An increase in INVCON suggests the economy is favouring investment. A decrease in INVCON suggests the economy is moving to a consumption focus.
A non-stationary measure for the relationship between investment and consumption in the economy.	(INVCON)	Investment / Consumption	Bank of England	An increase in (INVCON) suggests the economy is favouring investment. A decrease in (INVCON) suggests the economy is moving to a consumption focus.

In the model notation:

Table 74: Variable Summary in the model notation

Variable Name	Movement	Notation
GDP	Increase = increase in economic activity and *vice versa*.	↑ = ↑ economic activity ↓ = ↓ economic activity
Ln(GDP)	Increase = increase in economic activity and vice versa.	↑ = ↑ economic activity ↓ = ↓ economic activity
M4	Increase = increase in M4 and vice versa.	↑ = ↑ M4 ↓ = ↓ M4
(M4)[69]	Increase = increase in (M4) and vice versa.	↑ = ↑ M4 ↓ = ↓ M4
RESOURCES	An increase in RESOURCES suggests a movement toward initial stage production. A decrease in RESOURCES suggests a movement toward end stage production.	↑ = ↑ initial stage production ↓ = ↑ end stage production
(RESOURCES)	An increase in (RESOURCES) suggests a movement toward initial stage production. A decrease in (RESOURCES) suggests a movement toward end stage production.	↑ = ↑ initial stage production ↓ = ↑ end stage production
YIELD	An increase in YIELD suggests an increase in the market rate if the time preference of the economy remains fixed. A decrease in YIELD suggests a decrease in the market rate of interest if the time preference of the economy remains fixed.	↑ = ↑ contractionary monetary policy ↓ = ↓ expansionary monetary policy
YGAP	An increase in YGAP suggests a decrease in the market rate of interest if the time preference of the economy remains fixed.	↑ = ↓ expansionary monetary policy ↓ = ↑ contractionary monetary policy

[69] Bracketed variables show those used in construction of the Vector-Error Correction Models (Chapter 9).

	A decrease in YGAP suggests an increase in the market rate of interest if the time preference of the economy remains fixed.	
CYGAP	An increase in CYGAP suggests the market rate of interest is below the natural rate. No change in CYGAP suggests that the market rate of interest equals the natural rate of interest. A decrease in CYGAP suggests that the market rate of interest is above the natural rate of interest.	↑ = ↓ expansionary monetary policy ↓ = ↑ contractionary monetary policy
INVCON	An increase in INVCON suggests the economy is favouring investment. A decrease in INVCON suggests the economy is moving to a consumption focus.	↑ = ↑ investment ↓ = ↑ consumption
(INVCON)	An increase in (INVCON) suggests the economy is favouring investment. A decrease in (INVCON) suggests the economy is moving to a consumption focus.	↑ = ↑ investment ↓ = ↑ consumption

10.2.2 The Correlation Matrix

For Keeler (2001), there is much evidence for HTTC to be derived from a simple correlation matrix, the relationships between the variables predicted by Hayek's theory of the trade cycle are shown below with the observations from the actual data presented for comparison:

Table 75: Correlation Matrix

Link	Relationship predicted by HTTC	Observed Relationship via correlation matrix
ΔMR→ ΔM4	YIELD↓→M4↑ YGAP↑→M4↑	0.4519*** -0.3567***
ΔM4→ ΔRESOURCES	M4↑→INVCON↓	0.4275***
ΔM4→ ΔINVCON	M4↑→RESOURCES↑	-0.2705***
ΔRESOURCES →ΔGDP	RESOURCES↑→↑GDP	-0.3656***
ΔINVCON→ΔGDP	INVCON↓→↑GDP	0.8191***
ΔGDP→ΔRESOURCES	↑ln(GDP) → RESOURCES↑	-0.3656***
ΔGDP→ ΔINVCON	↑ln(GDP) → INVCON↓	0.8191***
ΔRESOURCES→ΔMR	RESOURCES↑→YIELD↑ RESOURCES↑→YGAP↓	-0.4333*** 0.5394***
ΔINVCON →ΔMR	INVCON↓→ YIELD↑ INVCON↓→YGAP↓	0.672*** -0.5610**
ΔMR→Δ(↓)GDP	YIELD↑→ GDP↓ YGAP↓→GDP↓	0.5903*** -0.5371***

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

Whilst it is clear that the lack of sophistication of the testing calls for far greater analysis, the HTTC predicted long term relationships over the time period are simply not present in the data. Leaving the short term linkages for the more sophisticated tests which follow, the fundamental long term relationship for Hayek's theory of the trade cycle is that expansionary monetary policy results in for Mulligan (2006) a permanent lowering of GDP. Remembering that the upward trend of UK GDP has been discounted, one would expect a negative correlation between YIELD and GDP (observed positive) and a positive correlation between YGAP and GDP, whereas a negative long term correlation is observed. As Hayek's theory of the trade cycle considers that a monetary expansion (which generally derives from a decrease in the market rate of interest below the natural rate) ultimately decreases GDP, a correlation of M4 and GDP can also be considered, this highly significant at the 1% level, reasonably strong (Pallant 2005) correlation of 0.5921 is positive whereas for HTTC it would be expected to be negative.

Of course, correlation is not causation, and the overall increase in GDP may still allow for HTTC predictions if instead the increase in GDP was constrained by the expansionary monetary policy. De Soto (2010) considers that the overall output can still increase, but at a level below what it would have been without expansionary policy. Even so, fundamental relationships from HTTC appear missing in the simple correlation matrix and the findings of the UK data (1980-2010) are not consistent with Keeler's (2001) study for the US. Using univariate and multivariate linear regression models (*as per* Subrick & Beaulier 2010, Bismans & Mougeot 2009) suggests some support for the relationships, however to note at the outset, once again the variable YIELD has far less effect than HTTC would suggest. However, Mulligan (2006) emphasises the difficulty that in the Austrian view the real value of economic activity is not the objective and observable exchange value captured in the GDP variable, but the subjective value gained by the individual on each activity, concluding that this value is intrinsically unobservable, hence the use of GDP as a common proxy, but for Mulligan a proxy without the subjective value required for a 'perfect' empirical evaluation of HTTC.

Firstly, GDP is regressed on four independent variables (RESOURCES, INVCON, M4 and YIELD), the overall characteristics of the model are broadly sound with a respectable R^2 and AR^2

(0.7488 and 0.7401 respectively), however the general direction of coefficient of INVCON and M4 are generally more supportive of an orthodox business cycle theory rather than the long term relationships of HTTC and the non-significance of YIELD queries HTTC. Mulligan (2006) considers it a triumph of HTTC that the interest rate variable offers considerable explanatory power over GDP and Keeler (2001) likewise. However rerunning the model with the stationary variable YGAP and using this measure of interest rate divergence suggests a slightly weaker overall model R^2 and AR^2 (0.7026 and 0.6921 respectively), however one where the interest rate variable has a coefficient consistent with Hayek's theory of the trade cycle (-0.0009147), which though relatively weak in terms of standard deviation, is statistically significant (albeit at the 10% level).

In terms of the relationships predicted by HTTC:

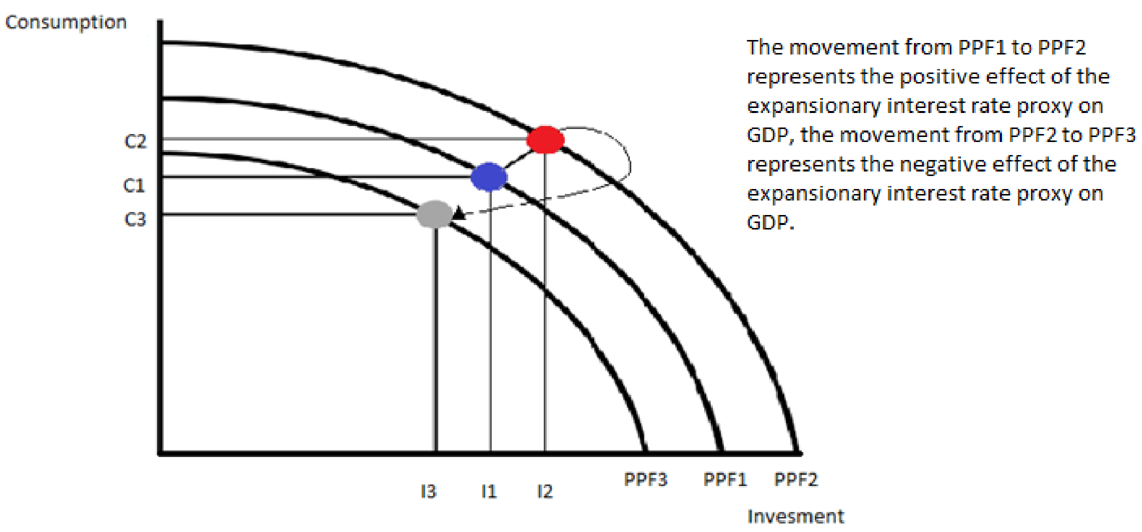
The multivariate and univariate regression models, suggest reasonable explanatory power in models of Hayek's theory of the trade cycle, but are not supportive of the conclusion of Carilli & Dempster (2008) that "Hayek's theory of the trade cycle is more than a collection of ad hoc observations about stylized (sic) facts". Carilli & Dempster (2008) consider that the evaluation of endogenous turning points in the coefficients for the variables provide a far clearer evaluation of the relevance of HTTC for an economy, as this is where the mechanisms are present, even if the long term relationship predictions of HTTC are not captured in the data.

The relationships of HTTC are for Keeler (2001), Carilli & Dempster (2008) and the Austrian School in general, de Soto (2006) more than a general overview relationship, for instance Keeler (2001) finds evidence for the relationships of HTTC over time which are consistent with the HTTC view of an unsustainable boom resulting from a pattern of resource allocation that is unable to sustain income growth.

10.2.3 Endogenous Turning Points

Hayek's theory of the trade cycle suggests endogenous turning points in the relationship between (1) YIELD / YGAP and GDP and (2) M4 and GDP. This can be seen in a PPF analysis shown below in Figure 69:

Figure 69: A PPF demonstration of the effect of Expansionary Monetary Policy on GDP.



Source: Author

A finite distributed lag model examination of the variables YIELD, YGAP and M4 is conducted to determine the pattern of the observed data compared to the pattern of the predicted. Hayek's theory of the trade cycle suggests that the form of the finite distributed lag model would be quadratic and thus more recent YIELD, YGAP and M4 alterations should increase GDP and more distant YIELD, YGAP and M4 alterations decreasing GDP. As Carilli & Dempster (2008) consider that "we cannot know the interval ex ante, but Austrian Business Cycle Theory does predict it", a comparison of the results from the UK data for YIELD, YGAP and M4 will be made against their results for term spread (presented in table 76) which are considered supportive of the HTTC mechanisms:

Table 76: Lagged effects of variables on GDP

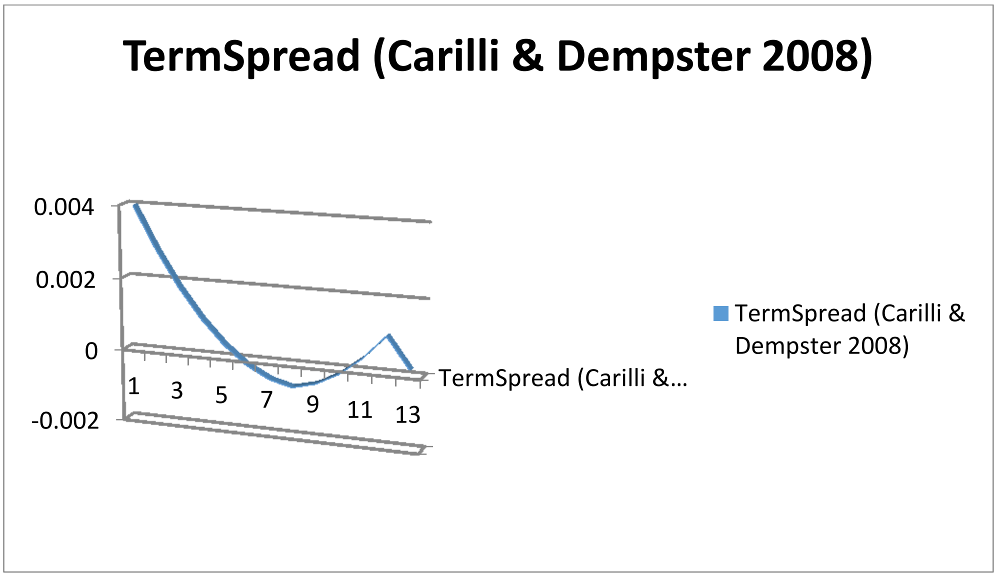
Lag	YIELD Coefficient***	M4 Coefficient***	YGAP Coefficient***	Term Spread[70]
t	0.101605	0.976534	-0.0037994	0.00399
t-1	-0.1047058	-0.1050004	-0.0000848	0.00283
t-2	0.19823	0.0314258	-0.0004202	0.00184
t-3	-0.0109924	0.0108487	0.000448	0.00102
t-4	0.0784046	0.0418213	0.0004718	0.00036
t-5	-0.619775	-0.61872	-0.0001443	-0.00014
t-6	-0.0064765	-0.0036186	0.0009551	-0.00047
t-7	0.0151947	0.425775	0.0007024	-0.00063
t-8	0.712036	0.0249355	-0.0001307	-0.00047
t-9	-0.0224519	-0.0085594	0.0004585	-0.00014
t-10	-0.178262	-0.0437193	0.0002134	0.00036
t-11	-0.211168	0.316596	0.0000509	0.00102
t-12	0.473678	0.219191	0.0001745	0.00017
R-Squared	56%	61%	27%	55%

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively (NB. This is the joint significance of the coefficients as per Russell & Langemeier (2015) and guidance from the STATA manual)

When considering the term spread observations from Carilli & Dempster (2008), the ‘turning point’, a clear change in direction of effect on output following an initial positive effect of an increase in term spread (hence a lowering of the market rate of interest) to a negative effect on output through lags 5 to 9 inclusive. This can be clearly seen qualitatively in figure 70:

[70] Carilli & Dempster (2008).

Figure 70: Lagged effects of term spread on GDP (Carilli & Dempster 2008)



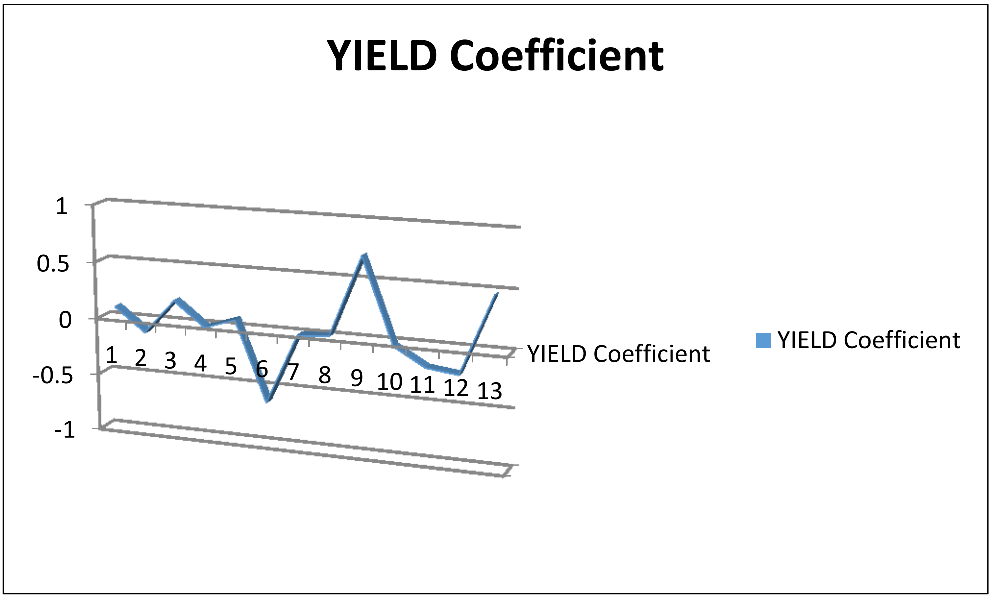
Where the effect of expansionary monetary policy on output can be seen to wane becoming negative at the bottom of the predicted quadratic curve, Carilli & Dempster (2008) consider this a key support for Hayek's theory of the trade cycle and suggests a process approach moving from the overall coefficient of the relationships to an examination of the movements within.

For the UK economy (1980-2010), replicating Carilli & Dempster (2008) suggests some support for the Austrian view, the overall relationships are non-supportive, for the Austrians a function of the non-measurability of the subjective value of economic action, for the orthodoxy fundamental problems with the HTTC. An examination of the movement over time suggests a different picture than the disagreement of overall relationship[71].

[71] Though these fundamental relationships, particularly Keeler's (2001) and Mulligan's (2006) demonstration of the triumph of HTTC of showing that lowering interest rates below the long term level results in permanently lowering output, missing from the UK data are cause for concern regarding the relevance of HTTC.

With regard to YIELD, one would expect a relatively symmetrical opposite to term spread as HTTC would predict that a lowering of YIELD (expansionary monetary policy) to result in an initial increase in economic activity followed by a decrease, HTTC would also predict a quadratic shape to the curve. Therefore the rise in YIELD, shown above should for HTTC demonstrate an immediate decline in economic activity, followed by a (unsustainable for the Austrians) rise, and then a sharp decline in economic activity as the demand for credit outstrips supply. This is shown in figure 71.

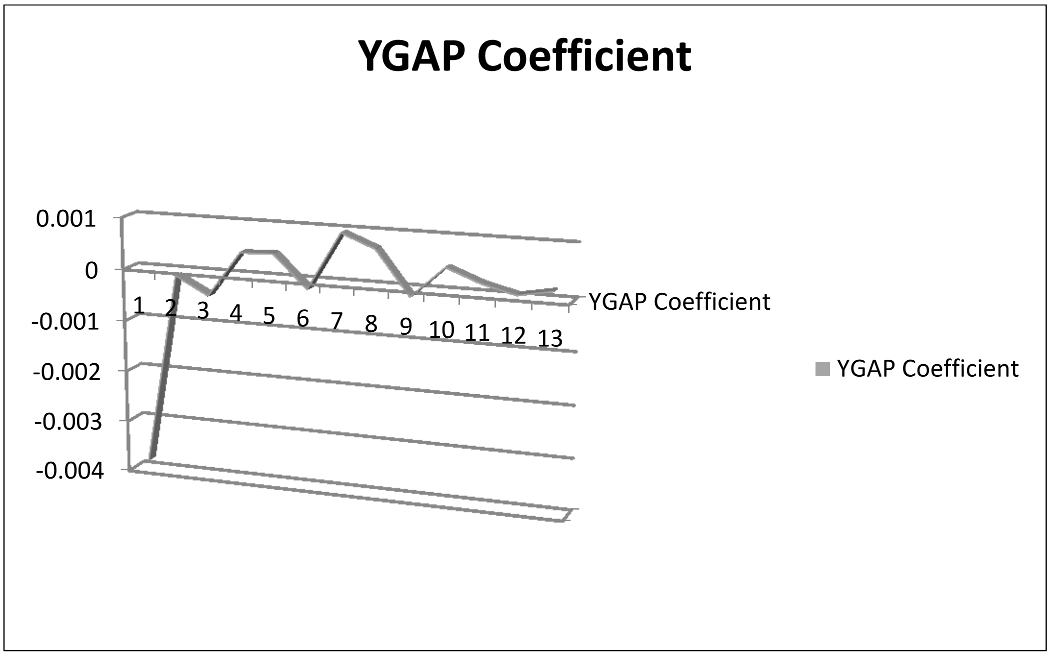
Figure 71: Lagged effect of YIELD on GDP



A pattern reasonably consistent with HTTC predictions, an intermittent decline in economic activity follows the rise in YIELD (increase in short term rates) up to lag 6, then there is the rapid increase (unsustainable boom) followed by a sharp decline.

Hayek's theory of the trade cycle predicts that YGAP will follow a similar but opposite pattern, with an increase in YGAP (representing a decrease in short term rates), having an initial positive effect on GDP, followed by negative *as per* Carilli & Dempster (2008). This is shown in figure 72.

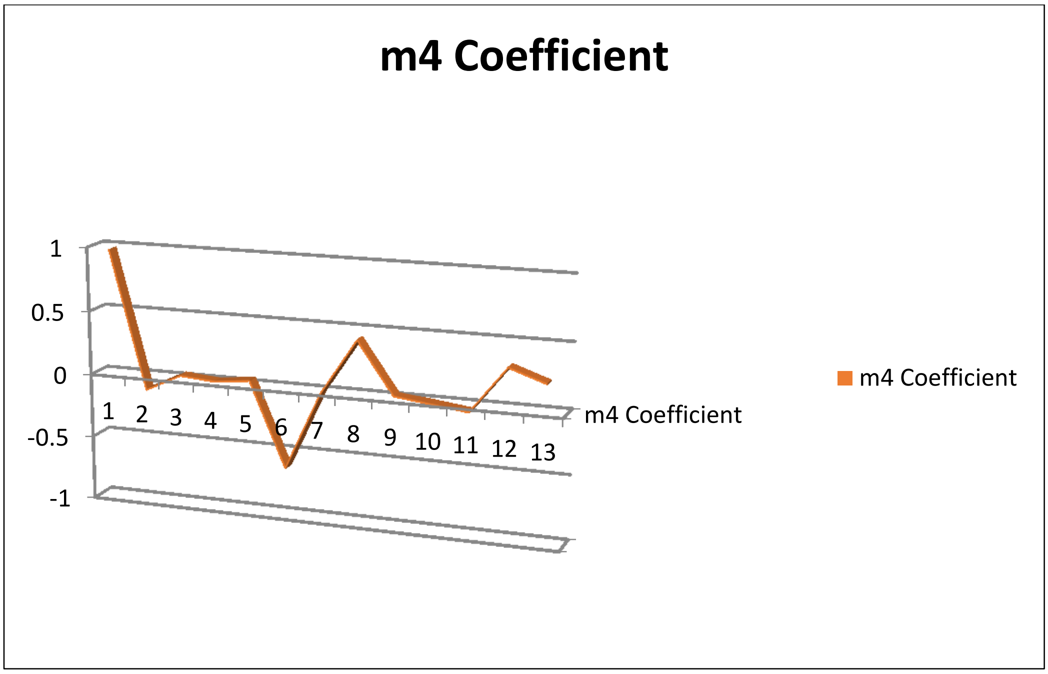
Figure 72: Lagged effect of YGAP on GDP



Initially a raise in YGAP has an initial negative effect on GDP which diminishes through to lag 3, which leads to a period of positive effects on GDP throughout the remaining lags (lags 5 and 8 have near zero negative effects). The replication of Carilli & Dempster (2008) does not find the HTTC predictions of lowering the short term rate on GDP, instead suggesting a lengthy lag effect of moderate positive effects. Keeler (2001) is however concerned with the term gap as a measure of expansionary policy as it is difficult to measure a static time preference in the economy. YIELD which measures the relationship between short and long term rates as oppose to YGAP which measures the definite gap, is potentially an answer to Keeler's view and does better fit the predictions of HTTC.

An expansionary monetary policy for the Austrian's creates more credit in the economy and thus increases M4. Following the predictions of HTTC, inflation of the money supply can have three distinct routes through to an inevitable recession. Mulligan (2006) summarises these as Deflation, Steady Inflation and Accelerating Inflation. However there is a fundamental commonality for predictions of HTTC that an increase in the money supply will inevitably lead to recession. One would therefore expect the lagged coefficients of an increase in M4 to have an initial positive effect on GDP with a later negative effect (shown in figure 73).

Figure 73: Lagged effect of M4 on GDP



An increase in M4 has an initial positive effect on GDP, which wanes rapidly with a slight negative effect in lag 2 and plateaus with a minor positive effect until lag 5, there is a reasonably large negative effect at lag 6 followed by a opposite positive effect. Whilst an increase in M4 does follow the predictions of HTTC, the prescribed effects of an inevitable long term negative effect on GDP are short lived.

There are however a set of (second order) predictions of Hayek's theory of the trade cycle which can be evaluated with the UK data in determining the relevance of HTTC for the UK economy, which are the existence of endogenous turning points in the coefficients of key variables effects on GDP. Carilli & Dempster (2008) evaluate historical US data, finding evidence of this turning point in term spread on output and cite this as a clear victory of the explanatory power of HTTC.

The predictions of Hayek's theory and the observations of endogenous turning points are summarised in table 77 and in table 78.

Table 77: Evaluation of Lagged Effect of Variables on GDP

HTTC Prediction	Observation
A rise in YIELD, should for HTTC demonstrate an immediate decline in economic activity, followed by a (unsustainable for the Austrians) rise, and then a sharp decline in economic activity as the demand for credit outstrips supply	A pattern reasonably consistent with HTTC predictions, an intermittent decline in economic activity follows the rise in YIELD (increase in short term rates) up to lag 6, then there is the rapid increase (unsustainable boom) followed by a sharp decline
An increase in YGAP (representing a decrease in short term rates), having an initial positive effect on GDP, followed by negative	Initially a raise in YGAP has an initial negative effect on GDP which diminishes through to lag 3, which leads to a period of positive effects on GDP throughout the remaining lags (lags 5 and 8 have near zero negative effects).
An increase in the money supply will inevitably lead to recession, the lagged coefficients of an increase in M4 to have an initial positive effect on GDP with a later negative effect.	An increase in M4 has an initial positive effect on GDP, which wanes rapidly with a slight negative effect in lag 2 and plateaus with a minor positive effect until lag 5, there is a reasonably large negative effect at lag 6 followed by a opposite positive effect.

Table 78: Observations of lagged effects Vs HTTC Second Order Predictions

Variable	HTTC Prediction	Observation
YIELD	(-)→(+)	(-)→(+)
YGAP	(+)→(-)	(-)→(+)
M4	(+)→(-)	(+)→(-)

Whilst the replication of Carilli & Dempster (2008) using a spread measurement as a proxy for expansionary monetary policy fails to match the predicted movement of Hayek's theory of the trade cycle, the actions of the variables YIELD and M4 do match the HTTC predictions. Carilli & Dempster (2008) and Keeler (2001) are quick to seek validation for HTTC in these matches, which whilst potentially supportive of HTTC for the Austrians are less convincing in the light of the tests of overall relationship discussed earlier.

10.2.3 The Vector-Auto Regression Tests

The Vector-Auto Regression Tests are supported as appropriate Austrian Econometric tools by Subrick & Beaulier (2010) and are used by Carilli & Dempster (2008) to further evaluate the predictions of Hayek's theory of the trade cycle against observed data. The lag structure is investigated using guidance from Carilli & Dempster (2008) and Becketti (2013) to develop a VAR appropriate to both Austrian econometric and orthodox econometric view points, and the lag order selection included Akaike's Final Prediction Error, Akaike's Information Criterion, Schwarz's Bayesian Information Criterion and Hannan & Quinn's Information Criterion *as per* standard econometrics and justified from the Austrian perspective by Carilli & Dempster's (2008) use.

After initial testing two VARs of two lags were constructed, one containing the variable YIELD and one containing the variable YGAP. All variables were tested for unit roots and the null hypothesis of containing a unit root was rejected in all cases. Post estimation tests were conducted to evaluate the VAR against alternative specifications with the information criterion shown below (in table 79) demonstrating the initial calculation of two lags was optimum:

Table 79: VAR (YIELD) & VAR (YGAP) Information Criterion

VAR (YIELD)			
Lags	2	3	4
AIC	-20.3596*	-18.32034	-17.56644
HQIC	-20.06995*	-18.0328	-17.27735
SBIC	-19.65155*	-17.61209	-16.8543

*indicates preferred option

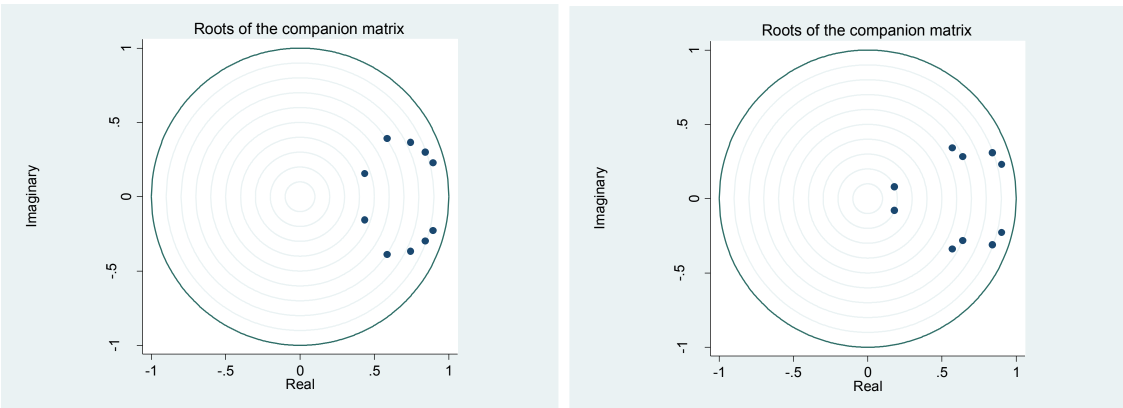
VAR (YGAP)			
Lags	2	3	4
AIC	-15.76878*	-14.16537	-13.53299
HQIC	-15.4797*	-13.87472	-13.24076
SBIC	-15.05665*	-13.4493	-12.01294

*indicates preferred option

Post estimation both VARs were found to satisfy the stability criteria, shown in figure 74:

Figure 74: VAR (YIELD) & VAR (YGAP) Roots of the Companion Matrix

VAR (YIELD) VAR (YGAP)



With appropriate tests of normality and autocorrelation, confirming the robustness of the models. Post estimation tests present an epistemological concern for the Austrian School as re specification would suggest a movement away from theory. Mulligan (2006) for instance considers normality to be a sufficient rather than necessary condition for valid estimates, however the specification of the VARs, based on theory and the literature have not been subsequently altered to cause concern to the Austrian School, thus the VAR models are robust by orthodox standards and appropriate for the Austrians.

The Austrian Econometric literature consider the explanatory power of models a potential mechanism for support of Hayek's theory of the trade cycle. Prediction arising from a Vector-Auto Regression model can be used for evaluation purposes within the Austrian Econometric Literature. Short term predictions derived Vector-Auto Regression models comprising a measure of the difference between the natural and market rate of interest are compared to those derived from a similar VAR model containing the Bank of England base rate as the interest rate variable below. Root Mean Square Error (RMSE) of the VAR forecasts compared to other simpler tests, in particular calculating the RMSE for each forecast horizon of the VAR and forecasts produced by the mean, random walk and a univariate autoregression (shown in table 80):

Table 80: RMSE comparisons for the Vector-Auto Regression Models

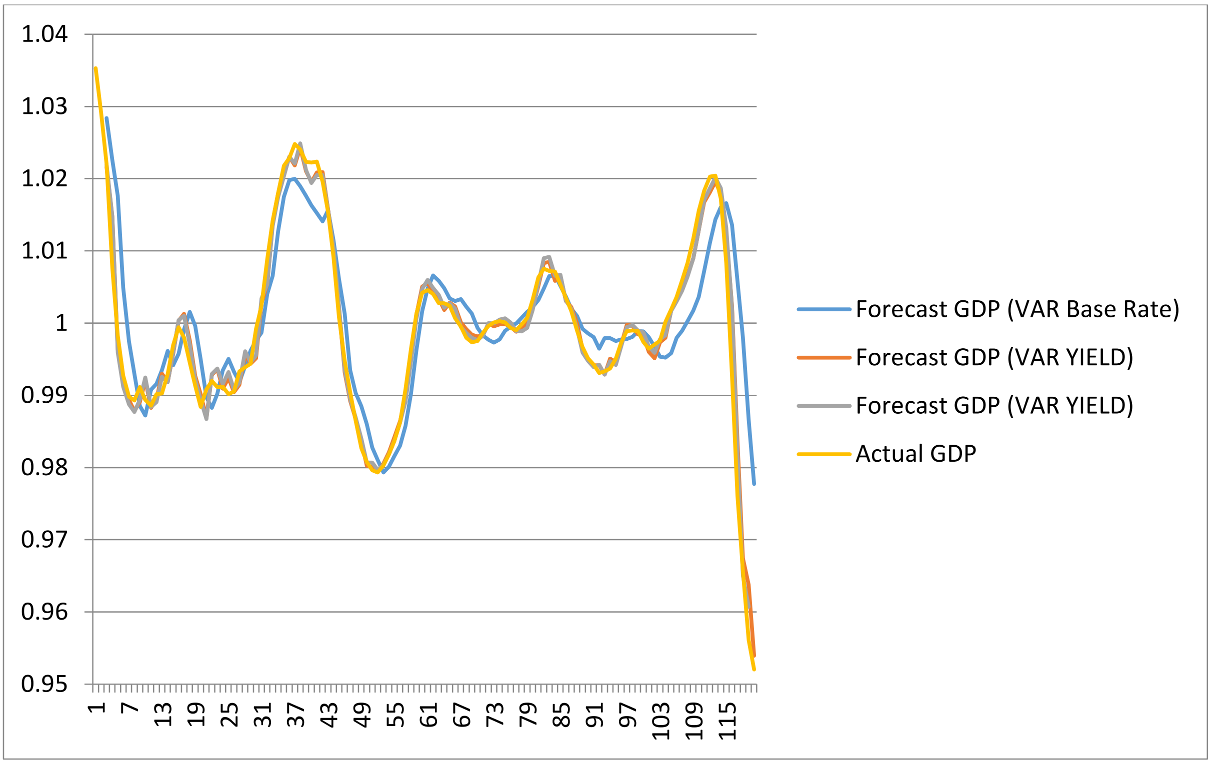
Equation	% improvement for VAR (YIELD)			% improvement for VAR (YGAP)			% improvement for VAR (Base Rate)		
GDP									
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	69	24	67	70	26	68	32	-67	25
4	19	14	15	18	13	14	-16	-26	-21
8	-4	23	-2	-6	22	-4	-15	14	-5
YIELD				**YGAP**			**Base Rate**		
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	52	20	51	5	28	58	36	-16	34
4	14	20	13	-17	29	26	8	8	7
8	3	22	3	2	33	3	-5	16	-4
RESOURCES									
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	28	8	25	32	14	30	31	3	3

4	-13	11	-16	-5	17	-7	-12	8	10
8	-28	18	-26	-26	20	-24	-25	21	12
M4									
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	1	-2	-2	7	4	4	2	7	3
4	-6	14	-7	10	27	9	10	23	10
8	-12	2	-11	-15	-2	-15	-13	-4	-12
INVCON									
Horizon	**M**	**RW**	**AR**	**M**	**RW**	**AR**	**M**	**RW**	**AR**
2	58	26	57	59	28	58	35	-13	33
4	31	33	30	27	29	26	0	3	-2
8	2	33	3	2	33	3	-14	22	-9

Hayek's theory of the trade cycle suggests that a divergence of the interest rate from its natural level will be a better indicator of future output than the interest rate alone. Measuring the % improvement in the RMSE for each forecast horizon of each VAR against a simpler predictive measure demonstrates the predictive power (for evaluation only) of Austrian variable VARs over a VAR which doesn't consider the Austrian perspective of interest rate divergence.

Hayek's theory of the trade cycle predicts that a VAR model containing a measure of interest rate divergence between the natural and market rates will have greater success in predicting GDP than a VAR containing a simple measure of set interest rates in the economy. As such it is supportive of the relevance of HTTC for the UK economy (1980-2010) that the Austrian variable VARs offer greater predictive power over GDP than a VAR containing a simple measure of the interest rate.

Figure 75: VAR Forecasts Vs Observed GDP



It can be seen in figure 76, that the Forecast of GDP deriving from the VAR not containing the measure of interest rate divergence (VAR Base Rate) is noticeably poorer than the Austrian Variable VARs. It can also be seen that the Austrian variable VARs cope more successfully with the 2007 financial and economic crisis than the VAR including the simple interest rate variable. As shown in table 81 both VAR YIELD and VAR YGAP outperform VAR (Base Rate).

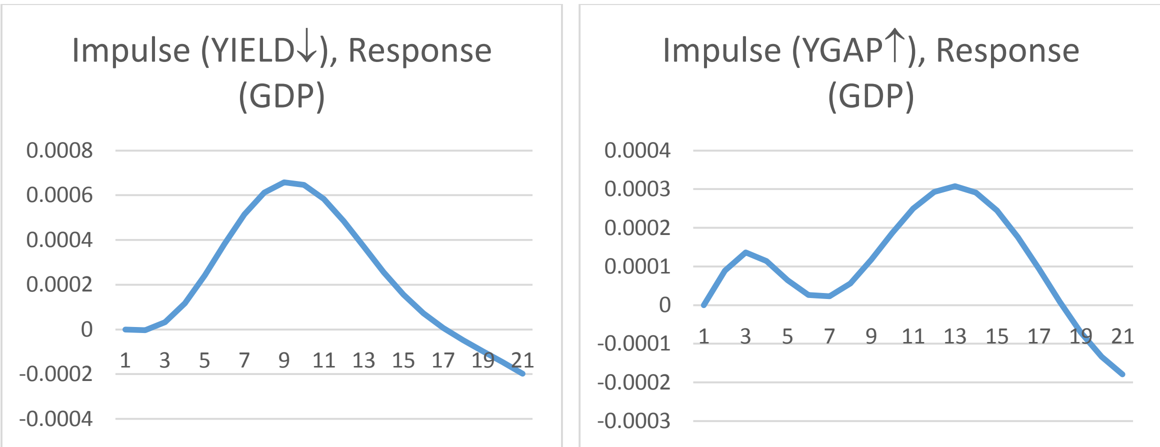
Table 81: HTTC Predictions of Mean Error Vs Observations

HTTC prediction	Observation
Mean error VAR (YIELD) < Mean error VAR (Base Rate)	Mean error VAR (YIELD) < Mean error VAR (Base Rate)
Mean error VAR (YGAP) < Mean error VAR (Base Rate)	Mean error VAR (YGAP) < Mean error VAR (Base Rate)

It should also be noted that the percentage improvement demonstrated above is of broader interest to the Austrian School of Economic Thought. The rejection of *scientism* of the school supports a use of simple models for Austrian econometrics, demonstrating the improvement of more complex models over results garnered from simpler tests is of use in persuading the Austrian School to adopt more complex tests, potentially bridging the gap between the Austrian School and the Orthodoxy.

Orthogonalized Impulse Response Functions allow for more direct testing of the predictions of Hayek's theory of the trade cycle. The relationship between expansionary monetary policy (YIELD↓ or YGAP↑) can be seen in figure 76:

Figure 76: Impulse Expansionary Monetary Policy, Response GDP



Over the time period, expansionary monetary policy can be seen to have an effect on GDP consistent with the prediction of Hayek's theory of the trade cycle. That is a positive effect on GDP in the near stages preceding monetary expansion, followed by a negative effect in the more distant horizons. However it should be noted that the negative effect in the period is far outweighed by the positive boost to GDP, for both variables the cumulative effect on GDP is positive:

Table 82: Long term Impulse Expansionary Monetary Policy, Response GDP

Action	Cumulative effect on GDP (20 steps)	Cumulative effect on GDP (120 steps)
YIELD↓	0.00464	0.003853
YGAP↑	0.002095	0.002618

Thus whilst the relationships predicted by HTTC can be seen within the data the overall

HTTC prediction of relationship	Observation
YIELD↓→GDP↓	YIELD↓→GDP↓
YGAP↑→GDP↓	YGAP↑→GDP↓

prediction of HTTC that an expansionary monetary policy permanently lowers GDP is far from conclusive.

Table 83: HTTC predictions of outcomes and relationships Vs observations of the response of GDP to the interest rate

HTTC prediction of outcome	Observation
YIELD↓→ ΣGDP Response ≤ 0	YIELD↓→ ΣGDP Response ≥ 0
YGAP↑→ ΣGDP Response ≤ 0	YGAP↓→ ΣGDP Response ≥ 0

The relationships predicted by HTTC are present, the outcomes predicted by HTTC are not, this is of course problematic for HTTC as even if the relationships can be demonstrated the overall relevance of the theory relies on its final predictions being evidenced.

10.2.3.1 VAR Orthogonalized Impulse Response Functions

The remaining relationships within the HTTC can be examined *via* the Orthogonalized Impulse Response Functions to evaluate the mechanisms of Hayek's theory of the trade cycle, these are summarised in table 84 and table 85.

Table 84: OIRF VAR YIELD

Link	Relationship predicted by HTTC	Observed Relationship within the OIRFs.
ΔM4→ ΔM4	YIELD↓→M4↑	YIELD↓→M4↑
ΔM4→ ΔRESOURCES	M4↑→RESOURCES↑	M4↑→RESOURCES↓
ΔM4→ ΔINVCON	M4↑→INVCON↓	M4↑→INVCON↓
ΔRESOURCES →ΔGDP	RESOURCES↑→↑GDP	RESOURCES↑→↑GDP
ΔINVCON→ΔGDP	INVCON↓→↑GDP	INVCON↓→↓GDP
ΔGDP→ΔRESOURCES	↑GDP → RESOURCES↑	↑GDP → RESOURCES↓
ΔGDP→ ΔINVCON	↑GDP → INVCON↓	↑GDP → INVCON↑
ΔRESOURCES→ΔMR	RESOURCES↑→YIELD↑	RESOURCES↑→YIELD↓
ΔINVCON →ΔMR	INVCON↓→ YIELD↑	INVCON↓→ YIELD↑
ΔMR→Δ(↓)GDP	YIELD↑→ GDP↓	YIELD↑→ GDP↓

Table 85: OIRFs VAR YGAP

Link	Relationship predicted by HTTC	Observed Relationship within the OIRFs.
ΔMR→ ΔM4	YGAP↑→M4↑	YGAP↑→M4↑
ΔM4→ ΔRESOURCES	M4↑→RESOURCES↑	M4↑→RESOURCES↓
ΔM4→ ΔINVCON	M4↑→INVCON↓	M4↑→INVCON↑
ΔRESOURCES →ΔGDP	RESOURCES↑→↑GDP	RESOURCES↑→↑GDP
ΔINVCON→ΔGDP	INVCON↓→↑GDP	INVCON↓→GDP↑
ΔGDP→ΔRESOURCES	↑GDP → RESOURCES↑	↑GDP → RESOURCES↓
ΔGDP→ ΔINVCON	↑GDP → INVCON↓	↑GDP → INVCON↑
ΔRESOURCES→ΔMR	RESOURCES↑→YGAP↓	RESOURCES↑→YGAP↑
ΔINVCON →ΔMR	INVCON↓→YGAP↓	INVCON↓→YGAP↓
ΔMR→Δ(↓)GDP	YGAP↓→GDP↓	YGAP↓→GDP↓

Several of the relationships predicted by Hayek's theory of the trade cycle exist within the data suggesting some relevance for it for the UK economy (1980-2010), however many of the key continuation stage links are not supported within the Vector-Auto Regression OIRF analysis of the data.

VAR YIELD MODEL:

(↓)YIELD→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↑)YIELD→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

VAR YGAP MODEL:

(↑)YGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)YGAP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

The links in the model are partially supported through the VAR OIRFs, however fundamental predictions from HTTC are missed, the trigger stage and correction links hold supportive of the overall HTTC, however questions must be asked of HTTC if the continuation stages of the theory prevent transmission of the expansionary monetary policy link (**ΔMR→ ΔM4)** through to the correction link (**ΔMR→Δ(↓)GDP**) in accordance with Hayek's theory of the trade cycle.

10.2.3.2 VAR Granger Causality Tests

Much of the Austrian Econometric literature (e.g. Wainhouse 1984, Keeler 2001) considers Granger Causality Testing as an appropriate method for evaluating the temporal relationships of variables. The Granger Causality Tests here are constructed *via* the Vector-Auto Regression *as per* Carilli & Dempster (2008). This in essence gives an Austrian approval to the method and the construction of the test and as previously demonstrated the VAR models are constructed with the post estimation evaluation required for orthodox econometrics and without any respecification which would be a cause for concern for the Austrians. The Granger Causality test results are shown in table 86:

Table 86: Granger Causality Test Results VAR YIELD & VAR YGAP

Equation	G* Variable	Chi^2 (Model 1)	Chi^2 (Model 2)
GDP	YIELD (1) / YGAP (2)	0.02394	0.33079
GDP	RESOURCES	6.496**	0.80469
GDP	M4	4.7079**	3.7165
GDP	INVCON	0.04411	0.12613
GDP	ALL	14.095**	5.3123
YIELD	GDP	2.7806*	-
YIELD	RESOURCES	0.78091	-
YIELD	M4	0.25197	-
YIELD	INVCON	0.00627	-
YIELD	ALL	8.3742*	-

YGAP	GDP	-	6.5502**
YGAP	RESOURCES	-	8.5869**
YGAP	M4	-	4.0248
YGAP	INVCON	-	3.5516
YGAP	ALL	-	28.676***
RESOURCES	GDP	14.135***	4.6925*
RESOURCES	YIELD (1) / YGAP (2)	2.3101	0.9945
RESOURCES	M4	1.5726	2.8681
RESOURCES	INVCON	1.5897	1.7276
RESOURCES	ALL	32.397***	12.091
M4	GDP	52.438***	22.183***
M4	YIELD (1) / YGAP (2)	1.0283	8.7984
M4	RESOURCES	4.1582**	1.5228
M4	M4	8.0126**	4.12
M4	ALL	71.905***	33.299***
INVCON	GDP	5.6237**	17.892***
INVCON	YIELD (1) / YGAP (2)	0.05595	8.2493**
INVCON	RESOURCES	0.00221	5.2268*
INVCON	M4	0.7651	9.3704**
INVCON	ALL	5.797	43.007***

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

Austrian econometric use of the Granger Causality test tends to seek temporal causation of expansionary monetary policy (YIELD and / or YGAP) on GDP. It appears however that neither YIELD or YGAP can be accepted as granger causing GDP and again a fundamental overall relationship of HTTC does not hold.

Carilli & Dempster (2008) state, “If the interest rate gap Granger causes GDP, we can conclude that the United States [here United Kingdom] has experienced economic fluctuations consistent with the predictions of HTTC”

However, even utilising two different variables for the interest rate gap (both derived from the Austrian econometric literature), the conclusion of this test is a rejection of the null hypothesis of YIELD / YGAP Granger causing GDP. Regarding the Carilli & Dempster (2008) statement above and paraphrasing their subsequent conclusion, the results of the Granger

Causality Tests are not favourable to Austrian Theory. The YIELD Austrian model as a whole however Granger causes GDP at the 5% level, interestingly the YGAP Austrian model does not.

Following the example of Wainhouse (1984), Granger Causality Testing can be used to consider the causations predicted by Hayek's theory of the trade cycle, shown in table 87 and table 88:

Table 87: HTTC Granger Causality SOPs Vs Observations (VAR YIELD Model)

HTTC Prediction	**VAR (YIELD) model**
YIELD G* Causes M4	YIELD does not G* Cause M4
M4 G* Causes RESOURCES	M4 does not G* Cause RESOURCES
M4 G* Causes INVCON	M4 does not G* Cause INVCON
RESOURCES G* Causes GDP	RESOURCES G* Causes GDP**
INVCON G* Causes GDP	INVCON does not G* Cause GDP
GDP G* Causes RESOURCES	GDP G* Causes RESOURCES***
GDP G* Causes INVCON	GDP G* Causes INVCON**
RESOURCES G* Causes YIELD	RESOURCES does not G* Cause YIELD
INVCON G* Causes YIELD	INVCON does not G* Cause YIELD
YIELD G* Causes GDP	YIELD does not G* Cause GDP

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

Table 88: HTTC Granger Causality SOPs Vs Observations (VAR YGAP Model)

HTTC Prediction	**VAR (YGAP) model**
YGAP G* Causes M4	YGAP does not G* Cause M4
M4 G* Causes RESOURCES	M4 does not G* Cause RESOURCES
M4 G* Causes INVCON	M4 G* Causes INVCON**
RESOURCES G* Causes GDP	RESOURCES does not G* Cause GDP
INVCON G* Causes GDP	INVCON does not G* Cause GDP
GDP G* Causes RESOURCES	GDP G* Causes RESOURCES*
GDP G* Causes INVCON	GDP G* Causes INVCON***
RESOURCES G* Causes YGAP	RESOURCES G* Causes YGAP**
INVCON G* Causes YGAP	INVCON does not G* Cause YGAP
YGAP G* Causes GDP	YGAP does not G* Cause GDP

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

In terms of Ganger Causation, the results on the model can be seen to be relatively non-favourable to HTTC, the response to the Carilli & Dempster (2008) statement that positive Granger Causation concludes the economy has experienced economic fluctuations consistent with Hayek's theory of the trade cycle is that the absence of the predicted Granger Causations suggest the UK's economic fluctuations are not consistent with HTTC.

Below are shown models demonstrating positive and negative Granger causations:

VAR (YIELD):

(↓)YIELD→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↑)YIELD→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

VAR (YGAP):

(↑)YGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)YGAP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

Whilst the Granger Causality Test results displayed above are far from convincing. Wainhouse (1984) further considers the creation of money in an economy causes GDP is supportive of Hayek's theory of the trade cycle, whilst the Granger Causality test for the YIELD model supports this at the 5% significance level, one must query how wholly Austrian this view is, orthodox economics would clearly view that the availability of money in an economy supports GDP and this is a principle of Monetarism (Ekelund & Hebert 1990). Carilli & Dempster (2008) note that evidence for HTTC is also evidence for monetarism, considering that Central Banks react to inflationary expectations reducing the money supply reversing the effects of monetary expansion and ending a liquidity boom in thus the trigger and correction stages are similar to HTTC, with the continuation stages different in HTTC. This is not dissimilar to the findings of the VAR impulse response functions thus prompting the need for further testing.

10.2.4 The Vector-Error Correction Model

The Austrian School consider Vector-Error Correction models as being particularly amenable to Austrian interpretation, with the error correction or disequilibrium adjustment process being of particular interest as “Even if one rejects the reality of any hypothesised equilibrium, estimates of the disequilibrium process still warrant interest”, Mulligan (2006).

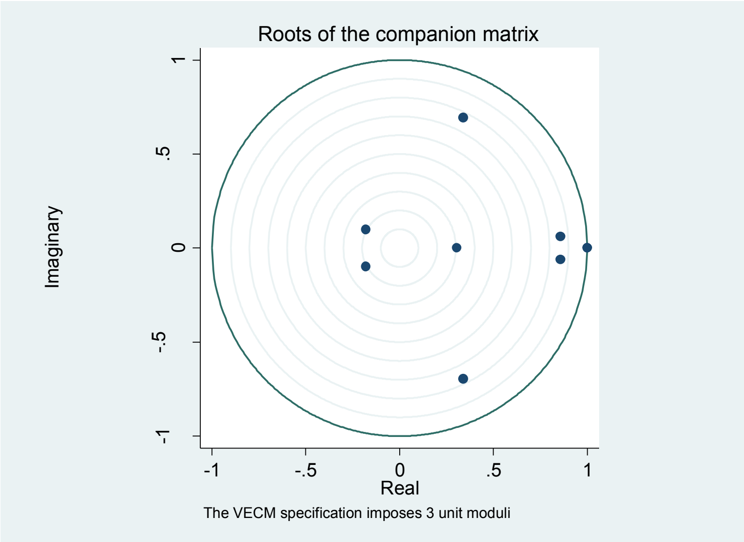
The Cointegrating Equation defines the long term equilibrium processes with the residual demonstrating an estimate of the disequilibrium in any time period, as such for the Austrians it is possible to identify the long run cointegrating relationships predicted by HTTC and identify periods of malinvestment and correction by the (+/-) disequilibrium in economic activity.

The first Vector Error Correction model of the thesis is constructed with orthodox economic guidance from Becketti (2013) within the bounds of the Austrian School by closely aligning the design to Mulligan (2006) and Keeler (2001), two papers considered as Austrian econometric works. Thus the model is appropriate for both orthodox and Austrian use, post estimation tests confirm that there is no need to respecify the model, which would be of concern to the Austrians, but as they were conducted the model is confirmed as being robust from an orthodox economic perspective.

The VECM requires variables with a unit root, as such the variable CYGAP was constructed, this variable is the cumulative sum of the variable YGAP and was confirmed to create a unit root. Likewise, the natural log of GDP was used as a measure of output containing a unit root. Estimates of the number of lags to incorporate and the number of cointegrating relationships were performed as recommended by Becketti (2013) and *as per* Mulligan (2006), cementing the Orthodox / Austrian acceptance of the process.

Thus a 2 lag 2 cointegrating VECM was constructed. As expected the VECM imposes 3 unit roots, shown in figure 77:

Figure 77: VECM Unit Roots



There is no evidence of instability nor of autocorrelated errors. Non-normality which is considered through a Jarque-Bera Test for Multivariate Normality of Residuals with all null hypotheses of normality accepted.

The two cointegrating equations took the form:

$\Delta lnGDP_t+0.0702253RESOURCES_t+0.1693787INVCON_t-0.0000055CYGAP_t-0.0055382-12.2349_t$

$\Delta CYGAP_t-0.001139M4_t-34.66767RESOURCES_t-106.1492INVCON_t-0.0344+107.2249_t$

With the coefficients of mixed significance, shown below in table 89:

Table 89: Cointegrating equation coefficients

CE1**	Coefficient
RESOURCES INVCON CYGAP	0.0702253** 0.34 0.912
CE2***	
RESOURCES INVCON CYGAP	-9.59*** -4.82*** -0.67

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

The residuals from the cointegrating equations can be seen below in figure 78, remembering that the residuals demonstrate the disequilibrium in any given time period:

Figure 78: Cointegrating relationships

CE1 CE2

The first cointegrating relationship, significant at the 5% level and the second, significant at the 1% level demonstrate a disequilibrium process relatively consistent with Hayek's theory of the trade cycle, the relationships between the variables can be seen to oscillate widely above equilibrium before financial or economic crisis and move under equilibrium levels. This process can clearly be seen in the lead up to and the activity below equilibrium following the 2007 financial crisis (correction). For both cointegrarting equations, unsurprisingly the 2007 crisis marks the most considerable movement away from equilibrium.

The disequilibrium process shows significant movement through the YGAP variable, with an R-Square of 0.7158, Mulligan (2006) considers it a compelling argument for HTTC that much of the adjustment process appears to work through the interest rate however unlike Mulligan (2006), the thesis VECM also demonstrates much of the adjustment process works through GDP (R-Square 0.6860). Mulligan's model demonstrates a 43% difference between the adjustment process for the interest rate variable (at 96%) and the adjustment process for the output variable (at 53%), whereas in the thesis VECM the difference is 5%.

Following a similar approach to the Vector-Auto Regression Models, Orthogonalized Impulse Response Functions deriving from the Vector Error Correction Model can be used to consider the internal mechanisms of the Hayek's theory of the trade cycle.

Firstly, a further investigation into the fundamental prediction of HTTC that expansionary monetary policy (CYGAP↑) results in a lowering of output. The long term Orthognslised Impulse Response Function of CYGAP on GDP is presented in table 90.

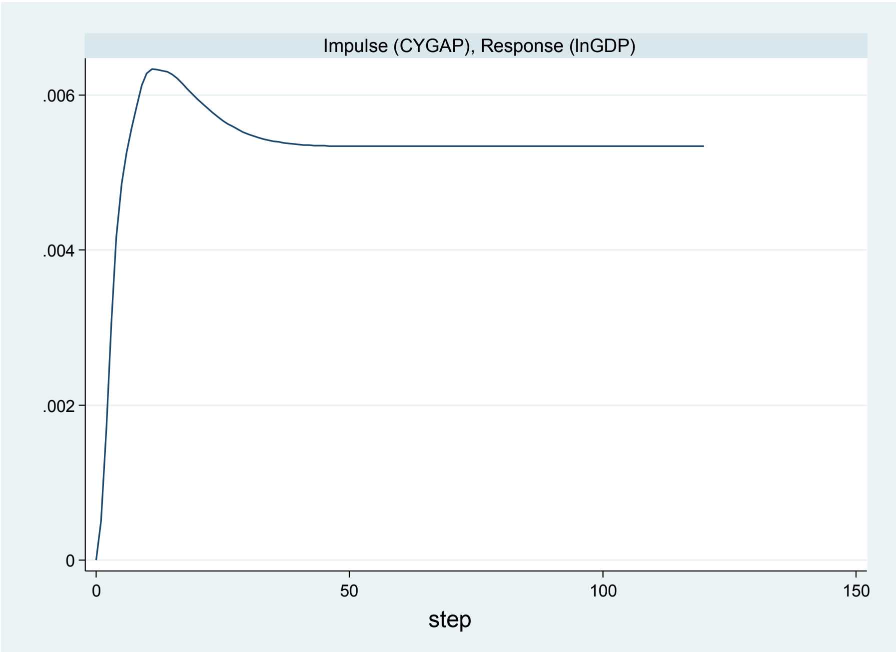
Table 90: Long term Impulse CYGAP, Response GDP

Impulse (CYGAP), Response (lnGDP)											
1	0	21	0.00589	41	0.005357	61	0.005337	81	0.005338	101	0.005338
2	0.000504	22	0.00583	42	0.005353	62	0.005337	82	0.005338	102	0.005338
3	0.001717	23	0.005772	43	0.005349	63	0.005337	83	0.005338	103	0.005338
4	0.003053	24	0.005719	44	0.005347	64	0.005338	84	0.005338	104	0.005338
5	0.004163	25	0.005672	45	0.005344	65	0.005338	85	0.005338	105	0.005338
6	0.004858	26	0.00563	46	0.005343	66	0.005338	86	0.005338	106	0.005338
7	0.005257	27	0.005591	47	0.005341	67	0.005338	87	0.005338	107	0.005338
8	0.005562	28	0.005556	48	0.00534	68	0.005338	88	0.005338	108	0.005338
9	0.005862	29	0.005525	49	0.005339	69	0.005338	89	0.005338	109	0.005338
10	0.006122	30	0.005497	50	0.005339	70	0.005338	90	0.005338	110	0.005338
11	0.006279	31	0.005473	51	0.005338	71	0.005338	91	0.005338	111	0.005338
12	0.006333	32	0.005453	52	0.005338	72	0.005338	92	0.005338	112	0.005338
13	0.00633	33	0.005434	53	0.005337	73	0.005338	93	0.005338	113	0.005338
14	0.006315	34	0.005418	54	0.005337	74	0.005338	94	0.005338	114	0.005338
15	0.006298	35	0.005405	55	0.005337	75	0.005338	95	0.005338	115	0.005338
16	0.006268	36	0.005393	56	0.005337	76	0.005338	96	0.005338	116	0.005338
17	0.006217	37	0.005383	57	0.005337	77	0.005338	97	0.005338	117	0.005338
18	0.006149	38	0.005375	58	0.005337	78	0.005338	98	0.005338	118	0.005338
19	0.006078	39	0.005368	59	0.005337	79	0.005338	99	0.005338	119	0.005338
20	0.006012	40	0.005362	60	0.005337	80	0.005338	100	0.005338	120	0.005338
										Σ	0.637224

Over the entire period, the response of the output variable (lnGDP) can be seen to a one percent increase in the term spread variable (CYGAP). An increase in CYGAP represents expansionary monetary policy, with a decrease in the market rate of interest increasing the interest gap assuming the time preference of the economy remains static. Austrian Business Cycle predicts a long term negative relationship between expansionary monetary policy and output, however above the relationship is positive not demonstrating the long term relationship between expansionary monetary policy and output.

This can be seen qualitatively in figure 79 and presented on table 96.

Figure 79: Impulse CYGAP, Response GDP



Formally:

Table 91: HTTC SOP Vs Observation

HTTC prediction of relationship	Observation
CYGAP↑→GDP↓	CYGAP↑→GDP↑

HTTC prediction of outcome	Observation
CYGAP↑→ ΣGDP Response ≤ 0	CYGAP↓→ ΣGDP Response ≥ 0

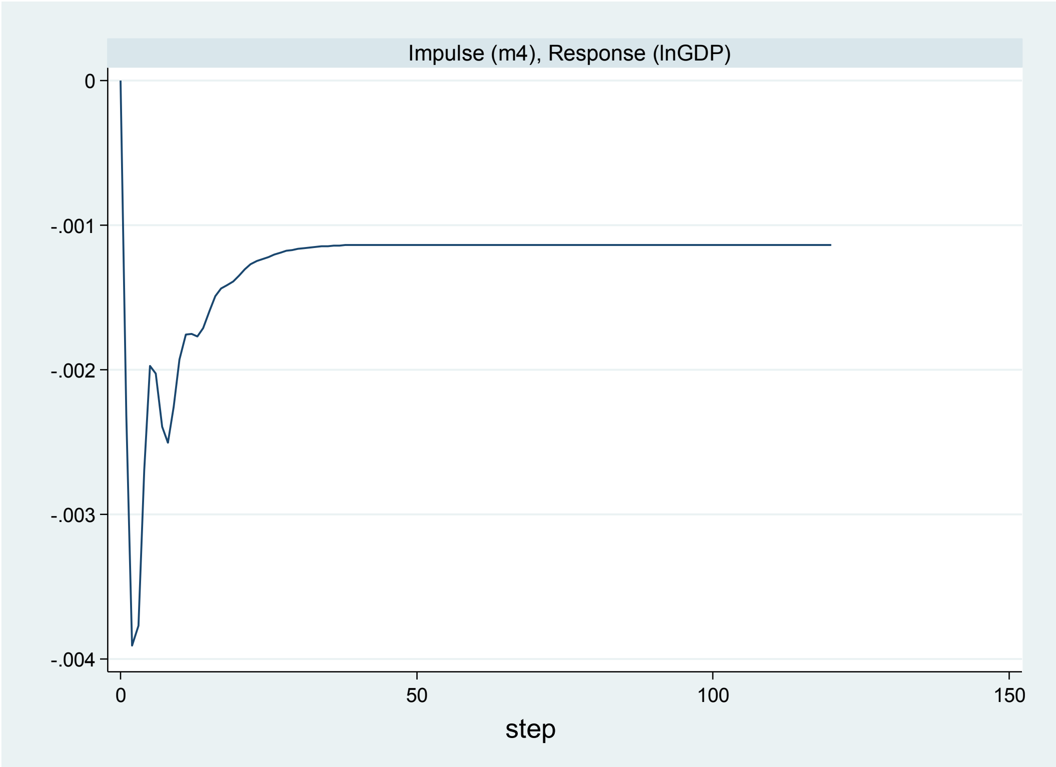
The HTTC predicted negative relationship between expansionary monetary policy and output should also be seen in the relationship between a money increase and output. Expansionary monetary policy for the Austrians should result in the creation of 'easy credit' represented by a rise in M4, HTTC predicts this should have a long term negative effect on GDP. The OIRF shown below in table 92, demonstrates the long term impact of a one percentage point rise in M4 on GDP:

Table 92: Long Term Impulse M4, Response GDP

Impulse (M4), Response (lnGDP)											
1	-0.002311	21	-0.001304	41	-0.001137	61	-0.001137	81	-0.001138	101	-0.001138
2	-0.003905	22	-0.001269	42	-0.001136	62	-0.001137	82	-0.001138	102	-0.001138
3	-0.003769	23	-0.001249	43	-0.001136	63	-0.001138	83	-0.001138	103	-0.001138
4	-0.002696	24	-0.001235	44	-0.001136	64	-0.001138	84	-0.001138	104	-0.001138
5	-0.001972	25	-0.00122	45	-0.001136	65	-0.001138	85	-0.001138	105	-0.001138
6	-0.002028	26	-0.001203	46	-0.001136	66	-0.001138	86	-0.001138	106	-0.001138
7	-0.002393	27	-0.001188	47	-0.001136	67	-0.001138	87	-0.001138	107	-0.001138
8	-0.002503	28	-0.001177	48	-0.001136	68	-0.001138	88	-0.001138	108	-0.001138
9	-0.002257	29	-0.001169	49	-0.001136	69	-0.001138	89	-0.001138	109	-0.001138
10	-0.001927	30	-0.001164	50	-0.001136	70	-0.001138	90	-0.001138	110	-0.001138
11	-0.001756	31	-0.001158	51	-0.001136	71	-0.001138	91	-0.001138	111	-0.001138
12	-0.001751	32	-0.001152	52	-0.001136	72	-0.001138	92	-0.001138	112	-0.001138
13	-0.001768	33	-0.001148	53	-0.001137	73	-0.001138	93	-0.001138	113	-0.001138
14	-0.00171	34	-0.001145	54	-0.001137	74	-0.001138	94	-0.001138	114	-0.001138
15	-0.001594	35	-0.001143	55	-0.001137	75	-0.001138	95	-0.001138	115	-0.001138
16	-0.00149	36	-0.001141	56	-0.001137	76	-0.001138	96	-0.001138	116	-0.001138
17	-0.001435	37	-0.001139	57	-0.001137	77	-0.001138	97	-0.001138	117	-0.001138
18	-0.001413	38	-0.001138	58	-0.001137	78	-0.001138	98	-0.001138	118	-0.001138
19	-0.001388	39	-0.001137	59	-0.001137	79	-0.001138	99	-0.001138	119	-0.001138
20	-0.001348	40	-0.001304	60	-0.001137	80	-0.001138	100	-0.001138	120	-0.001138
										Σ	-0.1562

Over the entire period, an increase in M4 has the overall negative effect consistent with Hayek's theory of the trade cycle, however it doesn't display the predicted boom bust pattern. For HTTC, the increase in M4 should initially raise output, having a negative effect in the more distant steps. However as can be seen below in figure 80, an increase in M4, has an initial negative effect which continues throughout the steps:

Figure 80: Impulse M4, Response GDP



This presents a problem for HTTC as here the overall relationship appears to hold, but the mechanism of that relationship is not consistent with HTTC.

The evaluation of the HTTC prediction and outcome is shown below in table 93, but it should be noted that even though the outcome is consistent, the support this gives for HTTC as relevant for the UK economy is limited.

Table 93: M4 HTTC SOP Vs Observation

HTTC prediction of outcome	Observation
M4↑→ ΣGDP Response ≤ 0	M4↑→ ΣGDP Response ≤ 0

This does however raise wider questions for the UK economy, with past Bank of England Governer, Mervyn King (2004)[72] considering negative M4 growth is a sign of falling economic activity and a justification for quantitative easing and low interest rates.

10.2.4.1 VECM Orthogonalized Impulse Response Functions

The OIRFs as per the Vector-Auto Regression Tests allow for a greater evaluation of the individual relationships predicted by Hayek's theory of the trade cycle and are presented in table 94.

Table 94: HTTC SOPs evaluated against VECM OIRFs

Link	Impulse / Response Relationship predicted by HTTC	Observed Impulse / Response Relationship
ΔMR→ ΔM4	**CYGAP↑→M4↑**	**CYGAP↑→M4↑**
ΔM4→ ΔRESOURCES	**M4↑→INVCON↓**	**M4↑→INVCON↓**
ΔM4→ ΔINVCON	**M4↑→RESOURCES↑**	**M4↑→RESOURCES↑**
ΔRESOURCES →ΔGDP	**RESOURCES↑→↑ln(GDP)**	**RESOURCES↑→↑ln(GDP)**
ΔINVCON→ΔGDP	**INVCON↓→↑ln(GDP)**	**INVCON↓→ln(GDP)↑**
ΔGDP→ΔRESOURCES	**↑ln(GDP) → RESOURCES↑**	**↑ln(GDP) → RESOURCES↓**
ΔGDP→ ΔINVCON	**↑ln(GDP) → INVCON↓**	**↑ln(GDP) → INVCON↑**
ΔRESOURCES→ΔMR	**RESOURCES↑→CYGAP↓**	**RESOURCES↑→CYGAP↓**
ΔINVCON →ΔMR	**INVCON↓→ CYGAP↓**	**INVCON↓→ CYGAP↓**
ΔMR→Δ(↓)GDP	**CYGAP↓→ GDP↓**	**CYGAP↓→ GDP↓**

[72] Speech given by Mervyn King, Governor of the Bank of England At the Lord Mayor's Banquet for Bankers and Merchants of the City of London at the Mansion House 16 June 2004

The support for HTTC is greater with this test than the corresponding VARs presented in Chapter 8, the model can be seen below:

(↑)CYGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)CYGAP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

However a similar conclusion must be drawn that supporting evidence for the trigger and correction stages of HTTC are present in the data, the continuation stage which is solely Austrian in its interpretation is not present.

An interpretation of the Austrian view of expansionary monetary policy can be developed from the supported aspects of the Hayek's theory of the trade cycle:

(↑)CYGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP
↘ (↓) INVCON ↗

However this interpretation of the Austrian view of monetary policy, does not create the unsustainable boom synonymous with Hayek's theory of the trade cycle, though can be seen to alter the temporal production structure of the economy consistent with Austrian Theory.

10.2.4.2 VECM Granger Causality Tests

Similar to the previous Vector-Auto Regression tests, Granger Causality Tests can be derived from the Vector Error Correction Model and are presented in table 95.

Table 95: Granger Causality Tests Derived from VECM

Equation	G* Variable	Chi2
Ln(GDP)	CYGAP	6.72**
Ln(GDP)	RESOURCES	0.06
Ln(GDP)	M4	0.98
Ln(GDP)	INVCON	4.95**
CYGAP	Ln(GDP)	1.04
CYGAP	RESOURCES	0.12
CYGAP	M4	0.68
CYGAP	INVCON	4.93**
RESOURCES	Ln(GDP)	3.86**
RESOURCES	CYGAP	10.41***
RESOURCES	M4	2.60*
RESOURCES	INVCON	0.17
M4	Ln(GDP)	0.20
M4	CYGAP	1.43
M4	RESOURCES	4.95**
M4	INVCON	0.67
INVCON	Ln(GDP)	3.51**
INVCON	CYGAP	3.59**
INVCON	RESOURCES	1.16
INVCON	M4	0.55

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

A reminder of Carilli & Dempster's (2008) statement regarding Granger causation of the interest rate gap and output:

"If the interest rate gap Granger causes GDP, we can conclude that the United States [here United Kingdom] has experienced economic fluctuations consistent with the predictions of HTTC"

It can be seen that in accordance with the prediction of Hayek's theory of the trade cycle, CYGAP is seen to Granger Cause ln(GDP) at the 5% level, Carilli & Dempster (2008), Mulligan (2006), Wainhouse (1984) consider this to be wholly supportive of Hayek's theory of the trade cycle, however the Granger Causality test is supportive of an interest rate causation of output and not necessarily of HTTC. For instance the relationship below:

(↑)CYGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP
↘ (↓) INVCON ↗

is supported by the OIRFs arising from the VECM and the demonstration of interest rate gap Granger Causing output.

The Granger Causality observations against the HTTC predictions ae shown in table 96.

Table 96: HTTC Granger Causality Predictions Vs Observations

HTTC Prediction	**VECM**
CYGAP G* Causes M4	CYGAP G* Causes M4**
M4 G* Causes RESOURCES	M4 G* Causes RESOURCES*
M4 G* Causes INVCON	M4 does not G* Cause INVCON
RESOURCES G* Causes GDP	RESOURCES does not G* Cause GDP
INVCON G* Causes GDP	INVCON G* Causes GDP**
GDP G* Causes RESOURCES	GDP G* Causes RESOURCES**
GDP G* Causes INVCON	GDP G* Causes INVCON**
RESOURCES G* Causes CYGAP	RESOURCES does not G* Cause CYGAP
INVCON G* Causes CYGAP	INVCON G* Causes CYGAP**
CYGAP G* Causes GDP	CYGAP G* Causes GDP**

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

The model can be seen below, with positive and negative links derived from the VECM Granger Causality tests highlighted:

(↑)CYGAP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)CYGAP→(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

Contrary to previous evaluations, the trigger, continuation and correction stages of HTTC all have some support, however the transmission of ΔM4 to ΔGDP is limited. Within the model M4 does not Granger Cause GDP, suggesting a different transmission of ΔMR to ΔGDP, and supporting the transmission of ΔMR to ΔGDP without the unsustainable boom of HTTC.

10.2.5 Replication of Mulligan (2006)

Mulligan (2006) conducts Vector Error Correction tests on US data to evaluate the relevance of Hayek's theory of the trade cycle. This study is cited relatively widely within the Austrian School as an ideal econometric evaluation of the mechanisms of HTTC as well as having recognition within the mainstream (e.g. Hoffmann 2010) demonstrating a mutually accepted method. The Mulligan (2006) study, demonstrates evidence supportive of HTTC and is considered an econometric demonstration of the relevance of HTTC. Thus a replication study for the UK should provide an econometric evaluation acceptable to orthodox economics and results from it should be acceptable to the Austrian School.

The Mulligan study constructs a VECM with the form:

$$\Delta C_t = \Theta(C_{t-1} - a - br_{t-1}) + \Delta C_{t-1} + \Delta C_{t-2} + \Delta C_{t-3} + \cdots + \Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3+\cdots+} u_t$$

$$\Delta \mathrm{r}_t = \Psi(C_{t-1} - a - br_{t-1}) + \Delta C_{t-1} + \Delta C_{t-2} + \Delta C_{t-3} + \cdots + \Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3+\cdots+} u_t$$

The replication study used a similar VECM with the form:

$$\Delta\ln(GDP)_t = \Theta(Ln(GDP)_{t-1} - a - bYGAP_{t-1}) + \Delta\ln(GDP)_{t-1} + \Delta\ln(GDP)_{t-2} + \Delta\ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} + \Delta YGAP_{t-2} + \Delta YGAP_{t-3+\cdots+}u_t$$

$$\Delta\mathrm{YGAP}_t = \Psi(Ln(GDP)_{t-1} - a - bYGAP_{t-1}) + \Delta\ln(GDP)_{t-1} + \Delta\ln(GDP)_{t-2} + \Delta\ln(\mathrm{GDP})_{t-3} + \cdots + \Delta YGAP_{t-1} + \Delta YGAP_{t-2} + \Delta YGAP_{t-3+\cdots+}u_t$$

Where Θ and Ψ are the structural adjustment or disequilibrium terms and indicate the importance of the past changes in the explanatory variables in adjustment toward the hypothesised equilibrium.

A comparison of variables can be seen in table 97.

Table 97: Mulligan and Replication Model Variables

Economic Phenomena	Mulligan Proxy	Thesis Proxy
Output	Ln(Consumerable Output)	Ln(GDP)
Interest rate divergence from 'natural rate'	Cumulative FED 10year constant rate – 3month secondary market rate (Term Spread)	Cumulative BoE 10yr UK gov. bond rate – 3month UK gov. bond rate. (CYGAP).

Appropriate tests to determine the number of lags and cointegrating relationships were conducted as per orthodox guidance from Becketti (2013), and the same construction specification as Mulligan is identified from the data and used. Following direction from the Mulligan study, the identification of a long term cointegrating relationship between the two variables allowed for an initial superconsistent OLS estimate with results not dissimilar to the Mulligan. Mulligan considers the end effect of a monetary expansion from the Austrian perspective, that is in the final stages of monetary expansion the monetary authority reverses its position decreasing the term spread. "in the late stages of monetary policy the term spread becomes negative". However it must be noted that this is even from the Austrian perspective a short term scenario, expansionary monetary policy increases the interest rate spread until the final stages (Keeler 2001). The Mulligan study only considers the short term culmination of of expansionary monetary policy and extrapolates from that, the previous models (VAR and VECM) consider the entirety of expansionary monetary policy, however to replicate Mulligan (2006), the end action of this monetary policy will be used.

Hence, expansionary monetary policy here will result in a decrease of the term spread (CYGAP↓) unlike the standard interpretation where an expansionary monetary policy will increase the term spread (CYGAP↑).

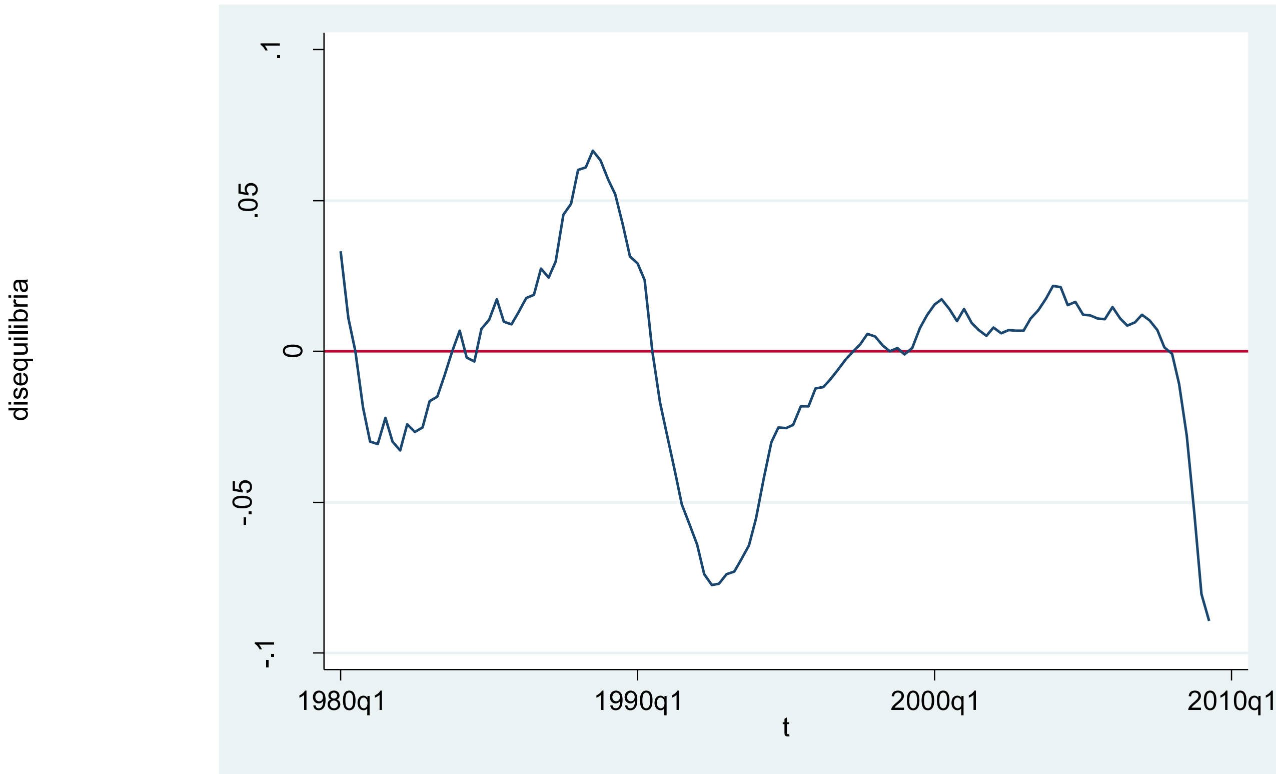
In the superconsistent OLS, the coefficient of CYGAP is positive wich is consistent with the findings of Mulligan, hence a decrease in term spread in accordance with Mulligan's interpretation of expansionary monetary policy, results in a decrease of GDP. An increase (decrease) in the market rate by 1 percent for one quarter and taking the antilog of 0.2089348, it can be seen that the effect on ln(GDP) is a gain (loss) of £1.62bn (chained at 2010 Pound Stirling). Mulligan concludes that the longer the market interest rate is kept below the natural interest rate the greater the impact on cumulative term spread and thus on output. Though the alternative interpretation of the OLS if expansionary monetary policy increases the term spread (CYGAP↑) in accordance with the Austrian view at the beginning of the expansionary policy is that expansionary monetary policy has a long term positive effect on GDP, not-consistent with the predictions of Hayek's theory of the trade cycle.

The construction of the replication VECM generates the cointegrating relationship:

$\ln(GDP)_t$+0.0015CYGAP-0.007-12.02

The disequilibrium by time period can be seen in figure 81.

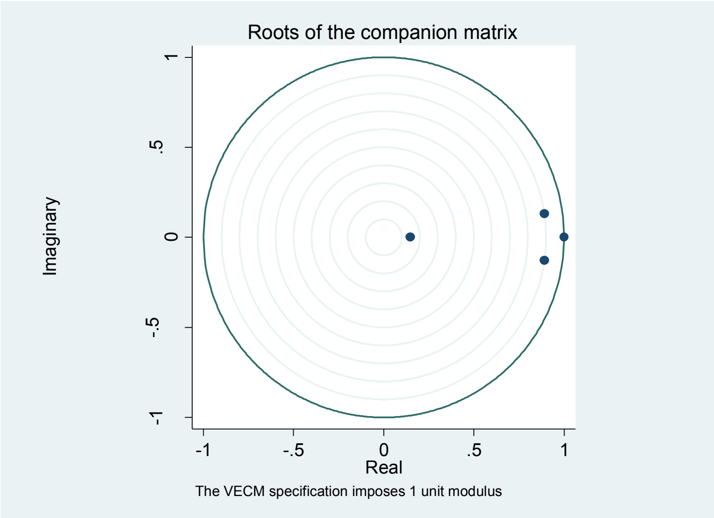
Figure 81: Replication VECM Cointegrating Relationship



This residual view, solved for ln(GDP) is relatively consistent with HTTC, showing economic activity above equilibrium pre crisis and below post. Mulligan finds support for HTTC in the fact that the adjustment process works well through the interest rate variable (Mulligan finds an R-square for the term spread adjustment process of 96%, whereas the VECM finds an R-square of 71%). However much of Mulligan's support comes from the clear difference in his study of R-Square between, output and term spread of 43% in favour of the term spread, however in the thesis VECM, the difference is 9% in favour of the term spread variable.

Mulligan's (2006) model suffers from non-normality of the residual series, it is stated in the paper that firstly normality is a sufficient rather than a necessary condition for valid VECM estimates and the similarity between the VECM model coefficients and the superconsistent OLS coefficients. However it remains that this would raise concerns within standard econometric modelling, for the above VECM, whilst the specification naturally imposes a unit root shown in figure 82.

Figure 82: Replication VECM Roots of the companion matrix



It is noted that one eigenvalue is close to the limit indicating that some shocks may not die out quickly.

Aside from this one unit root, there is no evidence of instability nor of autocorrelated errors. The non-normality which plagues Mulligan (2006) is considered through a Jarque-Bera Test for Multivariate Normality of Residuals with all null hypotheses of normality accepted.

Granger causality tests (shown below in table 98) are far more supportive of Hayek's theory of the trade cycle than those in the Mulligan study.

Table 98: Replication study Granger Causality Results

Equation	G*Variable	Chi^2
ln(GDP)	Cumulative YGAP	5.98**
Cumulative YGAP	ln(GDP)	0.04

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

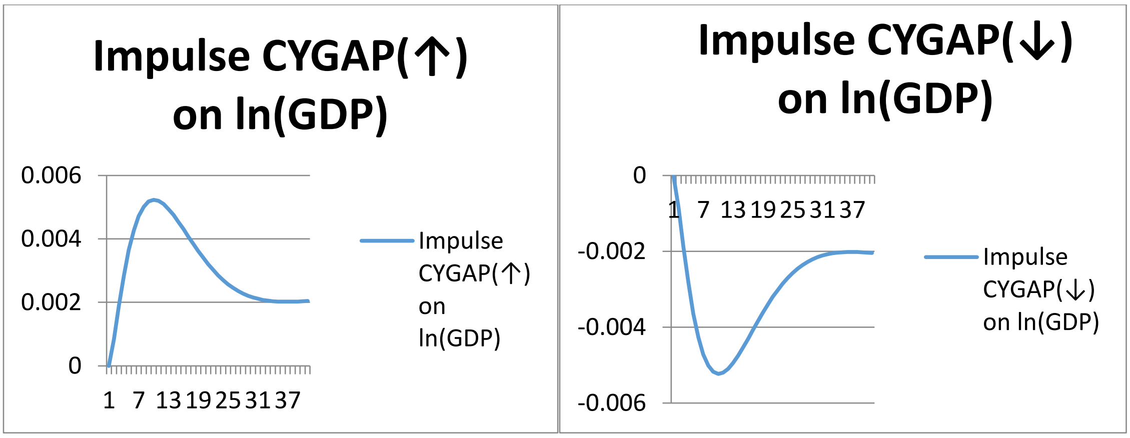
However Mulligan argues that his negative results are the result of the rejection of the hypothesis that all relevant variables are contained in the VECM (Davidson & MacKinnon

1993) and as such the larger previous Granger Causality tests will be used to evaluate the relevance of Hayek's theory of the trade cycle for the UK economy (1980-2010).

Mulligan finds support (*via* the end interpretation of the behaviour of CYGAP in expansionary monetary policy) from the impulse response function of output to term spread. Using Mulligan's interpretation of CYGAP, it can be seen below that an increase in CYGAP (remembering Mulligan considers CYGAP from a decrease perspective), generates a positive effect on ln(GDP) as shown in figure 83.

Figure 83: Impulse CYGAP, Response GDP

(A) (B)



Under Mulligan's interpretation of the behaviour of the interest rate gap (shown in diagram B above), it can be seen that in accordance with the prescriptions of Hayek's theory of the trade cycle, expansionary monetary policy results in a long term negative effect on output. However if considering that expansionary monetary policy does in fact increase term spread (and decreases it only in the last periods of monetary policy) then the results from diagram A are not as favourable to Austrian Theory.

A replication study of Mulligan (2006) does find some supportive evidence for Hayek's theory of the trade cycle, though the replication VECM is not as supportive of Austrian Theory as Mulligans. The replication VECM does not suffer from post estimation problems of specification, whereas the Mulligan model identifies issues but can not correct due to Austrian methodology issues, as such the replication VECM is judged to be more robust in the orthodox econometric sense.

However, the timing issue of Mulligan's interpretation of the behaviour of CYGAP remains contentious, this behaviour would, even in the general Austrian view (e.g. Keeler 2001), this behaviour would be expected to be short term and the long term implications outweighed by the prevalence of increased CYGAP in expansionary monetary policy.

Following the example of the Mulligan methodology, HTTC predictions of cointegrating relationships were tested with a series of two variable VECM and are presented below in table 99:

Table 99: Lags and Cointegrating relationships in the two variable VECMs

Variables	Number of lags	Number of Cointegrating Relationships (max 1)
ln(GDP) M4	4	1
ln(GDP) RESOURCES	2	1
ln(GDP) INVCON	2	0
CYGAP M4	2	1
CYGAP RESOURCES	2	0
CYGAP INVCON	2	0
M4 RESOURCES	1	1
M4 INVCON	1	1
RESOURCES INVCON	1	1

HTTC suggests cointegrating relationships between the links of the model , most of which can be identified with Johansen-Juselius tests for cointegration as per Mulligan (2006), Keeler (2001).

However HTTC would suggest a long term cointegrating relationship between the term spread (CYGAP) and the shift from end stage to initial stage output (RESOURCES) and likewise between term spread (CYGAP) and the shift from an investment to consumption focus in the economy (INVCON).

Thus, in term of the model, the identified cointegrating relationships are shown below:

ΔMR→ ΔM4→ ΔRESOURCES→ΔGDP→ΔRESOURCES→ΔMR→Δ(↓)GDP
↘ ΔINVCON ↗ ↘ ΔINVCON ↗

Though it should be noted that the existence of a cointegrating relationship does not necessarily mean that the direction and causation predicted by Hayek's theory of the trade cycle are present.

10.3 Second Order Predictions and Hypothesis Summary

In this section each SOP is stated and the evaluation within the OIRF analysis and Granger Causality Tests derived from VAR YIELD, VAR YGAP and the Vector-Error Correction Model shown in a table below.

Second order predictions (SOPs):

SOP 1 – Expansionary monetary policy increases the volume of 'Artificial Money' (here M4) in the economy. **Loose Monetary Policy→M4↑**

Table 100: Loose Monetary Policy→M4↑SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
YIELD↓→M4↑	YGAP↑→M4↑	CYGAP↑→M4↑
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests

YIELD does not G* cause M4	YGAP does not G* cause M4	CYGAP G* Causes M4**

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 2 – An increase in M4 leads to the economy moving to a consumption focus.

M4↑→INVCON↓

Table 101: M4↑→INVCON↓SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
M4↑→INVCON↓	M4↑→INVCON↑	M4↑→INVCON↓
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
M4 does not G* Cause INVCON	M4 G* Causes INVCON**	M4 does not G* Cause INVCON

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 3 – An increase in M4 leads to movement toward initial stage production.

M4↑→RESOURCES↑

Table 102: M4↑→RESOURCES↑SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
M4↑→RESOURCES↓	M4↑→RESOURCES↓	M4↑→RESOURCES↑
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
M4 does not G* Cause RESOURCES	M4 does not G* Cause RESOURCES	M4 G* Causes RESOURCES*

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 4 – The economy moving to initial stage production leads to an increase in economic activity. **RESOURCES↑→↑ln(GDP)**

Table 103: RESOURCES↑→↑ln(GDP) SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
RESOURCES↑→↑ln(GDP)	RESOURCES↑→↑ln(GDP)	RESOURCES↑→↑ln(GDP)
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
RESOURCES G* Causes GDP**	RESOURCES does not G* Cause GDP	RESOURCES does not G* Cause GDP

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 5 – The economy moving to a consumption focus leads to an increase in economic activity. **INVCON↓→↑ln(GDP)**

Table 104: INVCON↓→↑ln(GDP) SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
INVCON↓→ln(GDP)↓	INVCON↓→ln(GDP)↑	INVCON↓→ln(GDP)↑
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
INVCON does not G* Cause GDP	INVCON does not G* Cause GDP	INVCON G* Causes GDP**

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 6 – The increase in economic activity leads to the economy (further) focussing on initial stage production. **↑ln(GDP) → RESOURCES↑**

Table 105: ↑ln(GDP) → RESOURCES↑SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
↑ln(GDP) → RESOURCES↓	↑ln(GDP) → RESOURCES↓	↑ln(GDP) → RESOURCES↓
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
GDP G* Causes RESOURCES***	GDP G* Causes RESOURCES*	GDP G* Causes RESOURCES**

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 7 – The increase in economic activity leads to the economy (further) focussing on initial stage production. **↑ln(GDP) → INVCON↓**

Table 106: ↑ln(GDP) → INVCON↓SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
↑ln(GDP) → INVCON↑	↑ln(GDP) → INVCON↑	↑ln(GDP) → INVCON↑
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
GDP G* Causes INVCON**	GDP G* Causes INVCON***	GDP G* Causes INVCON**

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 8 – The focus on initial stage production leads to tighter monetary policy.

RESOURCES↑→Tighter Monetary Policy

Table 107: RESOURCES↑→Tighter Monetary Policy SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
RESOURCES↑→YIELD↓	RESOURCES↑→YGAP↑	RESOURCES↑→CYGAP↓
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
RESOURCES does not G* Cause YIELD	RESOURCES G* Causes YGAP**	RESOURCES does not G* Cause CYGAP

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 9 – The focus on consumption leads to tighter monetary policy. **INVCON↓→ Tighter Monetary Policy**

Table 108: INVCON↓→ Tighter Monetary Policy SOP Vs Observation

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
INVCON↓→YIELD↑	INVCON↓→YGAP↓	INVCON↓→CYGAP↓
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
INVCON does not G* Cause YIELD	INVCON does not G* Cause YGAP	INVCON G* Causes CYGAP**

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

SOP 10 – Tighter Monetary Policy leads to a reduction in economic activity. **Monetary Policy Correction → GDP↓**

Table 109: Monetary Policy Correction → GDP↓ SOP Vs Observations

YIELD VAR OIRFS	YGAP VAR OIRFS	VECM OIRFS
YIELD↑→GDP↓	YGAP↓→GDP↓	CYGAP↓→GDP↓
YIELD VAR G* Tests	YGAP VAR G* Tests	VECM G* Tests
YIELD does not G* Cause GDP	YGAP does not G* Cause GDP	CYGAP G* Causes GDP**

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

Hypotheses:

Hypothesis 1 - There is a long term inverse relationship between Expansionary Monetary Policy and the output proxy.

Hypothesis 1_0 - There is not a long term inverse relationship between Expansionary Monetary Policy and the output proxy.

Table 110: Expansionary Monetary Policy and GDP

YIELD VAR LT OIRFS	YGAP VAR LT OIRFS	VECM LT OIRFS
0.003655	0.001635	0.637224

Hypothesis 2 – There is a long term inverse relationship between an increase in M4 and the output proxy.

Hypothesis 2_0 – There is not a long term inverse relationship between an increase in M4 and the output proxy.

Table 111: Expansionary Monetary Policy (M4) and GDP

YIELD VAR LT OIRFS	YGAP VAR LT OIRFS	VECM LT OIRFS
0.007222	0.006242	-0.1562

Hypothesis 3 – There is an endogenous turning point consistent with Hayek's theory in the effect of YIELD on GDP.

Hypothesis 3_0 – There is not an endogenous turning point consistent with Hayek's theory in the effect of YIELD on GDP.

Hypothesis 4 – There is an endogenous turning point consistent with Hayek's theory in the effect of YGAP on GDP.

Hypothesis 4_0 – There is not an endogenous turning point consistent with Hayek's theory in the effect of YGAP on GDP.

Hypothesis 5 - There is an endogenous turning point consistent with Hayek's theory in the effect of M4 on GDP.

Hypothesis 5_0 - There is not an endogenous turning point consistent with Hayek's theory in the effect of M4 on GDP.

Table 112: Endogenous Turning Points (Hypothesis 2)

Lag	YIELD Coefficient***	M4 Coefficient***	YGAP Coefficient***	Term Spread[73]
t	0.101605	0.976534	-0.0037994	0.00399
t-1	-0.1047058	-0.1050004	-0.0000848	0.00283
t-2	0.19823	0.0314258	-0.0004202	0.00184
t-3	-0.0109924	0.0108487	0.000448	0.00102
t-4	0.0784046	0.0418213	0.0004718	0.00036
t-5	-0.619775	-0.61872	-0.0001443	-0.00014
t-6	-0.0064765	-0.0036186	0.0009551	-0.00047
t-7	0.0151947	0.425775	0.0007024	-0.00063
t-8	0.712036	0.0249355	-0.0001307	-0.00047
t-9	-0.0224519	-0.0085594	0.0004585	-0.00014
t-10	-0.178262	-0.0437193	0.0002134	0.00036
t-11	-0.211168	0.316596	0.0000509	0.00102
t-12	0.473678	0.219191	0.0001745	0.00017
R-Squared	56%	61%	27%	55%

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively (NB. This is the joint significance of the coefficients as per Russell & Langemeier (2015) and guidance from the STATA manual)

10.3.1 Interpretation of empirical results

Reflecting the Austrian view of the subjectivity of measurement of economic phenomena and the ongoing Austrian-Econometric methodological debate as selection of variables and 'Hayekian acceptable' econometric tests have been used within this thesis to evaluate the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle.

In order to evaluate the Understanding that Hayek's theory can provide for the UK Business Cycle, time series data (1980-2010) concerning the natural and market interest rates, the temporal structure of production, the investment / consumption focus of the economy, economic output and the amount of money in the economy was collected from the Bank of England Statistical Service. This data was used to develop the variables required to model Hayek's theory of the trade cycle in accordance with the Austrian-Econometric Literature. An

[73] Carilli & Dempster (2008).

initial statistical analysis of these variables, a correlation matrix *as per* Keeler (2001) and a series of Ordinary Least Squares Regression Models suggest some support for Hayek's theory of the trade cycle and allow for a more sophisticated analysis of Hayek's theory.

As such, and in accordance with the Austrian-Econometric Literature discussed in Chapter 4, the thesis first develops a Vector-Auto Regression Model using the variable YIELD as the HTTC interest rate proxy and then a Vector-Auto Regression Model using the variable YGAP as the HTTC interest rate proxy. In Chapter 8, the thesis develops two models with varying interest rate variables due to the concerns expressed by Keeler (2001) and Carilli & Dempster (2008) regarding the subjectivity of the interest rate from the Austrian perspective. Thus using the proxies suggested in the literature allow for increased Austrian acceptance of the empirical methodology as the measurement concern of the 'key Austrian Variable' (de Soto 2009) is reduced. These two Vector-Auto Regression Models, labelled in the thesis as VAR YIELD and VAR YGAP are tested for stability and reliability and successfully meet the post estimation analysis. In accordance with Hayekian Methodological Concerns (e.g. Mises 1977) and the rejection of Scientism (Ekelund & Hebert 1990) forecasts are produced for model evaluation purposes only.

In accordance with Keeler (2001) and Mulligan (2006), the non-stationary forms of the variables are used to develop a Vector-Error Correction Model of Hayek's theory of the trade cycle presented in Chapter 9. This model is subjected to rigorous post estimation testing and evaluated in accordance with Becketti (2013). Mulligan (2006) uses a bivariate Vector-Error Correction Model to evaluate Hayek's theory of the trade cycle and finds "convincing support" for the theory, as such a replication of this study using UK time series data is presented to determine whether Hayek's theory provides the same "encompassing explanation" over the UK data as Mulligan (2006) finds for the US data.

Both the Vector-Auto Regression and the Vector-Error Correction Models are successfully evaluated and subjected to rigorous post-estimation testing. Orthogonalized Impulse Response Functions and Granger Causality Tests are then developed to evaluate the relationships between the variables. The models presented in this thesis provide an empirical evaluation of the Second Order Predictions of Hayek's theory of the trade cycle (as per Carilli & Dempster 2008) and the testing of key supporting hypotheses derived from the literature.

The Second Order Predictions of Hayek's theory of the trade cycle can be seen below:

EMP→ (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→CMP →(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

(EMP = Expansionary Monetary Policy, CMP = Contractionary Monetary Policy)

The supporting hypotheses tested in this thesis are:

Hypothesis 1 - There is a long term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy.

Hypothesis 1_0 - There is not a long term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy.

Hypothesis 2 – There is a long term inverse relationship between an increase in M4 and the output proxy.

Hypothesis 2_0 – There is not a long term inverse relationship between an increase in M4 and the output proxy.

Hypothesis 3 – There is an endogenous turning point in the effect of YIELD on GDP.

Hypothesis 3_0 – There is not an endogenous turning point in the effect of YIELD on GDP.

Hypothesis 4 – There is an endogenous turning point in the effect of YGAP on GDP.

Hypothesis 4_0 – There is not an endogenous turning point in the effect of YGAP on GDP.

Hypothesis 5 - There is an endogenous turning point in the effect of M4 on GDP.

Hypothesis 5_0 - There is not an endogenous turning point in the effect of M4 on GDP.

The Individual Second Order Predictions; i. **EMP→ (↑)M4**, ii. **(↑)M4→(↓) INVCON**, iii. **(↑)M4→ (↑)RESOURCES**, iv. **(↑)RESOURCES→(↑)GDP**, v. **(↓) INVCON → (↑)GDP**, vi. **(↑)GDP→(↑)RESOURCES**, vii. **(↑)GDP→(↓) INVCON**, viii. **(↑)RESOURCES→CMP**, ix. **(↓) INVCON →CMP and** x. **CMP→(↓)GDP**, are empirically evaluated using econometric tests acceptable to Hayekian Methodology. Firstly a panel of Orthogonalized Impulse Response Functions, derived from robust Vector-Auto Regression Models and Vector-Error Correction Models of Hayek's theory of the trade cycle are used to determine if the Second Order Predicted Relationship of Hayek's theory are present in the relationships between the variables in the models. Furthermore a series of Granger Causality tests (as per Wainhouse 1984, Mulligan 2006 and Carilli & Dempster 2008) are used to evaluate the Second Order Predictions.

The first hypothesis,that of a long term inverse relationship between expansionary monetary policy and economic output (GDP) is assessed using the panel of Orthogonalized Impulse Response Functions (as per Keeler 2001 and Mulligan 2006). The second group of hypotheses, those concerning the existence of endogenous turning points in the effect of Expansionary Monetary Policy are evaluated with an investigation into the lagged coefficient effect of the variables on GDP.

Evaluation of Second Order Predictions

Carilli & Dempster (2008) consider that "the true measure of any business cycle theory in any historical period is the extent to which the economic phenomena predicted by the theory correspond to those actually observed”. They stress that by extent of economic phenomena predicted, they exclusively mean Second Order Predictions (SOPs) and not the ability of any theory to produce ‘true’ future forecasts.

The initial SOP, **EMP→ (↑)M4**, is examined using OIRFs of Expansionary Monetary Policy Proxies as an Impulse and ΔM4 as a response. Furthermore Granger Causality Tests are used *as per* Wainhouse (1984) to evaluate if **EMP** Granger Causes **(↑)M4**. The OIRFs for VAR YIELD, VAR YGAP and VECM support the **EMP→ (↑)M4** SOP. The Granger Causality Tests derived from both VAR models do not find that **EMP** Granger Causes **(↑)M4**, however within the Vector-Error Correction Model EMP is found to G*Cause M4 (significant at the 5% level).

The **(↑)M4→(↓) INVCON** SOP is supported by VAR YIELD and VECM OIRFs but not by VAR YGAP OIRFS, conversely the Granger Causality Tests derived from the VAR YIELD and Vector-Error Correction Models do not find that **(↑)M4** Granger Causes **(↓) INVCON**, however in the VAR YGAP Model **(↑)M4** G* Causes **(↓) INVCON** (Significant at the 5% level).

(↑)M4→ (↑)RESOURCES is not supported either by OIRF or by Granger Causality in either VAR model, however the VECM OIRF finds that **(↑)M4→ (↑)RESOURCES** and that **(↑)M4 G* Causes (↑)RESOURCES** (significant at the 10% level). **(↑)RESOURCES→(↑)GDP** is supported by VAR YIELD, VAR YGAP and VECM OIRFs and within the VAR YIELD Model **(↑)RESOURCES** G* Causes **(↑)GDP** (Significant at the 5% level). Within the VAR YGAP and Vector-Error Correction Models, **(↑)RESOURCES** is not found to Granger Cause **(↑)GDP**.

The **(↓) INVCON → (↑)GDP** SOP is supported by the OIRFs within the VAR YGAP and Vector-Error Correction Models but not within the VAR YIELD Model. Within the Vector-Error Correction Model **(↓) INVCON** G* Causes **(↑)GDP** (Significant at the 5% level), but within the VAR YIELD and VAR YGAP Models **(↓) INVCON** does not Granger Cause **(↑)GDP**. The OIRFs within the VAR YIELD, VAR YGAP and Vector-Error Correction Models do not support the

(↑)GDP→(↑)RESOURCES SOP though within all these models **(↑)GDP** is found to G* Cause **(↑)RESOURCES** (Significant at the 1%, 10% and 5% levels respectively).

The **(↑)GDP→(↓) INVCON** SOP is not supported by the OIRFs within the VAR YIELD, VAR YGAP and Vector-Error Correction Models however within these three models **(↑)GDP** is found to G* Cause **(↓) INVCON** (Significant at the 5% level in the VAR YIELD Model, at the 1% level in the VAR YGAP Model and at the 5% level in the VECM). The **(↑)RESOURCES→CMP** SOP is not supported by OIRF Analysis within the VAR YIELD and VAR YGAP Models of Hayek's theory of the trade cycle though the OIRF relationship between RESOURCES and CYGAP within the Vector-Error Correction Model supports the **(↑)RESOURCES→CMP** SOP. Within the VAR YIELD Model and the VECM, RESOURCES is not found to Granger Cause YIELD or CYGAP respectively, within the VAR YGAP Model **(↑)RESOURCES** G* Causes **CMP** (Significant at the 5% level).

(↓) INVCON →CMP is supported by the OIRF Analysis within the VAR YIELD, VAR YGAP and the Vector-Error Correction Models of Hayek's theory of the trade cycle. Within the VAR YIELD and VAR YGAP, **(↓) INVCON** is not found to Granger Cause **CMP**, however **(↓) INVCON** G* Causes **CMP** (Significant at the 5% level) Within the Vector-Error Correction Model of Hayek's theory of the trade cycle. The final **CMP→(↓)GDP** SOP is supported by OIRF analysis within all three models. VAR YIELD, VAR YGAP and the Vector-Error Correction Model of Hayek's theory of the trade cycle contain variable Impulse / Response relationships consistent with the **CMP→(↓)GDP** SOP. Within VAR YIELD and VAR YGAP Contractionary Monetary Policy is not found to Granger Cause GDP, however in the Vector-Error Correction Model of Hayek's theory **CMP** G* Causes **(↓)GDP** (Significant at the 5% level).

10.3.1.1 The Final Models (OIRF)

VAR YIELD

(↓)YIELD → (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↑)YIELD →(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

VAR YGAP

(↑)YGAP → (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→ (↓)YGAP →(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

VECM

(↑)CYGAP → (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)CYGAP →(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

10.3.1.2 The Final Models (Granger Causality Tests)

VAR VIELD

(↓)YIELD → (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↑)YIELD →(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

(EMP = Expansionary Monetary Policy, CMP = Contractionary Monetary Policy)

VAR YGAP

(↑)YGAP → (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)YGAP →(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

VECM

(↑)CYGAP → (↑)M4→ (↑)RESOURCES→(↑)GDP→(↑)RESOURCES→(↓)CYGAP →(↓)GDP
↘ (↓) INVCON ↗ ↘ (↓) INVCON ↗

10.3.1.3 Evaluation of Hypotheses

Regarding the first hypothesis:

> **Hypothesis 1 -** There is a long term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy.
>
> **Hypothesis 1_0 -** There is not a long term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy.

The long term Orthogonalized Impulse Response Functions of the variable relationships within the VAR YIELD, VAR YGAP and Vector-Error Correction Models suggest a long term positive relationship and thus allow for the acceptance of the null hypothesis, that there is not a long term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy. Regarding the second Hypothesis:

> **Hypothesis 2 –** There is a long term inverse relationship between an increase in M4 and the output proxy.
>
> **Hypothesis 2_0 –** There is not a long term inverse relationship between an increase in M4 and the output proxy.

The picture is a little more mixed, the VAR YIELD and VAR YGAP models identify a long term positive relationship between an increase in M4 and economic activity allowing for an acceptance of the null hypothesis that there is not a long term inverse relationship. The Vector-Error Correction Model finds a long term inverse relationship between an increase in M4 and the output proxy allowing for rejection of the null hypothesis and acceptance of the original.

The remaining hypotheses concerning endogenous turning points in the effect of YIELD, YGAP and M4 on GDP are examined using a Finite Distributed Lag Model following the example of Carilli & Dempster (2008).

In terms of Hypothesis 3, the FDLM allows for the rejection of the null hypothesis that there is not an endogenous turning point in the effect of YIELD on GDP, for hypothesis 4 the FDLM accepts the null hypothesis that there is not an endogenous turning point in the effect of YGAP on GDP. For Hypothesis 5, the FDLM allows for a rejection of the null hypothesis, that there is not an endogenous turning point in the effect of M4 on GDP.

10.4 Chapter Summary

This interpretation of findings chapter has presented the reduced structural form model series of second order predictions of Hayek's theory of the trade cycle against the results of a variety of econometric tests. Vector-Auto Regression models (*as per* Carilli & Dempster 2008) and Vector-Error Correction models (*as per* Mulligan 2006, Fisher 2013) are produced and subjected to rigorous post estimation testing to ensure reliability. The relationships between the variables within these models are used to evaluate the second order predictions of Hayek's theory, orthogonalized impulse response functions (OIRFs) are used to evaluate the predicted responses of the variables against the responses of one variable to another in each model. Granger Causality tests (*as per* Wainhouse 1984) are used to evaluate the predicted relationships between the variables against those in each model. These evaluations are presented throughout the chapter and collected in a final comprehensive evaluation section. Each second order prediction is evaluated against OIRFs of variables within a VAR model of Hayek's theory of the trade cycle containing the variable YIELD as the interest rate proxy, a VAR model of Hayek's theory containing the variable YGAP as the interest rate proxy and a

VECM of Hayek's theory. Following this each second order prediction is evaluated against a Granger Analysis of Causation of the variables within each VAR and VECM.

Additionally, five further key hypotheses, H1 & H2 concerning the overall relationship between expansionary monetary policy and H3, H4 and H5 concerning the existence of endogenous turning points (*as per* Carilli & Dempster 2008) are tested and presented for discussion in the following chapter.

Mulligan's (2006) Vector-Error Correction Model, suggests strong support for Hayek's theory of the trade cycle using US time series data. This thesis replicates this model using UK time series data presenting the results in this chapter for discussion in Chapter 11.

Chapter 11: Discussion

"In 1926, Mises was offered a Rockefeller award to visit America and accepted. In the margins of a busy speaking schedule, he explored the methods used in the American empirical studies of the economy that had so intrigued Hayek. He returned to Vienna believing that so long as the methodology was carefully scrutinised and selectively applied, a quantitative study of the business cycle …, might prove worthwhile. Mises set about raising funds for the new Austrian Institute for Business Cycle Research and did not have to look beyond his own seminar room to find a director. The obvious person was Hayek, and on January, 1927, the new body began work, with Hayek at its head."

Wapshott (2011, p40)

11.1 Introduction

This final Chapter begins with an evaluation of the New Austrian School and the general positioning of the research within the methodology of the New School (section 11.2) and then the wider calls for pluralism. The empirical results presented in the thesis are discussed and compared with the literature in section 11.3 in order to fully position the thesis within the existing body of literature. Kuehn's (2013) question of, "is there anything to the theory" is considered and an answer derived from the empirical evaluation in the thesis is presented in section 11.3.6. The meaning of the results for the relevance for Hayek's theory of the trade cycle's contribution to a pluralist macroeconomics is considered in section 11.4 and areas of further research identified by the thesis are explored in section 11.6. The Chapter ends with a final summary of the thesis presented in section 11.7.

This Chapter discusses the results of the thesis and their meaning for the relevance of Hayek's theory of the trade cycle for understanding the UK business cycle and positions the contribution of this thesis within the calls for pluralism and the Austrian empirical literature.

11.2 The appeal from New to Old

Subrick & Beaulier (2010) argue for a less ideological Austrian School, more open to outside influence and more willing to 'move on' from its traditional areas and sparing ground of the Great Depression. Indeed this thesis in providing an empirical examination of Hayek's theory of the trade cycle for the understanding of the UK Business Cycle is within this appeal. It is necessary for Austrian Theory to adopt empirical evaluation as per Luther & Cohen (2014) who state that "Engaging in sophisticated empirical analysis is a necessary (though not sufficient) condition for Austrian Business Cycle Theorists to be taken seriously by the broader macroeconomic community."

However as stated in Chapters 1 & 2 it is not simply the aim of this thesis in providing an empirical examination of Hayek's theory of the trade cycle to ingratiate it with the mainstream, but to provide a broad base of analysis which evaluates the theory in a manner acceptable to multiple groups within the calls for the creation of a wider economic pluralism.

11.3 Discussion

Much of heterodox economics shares a common feature, that is that there exists an inherent flaw in the existing economic system which leads to crisis (Ivanova 2012), though of course the differing Schools of Heterodox Economics disagree on the nature of this flaw and proposed solutions. As seen in Chapters 1 and 2 the flaw is not recognised by mainstream economics and concealed by a mainstream reliance on a "narrow and moribund theory" (Brown & Spencer 2014). The traditional Austrian view of the flaw of the system is contrary to the Marxist position that the inherent flaws in the capitalist system are beyond human control and traditionally against the Keynesian tradition controlling the flaws with "Big Government and Big Bank" (Ivanova 2012). Zimmerman (2003) argues in the Journal of Austrian Economics, that Austrian monetary policy is not ignored or the subject of a neo-classical dismissal conspiracy, but is simply often monocausal or too routed in Austrian ideology at the expense of relevant input from other perspectives. As such, the traditional Austrian prescription of "Small Government and No Bank" are simply unrealistic (Zimmerman 2003). The models of Hayek's theory of the trade cycle for the UK, presented in this thesis suggest some support for the Theory as being more than a simple collection of ad hoc observations in accordance with the Wainhouse (1984), Keeler (2001), Carilli & Dempster (2008), Dore & Singh (2012), Luther & Cohen (2014) and Manish & Powell (2014) empirical examinations of US data. Following the calls for the need for Austrian Theory to embrace the reality of continuing Central Banks and the existence of a necessary regulatory environment, the empirical evaluation of Hayek's theory of the trade cycle presented in this thesis exists to inform the monetary policy of the Central Bank rather than call for its removal.

11.3.1 Empirical Models for the Evaluation of Hayek's theory

It is clear from the final models sections (10.3.1.1 & 10.3.1.2) that corresponding with Mulligan (2006) and Dore & Singh (2012) a Vector-Error Correction Model provides the most support for each Second Order Prediction of Hayek's theory, however the key tipping point of Hayek's theory, the relationship between the temporal structure of production (RESOURCES) finds limited support. The VAR models (VAR YIELD and VAR YGAP) of Hayek's theory of the trade cycle provide less convincing support. Austrian Econometric-Literature tends to be dismissive of models providing less concrete support for the Business Cycle Theory, generally citing the Misean Critique of Econometric Analysis or the immeasurability of subjective variables (e.g. Mulligan 2006). However the VAR models of Hayek's theory like the VECM avoided the imposition of structural characteristics criticised by the Austrians as subject to the Lucas critique (see Lucas 1976) and followed the advice of Keeler (2001) to use ratios and movements within the variables to counter the subjectivity of measurement from the Austrian perspective. Furthermore the models presented meet the relevant criteria set out by Murphy, Barnett and Block (2012) as criticisms of Young (2005), are subjected to rigorous post estimation testing (presented in Chapter 8 and 9) and avoid the need for statistically led re-specification criticised by the Austrian School. Ultimately a model built to robust Austrian

Specifications which offers only limited support for Hayek's theory of the trade cycle is still valid for discussion to avoid Austrian Theory succumbing to the same criticisms of ideologically led analysis they level at the mainstream.

11.3.2 Discussion of the results

Beginning with the implications of Hypothesis 1, VAR YIELD, VAR YGAP and the Vector Error Correction Model all accept the null Hypothesis that there is not a long term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy. Keeler (2001) finds an inverse relationship between EMP and output, Powell (2002) analysed the Japanese Business Cycle finding that expansionary monetary policy does have an inverse relationship with output and Mulligan (2006) finds that EMP lowers real consumerable output permanently by a 'significant amount'. Carilli & Dempster (2008) find a similar picture and the majority of published Austrian Econometric Literature (Lester & Wolf 2013 find little empirical support for the Austrian Business Cycle Theory) find the same long term inverse relationship.

This thesis supports acceptance of the null hypothesis that there is not an inverse relationship and thus queries this key aspect of Hayek's theory of the trade cycle. From the Austrian perspective this finding is explained by the subjectivity of measurement plus the particular difficulty in ascertaining the natural rate of interest in an economy. However in accordance with Keeler (2001) multiple measures of the interest rate were used including a term spread proxy as per Mulligan (2006), Keeler (2001), Carilli & Dempster (2008), Dore & Singh (2012), Lester & Wolf (2013) and Luther & Cohen (2014) and a ratio measure of the market interest rate divergence from the natural rate specifically recommended by Keeler (2001) as countering the subjectivity of measurement criticism.

The thesis also presents an increase in M4 as a proxy for expansionary monetary policy and using this variable, evaluates the hypothesis that there is a long term inverse relationship between M4 and the output proxy. Both VAR YIELD and VAR YGAP allow for the acceptance of the null hypothesis that there is not a long term inverse relationship. The Vector Error Correction model of Hayek's theory of the trade cycle however fails to reject the null hypothesis displaying the long term inverse relationship in the OIRF analysis. Dore & Singh (2012) find a strong inverse relationship, though they focus on a short crisis period where large liquidity injections may have been the policy response to rather than the cause of declining output. Within the VAR models the M4 variable is de-trended to ensure stationarity, Austrian Business Cycle Theory can be interpreted to suggest that it is the steady growth of M4 overtime (hence the variable in the VECM) that is a symptom of the existing financial system criticised by the Austrians. It must be considered if it is this trend present in the VECM and not the VARs that results in the inverse relationship and failure of the VECM OIRFs to reject the null hypothesis. However one would still expect to see this relationship present in the VAR models to be convinced by this aspect of Hayek's theory of the trade cycle.

11.3.3 Endogenous Turning Points – Singularly Hayekian!

Carilli & Dempster (2008) seek to find evidence *in favour of*, rather than simply consistent with, Hayek's theory[74]. They posit that the effect of Expansionary Monetary Policy on GDP will be upward and then downward as malinvestment makes itself apparent. Likewise this thesis in addressing Hypotheses 3-5 seeks similar evidence in support of Hayek's theory of the trade cycle.

[74] Although the paper was recently published and thus had little impact on the approach of this thesis, Russell & Langemeier (2015, p27) consider that a rise in output followed by a fall determined by the sign of the coefficients is a particularly Austrian phenomenon and enables differentiation "between the claims of the ABCT and the claims of the Monetarists.

"We now seek to determine *whether GDP growth has a turning point endogenous to the interest rate gap*, regardless of manner in which the gap is produced. If the ABCT story holds, we would expect to see an interest rate innovation (an increase in the gap) have a positive impact on GDP in the near term and a negative impact in later periods."

Carilli & Dempster (2008)

Using the variables YIELD, YGAP and M4, a finite distributed lag model was created to evaluate the existence of the predicted turning point in GDP growth endogenous to the variable. The thesis fails to reject the null hypothesis that there is not a turning point in GDP growth endogenous to YIELD and M4, but accepts the null hypothesis for the variable YGAP. For Carilli & Dempster (2008) the failure to reject the null hypothesis for YIELD and M4 provides strong support for Hayek's theory of the trade cycle within the UK time series data and it is of key consideration that they consider this to be evidence in the data in favour of Hayek's theory over other theories of the Business Cycle. However the thesis accepts the null hypothesis using the YGAP variable, the closest variable to Carilli & Dempster's (2008) interest rate proxy.

It should be noted that Carilli & Dempster (2008) are unable to state when exactly the turning point will occur or the length and nature of it, but simply that Hayek's theory predicts that it will occur. They note that there is a strong need for caution in interpreting the magnitudes of the turning points but their presence presents strong evidence that "the endogenous boom-bust features of ABCT are present in the data".

11.3.4 Second Order Predictions and Hayek's Falsification Tests

The Second Order Predictions of Hayek's theory of the trade cycle each pass Hayek's Falsification Tests, that is the phenomena they explain do seem to correspond with observed facts (Wainhouse 1984). However no one model presented in the thesis supports all the Second Order Predictions entirely and the particularly Austrian aspects of Hayek's theory are the least well supported with the Second Order Predictions closer to standard economic theory (the relationship between the interest rate and economic activity) being better supported. This taken together with the acceptance of the null hypothesis that there is not a long term inverse relationship between Expansionary Monetary Policy through the interest rate and the output proxy and the acceptance of the null hypothesis that M4 does not have an inverse relationship with the output proxy potentially suggests less support for the holistic theory than the Second Order Prediction Analysis alone.

11.3.5 Replication of Mulligan (2006), Does Hayek's theory cross the Atlantic?

In the Mulligan (2006) VECM the coefficient of Cumulative term spread is considerably stronger in magnitude and statistical significance than the same proxy variable (CYGAP) in the replication VECM. However they both agree in terms of direction and are both significant, the reduction in magnitude could be due to the output proxy used, the Mulligan VECM uses the natural logarithm of consumption whereas the replication VECM uses the natural log of whole GDP due to the subjective estimation issue discussed earlier. This could mean that in effect the same magnitude is being measured, it is just the size of the output proxy which is mitigating the magnitude of the replication VECM CYGAP coefficient. The replication VECM adjustment terms of CYGAP both in direction and probability are more supportive of HTTC than Mulligan. The R^2 of the adjustment terms of the replication model indicate a more robust general model than the Mulligan VECM however are less favourable in determining the interest rate as the primary mechanism of the adjustment process. The reported information criterion; Akaike's information criterion and Schwarz's (Bayesian) information criterion suggest that the replication VECM suffers from moderately more information loss, however the values are particularly low. However, the Mulligan model suffers considerably from non-normality whereas the replication VECM does not, the creation of the variables (annual to monthly) in the Mulligan model may be a reason for this and are a potential weakness.

Both models present evidence of cointegration between output (GDP or consumerable output) and the cumulative interest rate term spread, this is supportive of HTTC, but not unexpected from the orthodox economic perspective, for instance the Interest Rate Transmission Mechanism Model is a key policy tool. However the direction of the coefficients and the long run implication of a reduced market rate of interest is of key consideration for Hayek's theory of the trade cycle. The replication VECM using data from standard Bank of England Datasets covering 1980Q1-2010Q4 is constructed and found to have a reasonably high amount of explanatory power over the historical data.

Cointegration analysis identifies a stable long term relationship between output, ln(GDP), and the cumulative interest rate gap, YGAP. The cointegrating vector consitutues a dynamic equilibrium which for the Austrians (e.g. Garrison 1984) entrepreneurial planners have generally effected toward during the observation period, though not necessarily achieving. Mulligan (2006) considers the market process consists of entrepreneurial planners effecting adjustment toward a dynamic equilibrium they continuously redefine. The stable cointegrating relationship provides support for this Austrian view of the interest rate as a signal for resource allocation supporting aspects of HTTC.

It can be seen through the coefficient of YGAP that the market interest rate falling results in a negative effect on consumption, supportive of the HTTC view of this leading to sub optimal resource allocation above the entrepreneur's risk and time preference and thus malinvestment. However the Austrian prescription of high interest rates can not be tested in the data as aside from the occasional divergence, many periods can be observed of the interest rate being (inappropriately for Mulligan) low, but no corresponding periods of this being (inappropriately) high. UK policy imperatives create an asymmetric data set in this regard and the VECM is unable to support or dispute the HTTC policy recommendation of constant high interest rates.

The results of the replication VECM cannot be said to be as supportive of HTTC as Mulligan (2006), however the replication VECM can be considered to provide a more robust general model which does not suffer from the post estimation errors identified in the Mulligan Model. As such the limited support for HTTC it provides can be considered as acceptable from both the Orthodox and Neoclassical perspectives.

11.3.6 Is there anything to the theory?

"Efforts to defend Hayek's Business Cycle Theory empirically are often underappreciated by Austrians as well as their critics. This literature is not large, but it makes considerable progress in evaluating the validity of Hayek's theory."

Kuehn (2013, p509)

This thesis provides an empirical evaluation of Hayek's theory of the trade cycle to determine its relevance for the United Kingdom's Business Cycle. The evaluation presented builds upon the key Austrian Empirical Literature presented in this thesis in table (8), addresses several criticisms of previous empirical evaluations of Hayek's theory and investigates both the reduced form aspect of theory and the causal mechanisms of the boom bust relationship predicted by Hayek.

The thesis begins with Kuehn's (2013) question, that post crisis (in both policy and academia) Hayek's Business Cycle Theory is gaining renewed attention causing Kuehn to query, is there anything to Hayek's Business Cycle Theory?

This thesis does not consider Hayek's theory of the trade cycle to be a panacea in the study of economic crisis, even if it were, its pure (Old) Austrian prescriptions would be difficult if not impossible to impose within the existing political structure present in the UK. Economic Crisis will elicit counter policy from politicians, for the political actors within the UK economy, the Hayekian prescription of non-interference would be electorally untenable. In fact Cwik (2008), considers that the singular reason for the fall from grace of Austrian Theory in the 'business cycle debates' of the 1930s, was that whilst the Keynesians had a plan for recovery, the Austrian prescription of 'do nothing' as the market is working failed to provide confidence. This thesis empirically evaluates Hayek's theory of the trade cycle in order to better inform the ongoing business cycle debates which have reignited following the recent economic crisis.

Kuehn (2013) considers that the relevance of Hayek's theory to modern business cycles and thus the notice that economists should give to it is an empirical question. However an empirical evaluation is prone to flaws from the Austrian Perspective in terms of measurement error of the natural interest rate and subjectivity of value as well as of course the wider Hayekian rejection of *Scientism*. This thesis argues that Hayek was quite accepting of an empirical study of the business cycle, particularly given his acceptance to lead a quantitative study of the business cycle at the new Austrian Institute for Business Cycle Research in 1927 and his later application for Rockefeller funding for an empirical appendix to his theory of capital.

Typically in the limited Austrian Economic Literature empirical studies are divided into two approaches, structural where the causal mechanisms of Hayek's theory of the trade cycle are evaluated and reduced form type where observations consistent with Hayek's theory are investigated. This thesis provides mainly a reduced form analysis similar to, but a development on Mulligan (2006), Carilli & Dempster (2008) and Dore & Singh (2012) coupled with elements of a structural analysis through an examination of the lengthening of the capital structure and the causal relationships present in the models developing on the work of Wainhouse (1984), Powell (2002) and Lester & Wolf (2012). This analysis form addresses the concerns of Keeler (2001), Carilli & Dempster (2008) and Kuehn (2013) that reduced form analysis where observations consistent with Hayek's theory are made without an examination that the observation has a Hayekian causal mechanism. Without the structural components in the reduced form model, it would be limited in the evaluation of the understanding that Hayek's theory can provide for the UK Business Cycle.

Thus the analysis presented in this thesis, the provision of a reduced form model with structural components alleviates the concern of observation without confirmation of mechanism. The variables are carefully picked to minimise the measurement error concern of the Austrian empiricists, for instance when considering the traditional problem ground of interest rate divergence measurement (as discussed in Keeler 2001) two proxies are constructed informed by the literature. Furthermore rigorous model specification and post estimation testing confirm the robustness of the chosen Vector-Auto Regression which were themselves justified from the literature (see Chapter 4, especially tables 8 & 9) and selected due to Austrian acceptance. Additional supporting hypotheses of Hayek's theory of the trade cycle are tested and similarly evaluated using robust yet Austrian acceptable empirical analysis.

Therefore, methodologically the analysis presented allows for an empirical examination of Hayek's theory that is accessible throughout the social sciences and acceptable to the Austrian School of Economic Thought. A preliminary working paper of the structural aspect of this approach (Whittle 2012) is cited amongst the Austrian Econometric Literature (Kuehn 2013[75]), and whilst of course a citation is not necessarily equal to full acceptance this furthers the justification of the Austrian acceptance of the methodology. It is useful to note that a recent

[75] See appendix A7.0.

paper published in the Quarterly Journal of Austrian Economics (Russell & Langemeier 2015) uses an approach developed from Carilli & Dempster (2008), similar to this thesis. As such there is further reassurance that the approach presented is acceptable to Hayekian economists and the Austrian School of Economic Thought.

11.3.6.1 Discussion of VAR YIELD, VAR YGAP and the VECM

The analysis of the Second Order Predictions of Hayek's theory of the trade cycle in accordance with Wainhouse's (1984) Hayekian Falsification Tests and Carilli & Dempster's (2008) statement that the true measure of any business cycle theory is the extent to which its predictions match observations, suggests some support for Hayek's theory. The thesis results concur with Carilli & Dempster's conclusion that Hayek's theory is more than a collection of ad hoc observations about stylised facts. The Second Order Prediction Model of the Theory gains a mixed level of support depending on the analysis model, however the initial and end SOPs; an expansionary monetary policy impulse leading to an increase in M4 response and a contractionary monetary policy impulse leading to a decrease in economic activity response are equally features of mainstream economics and whilst their wholesale support in the OIRF analysis within the VAR YIELD, VAR YGAP and Vector-Error Correction Models is useful as it suggests a further validity of the models, it does not alone add much support for the relevance of Hayek's theory of the trade cycle. It is the structural component of the testable model which can provide the strongest support for Hayek's theory. The variable relationships within both the VAR VIELD and the VAR YGAP models of Hayek's theory analysed via their Orthogonalized Impulse Response Functions provide only limited support for this mechanism in VAR YIELD Expansionary Monetary Policy does not affect the structure of production (RESOURCES) via M4, though it does affect INVCON. RESOURCES does have the predicted effect on economic activity, but INVCON does not. An increase in economic activity (the unsustainable boom) does not affect RESOURCES or INVCON as predicted by Hayek's theory and whilst INVCON affects monetary policy as predicted, RESOURCES does not. The relationships observed within VAR YIELD do not offer much support for the relevance of Hayek's theory for understanding the UK Business Cycle. VAR YGAP is slightly poorer in its evaluation of the Second Order Predictions of Hayek's theory. These results are consistent with Lester & Wolff (2013) who use a similar VAR / IRF analysis on US data and consistent with Luther & Cohen (2014) whose VAR / IRF analysis finds results as above supporting (but not exclusive to) the Austrian view.

As can be seen above the variable relationships within the Vector-Error Correction Model of Hayek's theory of the trade cycle are holistically the most supportive of Hayek's theory. Though the increase in economic activity (the unsustainable boom) does not affect RESOURCES or INVCON as predicted by Hayek's theory. The Vector-Error Correction Model is argued by Keeler (2001), Mulligan (2006) and Dore & Singh (2012) as being appropriate for Austrian Econometric Analysis and consistent with the thesis results produce a generally supportive view of Hayek's theory. All the informing VECM papers solely seek to determine the relationship between expansionary monetary policy (though Keeler 2001 includes some reference to the capital structure) and output. As such whilst the thesis VECM is consistent with these findings, it through the inclusion of a structural component is a clear development on these models. It is the structural component in the Vector-Error Correction Model presented which would allow for the model to fully support a solely Hayekian interpretation of the UK Business Cycle, however this element in the model remains unsupported. It is possible to say that the VECM presented supports the reduced form analysis consistent with the literature, but not the structural component which is consistent with the VAR / IRF analysis literature.

The (Granger) causal relationships of variables within the models provide a similar picture with the Vector-Error Correction Model providing the most (but not total) support for the Second Order Predictions of Hayek's theory of the trade cycle. Contrary to the literature (Wainhouse 1984, Carilli & Dempster 2008) within VAR YIELD Expansionary monetary policy has no identified Granger causal effect on M4 or this on RESOURCES or INVCON. In accordance with Hayekian Theory RESOURCES Granger causes a rise in GDP and this rise Granger Causes the predicted response in RESOURCES and INVCON though the subsequent Granger SOPs are not present in VAR YIELD. VAR YGAP also produces limited support for the structural component demonstrating a process of a rise in GDP Granger causing the predicted movement in RESOURCES which subsequently Granger Causes Contractionary Monetary Policy in accordance with Hayek's theory. Within VAR YGAP a rise in M4 and a rise in GDP also Granger Cause the predicted response in INVCON. The (Granger) causal relationship of variables within VAR YIELD and VAR YGAP is not consistent with the literature, though Carilli & Dempster 2008 only find Granger Causality results favourable to Hayek's theory using a particularly Austrian measure of the interest rate and do not find it when using their mainstream measure. However there is some support for the structural component of Hayek's theory, which is not assessed within the Austrian Econometric Literature despite Mulligan's (2006) rejection of his non-favourable results due to not including a Granger Causality evaluation of all the variables of Hayek's theory of the trade cycle.

The (Granger) causal relationships present within the Vector-Error Correction Model of Hayek's theory are entirely supportive of the expected (not exclusively Austrian relationships) in accordance with Carilli & Dempster (2008) and Dore & Singh (2012) at the same time addressing Mulligan's (2006) stated issue of not including all relevant variables[76]. The

[76] Though of course, this is a step toward inclusion of all relevant variables. The R^2 of the regression models presented in Chapter 7 suggest this is still an area for further research.

(Granger) causal relationships of the structural component including INVCON are also complete within the model, though the RESOURCES GDP and RESOURCES contractionary monetary policy Second Order Predictions are not supported in the model.

Within the Vector Error Correction Model of Hayek's theory of the trade cycle, all SOPs are supported by either the OIRF analysis or the Granger Causality test providing a strong level of support for Hayek's theory. However, much criticism is levelled by non-Austrian economists for Austrian ideological and methodological dismissal of empirical models which don't support their theories and much criticism is levelled by the Austrian's at other economists for theory led rather than evidence based models. As such it must be remembered that VAR VIELD and VAR YGAP, robust empirical models constructed within Austrian guidelines, informed by the Austrian-Econometric Literature and subjected to rigorous post estimation evaluation, offer only limited support for Hayek's theory.

11.3.6.2 Discussion of the Hypothesis Tests

Much of the Austrian Econometric Literature presents a key argument of Expansionary monetary policy resulting in a long term lowering of output. Mulligan (2006) states that that a lower interest rate accompanying a permanent lowering of the output proxy is a key assertion of Austrian Business Cycle Theory. Carilli & Dempster (2008) consider Garrison's (1989) view that Expansionary Monetary Policy leads to an initial increase then long term decrease in output a necessary feature of Hayek's theory. Keeler (2001) considers that for Austrian Business Cycle Theory in essence is characterised by expansionary monetary policy leading to an unsustainable expansion followed by a longer term contraction.

However the null of hypothesis 1, that there is not a long term inverse relationship between expansionary monetary policy and the output proxy is accepted with the OIRF analysis within the parameters of VAR YIELD, VAR YGAP and the Vector-Error Correction Model. All models use an interest rate proxy derived from the literature, including the variable YIELD considered by Keeler (2001) as alleviating the subjectivity of measurement concerns. The variable YGAP is derived from Keeler (2001), le Roux & Ismail (2004), Mulligan (2006) and Bismans & Mougeot (2009) and is also consistent in its construction to Carilli & Dempster (2008) and Hoffman (2010). The VECM variable CYGAP similarly so. Of these studies all find some supporting evidence in favour of Hayek's theory, that is expansionary monetary policy leading to an eventual reduction in output. However Carilli & Dempster (2008) do not find this with their more mainstream interest rate proxy and only with their singularly Austrian version of YGAP and Mulligan (2006) only finds this relationship taking the end Austrian prediction of expansionary monetary policy, investigating an eventual rate rise as the inevitable final stages of this policy.

When considering the possibility of expansionary monetary policy through directly increasing the money variable (hypothesis 2), VAR YIELD and VAR YGAP accept the null hypothesis that there is not a long term inverse relationship between an increase in the money supply and the output proxy. The Vector-Error Correction Model allows for the rejection of the null hypothesis and is thus more supportive of Hayek's theory.

However Hayek's theory of the trade cycle relies on the boom bust relationship of expansionary monetary policy creating an unsustainable increase in economic activity which leads to a contraction. Without this relationship in the data, the support for the business cycle theory proposed by Hayek for providing understanding of the UK business cycle is limited. Both YIELD and YGAP are however found to have the predicted relationship in a simple bivariate OLS model.

Carilli & Dempster (2008) consider that along with finding evidence consistent with Hayek's theory, the search must be broadened to finding evidence in favour of Hayek's theory over other theories of the business cycle. The existence of endogenous turning points in the effect of the expansionary monetary policy variable on the output variable would be solely consistent with Hayek's theory.

The thesis presents a series of finite distributed lag models (as per Carilli & Dempster 2008) to evaluate hypotheses 3, 4 and 5. The null hypothesis that there is not an endogenous turning point in rejected in the case of YIELD and M4 and accepted in the case of YGAP. In the case of YGAP an endogenous turning point is found but its pattern is not consistent with Hayek's theory.

11.3.6.3 So what does this all mean for the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle?

This thesis answers Kuehn's (2013) fundamental question concerning Hayek's theory of the trade cycle; "is there anything to the theory?" with a view similar to Carilli & Dempster (2008) that the theory is more than a collection of ad hoc observations of economic phenomena, that is yes, there is something to the theory. However given the criticisms of mono-theoretical economics and non-evidence (theory) based policy which have emerged post crisis, the thesis did not in empirically evaluating Hayek's theory expect to find a panacea, that is the singular answer to completely understanding the United Kingdom's Business Cycle. Instead the thesis finds some support for the second order predictions of Hayek's theory (reduced form analysis) within the data and some support for mechanisms of Hayek's theory (structural analysis) within the data. However none of the models presented within this thesis provide full support for the testable model of the Theory and singularly within the failure to reject the null of hypothesis 1, that the long term relationship between expansionary monetary policy and economic output is not inverse the total relevance of Hayek's theory for understanding the UK Business Cycle, can be questioned.

However, there are clearly elements of the Theory which are supported by the presented empirical evaluation. Consistent with Carilli & Dempster (2008) endogenous turning points in the effect of YIELD and M4 on GDP are discovered (though not in the effect of YGAP on GDP) which are considered by Carilli & Dempster (2008) to be in favour of Hayek's theory over any other. The OIRF analysis of relationships within VAR YIELD suggest an impulse response relationship of expansionary monetary policy to the investment consumption decision in accordance with Hayek's theory as well as the effect of a lengthening of the capital structure (an increase in RESOURCES) affecting GDP in accordance with Hayek's view, likewise this observation is repeated in the VAR YGAP model. An OIRF analysis of the Vector-Error Correction Model of Hayek's theory suggests strong reduced form support for Hayek's theory as well as strong structural support for the transmission of expansionary monetary policy through changes in the capital structure and the investment consumption decision consistent with Hayek's theory of the trade cycle. The OIRF analysis of the variable relationships within the Vector-Error Correction Model demonstrate strong support for Hayek's view of the creation of the (unsustainable) boom, however without the turning point supported and taken in conjunction of the findings of hypothesis 1, Hayek's theory of how the boom (inevitably) leads to the bust is less well supported.

Granger Causality Testing of the variable relationships within the models provides some further support for Hayek's theory, within VAR YIELD in accordance with Hayek's theory, the increase in RESOURCES (that is the lengthening of the capital structure) is seen to Granger cause an increase in GDP, with this in turn causing a further increase in RESOURCES. Within this model the driving mechanisms (structural effects) of Hayek's theory hold in the Granger sense, though the knock on effects of contractionary monetary policy do not. Within VAR YGAP, the increase in GDP is seen to Granger Cause an increase in RESOURCES consistent with Hayek and the beginnings of a bust through contractionary monetary policy are present with an increase in RESOURCES Granger Causing contractionary monetary policy. It is within the Vector-Error Correction Model that the variable relationships offer the greatest holistic support to the testable model of Hayek's theory, however it is only through removing the lengthening of the capital structure aspect of the theory and instead considering the structural process to entirely move through the investment / consumption decision does this support become total.

Thus this thesis must conclude that whilst there is some support for the relevance of Hayek's theory of the trade cycle for providing understanding of the UK Business Cycle, that support is not complete. Within the failure to reject the null of hypothesis 1 and given the mixed support of VAR YIELD, VAR YGAP and the Vector-Error Correction models, Hayek's theory provides a far greater relevance for understanding the boom aspect of the cycle than the cycle in its entirety.

The understanding of the drivers of the boom and the existence of endogenous turning points in the effects of YIELD and M4 on GDP agree with Carilli & Dempster's (2008) conclusion that Hayek's theory of the trade cycle is more than a collection of ad hoc observations and that it offers a clear picture of the transmission mechanism of the boom and at least some insight into the subsequent bust. In answering the question of the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle? The thesis presents support for Hayek's theory for understanding the drivers of the boom and the dual effects of relevant variable potentially furthering understanding of the bust stage. Hayek's theory can offer understanding, the empirical examination presented demonstrates the strengths and limitations of the theory for inclusion in a wider macroeconomic framework.

11.4 Hayek's theory of the trade cycle and the call for Pluralism

It is not the aim of this thesis to argue for the primacy of Hayek's theory of the trade cycle and, or the Austrian School (New or Old). Simply replacing one mainstream with another cannot provide a solution to the crisis in economics as a mainstream is static and constrained by its own ideological limitations, economic crisis is dynamic and arises from a situation not foreseen by the mainstream. Indeed within the call for a new pluralist economic methodology the primacy of one theory or methodology does not provide an answer to the criticisms of economics which have emerged particularly post crisis. A robust economics learns from the mistakes of the past (including the Hayekian mistakes), embraces new methodologies, policy based on evidence not pure theory and a true relationship within the wider social sciences.

However the Austrian School of Economic Thought provides its adherents with a dual edged benefit, the label Austrian (more so in the US) allows for a certain independence of thought and intellectual positioning for its members. However whilst this independence is explicit against non-Austrian views, the 'Austrian economist' is constrained within the theory and ideology of the Austrian School. It is when the paradigmatic uniqueness of the school becomes the end of its activities rather than merely a means to a larger end that the label which can protect a scholar's intellectual activities, now constrains them.

This thesis explores and evaluates Hayek's theory of the trade cycle within an 'Austrian Empirical' Framework and so evaluates Hayekian Theory within the freedom of Austrian Acceptance but not within the strict methodological constraints (though with allowances to the Austrian approach).

As such, the evaluation of Hayek's theory, allows for consideration of the Theory within the wider sphere of macroeconomic thought and allowing for a Hayekian contribution to a pluralist theory of the business cycle. Indeed this thesis does not present a case for the primacy of Hayek's theory of the trade cycle as the sole theory of the UK business cycle, but by facilitating *via* an empirical evaluation, a wider consideration of the theory outside the rigid constraints of the Austrian School of Economic Thought allows for the potential incorporation of Hayek's theory into post-crisis macroeconomics.

It is worth remembering Hayek's statement on a wider pluralism, not simply a pluralism within economics, but a call for an economics to embrace the wider social sciences, "Nobody can be a great economist who is only an economist and I am even tempted to add that the economist who is only an economist is likely to become a nuisance if not a positive danger", (Hayek 1967, 123) with Garnett Jr (2011) paraphrasing this specifically for a greater Austrian pluralism: "Nobody can be a great [Austrian] economist who is only an [Austrian] economist", (Hayek 1967, 123 with Garnett Jr (2011) additions).

11.5 Implications for the academic treatment of economics (the way forward)

Non-rejection of the null of hypothesis 1 and a similar (though not total as in hypothesis 1) outcome for hypothesis 2, queries the complete relevance of Hayek's theory of the trade cycle for understanding of the UK Business Cycle. The reduced form / structural model of the theory along with the rejection of the null hypothesis of H3 and H4 however allows for the conclusion that there is some understanding, particularly of the drivers of the boom stage of the UK business cycle, to be gleaned.

An empirical evaluation of Hayek's theory for understanding the UK Business Cycle is rare, a dual form (reduced form and structural analysis) one as presented in this thesis is doubly so. Thus there is a clear need for further empirical research as discussed later in this chapter, however, the findings of this thesis are reasonably consistent with the wider Austrian empirical literature which concentrates mainly on US data and finds some support for the mechanisms of Hayek's theory but generally does not manage to link this to the overall Business Cycle.

The findings of this thesis are relatively consistent with Hayek's theory of Capital in the boom and not necessarily as consistent with his overall theory of the Trade Cycle, therefore it may be a fruitful route for wider macroeconomics to maintain the capital and boom aspects of this Theory and abandon the holistic business cycle theory. It is clearly within the calls for a pluralist macroeconomics discussed throughout this thesis that the working elements of a theory should be preserved and incorporated into a wider macroeconomics. It is within Hayek's view that an economist should embrace all aspects of the economy, sociological, political, technological and historical and that an overall theory of the Business Cycle will have numerous inputs. Ultimately the economy is a function of society and Hayek's theory incorporating decision making through the capital structure and the investment / consumption decision provides some understanding of the UK Business Cycle. This understanding should not be discarded within the rejection of a not perfect complete theory, but used toward the creation of a pluralist macroeconomics with an ideology not based on the primacy of one theory but in the acceptance and incorporation of many to deliver a true evidence based economics.

11.5.1 Contribution to the literature

This thesis aimed to determine the relevance of Hayek's theory of the trade cycle for understanding the United Kingdom business cycle, and to do this in a way acceptable to the (New) Austrian School and accessible to the wider economic community. Following a review of the theory (chapter 3), the small Austrian empirical literature and discussing Hayek's greater acceptance of empirics, than say Mises, (chapter 4), the thesis took an empirical approach. A novel testable model of the theory was constructed (Chapter 5) by isolating the individual effects of the theory from the literature and developing Second Order Predictions as per Carilli & Dempster (2008). The thesis then evaluates the testable model coupled with testing additional supporting hypotheses, presenting a dual form approach addressing Kuehn's (2013) identified gap in the literature of single form (reduced or structural) analysis being unable to completely determine the validity of Hayek's theory. The thesis in evaluating Hayek's theory within the UK represents a considerable contribution to the literature with the vast majority of Austrian empirical pieces being US focussed[77]. The thesis is the first time the contained data (discussed in chapter 6) have been used in the Austrian empirical literature to evaluate Hayek's theory representing a further contribution to that literature. Chapter 7 presents an evaluation of endogenous turning points in the effect of the expansionary monetary policy on output, the first in the literature studying the UK. Chapter 8 presents VAR models built around different interest rate proxies, addressing a concern of Keeler (2001) and Carilli & Dempster (2008) and further contributing to the lack of UK analysis in the Austrian empirical literature. The Vector-Error Correction Model presented in Chapter 9 addresses Mulligan's (2006) concern of further relevant variables in the analysis and is the first of its kind in the Austrian Empirical literature to consider the temporal structure of production in the UK. Repeating Mulligan's (2006) bivariate VECM for the UK aimed to determine if the evidence Mulligan found for Hayek's theory US which is regarded in the Austrian Empirical literature as strongly supportive of Hayek's theory (e.g. Fisher 2013) is present in the UK. The replication study for the UK presented in this thesis (Chapter 9) did not find evidence as supportive as Mulligan for Hayek's theory in the UK and represents a further contribution to the literature.

[77] For example, Wainhouse (1984), Hughes (1997), Keeler (2001), Mulligan (2006), Carilli & Dempster (2008), Fisher (2013), Rusell & Langemeier (2015). The only reviewed study which provides any analysis of the UK is Bismans & Mougeot (2009), of which this thesis is a considerable development on in approach and data.

11.5.2 Contribution to Knowledge and Policy Implications

This thesis finds support for Hayek's drivers of the boom and of the existence of endogenous turning points suggesting a partial relevance for Hayek's theory of the trade cycle for understanding the UK Business Cycle. However the key hypothesis of an inverse relationship between expansionary monetary policy and economic activity finds limited support querying the holistic relevance of the theory.

The thesis suggests that Hayek's theory can provide some understanding of the UK Business Cycle and that this understanding could be incorporated into a pluralist macroeconomics.

The thesis contributes to the literature by providing an evaluation of Hayek's theory of the trade cycle using a testable model and both reduced form and structural analysis. Furthermore the thesis provides a consideration of the relevance of Hayek's theory of the trade cycle for the UK Business Cycle addressing a gap in the Austrian Empirical Literature. The chosen analysis of a variety of models and tests also contributes to the Austrian methodological literature providing a comprehensive approach to the evaluation of Hayek's theory.

The UK data used for the empirical evaluation does not feature in any of the reviewed literature and thus its use represents a further contribution toward the UK gap in the Austrian Econometric Literature. The thesis determines that whilst there is strong support for the partial relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle, it does not provide complete understanding. Therefore, Hayek's theory could contribute to a wider macroeconomics and a pluralist economics. A pluralist economics is not a sole theory economics, but based on evidence based policy, the working aspects of various theories (including neo-classical) and a true relationship with the wider social sciences.

The policy implications of this thesis are quite considerable, first and foremost all models demonstrate an additional effect of monetary stimulus beyond the expected increase in economic activity. That is monetary stimulus also has a direct lengthening effect on the capital structure of the UK economy. As noted in section 11.3.6, the empirical examination of Hayek's Theory of the Trade Cycle offers considerable explanation for the formation of the boom aspect of his boom bust theory and the resulting lengthening of the capital structure deriving from monetary stimulus is of relevance and importance to UK Policy and the Bank of England.

The results presented in this thesis suggest that a Policy decision to stimulate inflationary pressure in the UK economy via an interest rate reduction (below the natural rate) results in a greater structural change than is generally thought in the literature and by the Bank of England MPC

11.5.3 Limitations of the Research

An empirical evaluation of the relevance of Hayek's theory of the trade cycle for Understanding the UK Business Cycle has specific limitations from the Austrian Perspective as well as limitations identified from the thesis research.

This thesis has been constrained by the objective of Austrian and Hayekian acceptance, namely by the School's rejection of *Scientism*. As such, all tests and analyses have been justified from the literature (table 9), as a result the development of more sophisticated testing is restricted and potentially greater or clearer support for the relevance of Hayek's theory for understanding the UK Business Cycle could be found from greater refinement of the testing process. It is hoped that the evaluation of the VAR models demonstrating their success over simpler methods[78] (tables 46 and 53) provide a step toward Austrian and Hayekian acceptance of further refinement, though this must be a refinement process, which does not subject the Austrian Empirical Literature to the criticisms of Colander *et al* (2009) of economic analysis too far from reality and allows for acceptance into a pluralist macroeconomics.

The data used in this thesis provides a robust empirical evaluation, however the data is asymmetric toward low interest rates being used as monetary policy

From the Austrian and Hayekian Perspective, a notable limitation of the research is the subjectivity of the measurement of the natural interest rate and thus the interest rate proxy in the models (whilst informed by the literature) cannot be certain of capturing the interest rate changes required for expansionary monetary policy Hayek's theory of the trade cycle.

In the suggestions for further research section (11.7), the thesis calls for further research in Austrian Empiricism and in the measurement of the natural rate of interest to address these limitations.

11.6 Suggestions for further research

The empirical evaluation of Hayek's theory of the trade cycle presented in this thesis is rare, with the examination of both reduced form and structural analysis even more so. Thus a first overall suggestion for further research is simply for further Austrian empirical pieces. A greater literature in this area will allow for the development of further Austrian acceptable tests and methods, and in particular a wider cannon of literature to address the measurement difficulties of the interest rate proxy[79]. Within this call for a greater Austrian empirical

[78] However the results of a yet more sophisticated Structural Vector Auto Regression (presented as appendix A5.1&A5.2) relay comparable results to the Vector Auto Regression Models presented in Chapter 10.
[79] The results of a VAR model using the Bank of England Base Rate and a VAR Model using the GDP GAP (as per Carilli & Dempster 2008) are included as appendices A5.3 & A5.4. These different proxies provide comparable results for the evaluation of Hayek's Theory of the Trade Cycle.

literature, mention must be made of the dearth of literature which focusses on the UK rather than US Business Cycle and thus a call for a less US centric research programme. Specific to the analysis presented in this thesis, methodological concessions have been made for Austrian acceptance of the research and a greater cannon of Austrian empirical literature could lessen these over time, leading to a greater pluralist methodology.

In the thesis, the empirical examination of Hayek's theory led to an acceptance that it is more than a collection of ad hoc observations, however that the understanding it provides for the UK Business Cycle is focussed within the capital structure aspect of Hayek's theory and constrained by the overall relationship between expansionary monetary policy and economic output determined within hypotheses 1&2. Further research determining the efficacy of proxies for both expansionary monetary policy and output[80] (remembering the Austrian views on subjectivity) could re-evaluate these hypotheses allowing for Hayek's theory to provide further understanding of the bust and the long term than is presented in this thesis.

Ultimately, this thesis consistent with Kuehn (2013), suggests that the capital and decision making aspects of Hayek's theory are supported and research should be conducted to determine their relevance within a wider pluralist Business Cycle Theory.

11.7 Final Summary

In short, Hayek's theory of the trade cycle postulates that expansionary monetary policy leads to a lengthening of the capital structure and an economy with a greater focus on consumption. These changes generate an increase in GDP (The Boom). As the increase in GDP continues the economy continues lengthening the capital structure and consuming leading to

[80] However the results presented in A5.4 support the view of this thesis of Hayek's Theory of the Trade Cycle providing understanding rather than a complete theoretical explication of the UK economy.

contractionary monetary policy and a reduction in GDP (The Bust). The empirical examination of Hayek's theory using UK data supports the relevance of the Theory for understanding the drivers of the boom and offers some support for the relevance of the theory for understanding the bust. The overall tenet of the theory that expansionary monetary policy results in a long term lowering of GDP is queried, however the investment / consumption decision can be seen to completely Granger Cause the boom and inevitable subsequent bust in the data in accordance with Hayek's theory in one of the models presented.

Within the overall constraints of the hypothesis 1&2 results the complete understanding the theory can provide for the UK Business Cycle is limited, however given the varied support of the models and the failure to reject the null hypothesis of no endogenous turning point in the effect of YIELD and M4 on GDP, then the understanding the Hayek's theory can provide to elements of the UK business cycle is significant and is worthy of further attention. A final summary of this thesis is presented in table 113 located in appendix A8.0.

Given the results presented in this thesis, the relevance that Hayek's theory of the trade cycle can offer for understanding the UK business cycle and for incorporation into a wider pluralist macroeconomics warrants additional investigation at the least.

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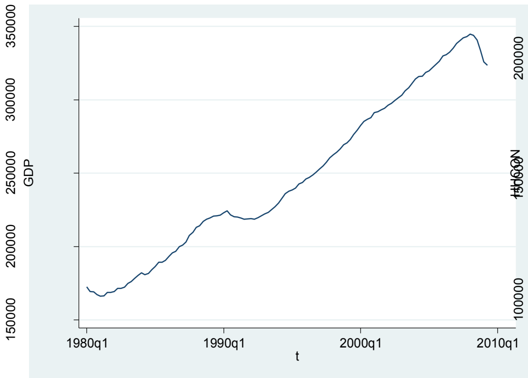
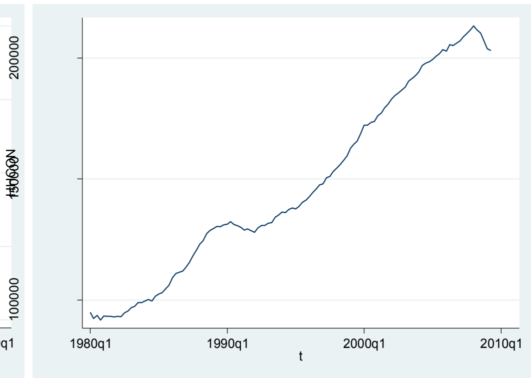
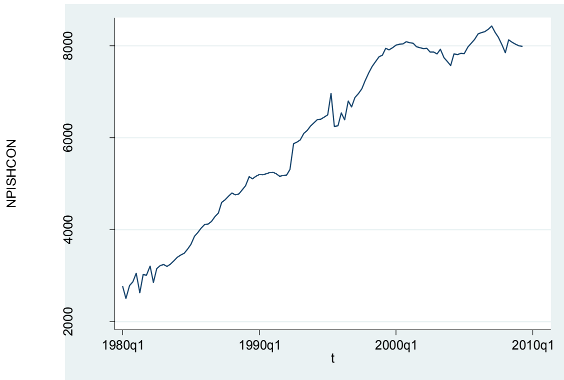
Appendices

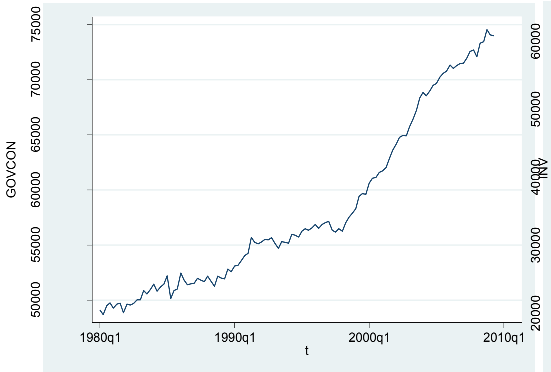
A1.0 Visual Representation of the Raw Data

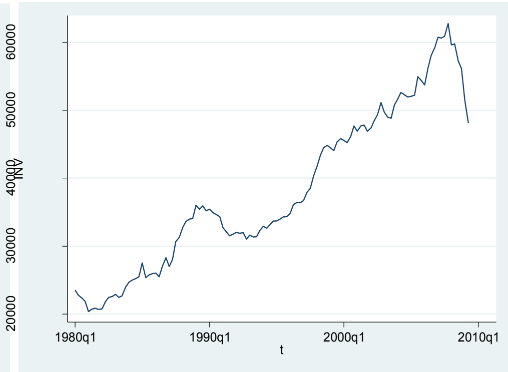


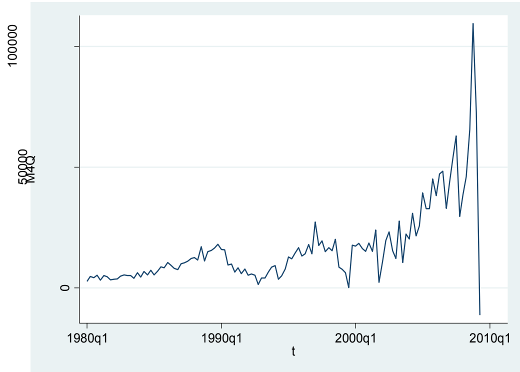




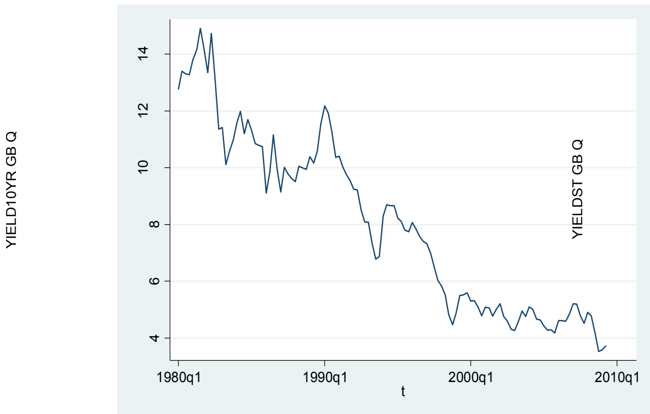
Clockwise, Timeseries plots of GDP, Household Consumption and NPISH Consumption.

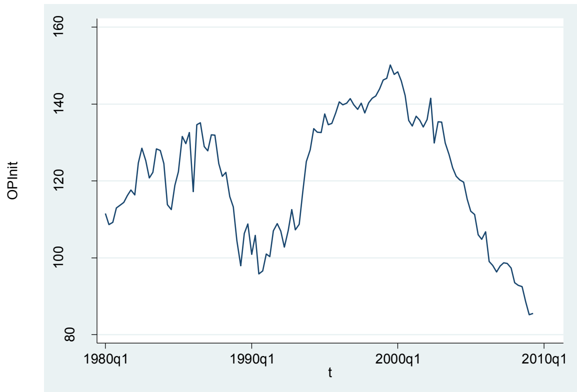




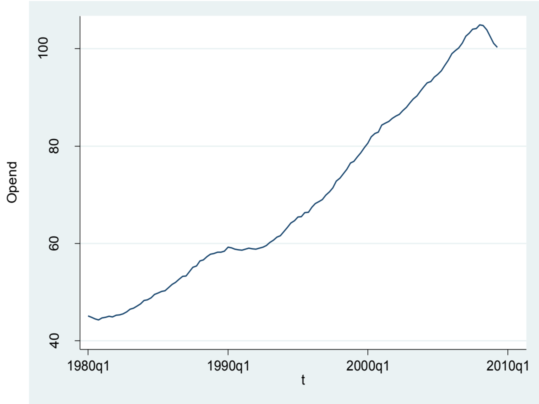


Clockwise, Timeseries plots of Government Consumption, Investment and M4.





Clockwise, Timeseries plots of the Long Term Interest Rate, Short Term Interest Rate and Initial Stage Output.



Timeseries plot of End Stage Output.

A2.0 Modified Dicky-Fuller Test Results and the detrending Process

A2.1 GDP

DF-GLS for gdp			**Number**	**of obs = 113**
DF-GLS mu		1% Critical 5%	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**-0.993**	-2.598	-2.063	-1.757
3	**-0.817**	-2.598	-2.073	-1.765
2	**0.085**	-2.598	-2.082	-1.774
1	**0.737**	-2.598	-2.09	-1.781
Opt Lag (Ng-Perron seq t) =	3	with RMSE 1342.285		
Min SC = 14.55679 at lag	1	with RMSE 1389.308		
Min MAIC = 14.47779 at lag	3	with RMSE 1342.285		

A2.2 Household Consumption

DF-GLS for hhcon			**Number**	**of obs = 113**
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**-0.448**	-2.598	-2.063	-1.757
3	**-0.149**	-2.598	-2.073	-1.765
2	**0.284**	-2.598	-2.082	-1.774

1	**1.845**	-2.598	-2.09	-1.781

Opt Lag (Ng-Perron seq t) =	2	with RMSE 1004.076
Min SC = 13.94915 at lag	2	with RMSE 1004.076
Min MAIC = 13.86109 at lag	2	with RMSE 1004.076

A2.3 NPISH Consumption

DF-GLS for npishcon			**Number**	**of obs = 113**
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**0.812**	-2.598	-2.063	-1.757
3	**1.205**	-2.598	-2.073	-1.765
2	**1.419**	-2.598	-2.082	-1.774
1	**1.746**	-2.598	-2.09	-1.781

Opt Lag (Ng-Perron seq t) =	4	with RMSE 147.5637
Min SC = 10.14299 at lag	1	with RMSE 152.8811
Min MAIC = 10.07342 at lag	4	with RMSE 147.5637

A2.4 Government Consumption

DF-GLS for govcon			**Number**	**of obs = 113**
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**2.345**	-2.598	-2.063	-1.757
3	**3.001**	-2.598	-2.073	-1.765
2	**3.769**	-2.598	-2.082	-1.774
1	**4.266**	-2.598	-2.09	-1.781

Opt Lag (Ng-Perron seq t) =	1	with RMSE 518.5742

Min SC = 12.58584 at lag	1	with RMSE 518.5742		
Min MAIC = 12.75444 at lag	4	with RMSE 511.151		

A2.5 M4

DF-GLS for M4q			**Number**	**of obs = 113**
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**1.837**	-2.598	-2.063	-1.757
3	**0.159**	-2.598	-2.073	-1.765
2	**-1.517**	-2.598	-2.082	-1.774
1	**-3.533**	-2.598	-2.09	-1.781
Opt Lag (Ng-Perron seq t) =	4	with RMSE 9007.277		
Min SC = 18.42075 at lag	4	with RMSE 9007.277		
Min MAIC = 18.41052 at lag	4	with RMSE 9007.277		

A2.6 Investment

DF-GLS for inv			**Number**	**of obs = 113**
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**-1.513**	-2.598	-2.063	-1.757
3	**-1.005**	-2.598	-2.073	-1.765
2	**-0.572**	-2.598	-2.082	-1.774
1	**-0.037**	-2.598	-2.09	-1.781
Opt Lag (Ng-Perron seq t) =	4	with RMSE 1061.299		
Min SC = 14.12408 at lag	2	with RMSE 1095.853		
Min MAIC = 14.04042 at lag	2	with RMSE 1095.853		

A2.7 Hayek's Natral Rate of Interest

DF-GLS for yield10yrgbq			Number of obs = 113	
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**0.266**	-2.598	-2.063	-1.757
3	**0.069**	-2.598	-2.073	-1.765
2	**0.434**	-2.598	-2.082	-1.774
1	**0.115**	-2.598	-2.09	-1.781
Opt Lag (Ng-Perron seq t) =	3	with RMSE .5231905		
Min SC = -1.128278 at lag	3	with RMSE .5231905		
Min MAIC = -1.243303 at lag	4	with RMSE .5180056		

A2.8 Hayek's Market Rate of Interest

DF-GLS for yieldstgbq			Number	of obs = 113
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**0.291**	-2.598	-2.063	-1.757
3	**0.249**	-2.598	-2.073	-1.765
2	**0.310**	-2.598	-2.082	-1.774
1	**0.287**	-2.598	-2.09	-1.781
Opt Lag (Ng-Perron seq t) =	1	with RMSE .8151717		
Min SC = -.3250424 at lag	1	with RMSE .8151717		
Min MAIC = -.3894699 at lag	1	with RMSE .8151717		

A2.9 Initial Stage Output

DF-GLS for opinit			Number	of obs = 113
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value

4	**-0.957**	-2.598	-2.063	-1.757
3	**-0.820**	-2.598	-2.073	-1.765
2	**-0.733**	-2.598	-2.082	-1.774
1	**-0.833**	-2.598	-2.09	-1.781

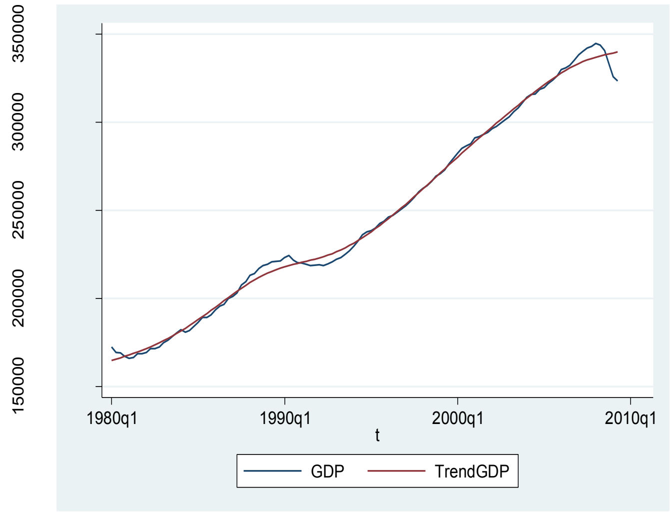
Opt Lag (Ng-Perron seq t) =	0 [use maxlag(0)]
Min SC = 3.159489 at lag	1 with RMSE 4.654847
Min MAIC = 3.10638 at lag	1 with RMSE 4.654847

A2.10 End Stage Output

DF-GLS for opend			**Number**	**of obs = 113**
DF-GLS mu		1% Critical	5% Critical	10% Critical
[lags]	**Test Statistic**	Value	Value	Value
4	**-1.738**	-2.598	-2.063	-1.757
3	**-1.221**	-2.598	-2.073	-1.765
2	**-0.358**	-2.598	-2.082	-1.774
1	**1.308**	-2.598	-2.09	-1.781

Opt Lag (Ng-Perron seq t) =	3	with RMSE .3641104
Min SC = -1.853828 at lag	2	with RMSE .3717005
Min MAIC = -1.940021 at lag	2	with RMSE .3717005

A2.11 GDP, Hodrick-Prescott Trend GDP and detrended GDP

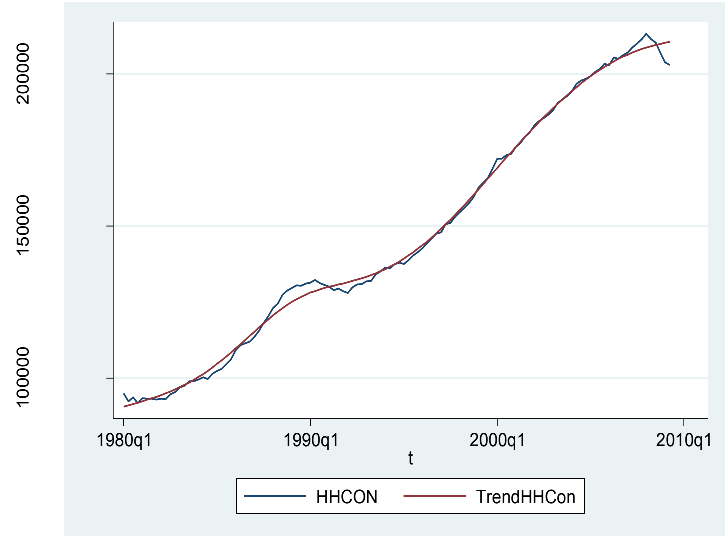


Data	Obs	Mean	Std. Dev.	Min	Max
GDP	118	247461.9	55163.1	166052	344809
Trend GDP	118	247461.9	54953.87	164688	339918.1

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of GDP this is the creation of the variable Stationary GDP = GDP / Trend GDP.

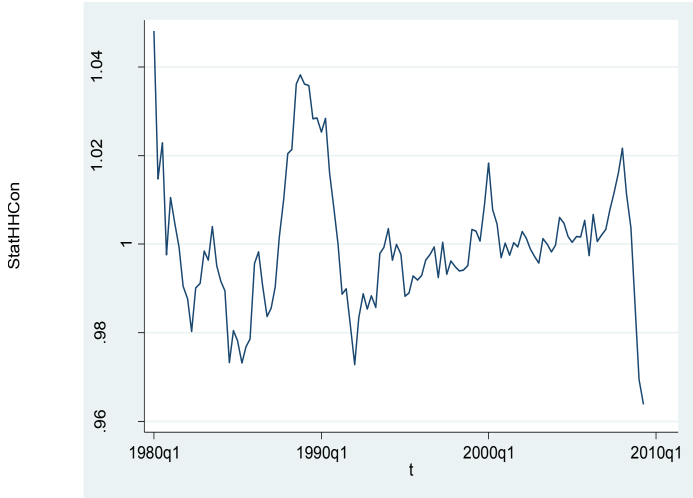
Data	Obs	Mean	Std. Dev.	Min	Max
Stationary GDP	118	0.999906	0.013562	0.952032	1.047046

A2.12 Household Consumption, Hodrick-Prescott Trend Household Consumption and detrended Household Consumption



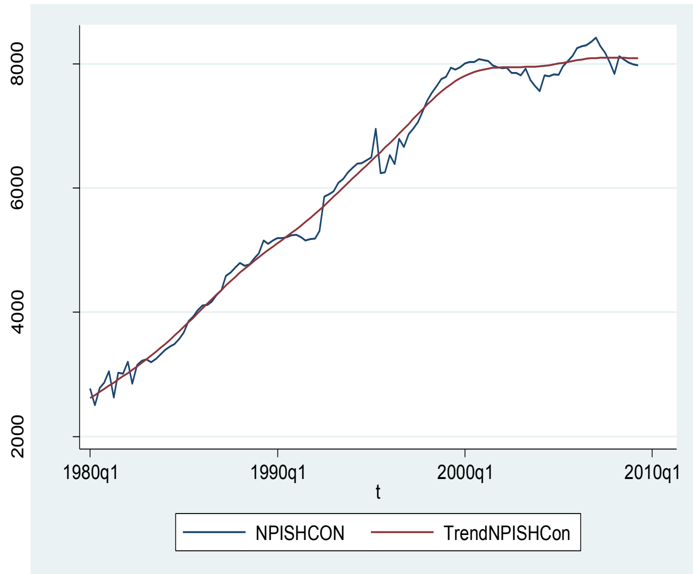
Data	Obs	Mean	Std. Dev.	Min	Max
Household Consumption	118	146995.4	38344.17	91684	213214
Trend Household Consumption	118	146995.4	38203.82	90606.37	210681.7

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of Household Consumption this is the creation of the variable Stationary Household Consumption = Household Consumption / Trend Household Consumption.



Data	Obs	Mean	Std. Dev.	Min	Max
Stationary Household Consumption	118	0.999827	0.014661	0.963786	1.048116

A2.13: NPISH Consumption, Hodrick-Prescott Trend NPISH Consumption and detrended NPISH Consumption

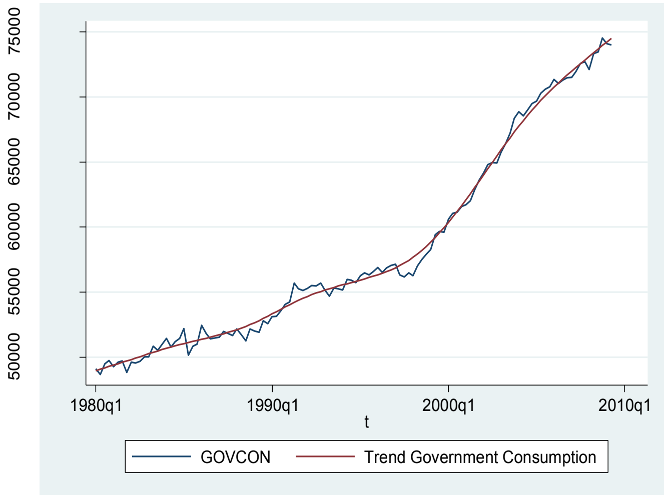


Data	Obs	Mean Std. Dev.	Min	Max
NPISH Consumption	118	6038.466 1874.357	2505	8424
Trend NPISH Consumption	118	6038.466 1862.735	2618.382	8106.011

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of NPISH Consumption this is the creation of the variable Stationary NPISH Consumption = NPISH Consumption / Trend NPISH Consumption.

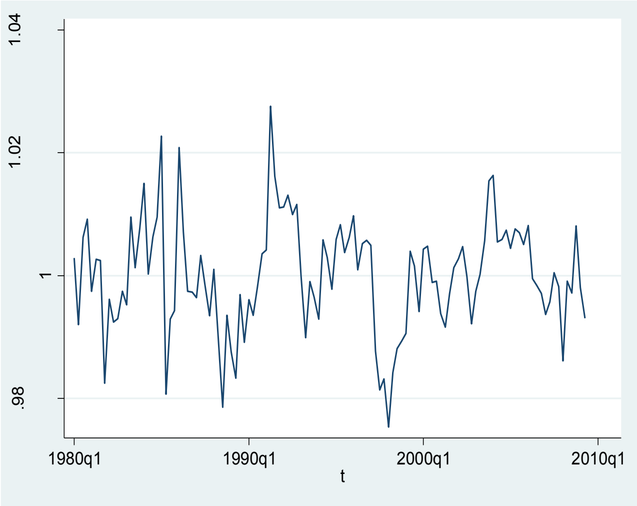
Data	Obs	Mean	Std. Dev.	Min	Max
Stationary NPISH Consumption	118	0.999877	0.030901	0.915669	1.083189

A2.14 Government Consumption, Hodrick-Prescott Trend Government Consumption and detrended Government Consumption



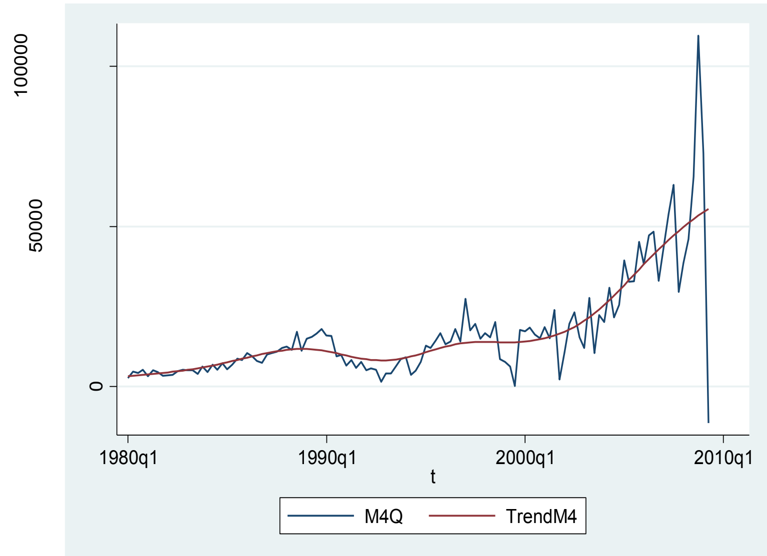
Data	Obs.	Mean	Std. Dev.	Min	Max
Government Consumption	118	58250.55	7733.077	48683	74553
Trend Government Consumption	118	58250.55	7697.193	48968.88	74510.07

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of Government Consumption this is the creation of the variable Stationary Government Consumption = Government Consumption / Trend Government Consumption.



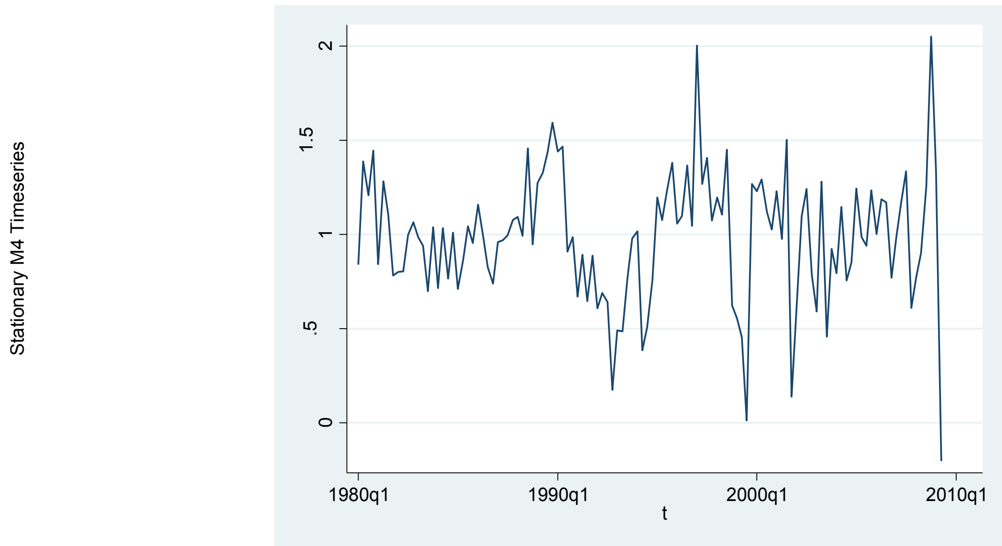
Data	Obs	Mean	Std. Dev.	Min	Max
Stationary Government Consumption	118	0.999962	0.009137	0.975318	1.02759

A2.15 M4, Hodrick-Prescott Trend M4 and detrended M4



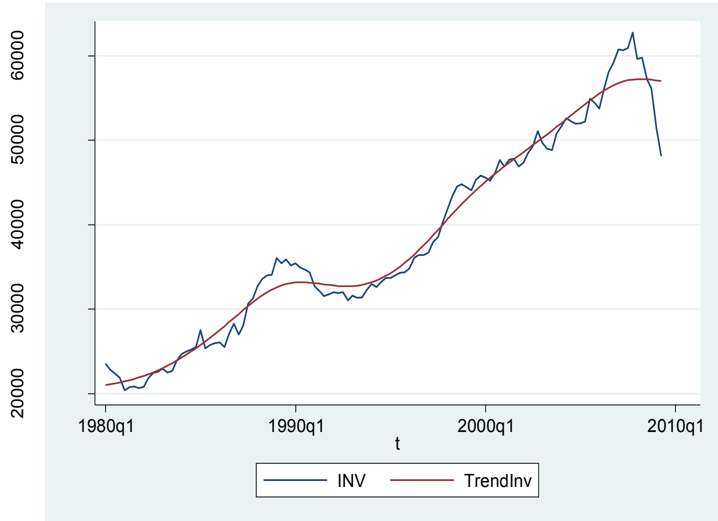
In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of M4 this is the creation of the variable Stationary M4 = M4 / Trend M4.

Data	Obs	Mean	Std. Dev.	Min	Max
M4	118	16492.37	16679.74	-11325	109457
TrendM4	118	16492.37	13266.14	3209.402	55471.32



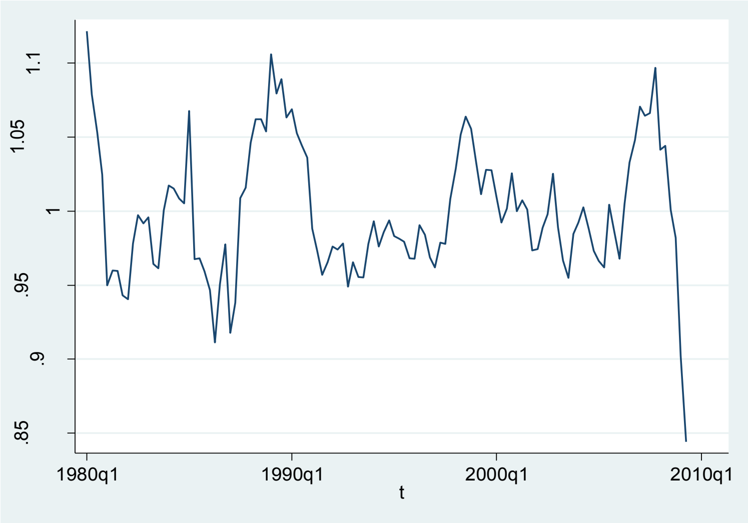
Data	Obs	Mean	Std. Dev.	Min	Max
Stationary M4	118	0.985234	0.347308	- 0.20416	2.050288

A2.16 Investment, Hodrick-Prescott Trend Investment and detrended Investment



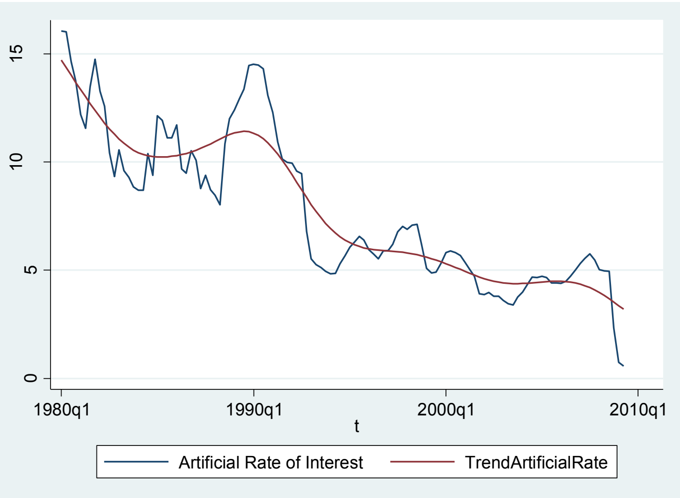
Data	Obs	Mean	Std. Dev.	Min	Max
Investment	118	38093.11	11767.29	20381	62738
Trend Investment	118	38093.11	11535.87	20999.63	57245.9

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of Investment this is the creation of the variable Stationary Investment = Investment / Trend Investment.



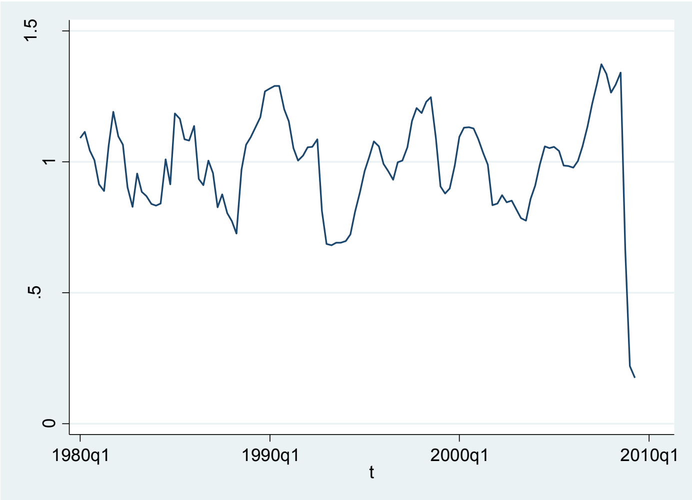
Data	Obs	Mean	Std. Dev.	Min	Max
Stationary Investment	118	0.999245	0.045031	0.844142	1.121544

A2.17 Market Rate of Interest, Hodrick-Prescott Trend Market Rate of Interest and detrended Market Rate of Interest.



Data	Obs	Mean	Std. Dev.	Min	Max
Market Rate of Interest	118	7.767542	3.573386	0.56	16.05
Trend Market Rate of Interest	118	7.767542	3.163257	3.193838	14.70389

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of The market rate of interest this is the creation of the variable Stationary Market Rate of Interest = Market Rate of Interest / Trend Natural Rate of Interest



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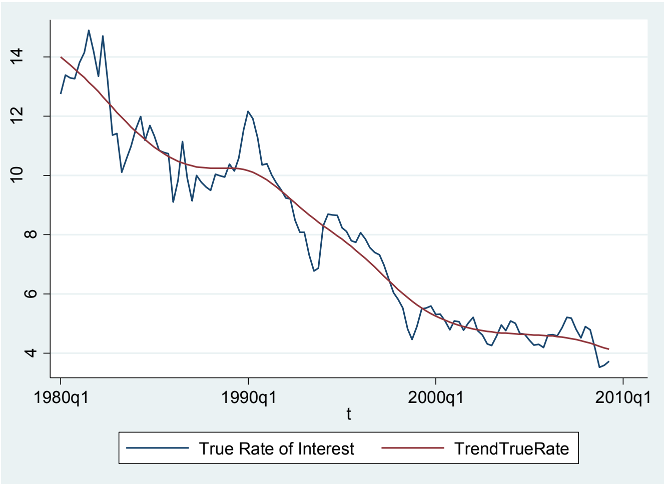
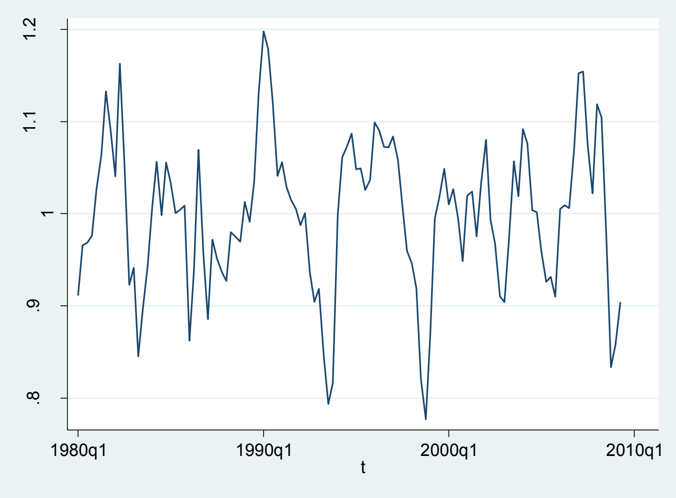
Data	Obs	Mean	Std. Dev.	Min	Max
Stationary Market Rate of Interest	118	0.992381	0.193638	0.175338	1.372486

A2.18 Natural Rate of Interest, Hodrick-Prescott Natural Rate of Interest Trend and detrended Natural Rate of Interest.



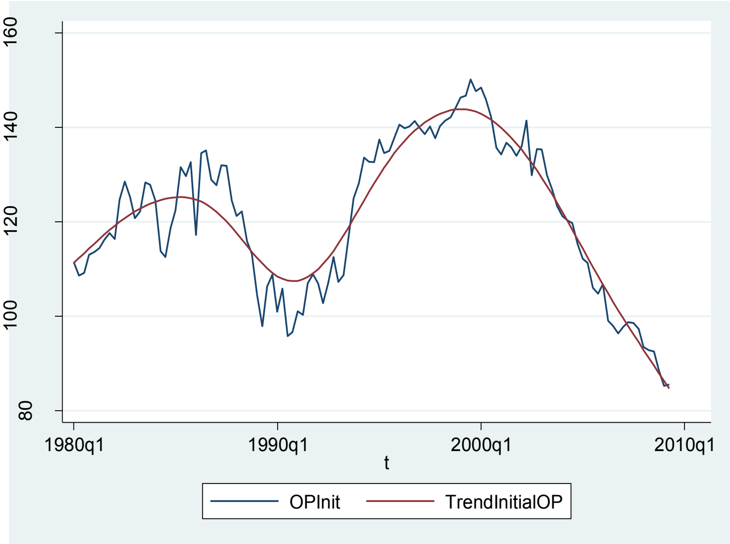
Data	Obs	Mean	Std. Dev.	Min	Max
Natural Rate of Interest	118	8.04783	3.119294	3.5295	14.9
Trend Natural Rate of Interest	118	8.04783	3.01729	4.130577	14.00305

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of The natural rate of interest this is the creation of the variable Stationary Natural Rate of Interest = Natural Rate of Interest / Trend Natural Rate of Interest



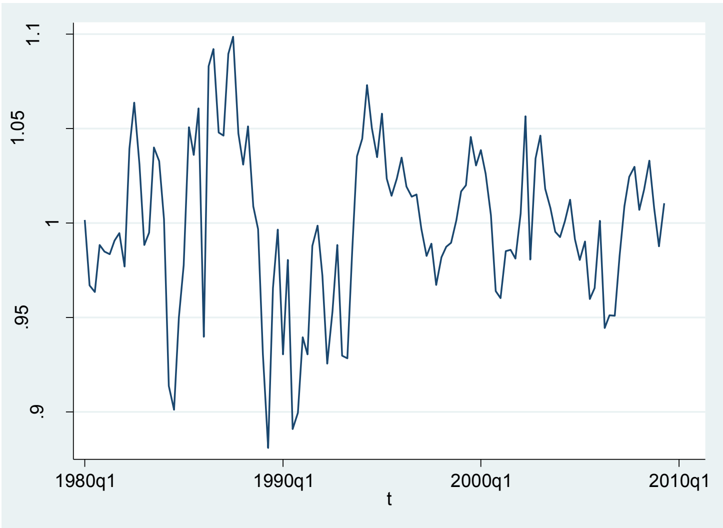
Data	Obs	Mean	Std. Dev.	Min	Max
Stationary Natural Rate of Interest	118	0.9991	0.082794	0.776908	1.197819

A2.19 Initial Stage Output, Hodrick-Prescott Initial Stage Output Trend and detrended Initial Stage Output.



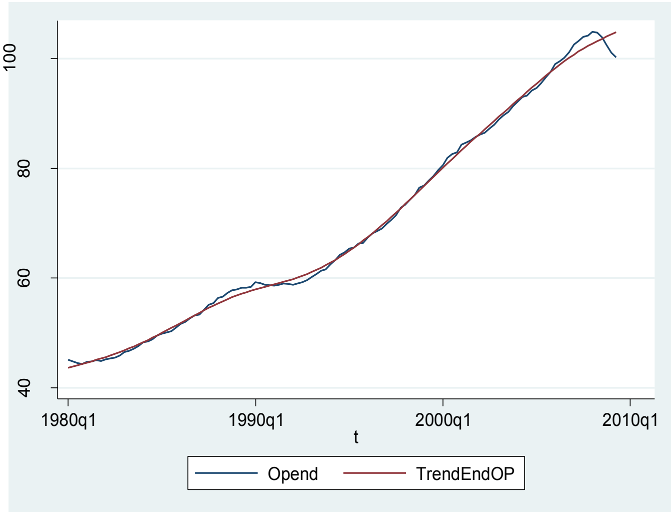
Data	Obs	Mean	Std. Dev.	Min	Max
Initial Stage Output	118	120.9424	16.2888	85.2	150.2
Trend Initial Stage Output	118	120.9424	14.38223	84.6201	143.8783

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of The Initial Stage Output this is the creation of the variable Stationary Initial Stage Output = Initial Stage Output/ Trend Initial Stage Output.



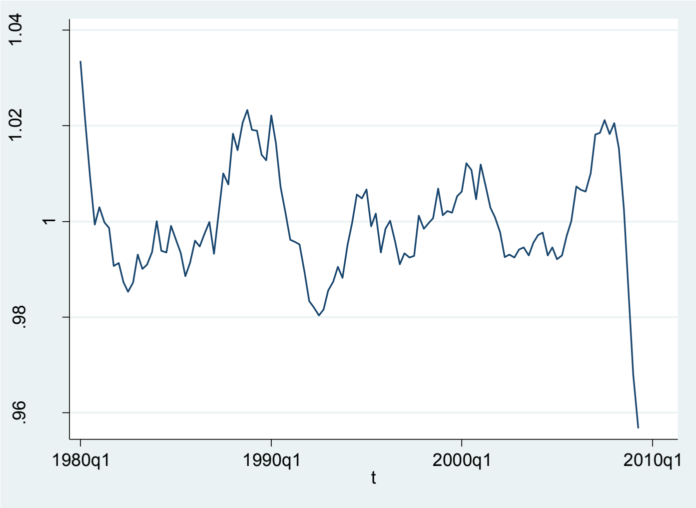
Data	Obs	Mean	Std. Dev.	Min	Max
Stationary Initial Stage Output	118	0.998889	0.042984	0.880862	1.098726

A2.20 End Stage Output, Hodrick-Prescott End Stage Output Trend and detrended End Stage Output



Data	Obs	Mean	Std. Dev.	Min	Max
End Stage Output	118	69.63475	19.07512	44.3	104.9
Trend End Stage Output	118	69.63475	19.03297	43.63387	104.8393

In order to make the variable stationary, deviation from the trend will be considered by dividing the raw data by the trend, in the case of The End Stage Output this is the creation of the variable Stationary End Stage Output = End Stage Output/ Trend End Stage Output.

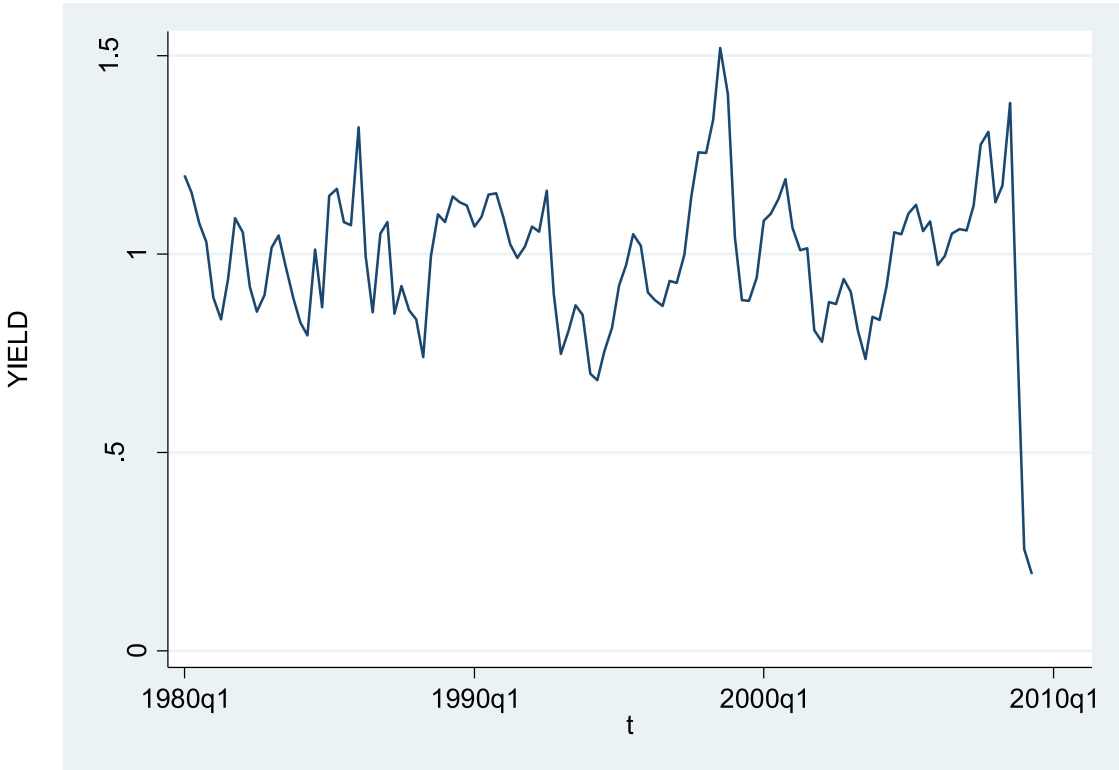


Data	Obs	Mean	Std. Dev.	Min	Max
Stationary End Stage Output	118	0.999922	0.011633	0.956702	1.033601

A3.0 The Constructed Variables:

A3.1 YIELD

$$\text{YIELD} = \frac{Market\ Rate\ of\ Interest}{Natural\ Rate\ of\ Interst}$$

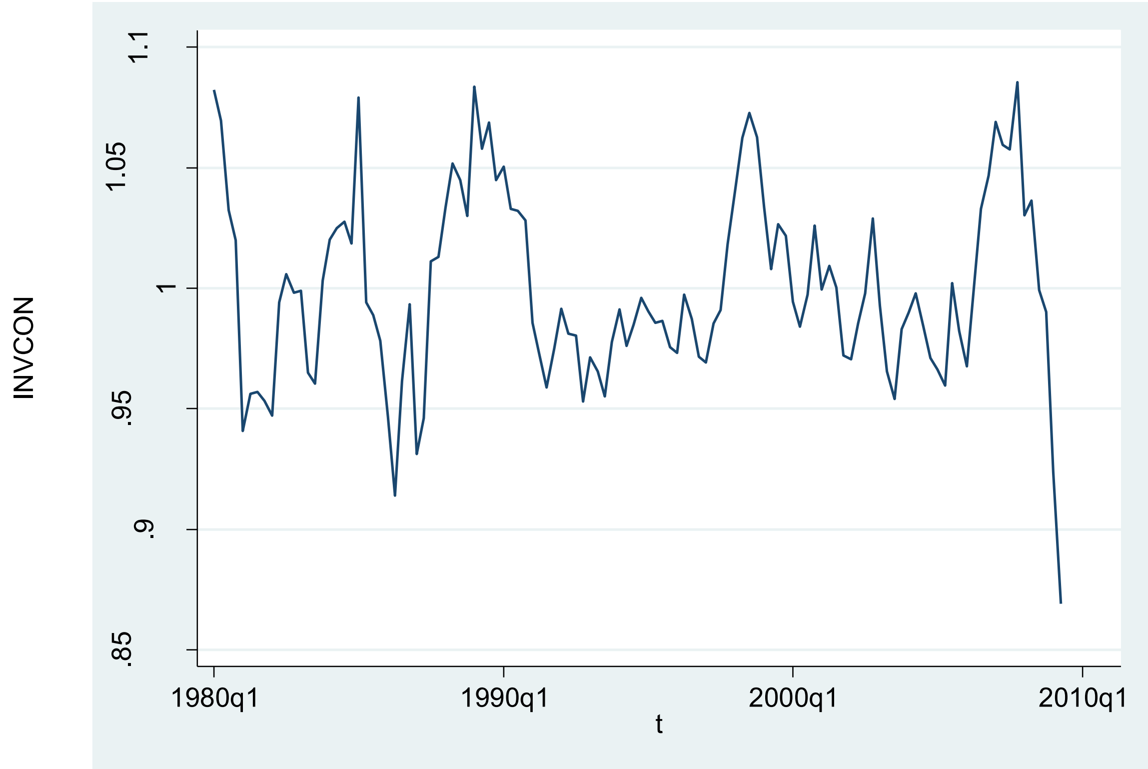


Variable	Obs	Mean	Std. Dev.	Min	Max
YIELD[81]	118	0.993469	0.185987	0.193986	1.518808

[81] The variables YGAP and CYGAP are discussed in depth and detailed as these appendices in section 9.2.2 of the main thesis.

A3.2 INVCON

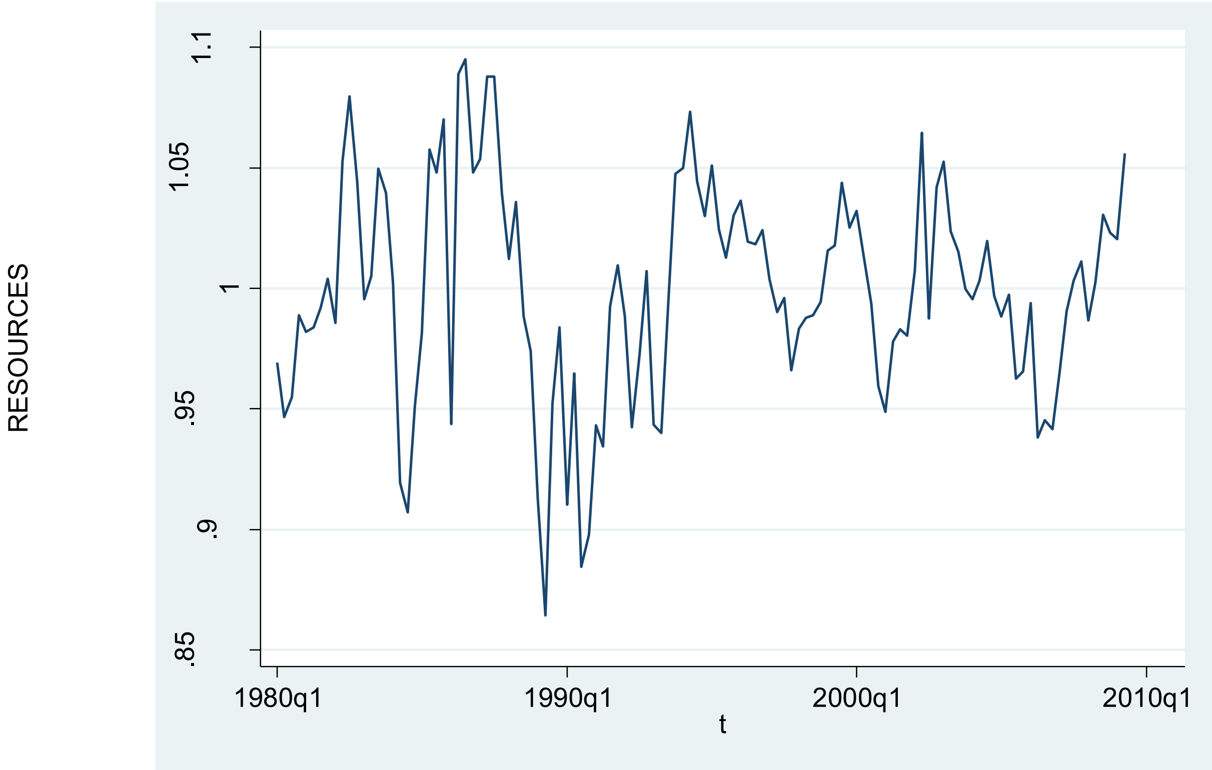
INVCON = $\frac{INVESTMENT}{CONSUMPTION}$



Variable	Obs	Mean	Std. Dev.	Min	Max
INVCON	118	0.999576	0.039183	0.869096	1.0855

A3.3 RESOURCES

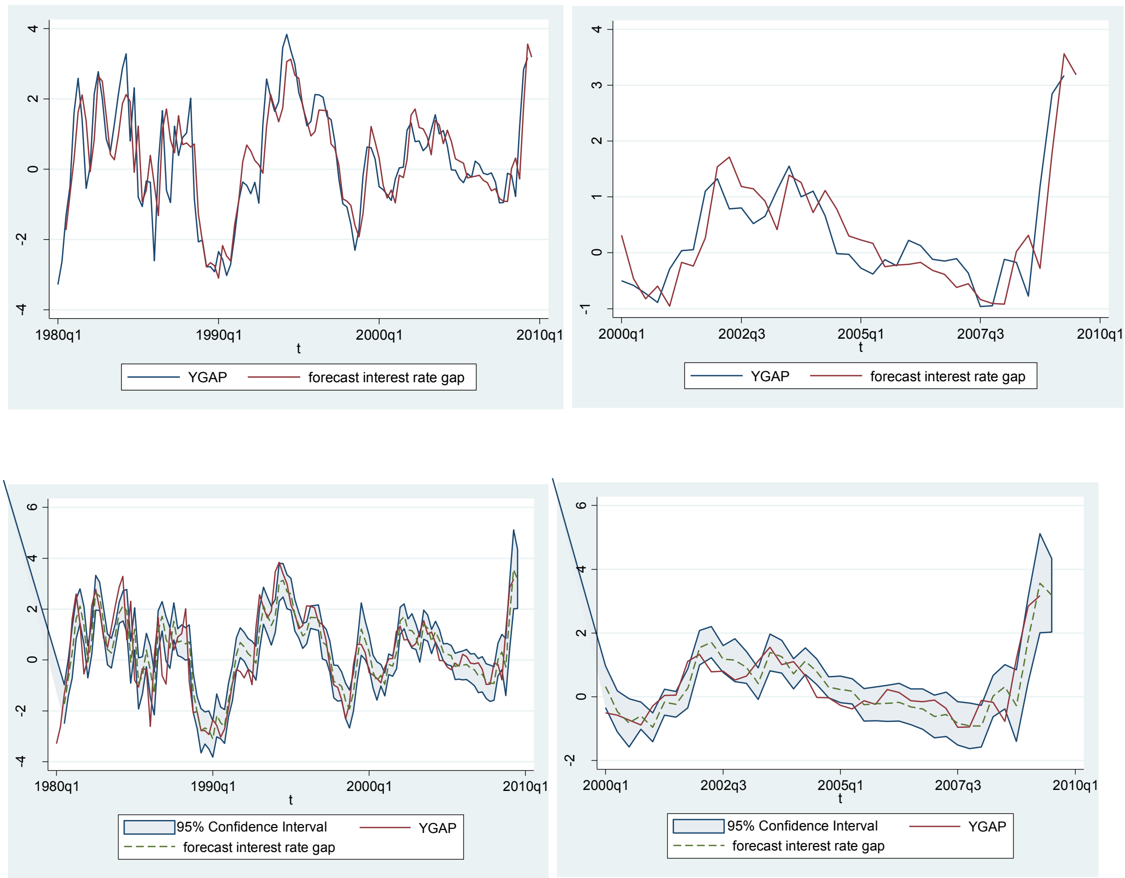
$$\text{RESOURCES} = \frac{\mathit{Initial\ Stage\ Output}}{\mathit{End\ Stage\ Output}}$$



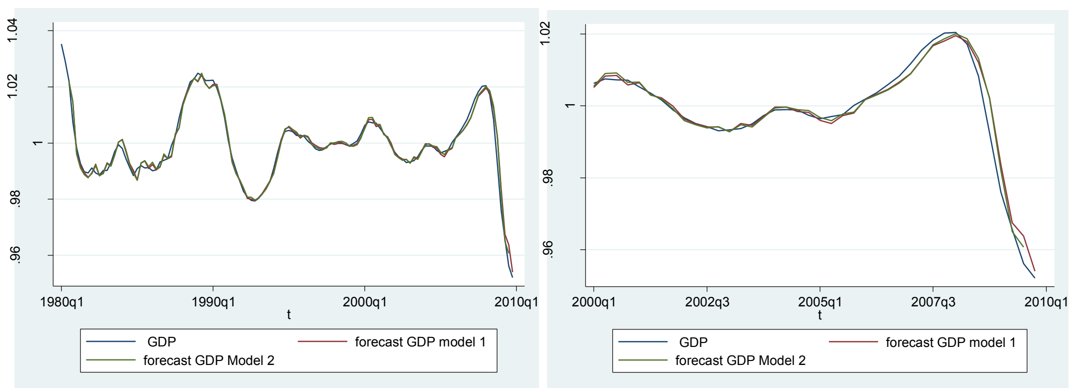
Variable	Obs	Mean	Std. Dev.	Min	Max
RESOURCES	118	0.999122	0.044972	0.864424	1.095094

A4.0 VAR YGAP Step Ahead Forecasts

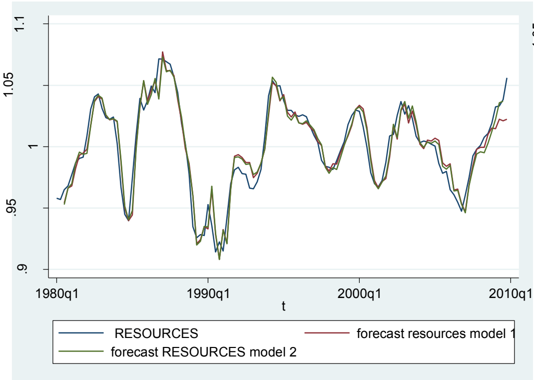
A4.1 VAR YGAP 1 Step Ahead (Forecast YGAP)

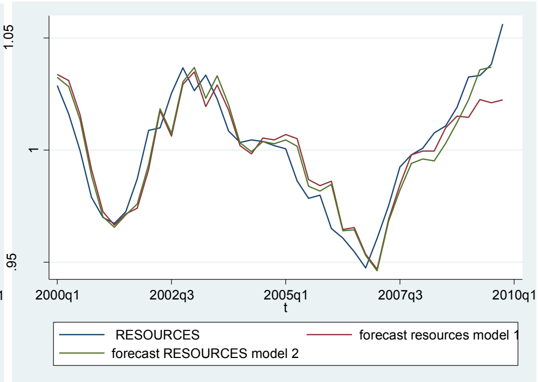


A4.2 VAR YGAP 1 Step Ahead (Forecast GDP)

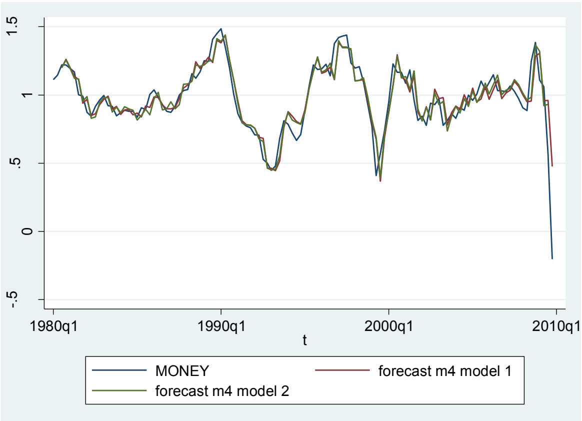


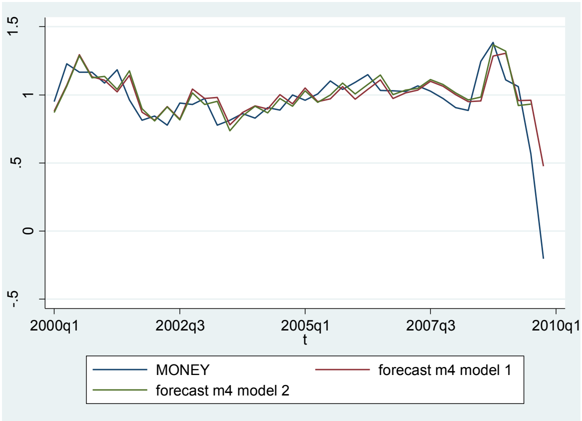
A4.3 VAR YGAP 1 Step Ahead (Forecast RESOURCES)



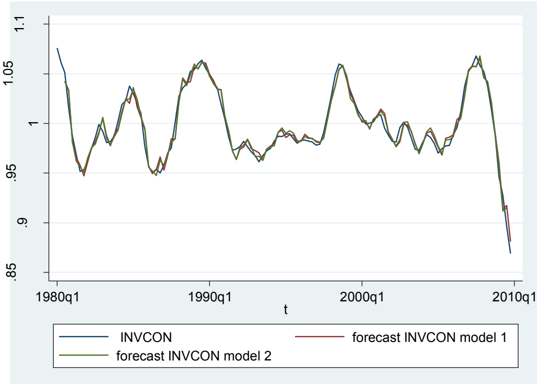


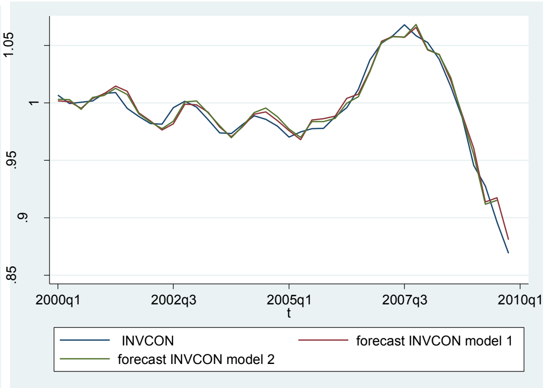
A4.4 VAR YGAP 1 Step Ahead (Forecast M4)





A4.5 VAR YGAP 1 Step Ahead (Forecast INVCON)





A5.0 Alternative VAR models

A5.1 SVAR YIELD

Relationship predicted by HTTC	Observed Relationship within the OIRFs (VAR)	Observed Relationship within the OIRFs (SVAR)
YIELD↓→M4↑	YIELD↓→M4↑	YIELD↓→M4↑
M4↑→RESOURCES↑	M4↑→RESOURCES↓	M4↑→RESOURCES↓
M4↑→INVCON↓	M4↑→INVCON↓	M4↑→INVCON↑
RESOURCES↑→↑GDP	RESOURCES↑→↑GDP	RESOURCES↑→↑GDP
INVCON↓→↑GDP	INVCON↓→↓GDP	INVCON↓→↓GDP
↑GDP → RESOURCES↑	↑GDP → RESOURCES↓	↑GDP → RESOURCES↓
↑GDP → INVCON↓	↑GDP → INVCON↑	↑GDP → INVCON↑
RESOURCES↑→YIELD↑	RESOURCES↑→YIELD↓	RESOURCES↑→YIELD↓
INVCON↓→ YIELD↑	INVCON↓→ YIELD↑	INVCON↓→ YIELD↑
YIELD↑→ GDP↓	YIELD↑→ GDP↓	YIELD↑→ GDP↓

A5.2 SVAR YGAP

Relationship predicted by HTTC	Observed Relationship within the OIRFs (VAR)	Observed Relationship within the OIRFs (SVAR)
YIELD↓→M4↑	YGAP↑→M4↑	YGAP↑→M4↑
M4↑→RESOURCES↑	M4↑→RESOURCES↓	M4↑→RESOURCES↓
M4↑→INVCON↓	M4↑→INVCON↑	M4↑→INVCON↑
RESOURCES↑→↑GDP	RESOURCES↑→↑GDP	RESOURCES↑→↑GDP
INVCON↓→↑GDP	INVCON↓→GDP↑	INVCON↓→GDP↑
↑GDP → RESOURCES↑	↑GDP → RESOURCES↓	↑GDP → RESOURCES↓

↑GDP → INVCON↓	↑GDP → INVCON↑	↑GDP → INVCON↑
RESOURCES↑→YIELD↑	RESOURCES↑→YGAP↑	RESOURCES↑→YGAP↑
INVCON↓→ YIELD↑	INVCON↓→YGAP↓	INVCON↓→YGAP↓
YIELD↑→ GDP↓	YGAP↓→GDP↓	YGAP↓→GDP↓

A5.3 VAR Base Rate

Observed Relationship within the OIRFs (VAR YIELD)	Observed Relationship within the OIRFs (VAR YGAP)	Observed Relationship within the OIRFs (VAR Base Rate)
YIELD↓→M4↑	YGAP↑→M4↑	YGAP↑→M4↑
M4↑→RESOURCES↓	M4↑→RESOURCES↓	M4↑→RESOURCES↓
M4↑→INVCON↓	M4↑→INVCON↑	M4↑→INVCON↑
RESOURCES↑→↑GDP	RESOURCES↑→↑GDP	RESOURCES↑→↓GDP
INVCON↓→↓GDP	INVCON↓→GDP↑	INVCON↓→GDP↑
↑GDP → RESOURCES↓	↑GDP → RESOURCES↓	↑GDP → RESOURCES↓
↑GDP → INVCON↑	↑GDP → INVCON↑	↑GDP → INVCON↑
RESOURCES↑→YIELD↓	RESOURCES↑→YGAP↑	RESOURCES↑→YGAP↑
INVCON↓→ YIELD↑	INVCON↓→YGAP↓	INVCON↓→YGAP↓
YIELD↑→ GDP↓	YGAP↓→GDP↓	YGAP↓→GDP↓

A5.4 VAR GDP GAP

Relationship predicted by HTTC	Observed Relationship within the OIRFs - VAR YIELD GDP GAP	Observed Relationship within the OIRFs – VAR YGAP GDP GAP
YIELD↓→M4↑	YIELD↓→M4↑	YGAP↑→M4↑
M4↑→RESOURCES↑	M4↑→RESOURCES↓	M4↑→RESOURCES↑
M4↑→INVCON↓	M4↑→INVCON↑	M4↑→INVCON↓
RESOURCES↑→↑GDP	RESOURCES↑→↑GDP	RESOURCES↑→↓GDP
INVCON↓→↑GDP	INVCON↓→↓GDP	INVCON↓→GDP↑
↑GDP → RESOURCES↑	↑GDP → RESOURCES↓	↑GDP → RESOURCES↓
↑GDP → INVCON↓	↑GDP → INVCON↑	↑GDP → INVCON↑
RESOURCES↑→YIELD↑	RESOURCES↑→YIELD↓	RESOURCES↑→YGAP↑
INVCON↓→ YIELD↑	INVCON↓→ YIELD↑	INVCON↓→YGAP↑
YIELD↑→ GDP↓	YIELD↑→ GDP↓	YGAP↓→GDP↓

A6.0 Orthogonalised Impulse Response Function Results

Horizon	Impulse (GDP), Response (GDP)	Impulse (GDP), Response (YIELD)	Impulse (GDP), Response (RESOURCES)	Impulse (GDP), Response (M4)	Impulse (GDP), Response (INVCON)	Impulse (YIELD), Response (GDP)	Impulse (YIELD), Response (YIELD)	Impulse (YIELD), Response (RESOURCES)	Impulse (YIELD), Response (M4)	Impulse (YIELD), Response (INVCON)
0	0.001742	0.010509	0.000408	0.004025	0.001966	0	0.032092	-0.001807	0.009688	0.001354
1	0.003232	0.021751	0.00009	0.015025	0.005014	3.60E-06	0.053652	-0.002602	0.025496	0.001785
2	0.004325	0.03188	-0.001072	0.036765	0.008224	-0.000032	0.062308	-0.002479	0.034972	0.001816
3	0.00494	0.038908	-0.00275	0.061602	0.010791	-0.000117	0.058636	-0.001839	0.03435	0.001822
4	0.005078	0.041527	-0.00457	0.080587	0.012262	-0.000242	0.04539	-0.001046	0.024516	0.001933
5	0.004798	0.039437	-0.006234	0.088415	0.012531	-0.000383	0.026558	-0.000312	0.008457	0.00208
6	0.004193	0.033284	-0.007538	0.084293	0.011733	-0.000515	0.0064	0.000292	-0.010079	0.002099
7	0.003368	0.024365	-0.008349	0.070667	0.010116	-0.000612	-0.011372	0.000779	-0.027334	0.001842
8	0.002424	0.014252	-0.008597	0.051425	0.007953	-0.000658	-0.024166	0.001193	-0.040115	0.001243
9	0.001451	0.004443	-0.00827	0.030447	0.005495	-0.000646	-0.030774	0.001563	-0.046289	0.000341
10	0.000524	-0.00389	-0.007416	0.010794	0.002958	-0.000583	-0.031325	0.001892	-0.045128	-0.000731
11	-0.000301	-0.010031	-0.006132	-0.005561	0.000527	-0.000485	-0.026998	0.002154	-0.037367	-0.001791
12	-0.000982	-0.013738	-0.004554	-0.017679	-0.001642	-0.00037	-0.019584	0.002305	-0.024951	-0.002655
13	-0.001496	-0.01517	-0.002836	-0.025428	-0.003424	-0.000256	-0.011026	0.002305	-0.010528	-0.003176
14	-0.001833	-0.014764	-0.001132	-0.029242	-0.004728	-0.000156	-0.003016	0.002129	0.003178	-0.003273
15	-0.001996	-0.013088	0.000423	-0.029874	-0.005504	-0.000073	0.003267	0.001782	0.013936	-0.002945
16	-0.002	-0.010712	0.001725	-0.0282	-0.00575	-6.70E-06	0.00726	0.001297	0.020399	-0.00226
17	-0.001867	-0.008116	0.002706	-0.025061	-0.005508	0.000048	0.008975	0.000733	0.022251	-0.00134
18	-0.001626	-0.005636	0.003338	-0.021157	-0.00486	0.000098	0.008846	0.00016	0.020103	-0.000333
19	-0.001306	-0.003459	0.003628	-0.016989	-0.003915	0.000147	0.007531	-0.000355	0.01521	0.000615
20	-0.000939	-0.001645	0.003611	-0.01286	-0.002795	0.000198	0.005711	-0.000755	0.009102	0.001385

A6.1 VAR YIELD

Horizon	Impulse (GDP), Response (GDP)	Impulse (GDP), Response (YIELD)	Impulse (GDP), Response (RESOURCES)	Impulse (GDP), Response (M4)	Impulse (GDP), Response (INVCON)	Impulse (YIELD), Response (GDP)	Impulse (YIELD), Response (YIELD)	Impulse (YIELD), Response (RESOURCES)	Impulse (YIELD), Response (M4)	Impulse (YIELD), Response (INVCON)
0	0.001742	0.010509	0.000408	0.004025	0.001966	0	0.032092	-0.001807	0.009688	0.001354
1	0.003232	0.021751	0.00009	0.015025	0.005014	3.60E-06	0.053652	-0.002602	0.025496	0.001785
2	0.004325	0.03188	-0.001072	0.036765	0.008224	-0.000032	0.062308	-0.002479	0.034972	0.001816
3	0.00494	0.038908	-0.00275	0.061602	0.010791	-0.000117	0.058636	-0.001839	0.03435	0.001822
4	0.005078	0.041527	-0.00457	0.080587	0.012262	-0.000242	0.04539	-0.001046	0.024516	0.001933
5	0.004798	0.039437	-0.006234	0.088415	0.012531	-0.000383	0.026558	-0.000312	0.008457	0.00208
6	0.004193	0.033284	-0.007538	0.084293	0.011733	-0.000515	0.0064	0.000292	-0.010079	0.002099
7	0.003368	0.024365	-0.008349	0.070667	0.010116	-0.000612	-0.011372	0.000779	-0.027334	0.001842
8	0.002424	0.014252	-0.008597	0.051425	0.007953	-0.000658	-0.024166	0.001193	-0.040115	0.001243
9	0.001451	0.004443	-0.00827	0.030447	0.005495	-0.000646	-0.030774	0.001563	-0.046289	0.000341
10	0.000524	-0.00389	-0.007416	0.010794	0.002958	-0.000583	-0.031325	0.001892	-0.045128	-0.000731
11	-0.000301	-0.010031	-0.006132	-0.005561	0.000527	-0.000485	-0.026998	0.002154	-0.037367	-0.001791
12	-0.000982	-0.013738	-0.004554	-0.017679	-0.001642	-0.00037	-0.019584	0.002305	-0.024951	-0.002655
13	-0.001496	-0.01517	-0.002836	-0.025428	-0.003424	-0.000256	-0.011026	0.002305	-0.010528	-0.003176
14	-0.001833	-0.014764	-0.001132	-0.029242	-0.004728	-0.000156	-0.003016	0.002129	0.003178	-0.003273
15	-0.001996	-0.013088	0.000423	-0.029874	-0.005504	-0.000073	0.003267	0.001782	0.013936	-0.002945
16	-0.002	-0.010712	0.001725	-0.0282	-0.00575	-6.70E-06	0.00726	0.001297	0.020399	-0.00226
17	-0.001867	-0.008116	0.002706	-0.025061	-0.005508	0.000048	0.008975	0.000733	0.022251	-0.00134
18	-0.001626	-0.005636	0.003338	-0.021157	-0.00486	0.000098	0.008846	0.00016	0.020103	-0.000333
19	-0.001306	-0.003459	0.003628	-0.016989	-0.003915	0.000147	0.007531	-0.000355	0.01521	0.000615
20	-0.000939	-0.001645	0.003611	-0.01286	-0.002795	0.000198	0.005711	-0.000755	0.009102	0.001385

Horizon	Impulse (RES), Response (GDP)	Impulse (RES), Response (YIELD)	Impulse (RES), Response (RES)	Impulse (RES), Response (M4)	Impulse (RES), Response (INVCON)	Impulse (M4), Response (GDP)	Impulse (M4), Response (YIELD)	Impulse (M4), Response (RES)	Impulse (M4), Response (M4)	Impulse (M4), Response (INVCON)
0	0	0	0.010288	-0.012909	-0.000743	0	0	0	0.100405	0.001297
1	-0.000061	-0.000919	0.013938	-0.00192	-0.00192	-0.000035	-0.002897	0.000899	0.103075	0.001104
2	-0.00022	-0.005048	0.014044	0.012542	-0.003392	0.000109	-0.005133	0.001125	0.064882	0.000964
3	-0.000438	-0.012054	0.012394	0.02014	-0.004734	0.000432	-0.004783	0.000531	0.024705	0.00142
4	-0.000654	-0.020051	0.00999	0.018965	-0.005574	0.000839	-0.00155	-0.000483	0.000203	0.00235
5	-0.000809	-0.026681	0.007408	0.011729	-0.005743	0.001218	0.003678	-0.001489	-0.006451	0.003371
6	-0.000863	-0.029985	0.004992	0.002513	-0.005279	0.001486	0.009432	-0.002237	-0.00084	0.004132
7	-0.000801	-0.028916	0.002943	-0.005176	-0.004354	0.001602	0.014224	-0.002666	0.00972	0.004453
8	-0.000633	-0.023517	0.001354	-0.009197	-0.003179	0.001563	0.016949	-0.002827	0.019452	0.00432
9	-0.000383	-0.01479	0.000233	-0.00887	-0.00194	0.00139	0.017089	-0.00281	0.025142	0.003829
10	-0.000089	-0.004371	-0.000477	-0.004728	-0.000764	0.001116	0.014739	-0.002689	0.02585	0.003116
11	0.000208	0.005888	-0.000873	0.001871	0.00028	0.000782	0.010485	-0.002505	0.022161	0.002302
12	0.000471	0.014326	-0.001062	0.009177	0.001162	0.000427	0.005214	-0.002267	0.015433	0.001474
13	0.000669	0.019774	-0.001141	0.015464	0.001873	0.000086	-0.000113	-0.001969	0.007266	0.000684
14	0.000786	0.021725	-0.00118	0.019394	0.002404	-0.000214	-0.004657	-0.001602	-0.000849	-0.000041
15	0.000817	0.020339	-0.001215	0.020248	0.002743	-0.000452	-0.007836	-0.001169	-0.007724	-0.000683
16	0.000771	0.01632	-0.001254	0.018018	0.002874	-0.000618	-0.009396	-0.000687	-0.012576	-0.001223
17	0.000663	0.010704	-0.001282	0.013328	0.002787	-0.00071	-0.009399	-0.000186	-0.015067	-0.00164
18	0.000514	0.004625	-0.001273	0.007233	0.002484	-0.000734	-0.008152	0.000295	-0.015282	-0.001913
19	0.000344	-0.00091	-0.001204	0.00094	0.001989	-0.000699	-0.006112	0.000716	-0.013638	-0.002027
20	0.000172	-0.005171	-0.001062	-0.004454	0.001348	-0.00062	-0.003768	0.001042	-0.010766	-0.001977

Horizon	Impulse (INVCON), Response (GDP)	Impulse (INVCON), Response (YIELD)	Impulse (INVCON), Response (RES)	Impulse (INVCON), Response (M4)	Impulse (INVCON), Response (INVCON)
0	0	0	0	0	0.006318
1	2.00E-06	0.002263	-0.000456	-0.001389	0.008998
2	0.000045	0.005139	-0.000549	-0.010297	0.008837
3	0.000134	0.007534	-0.000196	-0.021189	0.007012
4	0.000234	0.00865	0.00043	-0.027322	0.004558
5	0.000293	0.007967	0.001114	-0.02584	0.002162
6	0.000274	0.005348	0.001685	-0.018225	0.00018
7	0.000167	0.001111	0.002036	-0.008309	-0.001271
8	-7.90E-06	-0.004013	0.002129	0.000061	-0.002207
9	-0.000213	-0.009039	0.001985	0.004563	-0.002705
10	-0.000403	-0.012965	0.001669	0.004828	-0.002857
11	-0.000541	-0.015015	0.001269	0.002019	-0.002753
12	-0.000604	-0.014808	0.00087	-0.001975	-0.002468
13	-0.000586	-0.012431	0.000537	-0.005342	-0.002065
14	-0.000496	-0.008387	0.000302	-0.006881	-0.001594
15	-0.000355	-0.003461	0.000168	-0.006214	-0.001092
16	-0.000189	0.001466	0.00011	-0.003694	-0.000585
17	-0.000021	0.005599	0.000093	-0.000153	-0.000096
18	0.000127	0.008373	0.00008	0.003425	0.000353
19	0.000241	0.009534	0.000047	0.00619	0.000742
20	0.000315	0.009138	-0.00002	0.007609	0.001049

A6.2 VAR YGAP

Horizon	Impulse (GDP), Response (GDP)	Impulse (GDP), Response (YGAP)	Impulse (GDP), Response (RESOURCES)	Impulse (GDP), Response (M4)	Impulse (GDP), Response (INVCON)	Impulse (YGAP), Response (GDP)	Impulse (YGAP), Response (YIELD)	Impulse (YGAP), Response (RESOURCES)	Impulse (YGAP), Response (M4)	Impulse (YGAP), Response (INVCON)
0	0.001745	-0.037513	0.000298	-0.000192	0.001753	0	0.823639	0.000192	-0.010947	0.000999
1	0.003209	-0.150146	0.000136	0.00378	0.004218	0.000089	0.612264	0.000909	-0.022793	0.000175
2	0.004241	-0.214027	-0.000846	0.017557	0.00677	0.000136	0.387281	0.000897	-0.005378	0.000382
3	0.004771	-0.251767	-0.002305	0.033672	0.008556	0.000114	0.225018	0.00079	0.012063	0.000681
4	0.004808	-0.27534	-0.003915	0.047744	0.009256	0.000064	0.11492	0.000676	0.020666	0.000819
5	0.004412	-0.285364	-0.005397	0.05735	0.0089	0.000026	0.043261	0.000507	0.021472	0.000861
6	0.003679	-0.279541	-0.006545	0.061311	0.007698	0.000023	-0.001348	0.000277	0.017781	0.000894
7	0.002727	-0.257011	-0.007226	0.059458	0.005941	0.000056	-0.027716	0.000023	0.012462	0.000954
8	0.001675	-0.219548	-0.007384	0.052439	0.00393	0.000117	-0.042118	-0.000208	0.007358	0.001032
9	0.000635	-0.17114	-0.007027	0.041464	0.001928	0.000187	-0.048682	-0.000383	0.003393	0.001097
10	-0.000298	-0.11696	-0.006214	0.028043	0.000135	0.00025	-0.04996	-0.000489	0.00084	0.001113
11	-0.001057	-0.062321	-0.005045	0.013748	-0.001315	0.000293	-0.047512	-0.000531	-0.000414	0.001061
12	-0.001599	-0.01186	-0.003642	0.000029	-0.002358	0.000308	-0.042366	-0.000524	-0.000679	0.000932
13	-0.001911	0.030936	-0.002137	-0.011916	-0.002985	0.000291	-0.035318	-0.000485	-0.00032	0.000738
14	-0.002001	0.063917	-0.000658	-0.021223	-0.003231	0.000245	-0.027092	-0.000429	0.000318	0.0005
15	-0.0019	0.086214	0.000681	-0.027394	-0.003159	0.000176	-0.018396	-0.000368	0.000957	0.000246
16	-0.001648	0.098049	0.001787	-0.030291	-0.002844	0.000094	-0.009905	-0.000307	0.001404	2.40E-06
17	-0.001294	0.100465	0.002601	-0.0301	-0.00237	9.00E-06	-0.002216	-0.000247	0.001557	-0.000206
18	-0.000888	0.095048	0.003093	-0.027268	-0.001809	-0.00007	0.004201	-0.000187	0.001392	-0.000362
19	-0.000477	0.083662	0.003264	-0.022427	-0.001227	-0.000134	0.009037	-0.000126	0.000949	-0.000458
20	-0.000098	0.068241	0.003143	-0.016308	-0.000674	-0.000179	0.012166	-0.000063	0.000313	-0.000492

Horizon	Impulse (RES), Response (GDP)	Impulse (RES), Response (YGAP)	Impulse (RES), Response (RES)	Impulse (RES), Response (M4)	Impulse (RES), Response (INVCON)	Impulse (M4), Response (GDP)	Impulse (M4), Response (YGAP)	Impulse (M4), Response (RES)	Impulse (M4), Response (M4)	Impulse (M4), Response (INVCON)
0	0	0	0.010431	-0.007067	-0.000638	0	0	0	0.087919	0.000381
1	-0.000113	0.172004	0.014206	0.000975	-0.001613	8.60E-06	-0.100909	0.001272	0.083152	-0.000733
2	-0.000282	0.259347	0.014431	0.006158	-0.00322	0.000154	-0.131996	0.001534	0.061002	-0.0008
3	-0.000455	0.28094	0.0127	0.011379	-0.004609	0.000412	-0.129804	0.000912	0.039574	0.000038
4	-0.000593	0.26582	0.0101	0.016228	-0.005323	0.000719	-0.124413	-0.000126	0.023966	0.001306
5	-0.000664	0.230907	0.007317	0.01942	-0.00523	0.00101	-0.125924	-0.001188	0.014556	0.002576
6	-0.000648	0.184812	0.004741	0.020281	-0.004405	0.00123	-0.133016	-0.002043	0.00993	0.003548
7	-0.000537	0.132351	0.002566	0.018902	-0.003051	0.001348	-0.14034	-0.002601	0.008317	0.004067
8	-0.000343	0.077248	0.000868	0.015868	-0.001422	0.001348	-0.142749	-0.002864	0.008209	0.004093
9	-0.000086	0.023259	-0.000356	0.011981	0.000226	0.001233	-0.137109	-0.002879	0.00855	0.003682
10	0.0002	-0.025768	-0.001154	0.008033	0.001677	0.001021	-0.122654	-0.002711	0.008692	0.002941
11	0.000479	-0.066325	-0.0016	0.004666	0.002777	0.000738	-0.100578	-0.002417	0.008305	0.002005
12	0.000717	-0.095774	-0.001778	0.002293	0.003442	0.000416	-0.073345	-0.002045	0.00727	0.001008
13	0.000883	-0.112731	-0.001771	0.001075	0.003657	0.000088	-0.043971	-0.001631	0.005611	0.000067
14	0.000961	-0.117205	-0.001652	0.000935	0.003463	-0.000215	-0.015426	-0.001199	0.003447	-0.000727
15	0.000942	-0.110487	-0.001478	0.001612	0.002943	-0.000466	0.009797	-0.000768	0.00096	-0.001318
16	0.000833	-0.094858	-0.001287	0.002733	0.002203	-0.000649	0.02992	-0.000354	-0.001626	-0.001681
17	0.00065	-0.073195	-0.001101	0.003894	0.001358	-0.000752	0.043973	0.000029	-0.004074	-0.001821
18	0.000417	-0.048558	-0.000928	0.004734	0.000513	-0.000776	0.051758	0.000367	-0.006157	-0.001765
19	0.000161	-0.023817	-0.000765	0.004991	-0.000241	-0.000727	0.05372	0.000648	-0.007682	-0.001554
20	-0.000088	-0.001363	-0.000606	0.004538	-0.000843	-0.000618	0.050779	0.00086	-0.008516	-0.001238

Horizon	Impulse (INVCON), Response (GDP)	Impulse (INVCON), Response (YGAP)	Impulse (INVCON), Response (RES)	Impulse (INVCON), Response (M4)	Impulse (INVCON), Response (INVCON)
0	0	0	0	0	0.006151
1	4.00E-06	-0.00255	-0.000444	-0.001453	0.008762
2	0.000034	-0.0592	-0.000475	-0.008224	0.0087
3	0.00008	-0.111091	-0.000088	-0.015166	0.007157
4	0.000117	-0.130258	0.000559	-0.02005	0.00494
5	0.000121	-0.114591	0.001265	-0.021998	0.00258
6	0.000077	-0.074257	0.00186	-0.020907	0.000421
7	-0.000016	-0.022723	0.00224	-0.017317	-0.001339
8	-0.000149	0.02803	0.002373	-0.012215	-0.002602
9	-0.0003	0.069508	0.00228	-0.006744	-0.003346
10	-0.000445	0.097058	0.002017	-0.001917	-0.003605
11	-0.000556	0.109366	0.001653	0.001575	-0.003447
12	-0.000615	0.107609	0.001256	0.003442	-0.002964
13	-0.000608	0.094557	0.000879	0.003767	-0.002261
14	-0.000536	0.07378	0.000559	0.002912	-0.001446
15	-0.000406	0.049	0.000313	0.001387	-0.000619
16	-0.000236	0.023622	0.000142	-0.000277	0.000135
17	-0.000046	0.000429	0.000034	-0.001634	0.000752
18	0.000138	-0.01859	-0.000031	-0.002383	0.00119
19	0.000297	-0.032278	-0.000071	-0.0024	0.001434
20	0.000414	-0.040266	-0.000105	-0.001729	0.001492

A6.3 VECM

Horizon	Impulse (lnGDP), Response (lnGDP)	Impulse (lnGDP), Response (CYGAP)	Impulse (lnGDP), Response (M4)	Impulse (lnGDP), Response (RES)	Impulse (lnGDP), Response (INVCON)	Impulse (CYGAP), Response (lnGDP)	Impulse (CYGAP), Response (CYGAP)	Impulse (CYGAP), Response (M4)	Impulse (CYGAP), Response (RES)	Impulse (CYGAP), Response (INVCON)
0	0.005193	-0.037543	-2346.75	0.004847	0.000138	0	0.889891	772.596	0.022875	-0.000544
1	0.007545	-0.052212	-1508.07	0.006725	0.00124	0.000504	1.59669	374.667	0.003845	0.000326
2	0.008788	-0.150596	-304.12	-0.002081	0.001929	0.001717	2.08148	-63.3325	-0.005223	0.00069
3	0.009299	-0.29954	-182.903	-0.014493	0.002343	0.003053	2.39879	741.09	-0.008572	0.001262
4	0.009547	-0.479942	-630.233	-0.02828	0.002557	0.004163	2.57792	2020.63	-0.011196	0.001832
5	0.009786	-0.689652	-825.655	-0.039892	0.002714	0.004858	2.66551	2729.8	-0.016023	0.002273
6	0.01002	-0.927075	-524.7	-0.048874	0.002886	0.005257	2.69695	2707.92	-0.023064	0.002544
7	0.010145	-1.18159	-71.233	-0.056631	0.003048	0.005562	2.68759	2475.82	-0.030144	0.002714

8	0.010121	-1.43771	159.143	-0.064372	0.003152	0.005862	2.64149	2497.27	-0.035796	0.002867
9	0.010003	-1.68414	121.422	-0.072071	0.003191	0.006122	2.56404	2782.41	-0.040222	0.003023
10	0.009868	-1.9172	13.6024	-0.079018	0.003193	0.006279	2.46582	3067.65	-0.044386	0.003156
11	0.009749	-2.13733	0.737832	-0.084784	0.003189	0.006333	2.35823	3173.24	-0.048782	0.003242
12	0.009631	-2.34447	80.1692	-0.089547	0.003189	0.00633	2.24849	3138.54	-0.053152	0.003287
13	0.009495	-2.53673	154.775	-0.093733	0.003183	0.006315	2.13917	3100.65	-0.057022	0.003311
14	0.009339	-2.71204	162.903	-0.097576	0.003162	0.006298	2.03108	3131.75	-0.060231	0.003332
15	0.009181	-2.86984	122.738	-0.101031	0.00313	0.006268	1.92578	3201.39	-0.062961	0.003351
16	0.009036	-3.01119	84.9747	-0.103977	0.003096	0.006217	1.82561	3247.96	-0.06545	0.00336
17	0.008906	-3.1376	74.4149	-0.106409	0.003064	0.006149	1.73245	3249.6	-0.06777	0.003358
18	0.008786	-3.25018	78.6987	-0.108439	0.003034	0.006078	1.64697	3229.61	-0.069848	0.003348
19	0.008672	-3.34962	75.5142	-0.110187	0.003006	0.006012	1.56892	3217.91	-0.071617	0.003336
20	0.008564	-3.43666	57.7709	-0.111708	0.002976	0.00595	1.49789	3221.84	-0.073094	0.003325

Horizon	Impulse (M4), Response (lnGDP)	Impulse (M4), Response (CYGAP)	Impulse (M4), Response (M4)	Impulse (M4), Response (RES)	Impulse (M4), Response (INVCON)	Impulse (RES), Response (lnGDP)	Impulse (RES), Response (CYGAP)	Impulse (RES), Response (M4)	Impulse (RES), Response (RES)	Impulse (RES), Response (INVCON)
0	0	0	9766.87	-0.010173	0.000375	0	0	0	0.068358	-0.000606
1	-0.002203	0.131714	6764.48	-0.013146	0.000096	-0.000544	0.071628	-120.836	0.048154	-1.20E-06
2	-0.0038	0.411553	312.287	-0.031354	-0.00085	-0.000697	0.105573	-1918.48	0.037777	-0.000239
3	-0.003702	0.697934	-2443.87	-0.031794	-0.001424	-0.000465	0.118001	-2555.71	0.032661	-0.000232
4	-0.002684	0.895747	-430.884	-0.017523	-0.001262	-0.000017	0.082293	-1794.67	0.032046	-0.000068
5	-0.001992	1.01905	2549.1	-0.0032	-0.000837	0.000262	0.013199	-821.001	0.031802	0.000143
6	-0.002049	1.13584	3349.6	0.001854	-0.00065	0.00027	-0.062985	-547.309	0.029063	0.000255
7	-0.002406	1.28219	2105.32	0.000151	-0.000773	0.000162	-0.131644	-894.028	0.024743	0.000256
8	-0.002514	1.44148	781.386	-0.001014	-0.000956	0.000109	-0.195119	-1254.24	0.021041	0.000227
9	-0.002274	1.58071	626.739	0.001824	-0.000992	0.000143	-0.261088	-1263.41	0.018925	0.000232
10	-0.001947	1.68749	1314.5	0.006704	-0.000888	0.000187	-0.331383	-1034.39	0.017728	0.00027
11	-0.001774	1.77345	1878.3	0.010269	-0.000776	0.000175	-0.401241	-859.288	0.016417	0.000302
12	-0.00176	1.85431	1858.08	0.011451	-0.000741	0.000112	-0.465341	-867.334	0.014675	0.000306
13	-0.00177	1.93441	1517.59	0.011557	-0.000763	0.000042	-0.522248	-970.937	0.012892	0.000289
14	-0.001706	2.008	1308.94	0.012141	-0.000777	-4.10E-06	-0.573753	-1032.99	0.011507	0.000273
15	-0.001585	2.06935	1380.54	0.013499	-0.000754	-0.000032	-0.62172	-1012.2	0.010567	0.000267
16	-0.001476	2.11872	1563.18	0.014934	-0.000711	-0.000061	-0.666294	-961.762	0.009832	0.000266
17	-0.001416	2.16046	1653.67	0.015817	-0.000678	-0.000101	-0.70653	-941.829	0.009095	0.000262
18	-0.001387	2.19804	1615.19	0.016159	-0.000665	-0.000146	-0.741851	-961.049	0.008346	0.000251
19	-0.001357	2.23189	1543.77	0.016359	-0.000661	-0.000186	-0.772639	-989.151	0.007688	0.000239
20	-0.001313	2.26087	1526.28	0.016696	-0.000653	-0.000217	-0.799742	-1000.27	0.007188	0.000229

Horizon	Impulse (INVCON), Response (lnGDP)	Impulse (INVCON), Response (CYGAP)	Impulse (INVCON), Response (M4)	Impulse (INVCON), Response (RES)	Impulse (INVCON), Response (INVCON)
0	0	0	0	0	0.005077
1	0.001003	-0.177697	342.312	-0.005778	0.00436
2	0.000907	-0.266197	-193.655	-0.00358	0.004498
3	0.000808	-0.333529	-662.476	-0.007408	0.004428
4	0.000776	-0.391311	-876.119	-0.00889	0.004383
5	0.000795	-0.447787	-733.795	-0.009417	0.004388
6	0.000787	-0.502814	-526.382	-0.00974	0.004408
7	0.000727	-0.551807	-475.62	-0.010551	0.004409
8	0.000648	-0.592604	-569.702	-0.011675	0.004388
9	0.000591	-0.626781	-668.406	-0.012611	0.004363
10	0.000562	-0.657083	-683.984	-0.013133	0.004348
11	0.000543	-0.684789	-640.566	-0.013401	0.004344
12	0.000516	-0.709489	-606.655	-0.013667	0.004341
13	0.000483	-0.730496	-614.15	-0.014017	0.004333
14	0.000451	-0.747927	-643.762	-0.01437	0.004322
15	0.000428	-0.762586	-663.388	-0.014625	0.004312
16	0.000412	-0.775245	-662.772	-0.014772	0.004306
17	0.000398	-0.786222	-654.089	-0.01487	0.004302
18	0.000383	-0.79552	-651.69	-0.014968	0.004297
19	0.000369	-0.803179	-658.041	-0.015073	0.004293
20	0.000357	-0.809427	-666.272	-0.015161	0.004288

A6.4 VECM Variance Decomposition

Horizon	Impulse (lnGDP), Response (lnGDP)	Impulse (lnGDP), Response (CYGAP)	Impulse (lnGDP), Response (M4)	Impulse (lnGDP), Response (RES)	Impulse (lnGDP), Response (INVCON)	Impulse (CYGAP), Response (lnGDP)	Impulse (CYGAP), Response (CYGAP)	Impulse (CYGAP), Response (M4)	Impulse (CYGAP), Response (RES)	Impulse (CYGAP), Response (INVCON)
0	0	0	0	0	0	0	0	0	0	0
1	1	0.001777	0.054261	0.004414	0.000719	0	0.998223	0.005881	0.098301	0.011122
2	0.929006	0.001217	0.051946	0.00869	0.032932	0.002811	0.982883	0.004922	0.068038	0.008512
3	0.865176	0.003349	0.051225	0.007049	0.072814	0.017201	0.9585	0.004823	0.054554	0.012129
4	0.834768	0.008058	0.047282	0.022154	0.106345	0.042235	0.928486	0.007717	0.049989	0.024407
5	0.820427	0.015555	0.047214	0.071631	0.131144	0.072312	0.900144	0.03055	0.05055	0.044171
6	0.809262	0.02643	0.046868	0.14795	0.15	0.099565	0.873343	0.06689	0.05648	0.066863
7	0.798546	0.041225	0.043865	0.230772	0.16567	0.12107	0.844413	0.095472	0.07078	0.087696
8	0.78739	0.059903	0.041605	0.308832	0.179228	0.138305	0.811036	0.118023	0.091922	0.10526
9	0.776275	0.081803	0.040138	0.378659	0.190376	0.153524	0.773532	0.140491	0.114169	0.120495
10	0.766241	0.106042	0.038506	0.438927	0.198923	0.167666	0.733747	0.166598	0.13363	0.134492
11	0.757657	0.13185	0.036588	0.48815	0.20529	0.18043	0.693425	0.19529	0.150033	0.147473
12	0.750402	0.158579	0.034583	0.526245	0.210139	0.191398	0.653545	0.222006	0.164629	0.159092
13	0.744156	0.185614	0.032846	0.555118	0.213982	0.200652	0.614593	0.245448	0.178161	0.169141
14	0.738618	0.212366	0.031459	0.577172	0.217048	0.208617	0.576983	0.266873	0.190448	0.177793
15	0.733662	0.238355	0.030222	0.594278	0.219411	0.215683	0.541156	0.287305	0.201129	0.185383
16	0.729268	0.263252	0.028995	0.60762	0.221149	0.222023	0.507479	0.306879	0.210226	0.192159
17	0.725417	0.286858	0.027783	0.617966	0.22239	0.227662	0.476149	0.325057	0.218089	0.198216
18	0.722047	0.309053	0.026647	0.625957	0.223268	0.23263	0.447199	0.34154	0.225073	0.203583
19	0.71907	0.329779	0.025618	0.63217	0.223879	0.237011	0.420562	0.356571	0.231361	0.208315
20	0.716412	0.349022	0.024681	0.637067	0.224274	0.240919	0.396136	0.370502	0.236998	0.212503

Horizon	Impulse (M4), Response (lnGDP)	Impulse (M4), Response (CYGAP)	Impulse (M4), Response (M4)	Impulse (M4), Response (RES)	Impulse (M4), Response (INVCON)	Impulse (RES), Response (lnGDP)	Impulse (RES), Response (CYGAP)	Impulse (RES), Response (M4)	Impulse (RES), Response (RES)	Impulse (RES), Response (INVCON)
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0.939858	0.019441	0.005298	0	0	0	0.877843	0.013826
2	0.053759	0.005103	0.942253	0.034938	0.003177	0.003273	0.001509	0.000097	0.884113	0.007781
3	0.103602	0.023323	0.918906	0.12153	0.01205	0.004193	0.002033	0.02404	0.812408	0.005863
4	0.111261	0.046593	0.880301	0.177657	0.028657	0.003362	0.002088	0.061151	0.742288	0.004726
5	0.097371	0.066195	0.838044	0.170491	0.03405	0.002416	0.001658	0.076454	0.695412	0.003662
6	0.082264	0.080804	0.802683	0.143153	0.031577	0.001985	0.001194	0.073652	0.637546	0.003063
7	0.072208	0.093254	0.782052	0.1181	0.028194	0.001701	0.001008	0.068302	0.563772	0.002857
8	0.06686	0.106038	0.761249	0.096758	0.026332	0.001439	0.001137	0.068335	0.48475	0.002689
9	0.063424	0.119667	0.735048	0.079065	0.025981	0.001234	0.001534	0.072542	0.409459	0.0025
10	0.059863	0.133196	0.705676	0.064696	0.025855	0.001092	0.002188	0.076087	0.343544	0.002358
11	0.056109	0.145601	0.677303	0.054036	0.025166	0.000996	0.003105	0.076501	0.288485	0.002298
12	0.052744	0.156553	0.6533	0.046551	0.024123	0.000918	0.004256	0.075053	0.243547	0.002295
13	0.050043	0.166256	0.63223	0.040887	0.023141	0.000843	0.005572	0.073887	0.207228	0.002296
14	0.04789	0.174968	0.611742	0.036316	0.022391	0.000776	0.006975	0.073762	0.1779	0.002276
15	0.046023	0.18277	0.591547	0.032714	0.021805	0.000719	0.008417	0.074104	0.154142	0.002242
16	0.044288	0.189627	0.572505	0.030034	0.02125	0.000672	0.009872	0.074148	0.1348	0.002208
17	0.042681	0.195537	0.555396	0.028091	0.020672	0.000633	0.011321	0.073733	0.118949	0.002179
18	0.041241	0.200591	0.540124	0.026608	0.020105	0.000603	0.012743	0.073192	0.105856	0.00215
19	0.039972	0.204922	0.526043	0.025385	0.019587	0.000581	0.014115	0.072838	0.094951	0.002119
20	0.038839	0.208652	0.512755	0.024348	0.019127	0.000568	0.015421	0.0727	0.085792	0.002083

Horizon	Impulse (INVCON), Response (lnGDP)	Impulse (INVCON), Response (CYGAP)	Impulse (INVCON), Response (M4)	Impulse (INVCON), Response (RES)	Impulse (INVCON), Response (INVCON)
0	0	0	0	0	0
1	0	0	0	0	0.969036
2	0.011151	0.009288	0.000782	0.004221	0.947599
3	0.009829	0.012795	0.001006	0.004458	0.897144
4	0.008374	0.014775	0.003549	0.00791	0.835865
5	0.007474	0.016448	0.007738	0.011915	0.786973
6	0.006924	0.01823	0.009907	0.014871	0.748497
7	0.006475	0.020101	0.010309	0.016577	0.715583
8	0.006007	0.021886	0.010788	0.017738	0.686491
9	0.005543	0.023464	0.011781	0.018647	0.660647

10	0.005139	0.024827	0.013133	0.019203	0.638372
11	0.004809	0.026019	0.014318	0.019296	0.619773
12	0.004538	0.027066	0.015058	0.019029	0.604351
13	0.004306	0.027965	0.01559	0.018607	0.59144
14	0.004099	0.028708	0.016164	0.018164	0.580492
15	0.003913	0.029303	0.016822	0.017737	0.571158
16	0.003749	0.02977	0.017473	0.017319	0.563234
17	0.003606	0.030135	0.01803	0.016905	0.556543
18	0.003479	0.030414	0.018497	0.016505	0.550894
19	0.003365	0.030622	0.018929	0.016133	0.546101
20	0.003262	0.030769	0.019362	0.015795	0.542013

A6.5 The Vector Error Correction Model

Cointegrating Relationships:

$\Delta lnGDP_t+0.0702253RESOURCES_t+0.1693787INVCON_t-0.0000055CYGAP_t-0.0055382-12.2349_t$

$\Delta CYGAP_t-0.001139M4_t-34.66767RESOURCES_t-106.1492INVCON_t-0.0344+107.2249_t$

(CE1)**	Coefficient	Standard Error	z-statistic
Constant	-12.2349		
RESOURCES	0.0702253	0.0230476	3.05**
INVCON	0.1693787	0.5050294	0.34
CYGAP	-0.000055	0.0004983	0.912
(CE2)***	Coefficient	Standard Error	z-statistic
Constant	107.2249		
M4	0.0001139	0.0001161	-9.59***
RESOURCES	34.66767	7.193088	-4.82***
INVCON	106.1492	157.6183	-0.67

Error correction process Summary Statistics

	Δ(In GDP)	Δ(CYGAP)	Δ(M4)	Δ(RESOURCES)	Δ(INVCON)
Disequilibrium adjustment terms	0.0095545	-5.803247	-57447.81	-2.153823	0.0406237
Standard Error	0.0263901	4.526736	51201.94	0.3708044	0.0262105
z-statistics	0.36	-1.28*	-1.12	-5.81***	1.55*
RMSE	0.005168	0.886511	10027.3	0.072618	0.005133
Chi^2	231.5926***	266.9428***	50.8464***	43.62896***	26.99449**
R-Square	0.6860	0.7158	0.3242	0.2916	0.2030
Mean of Dependant Variable	12.39417	15.13345	16492.37	1.870593	0.1783089
SD of Dependant Variable	0.2245884	12.8185	16679.74	0.532012	0.0204267
Logarithm of Likelihood Function	-314.684				
Akaike Information Criterion	6.304896				
Schwarz criterion	7.515526				

*,** and *** show statistical significance at the 10%, 5% and 1% level respectively

A7.0 Kuehn (2013) – Selected Empirical Studies of Hayekian Business Cycle Theory

Figure 1: Selected Empirical Studies of Hayekian Business Cycle Theory

	Credit condition variable	Capital structure variable	Business cycle variable
Reduced form analyses			
Callahan and Garrison (2003)	Federal funds rate	--	NASDAQ Composite
Mulligan (2005)	Commercial and industrial loans	Investment and consumption spending	--
Mulligan (2006)	Term spread	--	Real consumable output
Carilli and Dempster (2008)	Gap between natural and actual interest rates	--	Log real GDP
Schnabl and Hoffmann (2008)	Interest rates	--	National stock market indices
Bismans and Mougeot (2009)	Term spread	Price and expenditure ratios for consumption and investment	Real GDP gap
Hoffmann (2010)	Gap between natural and actual interest rates	--	Industrial production
Structural: classification of sectors			
Wainhouse (1984)	Commercial and industrial loans, interest rates	Price ratios for a variety of earlier and later producer and consumer goods	Sectoral output
Butos (1993)	Total reserves, commercial bank loans, interest rates	Production, capacity utilization, and employment ratios for durable and non-durable manufacturing	--
Hughes (1997)	Money supply growth	Bank loans by sector	--
Mulligan (2002)	Interest rates	Sectoral employment	--
Powell (2002)	Money supply, discount rate	Sectoral output	GDP growth, unemployment
le Roux and Ismail (2004)	Term spread, short term interest rates, money supply	Capacity utilization ratio for heavy and light industries	Real GDP growth
Young (2005)	Federal funds rate	Sectoral job reallocation	--
Cachanosky (2012)*	Exchange rate regime	Price ratio for traded and non-traded sector	--
Whittle (2012)*	Term spread, money supply	Sectoral employment	--
Structural: stage of process			
Keeler (2001)	Term spread, money supply	Capacity utilization ratio for primary and advanced processing	Real GDP gap
Lester and Wolff (2012)*	Unanticipated changes in the federal funds rate	Price ratios for four production stages	--
Structural: estimation of period of production			
Weber (2009)*	--	Classification of sectors and estimate of average roundaboutness	--
Young (2012)	Federal funds rate	Total industry output requirement	--

Notes: * indicates a paper authored by a doctoral student

A8.0 Thesis Summary Table

Table 113: Thesis Summary

Aims & Objectives	The thesis aims and objectives were to produce an empirical examination of an Austrian Business Cycle Theory appropriate for Hayekian economists, the Austrian School of Economic thought and the wider macroeconomic community. This could then contribute toward the development of a wider pluralist macroeconomics.
Specific Research Problem	To determine the relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle.
Method	The thesis provides an empirical examination of HTTC informed by the Austrian Empirical Literature (see Table 8). Firstly the thesis develops a testable model of Hayek's theory incorporating both a reduced form and structural analysis. The testable model is evaluated with both an OIRF and Granger Causality Analysis of variable relationships within two Vector-Auto Regression Models (using different Austrian proxies of expansionary monetary policy) and a Vector-Error Correction Model. Secondly the thesis evaluates key hypotheses concerning (1) the long term relationship between output and expansionary monetary policy and (2) the existence of endogenous turning points in the effect of expansionary monetary policy on output. All hypotheses are tested using techniques derived from the Austrian Empirical Literature.
Ensuring acceptance to Hayekian and Austrian Economists.	Within the rejection of scientism and the wider rejection of econometrics the thesis must balance the needs of empirical examination with the objective of Hayekian and Austrian School acceptance of the method. This acceptance is ensured by utilising reduced form VARs and Vector-Error Correction Models as justified through the small cannon of Austrian Econometric Literature. Likewise the hypothesis testing methods are derived from the literature. The combination of reduced form and structural analysis present in this thesis is a development on, but informed by the literature and an answer to a wider criticism (Kuehn 2013) of the Austrian Empirical Literature from within the wider macroeconomic community. The Austrian methodological issues of measurement error (as described in Mulligan 2006) presents a persistent issue

	of acceptance, particularly for the expansionary monetary policy proxy. This thesis creates variables informed by the advice of Keeler 2001, Mulligan 2006 and Carilli & Dempster 2008 as well as using two different interest rate proxies (both derived from the literature) to address this potential Austrian criticism.
Findings	Some support for Hayek's drivers of the boom and of the existence of endogenous turning points is found suggesting a partial relevance for Hayek's theory of the trade cycle for understanding the UK Business Cycle. However the key hypothesis of an inverse relationship between expansionary monetary policy and economic activity finds limited support querying the holistic relevance of the theory. The thesis suggests that Hayek's theory can provide some understanding of the UK Business Cycle and that this understanding could be incorporated into a pluralist macroeconomics.
Contribution to Knowledge	The thesis contributes to the literature by providing an evaluation of Hayek's theory of the trade cycle using a testable model and both reduced form and structural analysis. Furthermore the thesis provides a consideration of the relevance of Hayek's theory of the trade cycle for the UK Business Cycle addressing a gap in the Austrian Empirical Literature. The chosen analysis of a variety of models and tests also contributes to the Austrian methodological literature providing a comprehensive approach to the evaluation of Hayek's theory. The UK data used for the empirical evaluation does not feature in any of the reviewed literature and thus its use represents a further contribution toward the UK gap in the Austrian Econometric Literature.
Wider impact	The thesis determines that whilst there is strong support for the partial relevance of Hayek's theory of the trade cycle for understanding the UK Business Cycle, it does not provide complete understanding. Therefore, Hayek's theory could contribute to a wider macroeconomics and a pluralist economics. A pluralist economics is not a sole theory economics, but based on evidence based policy, the working aspects of various theories (including neo-classical) and a true relationship with the wider social sciences.

Policy Impact	The thesis discusses (11.3.6) that the presented empirical evaluation of Hayek's Theory of the Trade Cycle supports Hayek's view of the formulation of the boom resulting from a monetary policy intervention, though the examination of the UK timeseries data is less convincing of the bust aspect of the boom / bust theory. However the boom formation is of key importance for UK Policy makers. The UK's primary source of inflation stimulus is via the interest rate transmission mechanism model, however this model does not include the lengthening of the capital structure in its effects of an interest rate reduction. The evaluation of Hayek's Theory of the Trade Cycle presented in this thesis suggests that a lowering of the interest rate (below the natural rate) in the UK produces the expected stimulus to economic activity, but also fundamentally affects the capital structure. This lengthening of the capital structure effect should also be considered by Policymakers as a consequence of expansionary monetary policy.