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UNIVERSITY OF SOUTHAMPTON

FACULTY OF BUSINESS AND LAW

School of Business

Volume I of I

Credit creation, monetary policy and the macroeconomy:

three empirical studies

by

Joshua Jacob Ryan-Collins

Thesis for the degree of Doctor of Philosophy

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ABSTRACT

FACULTY OF BUSINESS AND LAW

School of Business

Thesis for the degree of Doctor of Philosophy

CREDIT CREATION, MONETARY POLICY AND THE MACROECONOMY: THREE EMPIRICAL STUDIES

Joshua Jacob Ryan-Collins

This thesis is composed of three empirical studies examining the relationship between credit creation, monetary policy and macroeconomic activity. It is motivated by the neglect of credit in mainstream macroeconomic theory and empirical work prior to the financial crisis of 2007-08.

The first study investigates the relationship between monetary policy and nominal GDP in the United Kingdom over 50 years using a new quarterly dataset. Different theories of the monetary transmission mechanism are tested using the ‘General-to-Specific’ (GETS) method. A long-run cointegrating relationship is found between a real economy credit growth variable and nominal output growth. Changes to short-term interest-rates and broad money growth fall out of the parsimonious model. Vector error correction and vector auto-regression (VAR) analysis finds one- way Granger causality from credit growth to nominal-GDP growth.

The second study examines evidence of a ‘credit cycle’ by analyzing the dynamic interlinkages between credit, house prices, monetary policy, and economic activity in nine advanced economies. Credit is decomposed in to ‘productive credit’ (bank lending to non-financial firms and for consumption) and ‘asset market credit’ (lending for domestic mortgages or financial assets). Country-level and panel VAR analysis finds: 1) a secular growth in asset market credit relative to productive credit; 2) productive credit growth has a stronger impact on real-GDP growth than asset-market credit although there is cross-country heterogeneity; (3) property prices strongly influence both credit growth aggregates and the macroeconomy; and (4) interest rates are more weakly linked to the other variables.

The third study considers the monetary financing of government expenditure by central-banks as a monetary policy tool. This is pertinent today given historically high private and public debt-to-GDP levels. A literature review finds little support for the standard claim that such activity leads to damaging inflation. A counter-example is presented via an institutional case study of the central bank of Canada during the period 1935-1975 when it monetised on average 25% of government debt to support fiscal expansion and economic growth. Econometric analysis also finds no evidence for a relationship between monetary financing and inflation.

The policy implications of the thesis are that: 1) credit growth plays a central role in the monetary policy transmission mechanism; 2) there is evidence of a credit cycle strongly related to house prices in advanced economies which may be strengthening over time; and 3) monetary financing of government deficits should be considered as a policy tool given high private debt levels and private banks’ turn towards asset market credit creation.

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DECLARATION OF AUTHORSHIP

I, JOSH RYAN-COLLINS

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

3 STUDIES ON THE RELATIONSHIP BETWEEN CREDIT CREATION, MONETARY POLICY AND THE MACROECONOMY

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. [Delete as appropriate] None of this work has been published before submission [or] Parts of this work have been published as: [please list references below]:

Signed:

Date:.....

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Definitions and Abbreviations

| | |
|-------|--|
| ARDL | Autoregressive Distributed Lag econometric model |
| BoE | Bank of England |
| BoJ | Bank of Japan |
| CBI | Central Bank Independence |
| CPI | Consumer price index |
| DGP | Data Generating Process |
| ECB | European Central Bank |
| ECM | Error Correction Model |
| EU | European Union |
| FE | Fixed effects (in panel data) |
| FPC | Financial Policy Committee (a body of the Bank of England concerned with macroprudential policy) |
| GDP | Gross Domestic Product |
| GETS | General to Specific econometric modelling methodology |
| GFC | Global Financial Crisis of 2007–2008 |
| GUM | General Unrestricted Model |
| IDB | Industrial Development Bank (of Canada) |
| IMF | International Monetary Fund |
| IRF | Impulse Response Function |
| LSAP | Large scale asset purchase |
| LTI | Loan-to-Income (ratio) |
| LTV | Loan-to-Value (ratio) |
| MPC | Monetary Policy Committee (Bank of England) |
| NMC | New Macroeconomic Consensus |
| NSA | Not-Seasonally Adjusted |
| OECD | Organisation for Economic and Cooperation and Development |
| OFCs | Other financial corporations |
| OIRF | Orthogonalised Impulse Response Function |
| ONS | Office of National Statistics (UK statistics body) |
| PNFCs | Private non-financial corporations |
| PVAR | Panel vector autogression |

| | |
|------|---|
| SMEs | Small and medium-sized enterprises |
| QE | Quantitative Easing |
| VAR | Vector autoregression |
| YoY | Year-on-Year (or four-quarter) growth rate |
| ZLB | Zero-Lower Bound (referring to the lower bound of interest rates) |

Chapter 1: Introduction

This thesis is an empirical examination of the relationship between credit creation, monetary policy and macroeconomic activity. It is motivated by the neglect of credit in mainstream macroeconomic theory and empirical work in the decades leading up to the financial crisis of 2007-08. The objectives of the thesis are to develop an improved understanding of how bank credit influences and interacts with economic growth, inflation, asset prices and the money supply; how monetary and macroprudential policies can influence these dynamics; and what lessons can be learned from particular periods in economic history in regard to these questions.

The thesis is made up of three empirical studies, along with this introduction and a conclusion. In all three studies, new historical datasets are constructed and applied econometrics techniques are used to investigate the dynamic relationships between macroeconomic variables. Close attention is paid throughout to the institutional and historical dynamics of the financial systems and financial structures under observation, including the policy regimes of the central bank. Whilst the focus is empirical and largely inductive, insights are drawn from economics traditions that place a strong emphasis on financial structure, money and credit. Schumpeter's 'credit theory of money' or 'productivist credit' is the guiding theoretical approach – i.e. that bank credit flows stimulate new economic activity and ultimately enable economic growth - allied with insights from post-keynesian monetary economics and its emphasis on uncertainty and disequilibrium states. In this introduction, the empirical chapters are summarised, the motivation for the thesis and main contribution is set out; a broad theoretical overview of the relevant literature is provided;¹ and the methodological approach adopted is described.

1.1 Summary of the thesis

The first study (Chapter 2) investigates the relationship between monetary policy and nominal GDP in the UK. It is motivated by the recent turn by central banks towards QE, generally framed as a policy aimed at boosting *nominal* demand in the economy via the expansion of the money supply and/or the lowering of medium and long term interest rates to engineer portfolio rebalancing towards real economy investment. Whilst most studies of QE have focused on relatively short-time periods, this thesis constructs a new quarterly dataset going back to 1963 of

¹ More in-depth literature reviews focusing on relevant empirical work are provided at the beginning of each of the three studies.

variables that proxy different theories of the monetary policy transmission mechanism: broad money (monetarism), short-term interest rates (standard New-Keynesian price theory), long-term interest rates (QE or ‘portfolio rebalancing’ theory) and a disaggregated ‘real economy’ credit measure (credit theory of money). These variables are included in a single-equation GETS model with nominal GDP as the dependent variable. Noting the importance of mortgage credit to support consumption in the UK since the liberalisation of credit markets in the 1970s, we incorporate both lending for consumption and mortgages but exclude credit extended to other financial corporations from our definition of credit. A General-to-Specific (GETS) equilibrium-correction model is estimated which finds evidence of a long-run cointegrating relationship between the credit growth variable and nominal output growth. Changes to short-term interest-rates and broad money growth fall out of the model. Vector Error Correction and VAR analysis finds real-economy credit growth to Granger cause and be strongly exogenous to nominal GDP growth. The findings thus support the credit theory of money approach over other candidate theories of the monetary transmission mechanism.

The second study (Chapter 3) extends aspects of the analysis in Chapter 2 by examining the dynamic interlinkages between monetary policy, credit, house prices, and economic activity in nine industrialised countries, using a quarterly panel data from 1990–2014. The study is motivated by the evidence in recent studies of a strong role for asset prices in a ‘credit’ or ‘financial’ cycle that may have greater macroeconomic importance than the traditional business cycle. To try and model such a cycle, bank credit is decomposed into ‘productive credit’ (bank lending to non-financial corporations and to households for consumption) and lending to asset markets (domestic real estate or financial assets) using a newly constructed dataset. This division is driven by the hypothesis that the latter form of credit creation may be more closely linked to asset price-changes and the financial cycle than the former.

Country-level and PVAR analysis is employed and finds: 1) a secular pattern of increasing credit being extended to existing asset markets rather than to non-financial firms across all countries; 2) within this overall pattern, considerable cross-country heterogeneity in the dynamic relations exists between the variables; (3) that property prices play a central role in impacting both the credit growth aggregates and the growth of real output and inflation across nearly all countries; and (4), that monetary policy (interest rates) is more weakly linked to the other variables and appears to have no impact on productive credit. The findings generally support a Schumpeter-Minsky type theoretical framework with a financial or credit cycle driven by asset prices. The recent focus by some central banks on supporting business credit and dampening asset markets via quantitative interventions is justified in the light of the findings.

The third chapter considers the monetary financing of government expenditure by central banks or commercial banks to boost demand and/or relieve debt burdens. It is motivated by the very high private and public debt levels currently existing in many advanced and emerging economies (Buttiglione *et al.*, 2014) which seem to limit traditional monetary- or fiscal-policy options, which require an increase in either private or public debt to stimulate demand. The standard objection to monetary financing is that it will be inflationary. The chapter first reviews the relevant historical and empirical evidence and finds little support for this claim. Instead, it is found that neo-classical and New Keynesian theoretical models of inflationary monetary financing rest on inaccurate conceptions of the modern endogenous money creation process. A counter-example is then presented in the activities of the central bank of Canada during the period 1935–1975 when, working with the Government, it engaged in significant direct or indirect monetary financing to support fiscal expansion, economic growth and industrialisation. An institutional case study of the period, complemented by a GETS econometric analysis, finds no correlation between monetary financing and inflation. The findings lend support to recent calls for explicit monetary financing to boost highly indebted economies and a more general rethink of the prohibition on monetary financing. The latter is itself a key tenet of the concept of central bank independence (CBI) which is itself an important plank of the NMC policy framework that dominated macroeconomics prior to the 2007–2008 crisis.

Finally, Chapter 5 draws together the key findings of the three preceding chapters and reflects on the questions they raise for research and policy.

1.2 Motivation: macroeconomics and monetary policy after the Financial Crisis

The Global Financial Crisis (GFC) of 2007–2008 led to a questioning of many aspects of macroeconomic theory and monetary policy. Of particular concern was that the standard models used by economists and central banks to understand the economy failed to predict the crisis. One reason for this failure was that such models, typically employing Dynamic Stochastic General Equilibrium (DSGE) frameworks, did not adequately incorporate the financial sector and its key constituents: money, credit and banks.² Nobel laureate Joseph Stiglitz, for example, stated that:

² See for example Buiter (2009), Goodhart (2010b), Stiglitz (2011b), Adrian *et al.* (2012), Borio (2014), Jakab and Kumhof (2015)

This crisis, like so many earlier crises, was a credit crisis; but few of the macroeconomic models modeled credit; neither banks (perhaps particularly surprising in models used by central banks) nor securitisation was typically incorporated into the analysis. (Stiglitz, 2011a)

In contrast, economists that did explicitly include stocks and flows of credit and debt in their models fared better in predicting the crisis (Bezemer, 2009a). Indeed, the crisis seemed better explained by older traditions in macroeconomics, which emphasise the role of credit, financial cycles and disequilibrium states. These traditions include the work of Joseph Schumpeter (1983[1911], 2004 [1939]), the 1930s Chicago School economists (Fisher, 1933, Simons, 1951 [1948]) and John Maynard Keynes (1930, 1936). Whilst the approaches of these scholars have been developed by a number of heterodox economists since, as discussed in Section 1.4, they were, until the crisis, neglected in the mainstream monetary economics literature (Turner, 2013a).

Pre-crisis monetary policy in advanced economies also reflected this absence of an independent or causal role for credit or monetary aggregates in the economy. Instead policy was focused on maintaining price stability via the targeting of inflation. This would best be achieved via alterations to the central bank rate (base rate) of interest in an attempt to guide the economy back to equilibrium following real-economy shocks. Monetary policy was not in general influenced by the flows or stocks of credit and corresponding leverage building up in the financial system (Borio and Lowe, 2004). Tools that had previously been used to influence credit quantities were abandoned during the 1980s (Goodhart, 1989: 157-160, Werner, 2005: 268-270), as were attempts to control asset prices, even when there was evidence that they had attained levels beyond fundamentals (see e.g. Bernanke and Gertler, 2001).

Monetary policy since the GFC has undergone a transformation.³ Interest rates were lowered to the zero-lower bound (ZLB) and have remained there for the past seven years but this did not significantly boost nominal demand as mainstream models predicted. As a result, Central banks embarked on a range of quantitative stimulation policies aimed at increasing or reducing credit flows. These included ‘Quantitative Easing’ (QE) policies but also subsidising credit flows to particular sectors of the economy, in particular the small and medium-sized enterprise (SME) sector via Funding for Lending schemes (FLSs) in the UK (Churm *et al.*, 2012), Japan (Bank of Japan, 2014) and the Eurozone (European Central Bank, 2014).

Central banks also began introducing policies aimed at restricting certain forms of credit across entire national economies – so called ‘macroprudential’ policy (Galati and Moessner, 2013), whereas regulation had previously only focused on the stability of individual financial

³ For a recent example of new thinking, see the Bank of England’s (2015b: 17-19) new research agenda discussion paper.

institutions (microprudential policy). For example, in June 2014, the first limits on the UK mortgage market in 30 years were implemented by the Bank of England (BoE), via the newly formed Financial Policy Committee, restricting the amount that homeowners can borrow relative to their income (Bank of England, 2014: Executive summary, p1). Similar policies have been introduced in New Zealand and Hong Kong.

Concerns have been raised about both the new stimulative policies and macroprudential policies. In the case of the former, there are worries that the maintenance of historically very low interest rates and high-levels of liquidity via QE may lead to a further growth in the kind of unsustainable private debt and/or asset price booms that helped cause the GFC (Stein, 2013, B.I.S., 2014). At the same time, there are concerns that macroprudential policies, in particular the requirement that banks must hold higher levels of capital, may prevent productive lending (Bridges *et al.*, 2014).

A number of scholars have argued that central banks need to go further and alter their operational frameworks entirely, for example by targeting nominal GDP rather than inflation (Woodford, 2014, Sheedy, 2014) or engaging in monetary financing of government deficits to boost nominal demand (McCulley and Poszar, 2013, Wolf, 2013, Turner, 2014b).

The aftermath of the financial crisis has also seen a resurgence of interest in credit and money in the academic sphere. A number of new empirical studies have been undertaken reporting a strong link between credit growth in general and financial crises (Borio *et al.*, 2011, Schularick and Taylor, 2012, Aikman *et al.*, 2014) but also showing that the composition of credit can have different impacts on the economy. In particular, there is increasing evidence that rapid increases in domestic mortgage credit may be more closely related to crises than credit extended to non-financial firms, with the latter more closely correlated with real and nominal economic growth (Büyükkarabacak and Valev, 2010, Beck *et al.*, 2008, Mian and Sufi, 2010, Werner, 2012, Jordà *et al.*, 2014, Bezemer *et al.*, 2014).

In the light of these developments, a central concern of this thesis is to better understand, empirically, the role of banks, credit and money in influencing and being influenced by macroeconomic outcomes: nominal and real output growth, consumer and asset prices and how monetary policy – broadly defined – itself interacts with such variables. Understanding such dynamics could help shed light on the many new innovations in monetary policy being undertaken by central banks and inform further empirical and theoretical work in monetary economics.

1.3 Contribution

The thesis makes three main contributions to the monetary policy, macroeconomics and economic growth literature. First, new insights on the relationships between macroeconomic variables are gleaned by analysing credit in new ways. In the first two studies, credit *flows* rather than stocks are examined. The traditional economic growth literature has focused on credit stocks, which are seen to increase agents' capacity to reallocate factors of production and so support growth (Shaw, 1973, King and Levine, 1993b, Levine, 2005). Credit stocks are also stocks of debt, however, and a certain point they may reach a level that begins to negatively effect investment and consumption as firms and consumers de-leverage, resulting in a 'balance-sheet recession' (Fisher, 1933, Mishkin, 1978, Palley, 1994, Koo, 2011). The latter appears to have been a important cause of the long recession which followed the GFC when very high levels of household debt suppressed aggregate demand, as shown in the work of Mian and Sufi in the U.S.(2010, Mian *et al.*, Mian and Sufi) and the 'lost decade' in Japan (Koo, 2011). In contrast, credit *flows* allow firms and consumers to finance immediate expenditure and transactions and thus can be seen to have a first round positive impact on output (Werner, 2005, Biggs *et al.*, 2009, Bezemer, 2014).⁴

Secondly, rather than analysing credit in the aggregate form as is standard in the literature, credit is decomposed to see if different *types* credit flow may have different impacts on the economy. Following Schumpeter's (2004 [1939]: 151-153) notion of 'productive' and 'unproductive' credit and Werner's (1997, 2005) 'Quantity Theory of Credit', credit is disaggregated in to different categories – for example credit flows to non-financial firms versus credit flows for household mortgages and credit flows to other financial corporations – to examine how these influence macroeconomic variables. In contrast to recent panel studies that decompose credit and use annual data (Büyükkarabacak and Valev, 2010, Beck *et al.*, 2012, Jordà *et al.*, 2014, Bezemer *et al.*, 2014) quarterly data are used, enabling us to use established empirical time series methods, including vector autoregression (VAR) and Granger causality analysis where exogeneity assumptions can be carefully investigated.

A second contribution is the collection of new data. For all three studies, new datasets have been created, the construction of which involved inputting data electronically by hand from physical central bank or government publications⁵ or gaining access to such data following discussions

⁴ Biggs *et al.* (2009) finds that credit flows tend to be more positively correlated after crises to GDP than credit stocks. This explains the paradox of the so called 'credit-less' recoveries when output improves without any increase in credit to gdp/ratio.

⁵ The 'official statistics' and 'central bank statistics' sections of the library of the London School of Economics were the main sources for hand collected data.

and correspondence with central bank statistics officers of the relevant countries. For the times series study of the UK and Canada quarterly data was gathered going back to the 1960s and 1950s respectively whilst for the panel study new decomposed quarterly credit flow aggregates across nine advanced economies going back to 1990 are created. These series are longer than many equivalent datasets used in the macroeconomic literature meaning they may offer stronger inference on the existence of long-term and policy invariant relationships between variables.

A considerable effort was invested in cleaning the data so it was suitable for analysis. This included, for the credit data in particular, adjustment techniques to smooth out the many breaks in the data caused by administrative or structural changes to banking systems or changing definitions of credit and money. As well as providing the basis for the key insights of this study, these datasets will also serve as a resource for future studies.

Finally, this thesis contributes in a methodological sense by advancing the literature that is taking an inductive and data-driven approach to econometric model construction in contrast to the hypothetico-deductive method of Neo-Classical and New-Keynesian macroeconomics. It makes use of recent and innovative applied econometric methods, including state-of-the-art General To Specific (GETS) selection methods and panel vector autoregression (PVAR). Model construction and interpretation is also guided by a careful examination of the institutional and historical dynamics of the economies under study. The heterogeneous nature of financial and economic structures across different economies are taken seriously, as is how such structures are determined by social, political, and economic processes. This includes, for example, regime changes caused by the deregulation or liberalisation of financial markets.

In order to capture these dynamics, some of the key assumptions of general equilibrium modelling of the economy are dropped, including the existence of representative agents operating in information rich environments (further explored in Section 1.5.) Through all three chapters but particular the third, a historical case study of the Canadian economy, this thesis examines how economic theories, monetary policy, financial structure and the macroeconomy interact and evolve over time, mediated by institutional and political dynamics that are often neglected in mainstream economic analysis (Chick, 1996, Chang, 2002, Hodgson, 2009).

1.4 Credit, money and banking: an overview

1.4.1 Classical and neo-classical views of money

The relationship between money, credit and banking and the macroeconomy has been subject to considerable debate over the course of the twentieth century. The dominant theoretical approach, however, has its roots in classical economics. Here money, rather than credit, was the focus of attention. Money is generally considered to have four main functions: a unit of account, medium of exchange, store of value and means of settlement of debts (Davies, 2002: 27). Classical and neo-classical economics has emphasised mainly the means of exchange function. This derives from the conception of the origins of money as a special type of commodity that allows economic agents to optimise the efficiency of exchange of goods and services.⁶ Money emerges from barter relations as agents find certain commodities to be widely acceptable and begin to use them as media of exchange rather than keeping or consuming them (Jevons, 1875, Menger, 1892). For classical economists such as J.S. Mill, money was thus not fundamental to the creation of economic value but was a ‘technical device’ and ‘...like many other kinds of machinery, it only exerts distinct and independent influence of its own when it gets out of order’ (Mill, 1885 [1848]: 341). As Joseph Schumpeter (1994 [1954]: 277) describes it, this leads to a conception of money as a neutral, imaginary ‘veil’ lying over the ‘real’ economy:

‘Real analysis’ proceeds from the principle that all essential phenomena of economic life are capable of being described in terms of goods and services, of decisions about them and of relations between them. Money enters the picture only in the modest role of a technical device that has been adopted in order to facilitate transactions... so long as it functions normally, it does not affect the economic process, which behaves in the same way as it would in a barter economy: this is essentially what the concept of Neutral Money implies.

Neo-classical economics built on this conception of neutral exchange-optimising money as it developed mathematical models of the economy in the late nineteenth and twentieth century based on supply and demand equilibrium (Walras, 1954[1874]). In Walrasian general equilibrium, with perfect information assumed, agents automatically exchange goods and services, without delay or friction, according to the production costs of the commodity and agent’s marginal utility (Pigou, 1949). Walras created a hypothetical *numeraire* to enable the modelling of an exchange economy and postulated the existence of an omnipotent ‘auctioneer’ capable of knowing all exchange and utility values at all times. Later neo-classical economists

⁶ See Goodhart (1998) for a discussion of the two main theories of money which he refers to as ‘Metallist’ in regard to the means-of-exchange concept and ‘Cartalist’ which refers to the role of an authority imposing a unit-of-account. Chapter 4 of this thesis investigates the latter theory in more depth.

attempted to more substantively incorporate money in to models, hypothesising a near zero production function but relatively constant long-run utility function, since money was simply representative of the value of other ‘real’ commodities (Fisher, 2006 [1911]). Fisher formulated this approach with the ‘equation of exchange’ which states that under any given conditions of industry and civilisation, deposits tend to hold a fixed or normal ratio to money in circulation being used for transactions. The equation of exchange is

$$MV = PT$$

where M is Money (including bank deposits), V is the velocity of money, P is the general price level and T , the volume of transactions. In this ‘quantity theory of money’, V is presumed to be constant in the long-run meaning that the amount of money changing hands to pay for transactions is equal to the value of these transactions. Adjustments to the money supply, which is assumed to be exogenous, should thus feed directly through to prices and income. Thus M is the independent variable in the equation above. Hence money was built in to models of general equilibrium with the concept of its neutrality effectively maintained.

Banks, credit and debt are equally viewed as relatively neutral in such models. In a world of perfect information, frictionless exchange and rational agents with perfect foresight⁷ there would be no need for the intermediating activities of banks, nor for credit or debt – which allows the extension of exchange value through time. As Cechetti *et al.* (2011: 2) quoted in (Bezemer, 2012: 5), note:

For macroeconomists working to construct a theoretical structure for understanding the economy as a whole, debt is... trivial because (in a closed economy) it is net zero – the liabilities of all borrowers always exactly match the asset of all lenders... With no active role for money, integrating credit in the mainstream framework has proved to be difficult.

1.4.2 Keynes and the emergence of monetarism

The money neutrality thesis was challenged by the Great Depression of the 1930s as a number of economists identified the financial sector and money system as the locus of economic breakdown. Keynes’ (1936: ch12) was the most notable.. For Keynes, the necessity of fixing contracts in money results not because of money’s advantages as a medium of exchange but because of its store of value function and the need for agents in an economy to make decisions

⁷ See Modigliani and Miller (1958) for the classic account of a financial system with these properties

based on an uncertain future (Davidson, 1972). Agents' hold changing 'liquidity preferences' for money (and other assets) according to circumstances. The store of value function of money allows households and firms to withhold their consumption or investment at any given time by hoarding money according to their future expectations. Since capitalist production required money to finance wages, this could result in income and expenditures becoming disconnected and disequilibrium states resulting, a feature that 'real' analysis, where money was simply another commodity enabling exchange, or a numeraire, did not allow for. Bank's could play role in propping up 'effective demand' via credit creation, however they are equally effected by uncertainty over the future related to their liquidity expectations. Influenced by Keynes, governments in the 1950s and 1960s enacted a range of measures to regulate bank credit and used monetary and fiscal policy to stabilise the short-term business cycle with full employment the main objective of macroeconomic policy.

Although governments' adopted elements of Keynes' policy advice, macroeconomic theory development of the time reduced the notion of liquidity preferences down to a simple focus on the transactions 'demand for money' and the opportunity cost of forgone yield on other assets - securities or capital - that enabled money to be incorporated into a static general-equilibrium framework (Chick and Tily, 2014: 686:690). Keynes' fundamental concerns with uncertainty, future expectations and the propensity for effective demand and investment to disconnect from incomes in a monetary-production economy were thus neglected as macroeconomic theory developed (Davidson, 1972).

The neoclassical synthesis of the *IS-LM* framework considers the demand for transactions money and the interest rate differential between money and bonds (and other assets), but ignores credit and credit quantities and their flip-side, leverage and balance sheet stocks of debt. Friedman (1959) and later Tobin (1969) developed 'money demand' functions involving multiple different assets and agents engaging in portfolio rebalancing, but still within the context of a supply-demand general equilibrium and long-run stable relationship between money and income. The latter concept was buttressed by Friedman's (1963) seminal study with Anna Schwartz of the US economy which showed a stable long-run relationship between the stock of circulating money and inflation in the US over a 100 year period up to the 1960s.

Monetarist policy models, as well as assuming a stable velocity, rest upon the notion of a relatively stable relationship between base money (reserves) and the circulating stock of broad money – the 'money multiplier' (Humphrey, 1987). The theory was that central banks could control the money supply via adjustments to reserves – 'loanable funds' – via Open Market Operations (Brunner and Meltzer, 1983, Friedman, 1982). In practice, however, monetary authorities struggled both to effectively define and measure different monetary aggregates and/or

control broad money growth. In addition, any apparent link between monetary aggregates and inflation or output broke down in the 1980s and 1990s as the velocity of money embarked on a secular decline, posing an empirical puzzle for existing theory (Goldfeld, 1976, Werner, 1997, Werner, 2005: 114-133).

1.4.3 The New Macroeconomic Consensus

The financial innovations of the 1980s and 1990s, encouraged by the liberalisation of the financial sector in the U.S. and Britain, were perceived by some economists as one reason for the apparent breakdown between money and output. A range of new forms of tradeable assets emerged that were seen to be potential substitutes for money, such as bonds and non-bank credit. Developing earlier equilibrium portfolio optimizing models, , ‘New-Keynesian’ or ‘New Macroeconomic Consensus’⁸ (NMC) approaches advised that monetary policy should move away from quantities and on to the *price* of money – interest rates – mainly through central banks’ role in setting the nominal short-term interest rate or ‘base rate’ (Clarida *et al.*, 1999, Woodford, 2003, Arestis, 2011).

Empirical support for this approach came from studies using VARs which showed that monetary aggregates’ influence on output was significantly lessened when the short-term real interest rate was introduced (Sims, 1980, Litterman and Weiss, 1983). This ‘Real-Business Cycle’ approach downplayed any significant role for monetary policy outside adjustments to interest rates. The monetarist focus on inflation has remained, however, and explicit inflation-targeting, over and above other macroeconomic objectives, became the norm in the 1990s period in many developed countries.

In New Keynesian models, changes in the short-term interest rate positively affect the market rate that banks use to buy and sell reserves (loanable funds) to each other in the interbank market.⁹ This change is carried through by banks in their lending rates which modifies real-sector demand for lending and thus bank loan volumes and the money supply, which in turn affect real activity and inflation. The monetary authority adopts a policy rule based on a target nominal short-term interest rate based on expected inflation,¹⁰ the output gap, the deviation of inflation from target and the equilibrium ‘real’ rate of interest (Arestis, 2011). Monetary policy then involves reacting

⁸ Sometimes also referred to as ‘New Neoclassical consensus’ or ‘New Consensus Macroeconomics’.

⁹ Since in reality banks mainly borrow reserves in the interbank wholesale market, Open Market Operations (mainly via repos trading in government securities) are key to ensure sufficient liquidity so that the Bank base rate has traction. The closer the market rate of interest is to base rate, the more effectively monetary policy changes will carry through and the more ‘reliably monetary policy is implemented’ (Clews, 2005)

¹⁰ A strong role is assigned to Central Bank communications which directly affect markets by influencing inflationary expectations.

to inflation: above-target inflation leads the central bank to raise interest rates, whereas below-target inflation requires lowering interest rates to stimulate the economy. When inflation is on target and the output gap is zero the actual real rate of interest set by the monetary policy rule is equal to the equilibrium rate. Thus, provided the central bank has an accurate estimate of the equilibrium rate of interest, the economy can be guided to an equilibrium with a zero output gap and constant inflation.

Frequently, however, there will be frictions caused by nominal price rigidities, sticky wages or imperfect information and it is the disequilibrium caused by such frictions that provides monetary policy with causal influence on the economy. By targeting inflation and adjusting interest rates, monetary policy can help the economy back to the equilibrium rate of interest.

In such a theoretical framework, monetary or credit aggregates are not significant as policy tools. The monetary authority, having communicated and set its target inflation and interest rate stands ready to supply any quantity of money demanded by the interbank funding market to hit that interest rate – money is thus ‘endogenous’. Monetary or credit aggregates may propagate short-term frictions that may be caused by price rigidities but have no long-term effect on variables such as output and inflation. Indeed, in many presentations of the New Consensus models, for example the seminal work of Woodford (2003), there is no significant role for money, credit or banks.

One major challenge for New Keynesian theories has been mixed empirical evidence supporting a negative relationship between short-term nominal interest rates and output or inflation (Werner, 2012: 3-4). Cross-sectional studies have found that the real interest rate does not have a significantly negative effect on the output gap (King and Levine, 1993a, Goodhart and Hofmann, 2005). Indeed a positive correlation has been found in some studies, including for the US (Kuttner and Mosser, 2002) and for the USA, the UK, Germany, and Japan (Zhu, 2011). The Japanese recession of the 1990s saw repeated cuts to the short-term base rate but no resulting adjustment to nominal demand, which remained stagnant, or inflation. The financial crisis of 2007–2008 and the resulting recession has seen similar dynamics – rapid reductions in short-term interest rates did not lead to corresponding growth in bank lending or demand for loans, or proportionately large increases in inflation. Even after driving down medium term interest rates via QE and large scale asset purchases (LSAPs), there was little evidence of a return to pre-crisis rates of bank lending (Martin and Milas, 2012). In fact, one of the enduring puzzles of empirical macroeconomics (as opposed to theoretical studies) has been the difficulty of finding convincing evidence of the direction of causal relationship(s) between monetary aggregates, interest rates and output (Stock and Watson, 1989, Sims, 1992, Werner, 2005, Favara and Giordani, 2009).

1.4.4 The ‘Credit view’ and ‘balance sheet channel’ approaches

Concerns about the neglect of credit and the role of financial intermediation in the post-war period were raised by Gurley and Shaw (1955) who argued that a focus on money as a transaction medium was becoming difficult because of the multiple use of money and the ease with which near-money equivalents could be created. They developed the concept of an economy’s “financial capacity”: a measure of borrower’s ability to absorb debt without having to reduce spending commitments (Gertler, 1988: 564). Financial intermediaries were relevant because they extended borrowers’ financial capacity and helped overcome impediments to the flow of funds between savers and investors that the market for securities and other financial investments could not always provide. In such an approach, balance sheets and the quantities of credit did matter and could effect aggregate demand. This approach has been developed in the development economics literature, with many empirical studies showing a positive relationship between increases in private sector credit-to-GDP ratio correlating to increases in real GDP growth (Levine, 1997, Levine, 2005). Increases in credit intensity or ‘financial deepening’ have been key policies advocated by international financial institutions supporting developing countries such as the IMF and the World Bank.

Whilst credit is generally viewed as positively related to growth in the long-term, some economists have argued that credit markets themselves are prone to frictions due to information asymmetries between borrowers and lenders. Because the risk to taking the loan is much smaller to the business owner enjoying limited liability than the risk of default is to the bank, rather than raise interest rates upwards to equilibrium levels that might discourage solid borrowers, banks may choose instead to ration credit or ‘quantity ration’ (Keeton, 1979, Stiglitz and Weiss, 1981, Stiglitz and Weiss, 1992). In such models, economic shocks are seen as being amplified via the ‘credit channel’, ‘bank lending channel’, ‘balance sheet channel’ or ‘financial-accelerator’ (Kashyap and Stein, 1994, Bernanke and Gertler, 1995, Bernanke *et al.*, 1999), potentially over long periods. Balance sheet or collateral strength – of both banks and borrowers – take on extra importance following such shocks, with banks becoming more risk-averse, increasing their rationing of credit and amplifying and extending the initial shock to the system.

Again, however, changes in credit are not seen as independently causing shocks or major changes to output or inflation. As Bernanke and Gertler (1995: 28) state, “the credit channel is an enhancement mechanism, not a truly independent or parallel channel.” The credit view remains embedded in a general equilibrium framework with micro-foundations (discussed further in Section 1.5) in which the economy fluctuates in response to the propagation of exogenous real

and monetary shocks which are then reflected in credit and asset prices. A review of monetary policy theory in the light of the 2007–2008 financial crisis by two senior BoE staff concludes that the financial accelerator results in a ‘pseudo-endogenous model of credit but not one that allows for pronounced endogenous credit and financial cycles [as with the 2007-08 crisis] to be a driver of the business cycle’ (Hume and Sentance, 2009: 44).

In a post-crisis review of the quantitative performance of a range of different New-Keynesian models with financial frictions, Quadrini (2011), found that most such models were unable to predict fluctuations on the scale observed in reality. One reason for this was that the asset price variations which resulted from such models – and thus the changes in resulting borrower or intermediary net worth – are far smaller than observed in regular real world cycles. As former Governor of the BoE Mervyn King (2012: 14) has noted

The only way the addition of a financial sector ‘matters’ in these models is if we contemplate exogenous shocks to the financial friction itself. That is not very instructive....there seems no limit to the ingenuity of economists to identify such market failures, but not one of these frictions seems large enough to play a part in a macroeconomic model of financial stability.

This lack of predictive power may be related to two problems with New Keynesian models. The first is that, although their models depart from a strict Walrasian equilibrium framework by admitting asymmetric or imperfect information and credit rationing, they remain wedded to a division between real and monetary analysis in which credit and money’s function as a means of dealing with uncertainty is neglected. Keynes saw money as enabling agents to deal with uncertainty through time by preserving purchasing power (the precautionary motive). Bank lending decisions would also be related to future expectations about their liquidity. Keynes’ argued that this could lead to long-term disequilibrium conditions as effective demand and investment departs from income as agents’ increase their holdings of money or banks decrease their lending according to their liquidity preferences.

In New Keynesian models, this notion of uncertainty is instead subsumed in to ‘risk’ with agents using holding money assets to limit their exposure to stochastic shocks within a known probabilistic distribution (Dymski, 1993: 49-50, Davidson, 1972). This neglect of uncertainty limits the capacity of such models to show how endogenous crises and/or longer term disequilibrium conditions might emerge. Rather, in New-Keynesian models, agents, including banks, adjust to information asymmetries via adjusting their portfolio of assets or de-risking their loans, for example by requiring collateral. Once such adjustments have taken place across the economy, there will be a return to a form of equilibrium.

Secondly, although such models incorporate financial frictions it is still assumed that bank credit is created exclusively to fund firm investment. In fact, as already mentioned, modern commercial banks create the majority of new credit for the purchase of existing assets, in particular mortgage debt. Where there is a finite supply of land for new home building – as is the case in many desirable urban areas – this leads to an increase in house prices. Banks can thus be seen to generate endogenous increases in asset prices beyond fundamentals and thus bubbles and crashes without any need for exogenous shocks (Minsky, 1986a). In addition, there is also evidence that increases in asset prices (themselves caused by mortgage market lending) may have asymmetric impacts on the types of credit banks extend. A recent study in the US, for example, found that increases in asset prices led banks to substitute away from commercial lending towards mortgage lending (Chakraborty *et al.*, 2014). This brings us to an alternative view of the role of credit and banks in macroeconomics.

1.4.5 Credit theory of money

A third approach is to reject the basic premise of the New-Keynesian framework of a separation between the monetary and real sectors of the economy and the idea that money or credit are purely endogenous macroeconomic phenomenon. This perspective, which is adopted in this thesis, starts from the premise that in modern economies, bank liabilities (deposits) have become the dominant means of payment and final settlement. When a bank makes a loan, it creates both an asset (the loan) and a liability (a customer's deposit) which can be used to settle all non-interbank payments, including taxes, in the economy – a widely accepted definition of money (Ryan-Collins *et al.*, 2011, Mcleay *et al.*, 2014, Werner, 2014a). Such liabilities are also created when banks buy financial assets or fulfill overdraft requests (Ryan-Collins *et al.*, 2011: 56-57). Since no other person's deposits used in this process, credit – or money – 'creation' is a more technically correct term than 'lending'. The BoE recently confirmed that in the UK, 97% of the money supply is created by private banks via this process (Mcleay *et al.*, 2014). No other type of firm is able to create money using its own liabilities in this way (Werner, 2014c).

Since banks create deposits when they extend loans, credit creation leads to an expansion of the money supply and purchasing power – hence credit precedes money. The *flows* of new credit help shape the macroeconomic trajectory of the economy – they have 'real' effects.; whilst the money stock, the focus of attention of monetarists, is simply a residue (Lavoie, 1984). This 'credit theory of money' has a long historical tradition and features in the work of Wicksell (1936

[1898]), Schumpeter (1983[1911]), Knapp (1905), Innes (1914), Keynes (1930), and Fisher (1933).¹¹ Schumpeter (1983[1911]: 108) argues that bank credit creation is key to moving beyond the ‘circular flow’ notion of the economy that characterises classical economists’ equilibrium theories:

The creation of purchasing power characterises, in principle, the method by which development is carried out in a system with private property and division of labour. By credit, entrepreneurs are given access to the social stream of goods before they have acquired the normal claim to it. It temporarily substitutes... a fiction of this claim for the claim itself. Granting credit in this sense operates as an order on the economic system to accommodate itself to the purpose of the entrepreneur, as an order on the goods which he needs: It means entrusting him with productive forces. It is only thus that economic development could arise from the mere circular flow in perfect equilibrium. And this function constitutes the keystone of the modern credit structure.

(1930)Although Keynes does not discuss the credit creating role of banks in *The General Theory* (1936), in earlier (1930) and later (1937, 1939) writings it was clear that his conception of capitalist production was a monetary one and that it was not possible to separate the real and monetary aspects of the economy (Lavoie, 1984). Keynes repeatedly critiqued the notion that savings enabled investment, stating that ‘[bank] Credit expansion provides not an alternative to increased saving but a necessary preparation for it. It is the parent, not the twin of increased saving.’ (Keynes, 1939: 572).

Following Keynes, post-keynesian monetary theory, which supports the credit theory of money, has emphasised that production takes time and that banks create the necessary ‘savings’ – in the form of deposits generated via the act of lending – to enable financially constrained firms to invest prior to profit generation (Chick *et al.*, 1992, Rochon, 1999, Fontana, 2003, Graziani, 2003). Banks are thus a direct provider of investment capital rather than an intermediary of pre-existing savings who may propagate shocks emanating from the ‘real’ economy as with ‘Credit View’ models. Given Keynesian uncertainty and money’s store of value role and liquidity preferences, banks’ role takes on even more importance as it is only bank financing on investment that enables investment to maintain an equivalence with incomes over time and prevent recessions.

Within the post-Keynesian tradition there are different perspectives on the extent to which bank credit and money are endogenous, with ‘horizontalists’ claiming a flat demand curve for money (Moore, 1988) from firms whilst ‘structuralists’ emphasise banks’ changing liquidity preferences

¹¹ Innes (1914)

and uncertain expectations about the future and hence supply constraints driven by the state of effective demand in the economy (Dymski, 1992, Dow, 1996, Rotheim, 2006).¹²

Banks are thus ‘special’ because they create and allocate purchasing power in the real economy (Schumpeter, 1983[1911], Werner, 2011). Other financial intermediaries, such as pension and investment funds and capital markets more generally, allocate existing funds but do not create *new* purchasing power. Money-demand- or portfolio-rebalancing-led approaches to monetary policy and monetary economics only capture elements of these second round type allocations of funds. Although, at the level of the individual firm, one can hypothesise (with a number of assumptions) that the source of finance (debt versus equity) is irrelevant to the value of the firm (Modigliani and Miller, 1958), the same does not apply at the macroeconomic level. At the macroeconomic level, an increase in credit creation by the banking system that is not simultaneously cancelled out by an equivalent repayment of loans somewhere else in the economy will result in an increase in net purchasing power and economic transactions.

1.4.6 The importance of credit flows and credit allocation: banks as protagonists

Another key element of the credit theory of money is that the type as well as quantity of credit creation that banks undertake then becomes an important macroeconomic variable. Whilst in monetarist, New-Keynesian and some Post-Keynesian perspectives (Lysandrou, 2015), an implicit assumption is made that all credit flows to the real (productive) economy (i.e. to firms), the credit theory of money approach I will take in this thesis emphasises the macroeconomic impact of the sectoral allocation of credit. This recognises that a significant proportion of bank credit flows in to existing financial assets, for example land or property or financial assets. The outcome of such credit flows on economic growth is much less clear since they may simply lead to asset price inflation rather than new GDP transactions. This distinction was recognised by Fisher (2006 [1911]) and also by Keynes, who related that whilst income transactions might be closely related to GDP, transactions in second-hand (real or financial) assets:

...need not be, and are not, governed by the volume of current output. The pace at which a circle of financiers, speculators and investors hand round to one another particular pieces of wealth, or title to such, which they are neither producing nor consuming but merely exchanging, bears no definite relation to the rate of current production. The volume of such transactions is subject to very wide and incalculable fluctuations... (Keynes, 1971: vol 5, p42)

¹² A useful summary of the debate which assesses the empirical evidence and favours the structuralist approach is Howells (2006).

Werner (1997) develops a formal model of disaggregated credit that enhances Fisher's (2006 [1911]) original 'equation of exchange'. In this 'Quantity Theory of Credit', Fisher's stock measure of money M (see section 1.4.1) is split in to separate credit *flow* aggregates. Only credit created for GDP transactions (e.g. credit extended to non-financial firms for investment), C_R , contributes to nominal spending in the real economy. In contrast, credit created for the purchase of existing assets, C_F (such as existing real estate or financial assets), enables transactions in the financial sector and does not contribute to output. In the equations below¹³, ' Q ' rather than Y is used represent the quantity of transactions in either real (Q_R) or the financial (Q_F) sector:

$$CV = PQ$$

$$C = C_R + C_F$$

$$C_R V_R = P_R Q_R = P_R Y_R = \text{nominal GDP}$$

$$C_F V_F = P_F Q_F$$

Werner (1997, 2005) provides empirical evidence that disaggregated credit to private non-financial corporations is a strong predictor of nominal GDP growth in Japan and finds similar evidence in the UK (Lyonnet and Werner, 2012) and in Spain (Werner, 2014b). Bezemer *et al.* (2014) find in a study of 46 economies over 1990–2011 a negative relationship between credit stocks supporting asset markets (mainly domestic mortgages) and real GDP growth but positive growth effects of credit flows to nonfinancial business.

(Werner, 1997, 2005) argues that this disaggregated credit approach helps explain a number of long-term macroeconomic 'puzzles' These include the secular decline in the velocity of money and the difficulty that monetarists faced in successfully defining stocks of transaction related money. Both can be explained by an increase in credit creation for non-GDP related transactions such as mortgages. This leads to an increase in bank 'money' (deposits are created) but not an equivalent increase in GDP transactions in the real economy. Thus credit creation gives rise to an increase in the money supply but not an increase in nominal spending. The puzzle of the frequency of banking crises since the 1980s can also be related to excessive non-GDP credit creation resulting in asset bubbles and defaults (Werner, 2005: 226-230). The puzzle of the failure to find a positive and significant causal relationship between interest rates and economic growth or business cycles can be explained by the fact that interest rates do not significantly influence the *quality* of credit creation. And finally, this approach helps explain the failure of supply-side reforms to boost growth or inflation in Japan and other countries – such reforms may

¹³ These equations are adapted from Ryan-Collins *et al.* (2011). A more detailed exposition can be found in Werner (2005)

boost the potential growth rate but again has no impact on boosting corresponding increases in GDP-related credit creation (Werner, 2004).

1.4.7 Developing a theory of credit for empirical work

Werner's quantity theory of credit equations listed above imply a relatively simple relationship between the type of credit created by a banking system and nominal growth in the economy and asset price changes. Causation runs from banks (credit creation) to economic activity and asset prices. Key to this position is the notion of credit rationing. In an economy without perfect information, credit markets, like other markets, will not clear and we are in a state of disequilibrium. The outcome in such a market follows the short-side principle: whichever of demand or supply is smaller, that quantity will be transacted. Werner argues that the demand for credit-money should be considered very large as these are not commodities subject to decreasing marginal utility – having more money does not affect what other things you can or cannot have (Werner, 2005: 93). Rather than raising interest rates to 'clear' the market, banks' quantity ration and allocate credit to avoid adverse selection (Stiglitz and Weiss, 1981).

There are two possible concerns with this approach. One is that causality may run both ways – i.e. economic growth or – in Keynesian terms, future expectations of firms and households about income growth - may lead banks to increase their lending as well as vice versa. Another concern is that this approach neglects second round effects following the issuance of credit by the banking system. It may be the case that lending to existing assets that increases asset prices may have important second-round effects on consumption which in turn could effect nominal output. Changes in house prices are an obvious and topical example. An increase in house prices driven by bank credit expansion beyond income in the economy may trigger households to increase their consumption directly by reducing their savings (a wealth effect) or indirectly via choosing to take out a home equity loan (collateral effect) (Goodhart and Hofmann, 2008).¹⁴ Since in advanced economies in particular consumption makes up by the far the largest contribution to GDP and household equity makes up a large proportion of total wealth, these effects may well be important. There is evidence that the liberalisation of credit markets in the UK and the US enabled households to smooth their consumption via home equity withdrawal (Grydaki and Bezemer, 2013, Aron *et al.*, 2012) There may also be 'productive' sectors of the economy which are prone to speculative forms of bank lending leading ultimately to over-investment and

¹⁴ In neo-classical lifecycle models, any increase in house prices can only have short term macroeconomic effects since the in longer term it is cancelled out by non-asset owners reducing their consumption in order to increase their savings for future purchase. However, there is evidence that such effects may be asymmetric particularly in liberalised financial systems where it is easy to borrow against property, such as the UK – this thesis examined in Chapter 4 (section 3.2).

eventually economic collapse in the traditional Hayekian business cycle sense (Hayek, 1933). The construction sector in Ireland and Spain during the recent financial crisis are good examples. A simple division between productive and on productive credit creation may not be adequate to explain dynamics across the whole economy.

The post-Keynesian school, discussed above, places a stronger role on the the general state of the economy and effective demand, themselves influenced by actual and future perceived asset prices, as important determinants of credit supply. The work of Hyman Minsky has been particularly influential here. Minsky's (1986a) 'financial instability' hypothesis argues that capitalist system with credit creating banks are prone to endogenously generated positive and procyclical feedback effects. For Minsky, during periods of relative stability, confidence would build in both borrowers and banks leading to increases in credit creation which in turn leads to (capital-) asset prices rises, leading to looser collateral requirements and increased lending, increased prices, and so on until eventually there is a bust and the process goes in to reverse. Although there are similarities in the latter processes with the financial accelerator models of the New-Keynesian school, a key difference is that the financial cycles are continuously generated by the financial system and the economy itself, rather than being amplified by shocks from the 'real economy'. Instability is that endogenous to capitalist modes of production.

Such financial cycles occur because economic agents – banks, households, firms – are limited in their knowledge about the future. Building on Keynes's (1936) notion of liquidity preferences and uncertainty, Minsky (1993b: 79) argues that this leads to a situation where changes in asset prices can play a key role in macroeconomic dynamics whereby:

...a small increase in the failure of assets to perform can lead to large changes in available financing because the models of the economy that guide the behaviour of agents change. An episode of say, overindebtedness can lead to an increase in the utility derived from the asset whose market value seems secure relative to the utility derived from holding an asset whose income earning capacity is greater but whose market value seems less secure. Such relative prices of assets are in turn inputs in the determination of investment.

With such an approach, the economy is best understood not as being in a state of self-correcting equilibrium but as a set of bank, household, and firm balance sheets that interact dynamically over time to affect bank credit creation, consumption, and investment decisions.

Minsky and the post-Keynesian school more generally have not placed the same emphasis on the types of credit creation by the bank sector or explicitly distinguished between GDP and non-GDP credit circuits as in Werner's work. Minsky felt that capital assets could also be subject to

procyclical dynamics and over-investment as well as real estate or financial assets. However, he did become concerned in later writings that banks in the USA were shifting away from lending to non-financial firms towards consumer lending for household purchases or credit card debt as financial innovations – in particular securitisation – enabled banks to avoid capital and liquidity regulation by shifting such loans off their balance sheets (Minsky, 1987, Wray, 2009).¹⁵

1.4.7.1 *The role of policy, institutions and financial innovation*

In policy terms, if we accept that bank credit creation does matter for economic growth, this naturally turns our attention to the structure and behaviour of financial institutions that determine the flow of credit in to the economy – factors largely absent in pre-crisis monetary policy. In a world where credit markets do not clear and credit rationing is the norm, there may be strong arguments for policy to steer credit towards productive sectors of the economy or develop banking institutions that are incentivised to favour this form of credit. Credit guidance was commonplace in the post-war period in Europe (Hodgman, 1973) and has been highlighted as a feature that helps explain the rapid industrial development of East Asian economies (World Bank, 1993, Werner, 2005: 267-294). There is also evidence that bank size and ownership structure may influence the type of lending banks engage in. For example, research suggests smaller local or regional banks, typically not shareholder owned but cooperative, mutual or publically owned lend more effectively to SMEs with whom they develop long-term relationships with – so called ‘*relationship banking*’ – than larger banks (Berger *et al.*, 2005, Werner, 2012: 9-10, Greenham and Prieg, 2013, Ferri *et al.*, 2014). However, the liberalisation and globalisation of finance has led to waves of mergers and acquisitions in some countries resulting in branch closures and a shift away from such relationship banking.¹⁶

There is also evidence that public, central and state investment banks may be able to better support productive credit creation, growth and innovation, taking risks in new industries and markets that commercial lenders or investors are initially reluctant to enter (Epstein, 2006, Andrianova *et al.*, 2012, Mazzucato, 2013, Mazzucato and Penna, 2015, Bertay *et al.*, 2015). This issue is explored further in the third study (Chapter 4) on the Canadian Central bank in the 1935–1970 period.

¹⁵ Minsky (1987) argued this was a response to Chairman of the Federal Reserve Paul Volcker’s decision to push the Fed funds rate above 20% in 1979. This meant that no financial institution could afford to be stuck with long-term fixed-rate mortgages. Hence, regulators ‘freed’ banks and thrifts to pursue higher return and riskier activities (Wray, 1994).

¹⁶ See Dymski (1999), on the U.S. and Davies *et al.* (2010) and (Leyshon *et al.*, 2008) on the UK

Liberalisation, globalisation and developments in information and communication technology also appear to have altered institutional dynamics, bank business models and behaviour. The traditional business model of retail banking involves generating profits from the interest rate spread between the rate paid to banks on their assets and the rate a bank pays on its liabilities. However, banks have innovated over time in managing both their asset and liability sides to increase their profits (Chick, 1996).

On the asset side, the clearest example in recent times has been the shift towards the ‘originate and distribute’ model of banking that banks began engaging in on a large scale from the early 2000s. In particular, there was rapid growth in the market for residential mortgage-backed securities (RMBSs). This involved the creation of packages of different mortgage loans of different levels of riskiness which were securitised and sold on to investors – often long-term investors such as insurance companies and pension funds and even local and regional authorities. Profits were generated from the selling on of such loans rather than from the interest rate spread over the course of the loan. This process enabled banks to make profits that capital adequacy ratio or leverage requirements would otherwise have restricted.

Banks have also innovated on the liability side, shifting away from traditional and relatively stable funding models based on attracting retail deposits to increasing use of short-term wholesale funding, including from the non-bank sector. The ‘funding gap’ between deposits and loans widened for many institutions in the run up to the financial crisis, and was filled by (often very short-term) borrowing in the wholesale markets. Banks’ key liquidity risk is no longer a run by depositors, as in traditional banking, but a withdrawal of interbank lending, as happened during the financial crisis.

Related to both these innovations has been the rise of the shadow banking system, usually defined as banking activity carried out by institution(s) outside the banking system’s regulatory framework, including hedge funds and money market funds, as well as special purpose vehicles used by banks themselves to engage in off-balance-sheet lending activity – such as ‘asset-backed commercial paper’ (ABCP) programmes (Pozsar *et al.*, 2010). These vehicles are themselves often financed by short-term borrowing on wholesale markets – thus exposing banks to another source of market pressure.

1.5 Methodological approach

Macroeconomics is normally understood as involving the study of broad economic aggregates – such as output and the price level – as opposed to the examination of individual agents or firms. However, since the 1970s, there has been a shift towards grounding macroeconomic theory and modelling in micro-foundations. This is a form of methodological individualism whereby all explanations of economic phenomena “can only be presumed adequate if they run in terms of the beliefs, attitudes, and decisions of individuals.” (Blaug, 1992: 44). This shift was in part a reaction to the forecasting failures of the structural equation approach – involving large scale aggregated variables – associated with the ‘Cowles Commission’ (Leamer, 1983). In particular, the Lucas (1976) critique – that the parameters of such models were not policy-invariant as agents adjust their behaviours once policies are announced – was influential. It led to an effort to find micro-foundations and forecasts that incorporate individual preferences and expectations (Hoover, 2001: ch5).

One major problem with such an approach is that it is impossible to construct models that are able to account for the millions of individuals, firms and goods and their interactions in a given macroeconomy.¹⁷ To deal with this problem, neo-classical economists abstracted away this heterogeneity via the creation of ‘representative-agent’ models (see e.g. Sargent and Wallace, 1976), in which mathematical methods of microeconomic intertemporal choice optimisation subject to budget constraints can be applied to a single individual whose choices are taken to represent the aggregate choices of the economy (Colander *et al.*, 2009, Hoover, 2001: 111). In monetary economics in particular this approach was influential. Expectations seemed to play an important role in the effectiveness of policy announcements around, for example, changes to interest rates or increases in the government budget deficit (Sargent and Wallace, 1973).

This drive for micro-foundations, coupled with the apparent failure of Keynesian stabilisation policies to deal with the supply side shocks of the 1970s, led macroeconomics since the 1970s to turn decisively towards a hypothetico-deductive methodological approach which allowed the return of Walrasian equilibrium as the basis of investigation (Driffell, 2011). Models are constructed that involve hypothesised universal rules – or axioms – about the functioning of agents in the economy. These include the existence of representative agents with rational expectations (‘the rational expectations hypothesis’) operating in rich information environments with near-perfect foresight and frictionless or complete market clearing (Lucas, 1972, Phelps, 1973, Sargent and Wallace, 1975). Under such conditions, money, credit and debt contracts,

¹⁷ The so-called Cornout (1927 [1838]) problem, named after the nineteenth century mathematician and economist (quoted in Hoover (1984)).

banks and every other type of financial institution cease to become useful constructs for understanding fundamental economic processes, since such institutions exist *because* of information asymmetries or uncertainty about the future (Werner, 2005: 20-25). Indeed, it is a major challenge to build money in to equilibrium models of the macroeconomy, as noted by Hahn (1965) and later (Arrow and Hahn, 1971: 361) who stated that "in a world with a past as well as future in which contracts are made in terms of money, no equilibrium may exist".¹⁸

In contrast to rational expectations and representative agent theories, Keynes' 'monetary theory of production' (Keynes, 1973 [1933]) had at its heart the notion of uncertainty. This explains why, in the real world, contracts are fixed in money rather than 'real' terms since it is necessary to make decisions today based on an uncertain future, recognising that such decisions will affect some of the variables upon which those decisions are made (Davidson, 1972). Not only does a monetary economy require contracts to be fixed in money terms, but it also

requires institutions that can allow for the essential role that money plays in a monetary economy – there need to be both banks (and other financial institutions) and a central bank whose actions and policies allow for the finance and liquidity to be there when it is needed by the economy (Rotheim, 2006: 323).

Any modelling of complex phenomena will require some assumptions and simplifications in order for models to be tractable. But if the main purpose of macroeconomics is to guide macroeconomic policy, it is equally important that such assumptions do not undermine the ability of the model to be a useful guide to solving real world problems. As mentioned at the beginning of this chapter, the assumption that money, credit and banks did not play a significant independent role in the dynamics of the macroeconomy appears to have been an example of such a problematic assumption. It led to a situation where the majority of macroeconomic models were, by their construction, unable to predict the crisis of 2007-08 or indeed any form of endogenous crisis caused by the financial system (Stiglitz, 2011b). The failure to predict the crisis was thus a failure of the macroeconomic 'imagination' as two economists at the London School of Economics put it in a letter to the Queen (Besley and Hennessy, 2009). Reviewing the state of macroeconomics after the crisis, (Angrist and Pischke, 2010author-year: 18) describes the mainstream methodological approach (DSGE modelling) as a form of 'computational experiment' that is excessively theoretical:

...researchers choose a question, build a (theoretical) model economy, "calibrate" the model so that its behavior mimics the real economy along some key statistical dimensions, and then run a

¹⁸ See Pesaran (1987) and Pesaran and Smith (2011) for a more general critique of rational expectations theory.

computational experiment by changing model parameters (for example, tax rates or the money supply rule) to address the original question... Whatever might be said in defense of this framework as a tool for clarifying the implications of economic models, it produces no direct evidence on the magnitude or existence of causal effects. An effort to put reasonable numbers on theoretical relations is harmless and may even be helpful. But it's still theory.

This thesis takes a more inductive approach, as is taken in most research in the natural sciences (Werner, 2011). Instead of letting theory guide our data as with the DSGE approach, we ‘let the data guide theory choice’ (Colander *et al.*, 2008: 239). By using empirically driven model selection econometric techniques, such as GETS modelling (Hendry and Krolzig, 2005), Granger causality (Granger, 1969, Granger, 1988) and cointegration and VAR techniques (Hoover *et al.*, 2008), we can take an ‘archeological’ approach to the data, relying on statistical tools to guide us in finding the stable statistical relations among variables in the past (Hoover, 2006).

The above methods are not ‘theory-free’ of course but can be seen to avoid axiomatic theoretical assumptions, identification and priors. In contrast, DSGE models typically employ a simple-to-general framework, whereby a closely specified empirical implementation of a theory is presented and only modifications of limited nature are permitted, such as ad hoc stickiness to deal with misspecified dynamics. As Hendry and Mizon (2011) note, since “no current theories are structural in the sense of being invariant to all relevant regime change” it essential to have general models designed to “embrace a range of theories and different functional forms, and provide a good characterisation of the data, including possible regime changes.”

The ‘General to Specific’ (GETS) methodology (Hendry, 1995, Mizon, 1995, Julia Campos *et al.*, 2005) involves estimating a General unrestricted dynamic model which captures as many elements of the data generating process (DGP) and economic theory (including competing theories) and economic history as is feasible. This would include possible regime changes or mean shifts – caused for example by deregulation or liberalisation - or structural breaks. This general model is subsequently tested, transformed and reduced in size by performing a number of tests for restrictions. Such restrictions are themselves tested statistically to maintain the congruence of the model until a ‘specific’ final model is arrived. Competing models can be seen to be ‘encompassed’ in the general model if the relevant variables are included in the GUM, rather than being excluded in favour of the researcher’s preferred variable. Such an approach can be viewed as embracing the notion of parsimony, developed from Occam’s Razor.¹⁹ This states that when choosing between competing theories that have similar explanatory power, the one that is simpler and requires less data or restrictive assumptions is always preferable.

¹⁹ From the work of 14th century logician and Franciscan friar William of Ockham – see Thorburn (1915).

The GETS approach has its roots in the probability theory of Haavelmo (1944) where the focus of research is on obtaining good characterisations of the DGP before testing and on drawing out the implications of data that ought to constrain economic theorising. Rather than making theoretical assumptions about the deep parameters or microfoundations of the DGP it is assumed that we can never know its true structure but only approximate a very general version with existing theory. Simplifications and assumptions required for such models will involve the deductive method, but these assumptions should themselves be in line with empirical realities, rather than being taken as self-evident or axiomatic (Werner, 2005: 325). Thus, the notion that economic agents and interactions can be represented by homogeneous agents with rational expectations in an information-rich environment with near complete markets is not self-evident and has not been empirically demonstrated, so should not be incorporated as an assumption. Rather models should be constructed that allow for imperfect information (Stiglitz and Weiss, 1992), uncertainty (as distinct from risk) (Keynes, 1936, Davidson and Weintraub, 1973) ‘irrational’ behaviour (Akerlof and Shiller, 2010) and incomplete markets. All of the latter have been shown, empirically, to exist.

Chapter 2: Monetary policy and nominal GDP in the UK

In retrospect, the economics profession's focus on money – meaning various subsets of instruments on the liability side of the banking system's balance sheet in contrast to bank assets, and correspondingly the deposit assets on the public's balance sheet in contrast to the liabilities that the public issues – turns out to have been a half-century-long diversion that did not serve our profession well.

Benjamin Friedman (2012)

2.1 Introduction

Monetary policy since the 2007–2008 financial crisis has undergone a transformation. Central banks have shifted away from controlling inflation by varying the price of money via adjustments to short-term interest rates to a range of quantitative stimulation policies aimed at boosting nominal spending and macroprudential policies focused on credit aggregate growth (Aikman *et al.*, 2014). Of the former, the most notable has been QE or LSAPs, involving massive expansions of central bank balance sheets in the UK, the USA Japan, and the Eurozone. Introducing QE in the spring of 2009, the BoE's Monetary Policy Committee (MPC) notes state:

Given the Bank's role as monopoly supplier of sterling central bank money, the Committee had previously chosen to influence the amount of nominal spending in the economy by varying the price at which it supplied central bank money in exchange for assets held by the private sector. Under the operations now under consideration, the Committee would instead be focusing more directly on the quantity of money it supplied in exchange for assets held by the private sector... By increasing the supply of money in the economy, these operations should, over time, cause nominal spending to rise. (Bank of England, 2009: 8)

In the event, the BoE purchased £375 billion worth of UK gilts (government bonds) via the creation of central bank reserves as part of its QE asset purchase programme and it has maintained this level of purchases since November 2012. In addition to QE policies, central banks have also chosen to subsidise credit flows to the real economy, such as the BoE's FLS which subsidised commercial bank mortgage and SME lending (Churm *et al.*, 2012). Related

policies have been adopted by the Bank of Japan (BoJ) (Bank of Japan, 2014) and the European Central Bank (ECB) (European Central Bank, 2014).

Although direct influence over bank credit creation and allocation by monetary authorities has not been considered as a useful policy tool since the 1970s in the UK, it was a key element of monetary policy in the UK and other western nations in the post-war period (Hodgman, 1973, U.S. Congress, 1981, Goodhart, 1989, Werner, 2005).²⁰ Post-crisis, policy is shifting back in this direction. The Financial Policy Committee (FPC) was created to address macroprudential risk in the financial system and has powers to impose sectoral lending-based capital requirements (on top of international requirements) on banks. More recently, the FPC has also been granted powers to impose limits on Loan-to-Value (LTV) ratios and Debt-to-Income ratios for mortgage markets (Bank of England, 2015a). Since these policies were imposed seven years after the crisis, they suggest a permanent shift in policy towards a concern with quantities.

Assessing the impacts of these quantitative policies empirically creates challenges. For one, it is not entirely clear what the final target variable against which they are judged should be. Although initially framed as being aimed at boosting nominal spending as in Friedman quotation, later central bank announcements have emphasised more the intermediate target of medium- and long-term interest rates. With some exceptions,²¹ most studies of QE have focused on the latter and have been criticised for doing so since the resulting effect on a final target variable of nominal spending is often hypothesised rather than empirically tested – using concepts such as ‘portfolio rebalancing’ (Cobham and Kang, 2012, Goodhart and Ashworth, 2012, Martin and Milas, 2012).

A second problem is the time period over which analysis is conducted. Event studies have been a popular approach for examining QE (e.g. Joyce *et al.*, 2011, Gagnon *et al.*, 2011), but these focus on the crisis and post-crisis period, a time of extraordinary economic and financial dislocation, which creates counterfactual and attribution problems and may fail to capture typical macroeconomic lag dynamics. Event studies can perhaps be justified on the basis that QE and related policies were short-term or one-off policies to meet extraordinary circumstances. This argument loses weight the longer central banks continue to employ such policies. There is increasing evidence that balance sheets will remain permanently larger²² and historical evidence certainly supports this view (Ferguson *et al.*, 2014).

²⁰ See also the ‘supplementary special deposits scheme’ of the Bank of England (Ball and Tchaidze, 1982)

²¹ One exception is Joyce *et al.* (2012) who suggest that QE contributed around 1.5% to real GDP growth at its peak and boosted annual inflation by around 1.25%.

²² See for example, comments by Governor Mark Carney and Charlie Bean at the House of Commons Treasury Committee hearing on 24th June 2014 at 11.00am–11.05am (House of Commons, 2014). See also Hidaka and Fujioka (2014) on Japan.

Thirdly and finally, the time period for some of the more recent credit quantity policies, such as FLS and related macroprudential policies, is arguably too short to draw satisfactory conclusions about their impact.

This chapter is an empirical study of monetary policy in the UK which attempts to address these concerns. First, the impact of various different monetary policy variables is examined in a general unrestricted single-equation model with nominal GDP growth as the dependent variable. Four different dependent variables that can be seen to proxy for alternative theoretical explanations of the monetary policy transmission mechanism are analysed: short-term interest rates (New Keynesian), long-term interest rates (Portfolio rebalancing), a broad money aggregate (Monetarist), and a disaggregated ‘real economy’ credit variable. By including the latter, a less well-established theoretical approach is reflected – the ‘credit theory of money’ – but by doing so to some extent the more recent quantitative policies can be represented.²³ The long-time series used for the study justifies incorporating credit quantities as a dependent variable since it can be argued that in the 1963-1975 period this was one of the intermediate target variables of the Bank of England (Hall, 1983: ch 3, Goodhart, 1989: p156-158) and, as mentioned, it has become so once again post-crisis with the reintroduction of macroprudential policies.²⁴

Secondly, we use a newly constructed quarterly time series from the mid-1960s to test our hypotheses against multiple regime shifts, time dynamics, and effects of shocks. Although the UK is just one country, it is one that has undergone a number of major institutional and political changes in monetary policy over the period. Such location shifts are explicitly modelled using Impulse and Step-indicator saturation techniques (Santos *et al.*, 2008, Doornik *et al.*, 2013).

The GETS methodology (Julia Campos *et al.*, 2005) is used to develop a single-equation Error Correction Model (ECM) which finds a long-run cointegrating relationship between growth in GDP and credit to non-financial corporations and households (the ‘real economy’). Changes to short-term interest rates and broad money do not appear significant in this model. Similar results are found when the model is re-estimated in Vector Error Correction model (VECM) format. The problem of simultaneity between nominal GDP and credit with exogeneity and augmented Granger causality tests is tackled and the findings broadly support unidirectional Granger causality from real economy credit to GDP.

²³ Exchange rates are an additional possible instrument that might have been included in the analysis but these have generally not been given the same prominence in UK monetary policy as interest rates and quantity aggregates.

²⁴ It should be noted also that the Bank of England changed the main tools of monetary policy a number of times over the time period in question (credit quantities, short-term/long-term interest rates, monetary aggregates) so that it is not possible to identify a consistent approach to targetting during the period in question.

The chapter is laid out as follows: Section 2 summarises existing theories of the monetary policy transmission mechanism in the context of the recent quantitative policies and includes a discussion of the role of credit. Section 3 describes the data, empirical methodology, and related modelling decisions. Section 4 presents the results and Section 5 concludes with implications for policy.

2.2 Recent developments in monetary policy

2.2.1 Portfolio rebalancing approaches

Monetary policy has undergone considerable change over the past four decades since the abandonment of the Bretton Woods regime in the early 1970s. Most significant has been a shift away from attempting to control or influence monetary or credit aggregates. This may be largely attributed to the failure of monetarist experiments in the 1970s and 1980s, which involved an explicit attempt to control monetary (but not credit) aggregates (Kaldor, 1985, Hendry and Ericsson, 1991). New-Keynesian or NMC theories advised that monetary policy should move away from quantities and on to the price of money – interest rates – mainly through central banks' role in setting the nominal short-term interest rate or 'base rate' (Clarida *et al.*, 1999, Woodford, 2003), as described in Section 1.4.3.

The New-Keynesian approach largely held sway over central banks from the 1990s up to the crisis. In the face of a collapse in credit markets, nominal demand, and lending, central banks reduced interest rates to record lows in most advanced economies. This did not stimulate the expected growth or recovery. The failure of standard New-Keynesian monetary policy led to the adoption of new monetary policy experiments which had elements of both monetarist and New-Keynesian thinking. With short-term base rates having reached the ZLB, central banks moved their attention to medium- and longer-term interest rates. QE²⁵ or LSAPs involve central banks buying up long-dated assets in large quantities ostensibly to push down such rates. Three main channels or 'transmission mechanisms' have been identified via which QE impacts on the economy (Bernanke and Reinhart, 2004, Bowdler and Radia, 2012).²⁶

²⁵ For a review of the origins of the term QE, see Lyonnet and Werner (2012). QE has been implemented differently in different countries with different types of assets purchased by different central banks. For an international reviews see Joyce *et al.* (2012).

²⁶ A fourth channel not analysed here is an expectations channel. Announcements by central bankers, even if quite vague, can have strong impacts on markets by revealing information about the likely future path of monetary policy. Such effects can be analysed via event studies linked to policy announcements (see e.g. Krishnamurthy and Vissing-Jorgensen, 2011).

First, as commercial banks hold significantly higher levels of central bank reserves as a result of QE, it is possible that additional liquidity and reduced cost of funding will enable banks to increase their lending to the real economy, creating credit for new GDP transactions. In the UK, the first phase of QE in 2009, when £200 billion was injected in the space of just six months, may have supported bank lending, or at least prevented a further fall in credit creation. This argument can be seen as monetarist, in the sense that it hypothesises a relationship between the quantity of base money in the banking system and broad money (bank deposits) (Bridges and Thomas, 2012). However, in official publications, the BoE has played down this effect (Bowdler and Radia, 2012). It is difficult to identify such monetary or liquidity effects since a number of other schemes aimed more directly at improving banks' balance sheets were also underway at the time, including the government guaranteeing bonds issued by the banks (the credit guarantee scheme), the Special Liquidity Scheme, and the partial nationalisation of the Royal Bank of Scotland and Lloyds via tax-payer-funded recapitalisations. Nevertheless, in our econometric model broad money as a proxy for monetarist approaches is included (Section 3.1).

The main theoretical emphasis for QE policies has instead been placed on the 'portfolio channel' effect. The purchase of gilts from financial investors by the central bank results in the replacement of longer-term higher-yielding assets with more liquid but lower-yielding assets (deposits).²⁷ It is hoped that investors will rebalance their holdings by seeking similar kinds of financial assets with higher yields, in particular corporate assets – bonds or equities (shares) – that will in turn support businesses operating in the real economy, since it will bring down the cost of issuing new equity or bonds for firms and mean that it is likely they will be able to access more finance. For larger firms in particular, capital markets are recognised as an important substitute for bank credit. The possibility that monetary policy works through portfolio substitution effects, even in normal times, has a long intellectual history, having been supported by both Keynesians (Tobin, 1969) and monetarists (Brunner and Meltzer, 1973).

A third potential consequence of portfolio rebalancing is known as the 'wealth effect'. As investors buy more equities this should push up their price, meaning holders of these assets will feel wealthier. They may choose to invest this additional wealth in consumption which would contribute to GDP growth. It is also possible that banks, which also hold assets, will feel a wealth effect, too, because the value of their capital will rise. They may then pass on this effect via charging lower rates of interest. As with the liquidity effect mentioned earlier, however, the BoE has downplayed such an impact, arguing that the banking sector has been too severely damaged by the crisis for this to make a significant difference (Bowdler and Radia, 2012). There may also

²⁷ See Bridges and Thomas (2012) for an in-depth discussion. As well as seeking higher-yielding assets, certain kinds of investors, in particular pension funds, will want to hold assets of longer maturity than deposits as they have correspondingly long-dated liabilities.

be a wealth effect for households if banks do increase lending against property, resulting in rises in house prices. There is evidence that house prices play a significant role in the monetary policy transmission mechanism in the UK via consumption-collateral effects (Muellbauer and Murphy, 2008, Aron *et al.*, 2012).

A long-term interest rate is included in our model – the zero-coupon 10-year government bond yield –to test the effect of the QE/portfolio rebalancing policy on nominal GDP.²⁸ By including this variable, any distortions in the analysis arising from the Zero Lower Bound that has applied to the short-term rate (bankrate) since the onset of the financial crisis in 2008, as noted by Barnett and Thomas (2013), are avoided.

2.2.2 Fiscalist-demand-based approaches

There are a number of uncertainties surrounding the policy prescriptions described above and their impact on the transmission mechanism of monetary policy. The portfolio rebalancing and wealth effect channels are indirect since investors, firms, and households have multiple options following the portfolio adjustment that results from QE. Rather than buying newly issued corporate bonds or equities, investors may instead switch into foreign government bonds or simply buy existing corporate securities or invest in derivatives, which will have the effect of inflating the prices of these assets rather than creating GDP transactions. Even if investors do buy newly issued corporate assets, firms themselves may choose not to spend the additional funds on investment in new production. For example, the Office of National Statistics (ONS) estimated in 2013 that UK companies were sitting on £318 billion in cash, equivalent to 20% of GDP (Seymour, 2013). If companies choose to use the funds to pay down existing bank loans, QE would have the paradoxical effect of reducing the money supply.

For similar reasons, the wealth effect is subject to some uncertainty. The impact on consumption for any consumer household will depend on whether they feel the wealth increase is a long-term or merely a short-term improvement in their economic position. This is the problem of ‘Ricardian equivalence’ for monetary policy that has been highlighted by Woodford (2012) amongst others.

²⁸ Lyonnet and Werner (2012) also include the quantity and quality of the UK’s central bank balance sheet to test for the impact of QE-type policies in a GETS model. However, the growth rate of BoE assets over the 1963–2012 period is $I(0)$ in contrast to our other variables. In addition, since the stated aim of QE-type policies is to reduce medium- or long-term interest rates, including the 10-year bond yield in the model can be seen as a more direct way of testing this policy.

These dynamics have been theorised by some New-Keynesian economists as a ‘Liquidity Trap’ – a situation where monetary stimulus of any kind, including flooding markets with money – becomes ineffective because of depressed demand and expectations in the wider economy, as occurred during the Great Depression²⁹ (Eggertsson and Krugman, 2012, Krugman *et al.*, 1998). In such situations, it is argued, monetary policy becomes ineffective and fiscal policy boosting demand becomes the only way of returning the economy to equilibrium. The reason for the slow recovery, these economists have argued, is that the initially large fiscal stimulus in the USA immediately following the crisis was not maintained and that other countries, in particular those in the Eurozone, have adopted quite the opposite fiscal policies in the form of long-term austerity programmes.

Others have questioned the existence of the so-called liquidity trap, however. As Werner (2005: 246-260) points out, the liquidity trap argument only explains why monetary policy becomes ineffective once nominal interest rates reach the lowest possible level; it does not explain why very large *reductions* to bank rate or medium- and longer-term interest rates via QE appear to have had negligible proportional impact on demand over time: in the Japanese case over a decade, and in advanced countries following the 2007–2008 crisis, at least five years. To put it another way, it is not clear how the concept of a liquidity trap helps us understand how the economy moves from a state of equilibrium to disequilibrium, or *becomes* demand deficient.

It should also be noted that Japan did engage in a major fiscal stimulus in the 1990s. Government spending as a proportion of GDP rose from about one-sixth in the 1980s to half in the 1990s but failed to increase growth or inflation (Werner, 2005: 39). More recently, Larry Summers (2013) has argued that the USA (and western countries more generally) may have been suffering from a long-term liquidity trap, with real interest rates being around zero or negative, for 20–30 years with growth maintained only through repeated asset price bubbles. The causes of this ‘secular stagnation’ are not entirely clear, but might be related to declining population growth and innovation. In such a situation, massive and long-term fiscal expansion may be necessary to shock demand back in to equilibrium.

It is unclear how best to include what Werner (2005) termed the fiscalist approach in our model since it claims monetary policy of any kind will be ineffective at certain times in the business cycle but is rather vague as to when such liquidity trap conditions apply. However, our general unrestricted model (GUM) is an autoregressive distributed lag (ARDL) model (Section 2.4), which encompasses a simple univariate autoregressive model that might be expected to emerge if

²⁹ In traditional IS/LM analysis, the demand curve for money (LM) becomes horizontal meaning any shift to the IS curve via interest rates has no impact.

the ‘secular stagnation’/deficient-demand hypothesis described above had empirical tractability. Such a test is not trivial – a meta-analysis of forecasting models of the US economy in 2008 found the surprising result that no alternative model outperformed such a naive univariate model (Faust, 2008).

2.2.3 The role of credit

Different theoretical views of the role of credit in the monetary transmission mechanism are analysed in Sections 1.4.4 and 1.4.5. One of the main challenges in trying to demonstrate an empirical relationship between credit and output is the likely endogeneity of the variables concerned – in other words, it is not clear whether credit growth leads to output growth or vice versa. The idea that credit shocks can have an independent impact on the macroeconomy rests on the existence of supply-side credit rationing (Keeton, 1979, Stiglitz and Weiss, 1981, Stiglitz and Weiss, 1992) by banks independently of the state of demand. In the UK, since 2010 the BoE has conducted quarterly surveys of businesses in attempt to ascertain loan demand and found the supply-side constraint has consistently been stronger.³⁰ A recent historical VAR study by the Bank found that between a third and a half of the fall in GDP relative to its historic trend in the UK can be attributed to credit supply shocks and a much weaker role for aggregate demand shocks (Barnett and Thomas, 2013).

International studies have also found evidence of an independent role for credit. A study of Spanish bank lending using individual loan application data found robust statistical evidence of credit rationing over the 2002–2008 period (Jiménez *et al.*, 2012: 6). Similarly, a panel study by the ECB which used shocks to money demand as an instrument for bank lending concluded that ‘a change in loan growth has a positive and statistically significant effect on GDP... and underpins the reasoning behind giving monetary and credit analysis a prominent role the monetary policy strategy of the ECB’ (Ciccarelli *et al.*, 2010: 6).

If banks ration credit, then their allocative decisions also have macroeconomic importance. As already noted in Section 1.4.6, this takes on extra importance when considering the relationship between credit and output if a proportion of credit creation is not for GDP transactions but for existing financial assets. Jordà *et al.* (2014) in a panel study of 17 industrialised countries going back over 100 years find that about two-thirds of bank loans today are for the purchase of real

³⁰ See the Bank’s quarterly ‘Trends in Lending’ reports available at: <http://www.bankofengland.co.uk/publications/Pages/other/monetary/trendsinlending.aspx> and also Bell and Young (2010) who find evidence for both supply and demand effects but conclude that ‘qualitatively, tight credit supply is likely to have been the dominant influence.’

estate compared to one-third at the beginning of the twentieth century. The outcome of such credit flows on economic growth is much less clear since they may simply lead to asset price inflation rather than new GDP transactions.

In the UK case, empirical studies suggest secured household lending became an important contributor to GDP growth via wealth effects and consumption since the credit liberalisation of the early 1980s (Muellbauer, 2009, Aron *et al.*, 2012). These reforms allowed previously credit-constrained property-owning households to borrow for consumption purposes, using their homes as collateral. This poses something of a quandary as to which credit aggregate is most sensible to include in any model seeking to understanding the relationship between monetary policy, credit, and nominal GDP. This is discussed further in the next section.

2.3 Data

2.3.1 Features of the data

The original levels' dataset runs from 1963(q1) to 2012(q4). All data are quarterly since this is the most frequent period available for the variable of interest, nominal GDP. Pre-estimate visual examination suggested none of the variables were stationary in their levels and there was evidence of exponential trends. The data was also not-seasonally adjusted (NSA). The Year-on-Year (*YoY*) (or four-quarter) growth rates were taken to de-trend and de-seasonalise the data – this is the equivalent to the seasonal (4th) difference of the log (Cryer and Kellet, 1986: 95), formally:

$$YoYx = \frac{(x_t - x_{t-4})}{x_{t-4}} \quad (1)$$

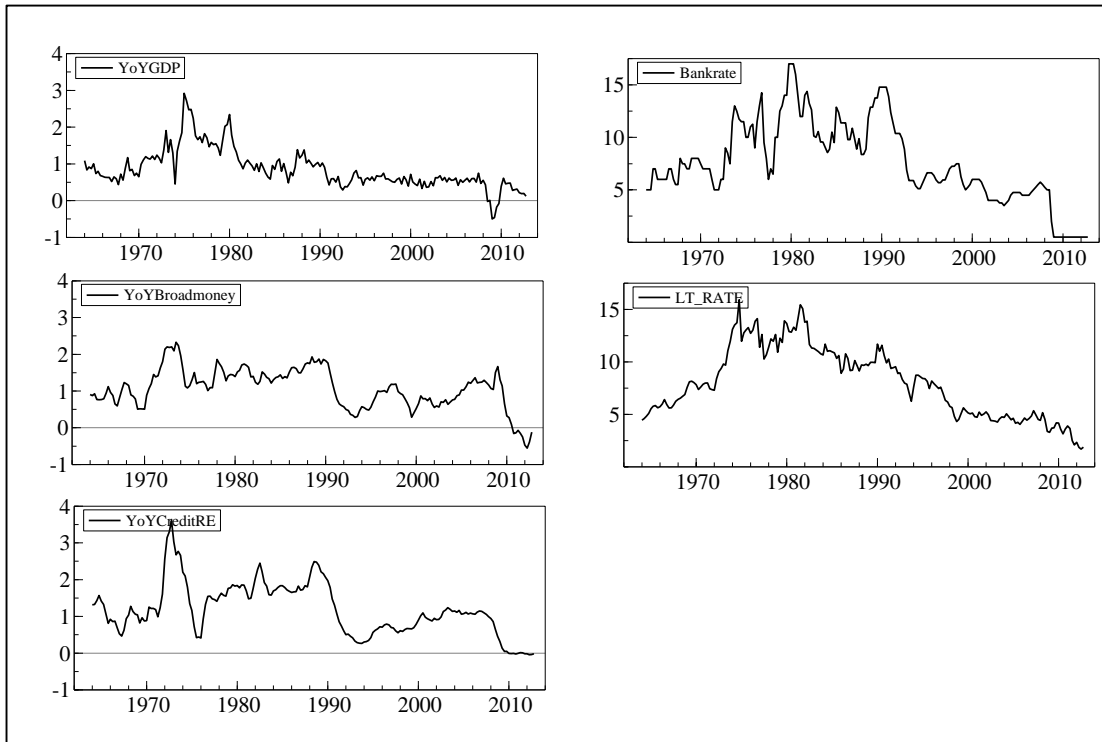
where *YoY* is the Year-on-Year (or four-quarter) growth rate and *x* the variable of interest. An alternative option would have been to de-seasonalise the data and use log-levels. However, seasonal adjustment techniques remain under discussion in relation to monetary data (see, e.g. Gilhooly and Hussain, 2010) so the former option was preferred. This transformation also focuses attention on the medium-term dynamics of the data and enables to the abstraction from short-term noise, an approach now becoming more popular in monetary policy studies (see e.g. Cobham and Kang (2012), and Borio (2014)).

The dependent variable is nominal GDP growth (*YoYGDP*) and there are four conditional variables: broad money growth (*YoYBroadmoney*), long- (*LT_Rate*) and short- (*Bankrate*) term interest rates, and a real economy credit variable (*YoYCreditRE*). Further information on data choice and constructions is provided in Section 2.3.2. Summary statistics of the data series are displayed in Table 1. There is a significant difference in the mean and standard deviation of our credit and monetary growth rate variables over the 196 quarters under study. The greater volatility of credit is also shown in Figure 1, showing the YoY growth rate time series plots.

Table 1: Summary statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------------------|-----|-------|-----------|--------|-------|
| <i>YoYGDP</i> | 196 | 0.850 | 0.53 | -0.499 | 2.918 |
| <i>YoYCreditRE</i> | 196 | 1.185 | 0.71 | -0.042 | 3.606 |
| <i>YoYBroadmoney</i> | 196 | 1.073 | 0.541 | -0.552 | 2.327 |
| <i>LT_RATE</i> | 196 | 8.007 | 3.328 | 1.7 | 15.93 |
| <i>Bankrate</i> | 196 | 7.608 | 3.848 | 0.5 | 17 |

Figure 1: Time series variable plots (YoY growth rates)



Unit-root testing of the data in YoY growth rates, using the Phillips-Perron (1988) approach that accounts for structural breaks, showed that all variables are $I(1)$ as shown in Table 2 and thus potentially cointegrated.

Table 2: Phillips-Perron Unit root tests

| | PP Z(t) Statistic | | | | Outcome |
|----------------------|-------------------------|--------|--------------------------|---------|--------------|
| Variable | YoY growth rate (t=195) | | ΔYoY growth rate (t=194) | | |
| constant | Yes | No | Yes | No | |
| <i>YoYGDP</i> | -2.758 | -1.623 | -16.194 | -16.230 | <i>I</i> (1) |
| <i>YoYCreditRE</i> | -2.219 | -1.450 | -7.773 | -7.786 | <i>I</i> (1) |
| <i>YoYBroadmoney</i> | -2.038 | -1.231 | -9.177 | -9.200 | <i>I</i> (1) |
| <i>LT_Rate</i> | -0.922 | -0.608 | -16.676 | -16.709 | <i>I</i> (1) |
| <i>Bankrate</i> | -1.849 | -1.003 | -12.515 | -12.544 | <i>I</i> (1) |
| <hr/> | | | | | |
| | Critical values | | | | |
| | | 1% | 5% | 10% | |
| | With const | -3.48 | -2.88 | -2.57 | |
| | No const | -2.59 | -1.95 | -1.62 | |

Notes: Lags for Phillips-Perron's (1988) test chosen using Newey–West (Newey and West, 1994) automatic bandwidth selector applied by Hobijn *et al.* (1998).

Given this interest in the long-term relationships between the variables, including possible cointegration, whereby linear combinations of non-stationary variables may induce stationarity (Hendry *et al.*, 1978), all variables were initially examined in their *I*(1) growth rate format (Figure 1). Second-differencing *YoYGDP* in particular led to over-differencing and loss of information. Most selection tests remain valid with integrated data and most diagnostic tests also remain valid (Sims *et al.*, 1990, Wooldridge, 1999). Because of the potentially long lags associated with monetary policy and the problem of autocorrelation, five lags for each variable in the GUM are included.

2.3.2 Data choices and construction

The literature on central bank performance identifies a range of goals related to macroeconomic stability, including price and exchange rate stability and maximising output (Hasan and Mester, 2008). Nominal GDP is a widely accepted final target variable for monetary policy (Mccallum and Nelson, 1999, Sumner, Woodford, 2012) as it can be seen to combine price stability and output. As mentioned in the Introduction, the quantitative stimulation policies that are the indirect subject of our analysis have been targeted at nominal rather than real spending and growth. Hence real GDP or real interest rates or inflation are not included in our model.³¹ Nominal GDP data was sourced from the ONS.

³¹ The remit of the BoE is as follows: In relation to monetary policy, the objectives of the BoE shall be—(a) to maintain price stability, and (b) subject to that, to support the economic policy of Her Majesty's Government. The latter has been most recently defined as: 'to achieve strong, sustainable and balanced growth that is more evenly shared across the country and between industries' (Osborne, 2013)

Excluding a measure of inflation from the model is a departure from the literature in this area but there are a number of justifications for doing so. First, monetary authorities and other financial actors in the economy make decisions in real time using information on nominal, rather than real variables. This is a feature that Keynes and post-Keynesian economists have attributed to the existence of uncertainty about the future (Davidson, 1972). Second, if a measure of credit is to be included in the model, and the model tested as to whether credit has real effects on the economy (as posited by the credit theory of money), it becomes difficult to say which set of prices should be included. For example, just including the UK Consumer Price Index (CPI) would bias our model towards adjustments in the prices of goods and services but exclude changes in asset prices, which research suggests plays an important role in financial crises, including the 2007–2008 crisis. Since the CPI is highly correlated with the GDP deflator, and since the latter is not only correlated with nominal GDP but can be considered a component of it, an inclusion of a price variable may bias the results.³²

BoE data were used to construct the remaining time series and the relevant codes are shown in Table 3.³³ Where data were only available in weekly or monthly form, the value at the end of every quarter was used, or the average monthly or weekly value in the month or week closest to the end of the respective quarter – exact periods are specified in Table 3.

For the nominal monetary and disaggregated credit aggregates, new time series had to be constructed as the BoE does not publish consistent measures back to 1963. For money the BoE’s ‘broad money’ (previously M4) measure was used, the broadest deposit aggregate measure on the liability side of the UK’s consolidated banking systems’ balance sheet

³² In Chapter 4, where there is an explicit interest in examining asset prices, real GDP is examined and consumer price inflation included in the model (as well as asset prices).

³³ All data can be downloaded from the Bank of England Interactive Database:
<http://www.bankofengland.co.uk/boeapps/iadb/newintermed.asp>

Table 3: Time series data summary and construction

| Variable name and abbreviation | Hypothesised effect | Series name (BoE unless specified) | Period | Code (BoE interactive database code unless stated) |
|--|---|---|-------------------|--|
| Year-on-Year Nominal GDP (<i>YoYGDP</i>) | n/a | ONS: Total gross final expenditure (aligned - P.3+P.5+P.6 : CP NSA) – (minus) Imports: Total Trade in Goods & Services: CP NSA + (plus) Statistical Discrepancy Gross Domestic Product : CP NSA | End of quarter | ONS codes: ABMD BKTL RVFD DMUN |
| Short-term interest rate (<i>Bankrate</i>) | Standard monetary policy impact – reduction in base rate leads to increase demand and supply of credit and hence growth | Quarterly average of official bank rate divided by 100 | Quarterly average | IUQABEDR |
| Long-term Interest rate (<i>LT_Rate</i>) | Reduction in bond yields induces portfolio rebalancing and wealth effects | 10-year nominal zero-coupon bond yield from British Government Securities | End of Quarter | IUQMNZC |
| Year-on-Year growth rate of broad money – the broadest deposit aggregate (<i>YoYBroadmoney</i>) | Increase in broad money will have portfolio rebalancing effects as investors switch out of deposits and in to higher yielding corporate assets. | 1963(Q2)–1995(Q3): Quarterly amounts outstanding of monetary financial institutions' sterling M4 liabilities to private sector: (other financial corporations + private non-financial corporations + household sector); 1995(Q4):2013(Q2) – recursive addition of break adjusted quarterly changes (flows) of M4 liabilities to the private sector to 1995(Q3) level. | End of quarter | LPQAUYM LPQAUZI |
| Year-on-Year growth rate of Bank credit to the real economy (excluding the effects of securitisation) (<i>YoYCreditRE</i>) | Credit creation by banks for GDP transactions should directly create growth | Quarterly amounts outstanding of monetary financial institutions' sterling M4 net lending to private non-financial corporations + total household sector + recursive addition of break adjusted quarterly changes (flows) to M4 net lending to non-financial sector and household sector (to 1963q2 level). | End of quarter | LPQB9Y2 + LPQBD68 + LPQB9Y3 + LPQB8Y8 |

Credit proved the most challenging variable to construct, perhaps unsurprisingly since no previous studies had attempted to analyse credit over such a long time period in the UK. Figure 2 shows three different credit aggregates (amounts outstanding of banks' sterling net lending) for the UK since 1963. The three aggregates are lending to non-financial companies, lending to households (including mortgage credit and consumption) and lending to non-bank financial corporations. Figure 2(a) shows the credit stock-to-GDP ratio. There was an explosion in household lending as a proportion of GDP from the 1980s in contrast to lending in the private non-financial corporation sector which grows much more gradually. There was also a sharp increase in lending to other financial corporations leading up the financial crisis.

Figure 2: Credit aggregate-to-GDP ratios and (b) YoY growth rates in the UK, 1963q1–2012q1

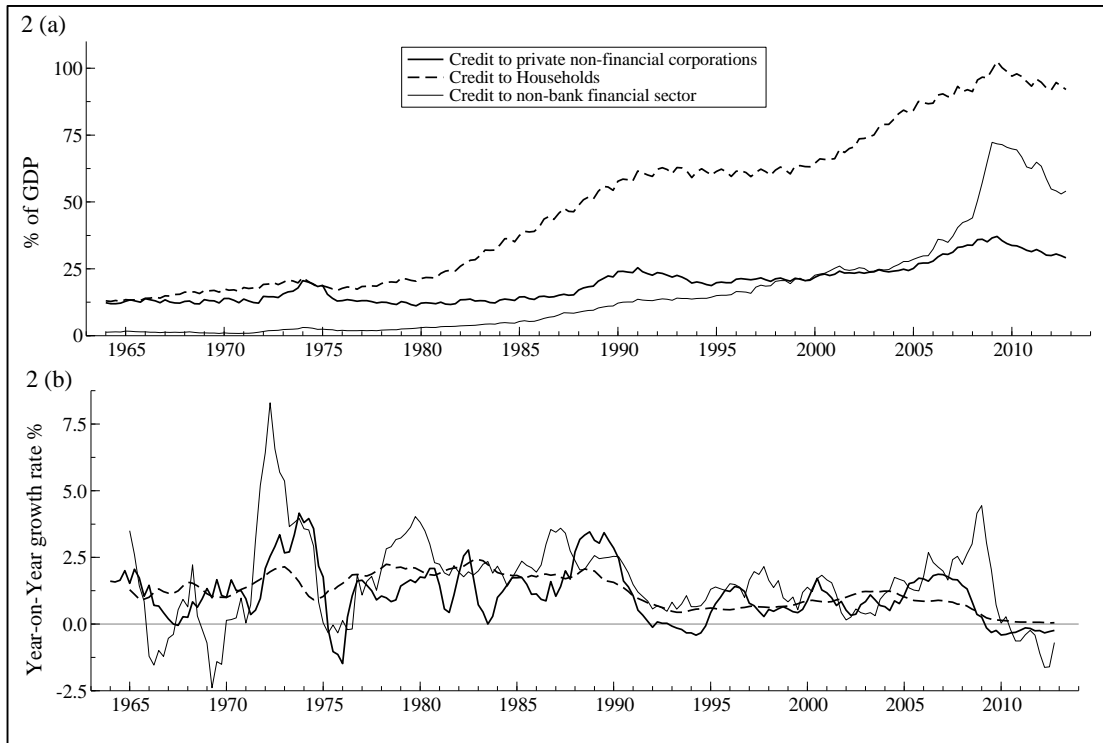


Figure 2(b) shows the YoY growth rate of the credit composites. The growth rate of lending to households is considerably smoother than lending to private non-financial corporations. There is considerable evidence that mortgage lending in the UK and, relatedly, changes in house prices may affect consumption, which itself is the most important contributor to economic growth in expenditure terms making up about two-thirds of overall GDP. Private consumption is driven by a range of factors, including disposable income; consumer credit conditions; wealth, including property wealth; and future expectations of income and wealth over the lifecycle. In the UK, where the level of home ownership is relatively high at 68% (with regional variations), property wealth (net, excluding private pensions) accounted for 62% of total wealth (£3.375 trillion) in 2010 (Office National Statistics, 2008-10: 2).

In a comparative study of the relationship between credit, housing collateral and consumption in the UK, Aron *et al.* (2012) report that prior to the liberalisation of credit in the early 1980s there was no evidence of a relationship between consumption-to-income and housing wealth-to-income ratios. Post credit liberalisation, however, consumption became less volatile and clearly correlated with household wealth, providing strong evidence of a consumption-smoothing collateral channel. A similar consumption-smoothing role for mortgage credit is found to be a key explanation of the ‘Great Moderation’ in the USA in a study by (Grydaki and Bezemer, 2013).

For this reason it was decided to include mortgage lending in the ‘real economy’ credit aggregate along with bank lending to private non-financial corporations. This approach also follows that of (Lyonnet and Werner, 2012) who carry out a similar study to ours on UK monetary policy over a much shorter time period. One way to disaggregate mortgage credit data that were directly used for consumption and residential investment would have to be to only include lending for mortgage equity withdrawal rather than for house purchases. Unfortunately, data on equity withdrawal were not available from the BoE for the required time period.

2.3.3 Data adjustments

In the late 1990s and 2000s, there were a number of changes to monetary aggregates caused by changes to the BoE’s definitions of banks and building societies, EU reporting requirements, and bank failures and mergers, in particular during and following the financial crisis. These changes, some of which ran to billions, are not captured in the BoE’s levels data but are captured in the Bank’s ‘quarterly changes to amounts outstanding’ or ‘flows’ data series (Bank of England, 2013). For both *YoYBroadmoney* and *YoYCreditRE*, a new, break-adjusted levels’ series is created by indexing against the 1963q1 level. The 1963q2 level is thus the addition of the real 1963q1 level and the 1963q1 corresponding change (or ‘flow’), the 1963q3 level is the new 1963q2 added to the 1963q2 change and so on. This gives a more accurate picture of the dynamics in monetary aggregates over time and means structural breaks or dummies relating to definitional changes for this period can be avoided.

Prior to Q2 1975, the BoE did not include data on unsecured lending to households, lending to non-incorporated companies, or to not-for-profit institutions serving households (NPISH) in its measures of lending to the economy (Bank of England, 1975). The figure for credit to the real economy 1963q1–1975q1 thus includes an estimate of these categories. The figure is a residual derived from subtracting lending to Other Financial Corporations from the Bank’s ‘Total Private Sector Credit’ aggregate which does include these categories.³⁴

Finally, the effect of securitisation is excluded from credit and money series. When a bank securitises a loan, it is removed from its balance sheet and may no longer register as an asset of the financial system; however the corresponding liability (deposit) remains in the economy and the potential GDP impact of the lending does not ‘disappear’. The BoE’s series ‘M4ex- excluding the effects of securitisation’ maintain the assets on the banks’ balance sheets, giving a truer

³⁴ This followed a personal email correspondence with Bank of England staff, 16 January 2014. Email available on request.

picture of credit flows, so this version of the respective series for lending to private non-financial corporations and households is included (Bank of England, 2012).

2.4 Empirical Methodology

2.4.1 General-to-specific modelling

Given the competing theories described in Section 2, we should be wary of *a priori* theoretical assumptions and restrictions when estimating an empirical model. Instead the GETS methodology (Hendry, 1995, Mizon, 1995, Julia Campos *et al.*, 2005) is adopted.³⁵ We commence with a GUM which embeds the competing economic theories of the monetary transmission mechanism. The GUM should be *congruent*, i.e., statistically valid (see e.g. Bontemps and Mizon, 2008). Selection is undertaken on the GUM in which valid reductions are applied to reduce the model to a parsimonious congruent specification. The ‘Autometrics’ search algorithm, which uses a tree-search to detect and eliminate statistically insignificant variables, is utilised (Doornik, 2009).³⁶

Sufficient lags are also included to ensure no residual autocorrelation, one of the major challenges when analysing macroeconomic time series. Inclusion of such lags, even where they give rise to signs that are the reverse of the expected, is seen as a preferable method of removing autocorrelation to pre-estimation differencing, since the investigator does not know *a priori* that the autocorrelation is caused by the existence of a unit root and valid information about the reaction of variables to structural breaks; such differencing risks hiding potential regime shifts (Hendry and Mizon, 1978). Assuming multiple potential explanatory variables (x) are being examined, the GUM of Year-on-Year nominal GDP (YoYGDP) will thus be an ARDL model of the general unrestricted form:

$$YoYGDP_t = \sum_{i=1}^n \alpha_i YoYGDP_{t-i} + \sum_{i=0}^n \beta_i x_{t-i} + \varepsilon_t \quad (2)$$

where α_i and β_i are coefficients, n is the maximum lag length included and ε_t is a white noise, serially-uncorrelated error: $\varepsilon_t \sim \text{IN}[0, \sigma_\varepsilon^2]$.

³⁵ The econometrics software PCGive including the Autometrics selection algorithm was used for all the modelling in this chapter.

³⁶ Monte Carlo tests show that GETS selection from the GUM recovers the DGP from large equations with a size and power close to commencing the search from the DGP itself (Hendry and Krolzig, 2005).

Most widely used time series models are special cases of Equation 2, including static relationships, autoregressive error processes, leading indicator, growth rate, distributed lag, partial adjustment, and equilibrium or error correction models (ECMs) (Hendry *et al.*, 1984). The ARDL thus has the advantage of avoiding invalid restrictions based on theoretical assumptions (De Boef and Keele, 2008: 186).

The ECM (or equilibrium correction model) is the most common transformation of the ARDL model. Macroeconomic time series will typically have unit roots and it is wise to test variables for cointegration prior to differencing to $I(0)$ space, whereby two variables may share the same stochastic process and their linear combination will result in a stationary error process.

Cointegration of y_t and x_t in Equation 2 can be tested via the Engle-Granger two-step method (Engle and Granger, 1987) whereby both variables are initially tested for stationarity and if found to be $I(1)$, regressed against each other with appropriate lags to remove autocorrelation. If the residuals of this auxiliary regression are found to be stationary, this is evidence of cointegration. A short-run ECM can then be estimated via first differencing to give:

$$\Delta Y_oYGD P_t = \alpha_1 \Delta X_t + \alpha_2 (Y_oYGD P_{t-1} - \beta^* \cdot x_{t-1}) + \varepsilon_t \quad (3)$$

where the long-run coefficient β^* (when $Y_oYGD P_t = Y_oYGD P_{t-i}$ and $x_t = x_{t-i}$ for all i) is derived³⁷ from the estimated OLS coefficients as

$$\beta^* = \frac{\sum_{i=0}^n \hat{\beta}_i}{1 - \sum_{i=1}^n \hat{\alpha}_i} \quad (4)$$

Once a congruent GUM has been identified, a specific, parsimonious model is then estimated via valid reductions of variable lags based on statistical significance from the general model. This allows conditioning of later inferences on the congruent model specification as the best representative of the DGP.

By including relevant variables, the GETS approach allows monetarist (monetary aggregates), New-Keynesian (short-term interest rates), more recent central bank portfolio and wealth-channel approaches (long-term interest rates), and credit theory of money perspectives (disaggregated

³⁷ See Charemza and Deadman (1992) for detailed derivations.

credit flows) to be equally represented and encompassed in the first GUM (the specific variables used and the theoretical hypothesis behind them are summarised in Table 3).

With many variables and lags, many different potential reduction ‘pathways’ with correspondingly different combinations of variables may be available to the researcher. There may then appear to be a danger of ‘data mining’ if there is no automatic encompassing relationship between the final models of different researchers who have ‘wandered down different paths in the forest of models nested in the general model’ (Hoover and Perez, 1999: 3). However, software algorithms have been developed that enable many hundreds of competing terminal models to be compared for encompassing and statistical robustness (Hendry and Krolzig, 2005). The ‘Autometrics’ search algorithm is utilised, which uses a tree-search, rather than simple step-wise sequential reduction to detect and eliminate statistically insignificant variables (Doornik, 2009). As described by Castle *et al.* (2012: 239):

This algorithm does not become stuck in a single-path sequence, where inadvertently eliminating a relevant variable leads to retaining other variables as proxies (as could happen in stepwise regression)... A path terminates when no remaining variables meet the reduction criterion. At the end, there will be one or more non-rejected (called terminal) models. All such models are congruent, undominated, mutually-encompassing representations.

Monte Carlo tests shows that GETS selection from the GUM recovers the DGP from large equations with a size and power close to commencing the search from the DGP itself (Hendry and Krolzig, 2005).

2.4.2 VAR, VECMs, and testing for exogeneity

Single-equation modelling imposes implicit assumptions about the exogeneity of the regressors on the right-hand side of the model. This approach has been criticised, particularly in the context of macroeconomic variables, where there may be contemporaneous feedback between variables such as output interest rates and monetary or credit aggregates, as agents in the economy react to changing conditions or alter their expectations (Lucas, 1976) (Section 1.4).

Since the contemporaneous values of the regressors are included in the single-equation model (Equation 2), the exogeneity assumption is tested using the VAR method. Following Engle *et al.* (1983), weak exogeneity is tested for by estimating single-equation variables in a VAR system,

where each variable is a function of its own past lags and of past lags of the other variables (Sims, 1980, Bernanke, 1986). A simple bivariate VAR in levels is:

$$\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} \pi_{10} \\ \pi_{20} \end{pmatrix} + \begin{pmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{pmatrix} + \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{pmatrix} \quad (5)$$

where $\pi_{10} \dots \pi_{22}$ are matrix coefficients and ϵ_t is a vector of innovations that may be contemporaneously correlated but are not autocorrelated. Since the VAR model involves only lagged variables on its right-hand side and since these variables by definition are not correlated with the error term (assuming no autocorrelation), it can be consistently estimated, equation by equation, by ordinary least squares (Charemza and Deadman, 1992: 157). Additional deterministic components, such as intercept, trend, and dummy terms, can be added as appropriate.

Where it is believed that the two variables are cointegrated, it can be transformed as with Equation 3 by first differencing to:

$$\begin{pmatrix} \Delta y_t \\ \Delta z_t \end{pmatrix} = \begin{pmatrix} \pi_{10} \\ \pi_{20} \end{pmatrix} + \begin{pmatrix} \pi_{11-1} & \pi_{12} \\ \pi_{21} & \pi_{22-1} \end{pmatrix} + \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{pmatrix} \quad (6)$$

If the middle matrix, denoted Π , is singular, it has a reduced rank³⁸ and can be expressed as:

$$\Pi = \alpha\beta' = \begin{pmatrix} \alpha_{11} \\ \alpha_{12} \end{pmatrix} (\beta_{11} \beta_{12}) \quad (6b)$$

where β gives the cointegrating vector (the linear combination required for stationarity) and α gives the speed of adjustment towards equilibrium. It is then possible to normalise on β_{11} ; this is a rotation of the cointegrating space. Equation 6 can then be reduced to a VECM:

$$\begin{aligned} \begin{pmatrix} \Delta y_t \\ \Delta z_t \end{pmatrix} &= \begin{pmatrix} \pi_{10} \\ \pi_{20} \end{pmatrix} + \begin{pmatrix} \alpha_{11}^* \\ \alpha_{12}^* \end{pmatrix} + (1 \ \beta_{12}^*) \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{pmatrix} \\ &= \begin{pmatrix} \pi_{10} \\ \pi_{20} \end{pmatrix} + \begin{pmatrix} \alpha_{11}^* \\ \alpha_{12}^* \end{pmatrix} + (y_{t-1} + \beta_{12}^* z_{t-1}) + \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{pmatrix} \end{aligned} \quad (7)$$

³⁸ The rank of a matrix is defined as the maximum number of linearly dependent rows. The rank of an $n \times n$ non-singular matrix must be n . The rank of the matrix is tested for using the Johansen and Juselius (1990) Maximum Likelihood technique.

Equation 8 is the equivalent to the ECM in Equation 3 with $(y_{t-1} + \beta_{12}^* z_{t-1})$ stationary.

A variable z can be regarded as ‘weakly exogenous’ for a set of parameters of interest, say ω , if knowledge of ω is not required for inference on the marginal process of z_t . (Charemza and Deadman, 1992: 225).³⁹ By normalising on a VECM for identification as described above and then placing zero restrictions on the short-run α feedback coefficients, it is possible to see whether the regressors in this single-equation model are weakly exogenous.

In addition, z can be regarded as ‘strongly exogenous’ when if, in addition to being weakly exogenous, previous instances of z tell us no information about the present value of ω – or z is not ‘Granger caused’ by ω (Granger, 1969). Again, Granger causality can be tested for by adding restrictions to the lags of the variable of interest in a VAR system and conducting Wald tests for the significance of the reduction.⁴⁰ In the context of non-stationary or cointegrated variables, an additional lag m can be added to the VAR according to the m th order of integration to ensure asymptotic properties on the χ^2 test for the reduction, following Toda and Yamamoto (1995).

2.4.3 Structural breaks and indicator saturation

As is clear from Figure 1, there was a great deal of volatility in the growth rate series in the 1970s and early 1980s. In terms of international shocks, the period saw the collapse of the Bretton Woods fixed exchange rate regime and two major oil shocks. There was also significant domestic deregulation, with the Competition, Credit and Control Act of 1971 marking a shift away from quantitative controls on credit towards price via interest rate adjustments and, in 1979, the lifting of exchange controls, opening the banking sector to greater foreign competition and giving domestic institutions access to the developing Eurodollar markets. Banks were permitted to enter the mortgage market from 1980 and mortgage lending significantly liberalised, enabling consumption smoothing via home equity withdrawal (Aron *et al.*, 2012).

Attempting to model so many shocks and regime shifts is challenging. Rather than selectively adding dummies for obvious outlying residuals – of which there were many – the method of ‘indicator saturation’ was adopted following Hendry *et al.* (2004). This involves, for both step

³⁹ In statistical terms, if ω is a set of random variables, its joint density (ω_t, \dots, z_t) can always be written as the product of ω_t conditional on z , times the marginal of z ; the weak exogeneity of z entails that the specification of the latter density is irrelevant to the analysis, and, in particular that all parameters which appear in this marginal density are nuisance parameters (Engle *et al.*, 1983: 277).

⁴⁰ See Hamilton (1994: 302-309) for a formal derivation of Granger-causality testing.

(mean- or location-shifts) and impulse (outliers) indicators, adding a dummy variable for each observation. The ARDL model is then of the general form:

$$y_t = \sum_{i=1}^J \alpha_i y_{t-i} + \sum_{k=1}^N \sum_{i=0}^J \beta_{ki}' x_{k,t-i} + \sum_{i=1}^T \delta_i 1_{[t=t_i]} + \sum_{i=2}^T \gamma_i S_{[t=t_i]} + \varepsilon_i \quad (8)$$

where $\mathbf{x}_t = (\mathbf{x}_{1,t}, \dots, \mathbf{x}_{N,t})$ is an $(N \times 1)$ vector of potential explanatory variables, $\sum_{i=1}^T \mathbf{1}_{[t=t_i]}$ is a set of saturating impulse indicators defined by $\mathbf{1}_{[t=j]} = \mathbf{1}$ for observation $t = j$, and zero otherwise and $\sum_{i=2}^T S_{[t=t_i]}$ is a set of saturating step dummies defined by $\mathbf{1}_{[t \leq j]} = \mathbf{1}$ for observations up to j , and 0 otherwise, J is the maximum lag length and ε_t is a white noise, serially uncorrelated error: $\varepsilon_t \sim \text{IN}[\mathbf{0}, \sigma_\varepsilon^2]$ for $t = 1, \dots, T$.

By adding half of the indicator variables, then conducting model selection (as described above), then adding the other half and selecting again, it is theoretically possible to create consistent standard errors even though such dummies will be inconsistent; the ratio of the first half to the second has a T -distribution under the null for normally distributed errors (Castle *et al.*, 2012, Hendry *et al.*, 2004). These two terminal models are then combined and selection proceeds (Doornik and Hendry, 2013). In practice, the Indicator Saturation algorithm in *Autometrics* in the *PCGive* software package analyses across multiple different combinations of blocks of indicators to find those that are most statistically significant. Under the null that there are no outliers, αT indicators will be retained on average for a significance level α , and simulations under the alternative demonstrate a high power for location shifts, even in dynamic models (Johansen and Nielsen, 2009).

2.5 Empirical results

2.5.1 Single-equation modelling

Rather than jointly selecting the relevant indicators and step-dummies with the variables, a step- and impulse-indicator saturation was first applied to the GUM with all regressors held unrestricted with five lags. Selection of the indicators is undertaken at the 2.5% significance level. This yielded three impulse indicators— for 1975q1, 1979q1, and 1979q3 (denoted I_{date} followed by the date in the equations below). It also yielded three step-indicators, indicating location shifts, for 1974q1, 1976q4, and 1981q2 (denoted using S_{date}). These indicators match with the oil shocks and financial liberalisation policy changes described in Section 2.4.3.

The indicator variables are added to the GUM and a well-specified general model is found, as shown in Table 4. The general model with *YoYGDP* as the dependent variable is estimated over 1965q2–2012q4, and includes five lags of all conditioning variables, five lags of the dependent variable, and the six indicators listed above. The GUM delivers an equation standard error of 1.3% and passes all the standard statistical tests relating to autoregressive errors (AR 1–5 test), autoregressive conditional heteroskedasticity (ARCH 1–4), Normality, White’s tests for heteroskedasticity (Hetero), Ramsey’s Reset test for functional form, and Chow’s test for a break after 1998q4. Graphical inspection (Figure 3) shows a good fit of the scaled residuals (*r*), residual distribution, and autocorrelation function (ACF), confirming the model is robust.

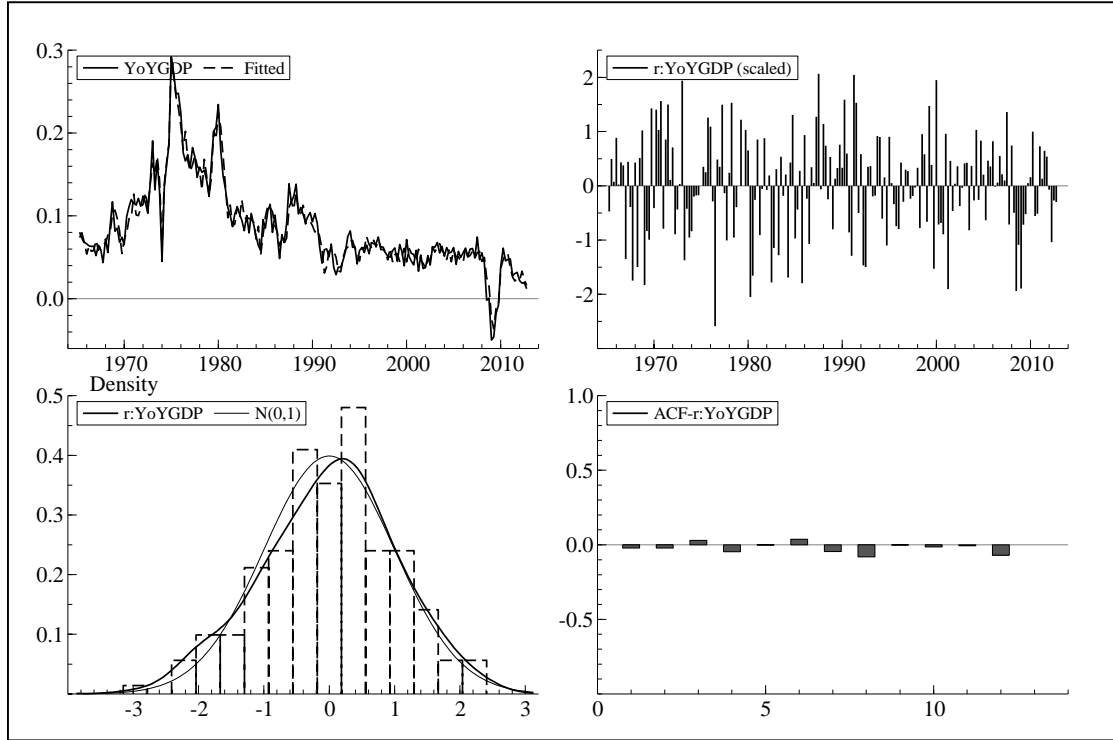
Table 4: General unrestricted single-equation model using OLS

Dependent variable: *YoYGDP*

| Variable | β | <i>t</i> -ratio | Variable | β | <i>t</i> -ratio |
|----------------------|-----------|-----------------|-------------------------|-----------|-----------------|
| <i>constant</i> | 0.01 *** | 2.77 | <i>Bankrate</i> | 0.00 | 0.79 |
| <i>YoYCreditRE</i> | 0.28 *** | 3.07 | <i>Bankrate_1</i> | 0.00 * | 1.81 |
| <i>YoYCreditRE_1</i> | -0.13 | -0.85 | <i>Bankrate_2</i> | -0.00 ** | -2.60 |
| <i>YoYCreditRE_2</i> | -0.25 * | -1.70 | <i>Bankrate_3</i> | 0.00 * | 1.95 |
| <i>YoYCreditRE_3</i> | 0.32 ** | 2.13 | <i>Bankrate_4</i> | -0.00 ** | -2.14 |
| <i>YoYCreditRE_4</i> | 0.22 | 1.47 | <i>Bankrate_5</i> | 0.00 | 1.27 |
| <i>YoYCreditRE_5</i> | -0.35 *** | -3.74 | <i>I__1975_1</i> | 0.06 *** | 3.13 |
| <i>YoYBroadmoney</i> | 0.16 * | 1.87 | <i>I__1979_1</i> | -0.05 *** | -3.09 |
| <i>YoYBroadmon_1</i> | -0.51 *** | -3.77 | <i>I__1979_3</i> | 0.04 *** | 2.98 |
| <i>YoYBroadmon_2</i> | 0.52 *** | 3.78 | <i>S_1974_1</i> | 0.07 *** | 8.75 |
| <i>YoYBroadmon_3</i> | -0.19 | -1.47 | <i>S_1976_4</i> | 0.04 *** | 6.13 |
| <i>YoYBroadmon_4</i> | 0.06 | 0.49 | <i>S_1981_2</i> | 0.04 *** | 6.12 |
| <i>YoYBroadmon_5</i> | -0.06 | -0.73 | <i>YoYGDP_1</i> | 0.57 *** | 9.02 |
| <i>LT_RATE</i> | 0.00 | 0.19 | <i>YoYGDP_2</i> | 0.093 | 1.33 |
| <i>LT_RATE_1</i> | -0.00 | -0.72 | <i>YoYGDP_3</i> | 0.060 | 0.88 |
| <i>LT_RATE_2</i> | 0.00 | 0.79 | <i>YoYGDP_4</i> | -0.47 *** | -6.63 |
| <i>LT_RATE_3</i> | -0.00 | -0.08 | <i>YoYGDP_5</i> | 0.06 | 1.10 |
| <i>LT_RATE_4</i> | 0.00 | 0.23 | | | |
| <i>LT_RATE_5</i> | 0.00 | 1.05 | | | |
| | | | S.E. of regression | 0.013 | |
| | | | Adjusted R ² | 0.93 | |

Note: Obs 1965:2-2012:4 (T = 191); ***= significant at 1% level; ** = at 5% level; * = at 10% level

Figure 3: GUM I(1) diagnostic test plots and test results



Diagnostic tests

AR 1-5 test: $F(5,150) = 0.26376$ [0.9322]

ARCH 1-4 test: $F(4,183) = 0.84164$ [0.5004]

Normality test: $\chi^2(2) = 1.6598$ [0.4361]

Hetero test: $F(61,126) = 1.1193$ [0.2951]

RESET23 test: $F(2,153) = 3.4482$ [0.0343]*

Chow test: $F(56,99) = 0.67573$ [0.9448] for break after 1998(4)

Automatic model selection is then applied using *PCGive's Autometrics* software which uses a tree search to sequentially reduce at a 5% significance level. The final selected model is reported in Equation 10 (standard errors are reported brackets – the full reduction process is available on request). The model passes all diagnostic tests (i.e., congruence is maintained) and the equation standard error is close to that of the GUM at 1.4%.

$$\begin{aligned}
YoYGDP = & 0.01 + 0.5*YoYGDP_1 + 0.2*YoYGDP_2 - 0.4*YoYGDP_4 + & (9) \\
(Std Error) & (0.003) \quad (0.05) \quad (0.06) \quad (0.05) \\
& + 0.2*YoYCreditRE - 0.4*YoYCreditRE_2 + 0.5*YoYCreditRE_3 \\
& \quad (0.04) \quad (0.1) \quad (0.1) \\
& - 0.3*YoYCreditRE_5 + 0.003*LT_RATE_1 + 0.04*I_1975(1) \\
& \quad (0.05) \quad (0.0006) \quad (0.02) \\
& - 0.04*I_1979(1) + 0.05*I_1979(3) - 0.07*S_1974(1) + \\
& \quad (0.02) \quad (0.02) \quad (0.008) \\
& 0.04*S_1976(4) + 0.04*S_1981(2) \\
& \quad (0.007) \quad (0.006) \\
& \quad \quad \quad S.E. of Regression: \quad 0.014 \\
& \quad \quad \quad Adjusted R^2: \quad 0.92
\end{aligned}$$

Growth of broad money and short-term interest rates fall out of our parsimonious model. The long-term interest rate is retained but it has the opposite sign to what might be expected (positive rather than negative) according to the portfolio rebalancing theory outlined in Section 2.2.1. It also has a very weak coefficient. In contrast, the growth rate of credit to the real economy (*YoYCreditRE*) is highly significant with a net coefficient across all lags (including the present value) of 13%. Lags of GDP are also significant with a net coefficient of 30%. From this parsimonious model, a dynamic short run *Error Correction Term* can be deduced which shows a strong relationship between *YoYGDP* and *YoYCreditRE*:

$$ECM = YoYGDP - 0.015 - 0.132 \times YoYCreditRE - 0.0048 \times LT_Rate \quad (10)$$

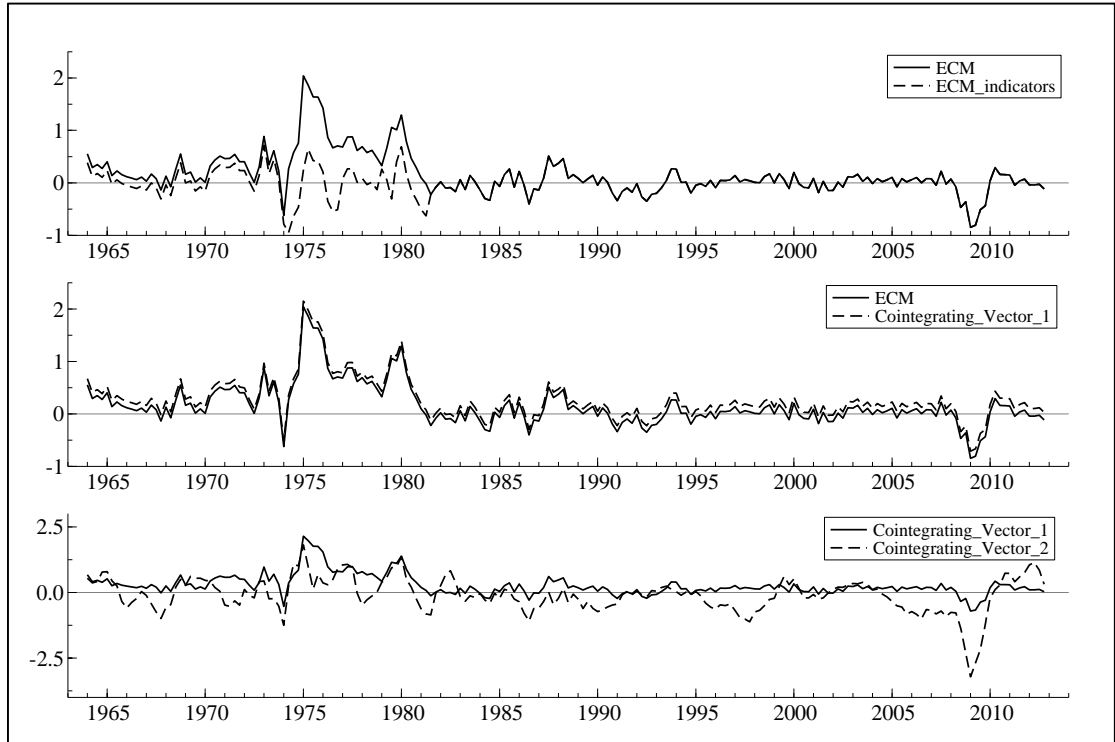
ADF cointegration tests show the ECM to be stationary at the 1% significance level with the indicators included and at the 5% level with the indicators excluded (see the top plot in Figure 4 and Table 5).

Table 5: ADF Unit Root cointegration test

| D-lag | <i>t-adj</i> |
|-------|--------------|
| 5 | -5.042** |
| 4 | -6.592** |
| 3 | -9.140** |
| 2 | -7.417** |
| 1 | -7.056** |
| 0 | -6.675** |

Note: ECM with indicators: no constant (T=190); the sample is: 1965(3) – 2012(4) (196 observations and 1 variable); ** = reject null hypothesis of a unit root at 1% significance; * = reject at 5% significance; MacKinnon critical values: 5%=-3.74 1%=-4.29.

Figure 4: Error correction model (ECM) and Cointegrating Vector plots



The GUM is then transformed to $I(0)$ space by differencing and including the lagged ECM (Equation 11). Rather than including the indicators restrictedly in the cointegrating space, the ECM is first entered excluding the indicators; the impulse indicators are entered restrictedly and the step indicators unrestrictedly, providing a constant. The *Bankrate* and *Broadmoney* are dropped from the GUM, given they were dropped from our $I(1)$ GUM but we include the same set of indicators. Model selection is again applied using autometrics and delivers the following parsimonious ECM:

$$\begin{aligned}
 \Delta YoYGDP = & 0.19 * \Delta YoYGDP_1 + 0.37 * \Delta YoYGDP_2 + 0.46 * \Delta YoYGDP_3 + & (11) \\
 (\text{Std.Error}) & (0.06) & (0.06) & (0.06) \\
 & 0.23 * \Delta YoYCreditRE + 0.09 * \Delta YoYCreditRE_1 - \\
 & (0.08) & (0.08) \\
 & 0.2 * \Delta YoYCreditRE_2 + 0.4 * \Delta YoYCreditRE_4 - 0.7 * ECM_1 \\
 & (0.08) & (0.08) & (0.05) \\
 & - 0.07 * S_1974(1) + 0.04 * S_1976(4) + 0.04 * S_1981(2) + \\
 & (0.007) & (0.007) & (0.005) \\
 & 0.05 * I_1975(1) - 0.04 * I_1979(1) + 0.05 * I_1979(3) \\
 & (0.02) & (0.02) & (0.02) \\
 \text{S.E. of Regression:} & 0.014
 \end{aligned}$$

Adjusted R2: 0.59

Diagnostic tests

AR 1–5 test: $F(5,172) = 1.2362$ [0.2942]
ARCH 1–4 test: $F(4,183) = 1.2752$ [0.2814]
Normality test: $\text{Chi}^2(2) = 1.7382$ [0.4193]
Hetero test: $F(19,168) = 1.5072$ [0.0884]
Hetero-X test: $F(47,140) = 1.6001$ [0.0189]*
RESET23 test: $F(2,175) = 0.00031044$ [0.9997]

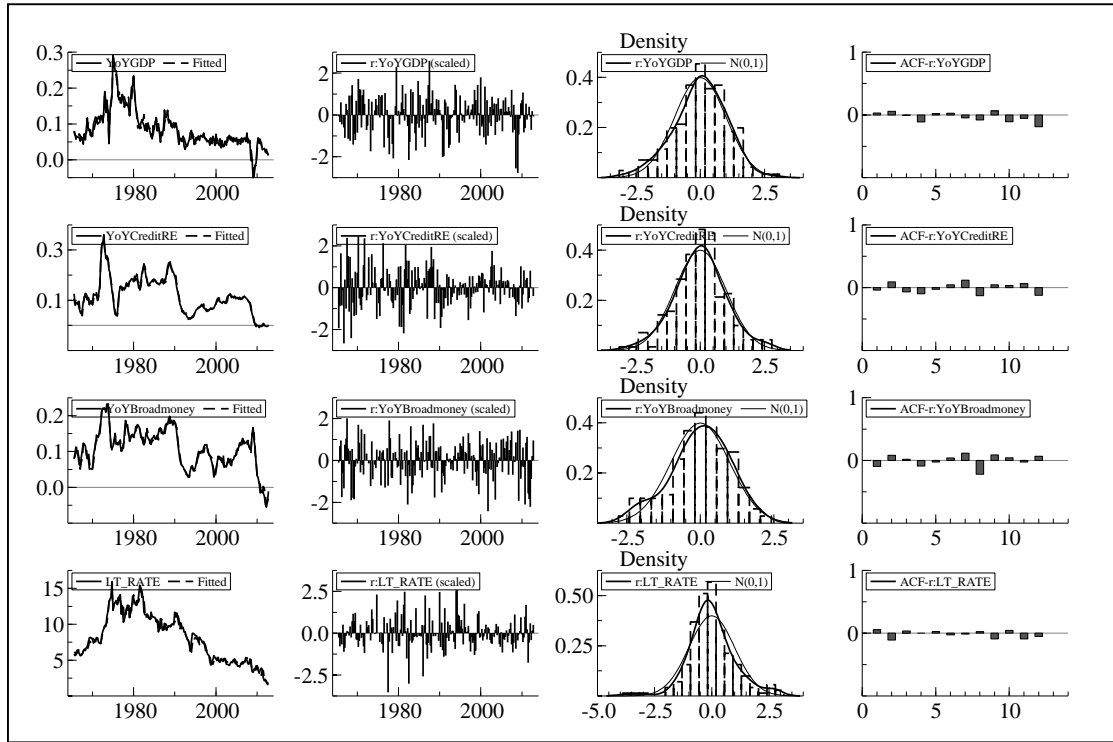
The lagged Error Correction Term (ECM_I) is of the expected sign, highly significant and with a large coefficient, implying rapid adjustment of GDP to changes in equilibrium caused by the growth of credit to the real economy, as described in Equation 11. The long-term interest rate (LT_Rate) falls out of the model (although it is captured in the ECM term). The first lag of $\Delta YoYCreditRE$ is not significant but retained as part of the diagnostic testing carried out by autometrics. The constant is not retained in the model, but the step indicators act as a constant and the impulse indicators are also all retained. The model passes all diagnostic tests at the 5% significance level.

2.5.2 VAR and VECM

One concern with the single-equation ECM approach is that it is limited to discovering one cointegrating relationship but there may be multiple ones between these variables. In addition, this approach makes implicit assumptions about the exogeneity of the right-hand side variables and there are concerns about reverse feedback from $YoYGDP$ to $YoYCreditRE$. The endogeneity of the variables is tested for by estimating a VAR model for the above model.

Six lags of the endogenous variables are included to ensure no residual autocorrelation. Given the larger number of parameters required for a multiple equation model, the short-run *Bankrate* variable is dropped, which has already been seen to be relatively insignificant in the single-equation model. Indicator saturation is again run across all variables in unrestricted form to ascertain significant impulse and step dummies. The VAR is then estimated with an unrestricted constant and indicators. The VAR is reasonably well specified as shown in Figure 5 showing the graphical diagnostics. The roots of the companion matrix indicate that there is no eigenvalue greater than 1, which suggests that there is no explosive root (full diagnostics are reported in Appendix A1.1, A1.2, Figure 27).

Figure 5: Unrestricted VAR(6) - diagnostics



The Johansen (Johansen and Juselius, 1990) multivariate Maximum-Likelihood cointegration test is run to ascertain the number of cointegrating vectors (Table 6).

Table 6: Johansen Maximum Likelihood Ratio (MLR) test for cointegration

| Rank | Trace test [Prob] | Max test [Prob] | Trace test (T-nm) | Max test (T-nm) |
|------|--------------------|------------------|-------------------|-----------------|
| 0 | 126.72 [0.000]** | 75.65 [0.000]** | 110.72 [0.000]** | 66.10 [0.000]** |
| 1 | 51.07 [0.000]** | 25.25 [0.010]* | 44.62 [0.000]** | 22.06 [0.035]* |
| 2 | 25.82 [0.001]** | 24.44 [0.001]** | 22.56 [0.003]** | 21.36 [0.002]** |
| 3 | 1.38 [0.240] | 1.38 [0.240] | 1.21 [0.272] | 1.21 [0.272] |

Notes: Unrestricted constant; 6 lags; ** = reject null hypothesis of a unit root at 1% significance; * = reject at 5% significance

The trace and max eigenvalue tests suggest the existence of two cointegrating vectors at the 1% significance level. The model is re-estimated as a VECM with a rank of 2, an unrestricted constant with no trend and the indicators are added in unrestricted form. The long-run cointegrating relations are given in Equation 13:

$$\begin{bmatrix} \hat{\beta} & YoYGDP & YoYCreditRE & YoYBroadmoney & LT_Rate \\ 1 & 1 & -0.167(0.049) & 0 & -0.005(0.00) \\ 2 & 1.226(0.41) & 1 & 2.19(0.28) & 0 \end{bmatrix} \quad (12)$$

[standard errors in brackets]

As can be seen in Figure 4 (middle plot) the first cointegrating vector in Equation 13 largely resembles the single-equation ECM (Equation 11), confirming the validity of this approach.⁴¹ The second cointegrating vector suggests an equilibrium-correction relationship between credit and broad money growth, which would be expected if the credit theory of money approach – that loans create deposits – is accepted. ADFcointegration tests find both cointegrating vectors are stationary (results available on request).

The restriction that the α coefficients on *YoYCreditRE* are zero on both cointegrating vectors is tested to establish the weak exogeneity of credit growth. This restriction is accepted at the 1% significance level [$\chi^2(2) = 3.71$ [0.16]]. The short-run coefficients on the long-term interest rate and *YoYCreditRE* are jointly restricted to test for weak exogeneity and this restriction is also accepted at the 1% level [$\chi^2(4) = 5.72$ [0.22]].

Finally, weak exogeneity in the growth of *YoYBroadmoney* is tested for. In this case the restriction that the α coefficient on *YoYBroadmoney* is equal to zero is not accepted (although only at the 10% significance level – $\chi^2(2) = 6.98$ [0.03]), and it would appear that there may be short-term feedback between *Broadmoney* and the other variables. As a robustness check, the single-equation model was re-run dropping the contemporaneous value of *YoYBroadmoney*. This led to *YoYBroadmoney* and *Bankrate* being retained in the ECM term but with insignificant t -values in the long-run static equation (-0.133 and 0.79) and tiny coefficients, so makes little difference to our model (full results are reported in Appendix A.1.3).

From a theoretical perspective, short-term feedback from *YoYBroadmoney* could be seen as supporting the portfolio-rebalancing approach discussed in Section 2.2.1. The non-bank private sector and households are likely in the short-term to adjust their holdings of deposits – switching in and out of higher yielding assets such as bonds – according to economy-wide trends (see Arestis and Howells, 1999).

Our final restricted VECM is presented in Equation 14:

⁴¹ The cointegrating vectors have been normalised by their means and variance, hence do not centre on zero.

$$\begin{aligned}
& \left[\begin{array}{ccc} \hat{\alpha} & 1 & 2 \\ YoYGDP & -0.49(0.06) & 0.032(0.03) \\ YoYCreditRE & 0 & 0 \\ YoYBroadmoney & -0.063(0.05) & 0.111(0.02) \\ LT_Rate & 0 & 0 \end{array} \right] \quad (14) \\
& \left[\begin{array}{ccccc} \hat{\beta} & YoYGDP & YoYCreditRE & YoYBroadmoney & LT_Rate \\ 1 & 1 & -0.148(0.05) & 0 & -0.005(.00) \\ 2 & 1.279(0.31) & 1 & -1.634(0.21) & 0 \end{array} \right]
\end{aligned}$$

Finally, strong exogeneity was tested for. As our variables are non-stationary and/or cointegrated, the Toda-Yamamoto (Toda and Yamamoto, 1995) ‘augmented Granger causality test’ was adopted which involves adding an additional lag m to the VAR according to the m th order of integration to ensure asymptotic properties on the χ^2 test for the reduction.⁴² Using the original unrestricted VAR estimated in Section 4.2, one additional lag was added to the six that were originally estimated as our variables are all $I(1)$. The indicators and constant are kept unrestricted as before (the full VAR equations are reported in Appendix A.1.4, Figure 28). Wald tests are then conducted on the variables of interest to test for Granger non-causality and derive strong exogeneity.

The VAR augmented Granger causality tests (Table 7) support our single-equation and VECM findings. *YoYCreditRE* is the only variable where exclusions of past occurrences are not accepted in determining the present value of *YoYGDP* (block 1 in Table 7). Meanwhile, past occurrences of *YoYGDP* can be excluded from the *YoYCreditRE* VAR (block 2, Table 7). Since it has already been found that *YoYCreditRE* is weakly exogenous to *YoYGDP*, it can be concluded that it is strongly exogenous and that the problem of simultaneity has been addressed. The same cannot be said of the *LT_Rate* however, which fits with our inclusion of this variable, albeit with a very weak coefficient, in our cointegrating equations (Equations 11 and 13).

⁴² Bauer and Maynard (2012) show that by extending this surplus lag approach to an infinite order VARX (VAR with an exogenous variable) framework, it can provide a highly persistence-robust Granger causality test that accommodates a stationary, nonstationary, local-to-unity, long-memory, and certain (unmodelled) structural break processes in the forcing variables within the context of a single χ^2 null limiting distribution.

Table 7: Toda-Yamamoto Granger non-causality tests

| Dependent Variable | Excluded from VAR (with 6 lags) | χ^2 | P-value |
|----------------------|---------------------------------|----------|----------|
| <i>YoYGDP</i> | <i>YoYCreditRE</i> | 15.629 | 0.0159* |
| <i>YoYGDP</i> | <i>LT_Rate</i> | 10.099 | 0.121 |
| <i>YoYGDP</i> | <i>YoYBroadmoney</i> | 7.6436 | 0.265 |
| <i>YoYGDP</i> | <i>ALL</i> | 39.984 | 0.002** |
| <i>YoYCreditRE</i> | <i>YoYGDP</i> | 7.6016 | 0.279 |
| <i>YoYCreditRE</i> | <i>YoYBroadmoney</i> | 4.4784 | 0.612 |
| <i>YoYCreditRE</i> | <i>LT_Rate</i> | 15.377 | 0.018* |
| <i>YoYCreditRE</i> | <i>ALL</i> | 30.901 | 0.03* |
| <i>YoYBroadmoney</i> | <i>YoYGDP</i> | 10.134 | 0.1191 |
| <i>YoYBroadmoney</i> | <i>YoYCreditRE</i> | 17.972 | 0.0063** |
| <i>YoYBroadmoney</i> | <i>LT_Rate</i> | 15.025 | 0.0201* |
| <i>YoYBroadmoney</i> | <i>ALL</i> | 59.199 | 0.000** |
| <i>LT_Rate</i> | <i>YoYGDP</i> | 12.689 | 0.0482* |
| <i>LT_Rate</i> | <i>YoYCreditRE</i> | 8.0887 | 0.2317 |
| <i>LT_Rate</i> | <i>YoYBroadmoney</i> | 3.9699 | 0.6807 |
| <i>LT_Rate</i> | <i>ALL</i> | 24.764 | 0.1316 |

Note: *Exclusion rejected at 5% significance level; **Exclusion rejected with 1% significance level

The 1% rejection of exclusions of *YoYCreditRE* on *YoYBroadmoney* again supports the credit theory of money approach outlined in Section 2.3, that loans create deposits, and the *LT_Rate* also appears to have some influence. The *LT_Rate* itself appears independent of the other variables with the exception of *YoYGDP*.

2.6 Conclusion

The post-2008 financial crisis years have seen a range of experiments in monetary policy, most notably quantitative stimulation policies, explicitly targeting nominal spending. Whilst the former policies were initially considered to be extraordinary and short-term responses to the

crisis, their ongoing use and in some cases expansion suggests they may now be considered less unconventional and merit empirical scrutiny.⁴³

This chapter has attempted to do so by examining UK monetary policy and its relation to nominal GDP over a long time period with many shocks, regime shifts, and changes to monetary policy. The long time period and the inclusion of a wide range of variables in this initial general model means that it is possible to encompass a range of different candidate theories of the monetary transmission mechanism, including monetarist approaches, New-Keynesian price theory and its more recent portfolio rebalancing variant under QE, fiscal-demand-based theories and the credit theory of money.

These findings broadly support the credit theory of money approach over the other theories. A long-run cointegrating relationship between the growth rate of real economy (non-financial firm and household) credit and the growth rate of nominal GDP is found. Nominal GDP growth is shown to be strongly exogenous of credit growth and credit growth Granger causes nominal GDP. In contrast, the more standard New Keynesian monetary policy instrument – changes to short-term interest rates – drop out of the model and changes to long-term interest rates are only weakly correlated to GDP and weakly exogenous. The growth rate of broad money also falls out of the model supporting the rejection of monetarist models.

The findings support the argument for an independent role for bank credit (shocks) in influencing nominal output over and above aggregate demand shocks, in accordance with a number of recent VAR, panel and structural equation studies by central banks (Lown and Morgan, 2006, Ciccarelli *et al.*, 2010, Jiménez *et al.*, 2012, Barnett and Thomas, 2013). The findings support Werner's 'quantity theory of credit' approach, too, which also found a strong relationship between disaggregated credit flow and nominal GDP in Japan (Werner, 1997, 2005), the UK (Lyonnet and Werner, 2012), and Spain (Werner, 2014b). Since domestic real estate lending is included in this real-economy credit variable, it also supports the idea of a strong consumption effect from equity withdrawal and possibly also wealth effects from rising house prices in the UK economy (Goodhart and Hofmann, 2008, Aron *et al.*, 2012). The role of asset prices is explored in more depth in the following chapter.

From a policy perspective, the findings raise questions about the efficacy of the strong focus on targeting interest rates (of whatever term) as the main tool of monetary policy, whether by

⁴³ The fact that the BoE has chosen to hold the quantity of assets purchased via quantitative easing stable at £375 billion should not be construed as an abandonment of the policy. Each year a certain proportion of gilts mature and to maintain the £375 billion level, the Bank must purchase additional assets of the equivalent value via the creation of central bank reserve money.

manipulation of the base rate, standard open market operations, or LSAP/QE operations. Rather, the findings support the more recent turn towards targeting credit quantities, such as the BoE's FLS which subsidises mortgage and SME bank lending. The FLS is widely credited with helping the UK's recovery by stimulating mortgage lending but this element was withdrawn by the Bank out of concerns that the housing market might overheat (Titcombe, 2013). However, the FLS has been less successful in stimulating lending to SMEs with net lending to the non-financial corporate sector continuing to contract.⁴⁴ Other quantitative policy proposals to stimulate business lending that the Bank might consider include reducing domestic and international capital requirements for SME lending (Turner, 2013b) or creating a large-scale SME-loan securitisation market.⁴⁵

⁴⁴ The Bank of England's Credit Conditions Survey, 3rd Quarter 2014:
<http://www.bankofengland.co.uk/publications/Pages/other/monetary/ccs/ccs1410.aspx>

⁴⁵ Former member of the MPC Adam Posen argued for such a policy in the UK 2013 (Fleming (2013) and similar calls have been made in the Eurozone context (Mersch (2014)).

Chapter 3: Disaggregated credit, asset prices and economic activity: a Panel VAR approach

3.1 Introduction and motivation

There has been growing interest in the concept of a credit cycle or a financial cycle in macroeconomics since the GFC of 2007–2008. Although the role of credit and asset prices was neglected in pre-crisis DGSE models, the crisis revealed the vital role of these factors and their interaction with household balance sheet dynamics in determining patterns of output growth above and beyond a short-term business cycle (see Goodhart, 2010b, Schularick and Taylor, 2012, Adrian *et al.*, 2012, and Borio, 2014). Central banks, in shifting towards macroprudential policies that target sectorally specific credit quantities and asset prices and incorporating money and credit dynamics in their macro-models, are clearly of the opinion these factors matter (see e.g. Galati and Moessner, 2013, and Aikman *et al.*, 2014).

It is well established in the empirical literature that there exists a positive relationship between bank credit and output growth, with deeper credit markets enabling higher levels of GDP growth.⁴⁶ It is also well established, however, that rapid increases in the credit-to-GDP ratio are a good predictor of financial bubbles, crises, and lengthy recessions (Borio and Lowe, 2002, Rogoff and Reinhart, 2009). The literature on financial bubbles is considerably older than these studies of course – classic accounts include Kindleberger (1978[2011]), and Minsky (1986a). A number of recent studies have shown that, beyond a certain financial system size the credit-to-GDP correlation turns negative (Arcand *et al.*, 2012, Cecchetti and Kharroubi, 2012).

In most theoretical and empirical models, credit is conceptualised at a broad aggregate level – most commonly ‘credit to the private sector’⁴⁷ – and it is assumed that most lending goes to firms for investment. However, a number of scholars have argued that macroeconomic and monetary policy needs to consider the impact of different types of credit flows on the macroeconomy. The key finding is that credit flows to non-financial corporations are more strongly correlated with

⁴⁶ See Schumpeter (1983[1911]), Gurley and Shaw (1955), McKinnon (1973), and Shaw (1973) for seminal accounts. See (Levine, 2005), for a review of the empirical literature.

⁴⁷ For example, the IMF’s International Financial Statistics (IFS) code ‘Credit to the private sector’ is a commonly used aggregate.

economic growth than credit flows to existing assets, for example domestic real estate lending or financial sector lending (Werner, 1997, 2005, Büyükkarabacak and Valev, 2010, Beck *et al.*, 2012, Bezemer *et al.*, 2014, Jordà *et al.*, 2014). These same studies and others also find that rising asset-market credit and asset prices are more strongly correlated to financial crises than rising credit *per se*, posing financial stability risks with related negative impact on output in the aftermath of credit ‘busts’ (Crowe *et al.*, 2013, Borio *et al.*, 2011, Mian *et al.*, 2013).

The need to distinguish between different types of credit flow and include asset prices takes on additional importance given that recent research shows that in the last 30 years banking systems in industrialised economies have shifted from being primarily providers of credit to non-financial corporations to being providers of credit to assets markets, in particular domestic real-estate markets. Jordà *et al.* (2014), in a study of 17 advanced economies since 1914, report that the share of mortgage loans in banks’ total lending portfolios doubled from 30% in 1900 to 60% today. The authors conclude that:

The intermediation of household savings for productive investment in the business sector—the standard textbook role of the financial sector—constitutes only a minor share of the business of banking today, even though it was a central part of that business in the 19th and early 20th centuries.

If the composition of credit has changed so fundamentally away from lending towards non-financial businesses and towards asset markets, this may provide an explanation for the decreasing and eventually negative marginal returns of credit to output growth. Such forms of credit do not support GDP transactions (Werner, 2005, Bezemer *et al.*, 2014) and instead may raise the stock of household debt-to-income ratio to a level that begins to negatively affect consumption, as has been noted by Mian and Sufi (2008) in the United States.

However, despite the evidence of a powerful link between house prices, credit growth, and crises prior to the financial crisis, monetary policy was generally not used to prevent asset booms. The consensus was that it was better to wait for the bust and clean up afterwards than attempt to contain/prevent the boom altogether. First, it was thought difficult to ascertain when asset prices had risen ‘beyond fundamentals’. Secondly, monetary policy approaches had become limited to the use of short-term interest rates and was felt to be too blunt a tool to target a narrow part of the market such as property prices (see, e.g., Bernanke and Gertler, 2000, Dell’ariccia *et al.*, 2012).

In the aftermath of the 2008 financial crisis, however, many central banks have begun targeting the growth, or restriction, of credit to particular economic uses in the economy – a development hitherto unthinkable, as not supported by conventional monetary theory. Most notably, central

banks have developed ‘macroprudential’ policies aimed at reducing credit for asset-market transactions, for example LTV or Loan-to-Income (LTI) ratios for mortgages in the UK (Bank of England, 2014) in an attempt to ‘curb the credit cycle’ (Aikman *et al.*, 2014).

In light of these issues, this chapter studies the dynamic interlinkages between two different credit composites (credit to firms and for consumption on the one hand and asset-market credit on the other), monetary policy (proxied as the three-month interest rate), house prices, and economic activity in a sample of nine industrialised countries. There are three main contributions.

First, credit in disaggregated form is analysed using a new, hand-collected quarterly dataset collected from national central bank datasets, spanning the period 1990–2014. This is the first attempt, as far as the author knows, to examine disaggregated credit data at a quarterly level across a panel of countries. The aforementioned panel studies involving disaggregated credit – those of Beck *et al.* (2008), Büyükkarabacak and Valev (2010), Bezemer *et al.* (2014), and Jordà *et al.* (2014) – use annual data, which limits the application of many empirical time series methods, in particular VAR-type analysis where exogeneity assumptions can be carefully investigated. Meanwhile, related studies using quarterly data have focused on single country cases (Werner, 2005, Werner, 2014b, Bernardo *et al.*, 2013) limiting the generalisability of their findings. By taking this approach, it is possible to quantify the extent to which ‘productive credit’ and credit to ‘asset markets’ affect and are affected by macroeconomic activity. Country-level and panel VAR (PVAR) analysis is used for this purpose and this analysis justifies the segregation of different credit flows when examining the credit cycle.

Second, this study finds a pivotal role for asset prices in influencing credit flows and output growth, supporting recent work that finds evidence of a long-wave financial or credit cycle driving the macroeconomy over and above the standard business cycle (Aikman *et al.*, 2014, Borio, 2014).

The rest of the chapter is structured as follows. In Section 2, a succinct survey of theoretical and empirical literature on the dynamic interlinkages among asset prices, credit, and output is undertaken. In Section 3, the data are presented in the context of the hypotheses. Section 4 presents and discusses methodologies. Empirical results are discussed in Section 5 and Section 6 concludes.

3.2 Asset prices, credit, and output – existing literature

Traditional DSGE macroeconomic models with only a limited or non-existent role for credit and money are clearly not well equipped to analyse credit- or asset-price-driven cycles (Goodhart, 2009, Stiglitz, 2011b, Borio, 2014). As was noted in Chapter 1, Section 1.4.3, attempts have been made to introduce a credit channel in to the general equilibrium framework via the imposition of financial ‘frictions’. Here, lending decisions may be affected by asset prices and balance sheets in conditions where banks ration quantities according to collateral strength, amongst other factors (Kashyap and Stein, 1994, Bernanke and Gertler, 1995, Kiyotaki and Moore, 1997, Bernanke *et al.*, 1999). This results in a ‘financial accelerator’ role for credit, whereby in an upturn, better growth prospects improve borrower creditworthiness and collateral values and lenders increase the supply of credit and may also relax lending standards. More abundant credit allows for greater investment and consumption and further increases collateral values. In a downturn, the process goes into reverse.

Building on these insights, a number of theoretical contributions since the financial crisis of 2008 argue that excessive household leverage, followed by asset price collapses, led to a collapse in aggregate consumption and demand, resulting in a prolonged recession (Hall, 2011, Eggertsson and Krugman, 2012). These studies focus on a ‘liquidity trap’ concept as the explanation for why monetary policy was unable to stimulate investment or consumption when asset prices fell but interest rates hit the ZLB.

As already noted in Section 1.4.4, in financial accelerator-type models, changes in credit or in household balance sheets are not seen as independently causing shocks or major changes to output or inflation. Also, in the stylised models used in such studies, credit is still generally assumed to flow to firms for production rather than to asset markets and the impact of disequilibrium stocks of debt are not modelled. This may help explain why such models did not foresee the financial crisis of 2007–2008 and more generally are unable to generate the types of large swings in asset prices that have characterised actual economies (Quadrini, 2011).

An alternative approach is to assume that credit (and debt) stocks and flows have real and long-term effects on asset prices that can affect consumption and investment, independently of standard business cycle fluctuations, and can create and prolong disequilibrium conditions. The theoretical background to this credit theory of money has been reviewed in the introduction (Section 1.4.5). Whilst work in this tradition was largely neglected for most of the post-war period, it has received increased attention in the wake of the financial crisis. With such an approach, the banking system is not simply an intermediary, transferring real resources from one

part of the economy to another, but a generator of nominal purchasing power, with loans creating deposits.⁴⁸ Credit is not a ‘friction’ in the circular flow of ‘real’ resources but the starting point of a process that enables entrepreneurs to invest with no previous savings. But equally, such credit creation can lead to the build-up of financial bubbles as credit flows to asset markets in speculative booms.

Werner (1997, 2005) develops a formal model of disaggregated credit – the ‘Quantity Theory of Credit’ (also discussed in Chapter 1, Sections 1.4.5 and 1.4.6). This theory splits credit flows in to three categories: ‘productive credit’ (to non-financial firms) that leads to nominal GDP growth, consumption credit that leads to consumer price inflation, and financial credit that leads to asset price inflation. His empirical evidence is from Japan but has been corroborated by empirical time series evidence from other countries (Werner, 2012, 2014b). Building on Werner’s work, the former Chair of the UK Financial Services Authority Lord Adair Turner (2013a) has emphasised how the financial crisis was the result of positive feedback between credit creation by banks for mortgage assets driven by – and driving – increasing asset prices. The process was further exacerbated by banks shifting mortgage loans off their balance sheets via the creation of sophisticated asset-backed securities and credit default swap products that gave the appearance of spreading risk (see, e.g. Shin, 2010, and Pozsar *et al.*, 2010).

Disaggregated credit panel studies have also found a stronger correlation between credit to the non-financial corporate sector and real output growth than credit to the household sector (Beck *et al.*, 2008, Büyükkarabacak and Valev, 2010, Bezemer *et al.*, 2014). Bezemer *et al.* (2014) find a negative relationship between credit-to-GDP stocks supporting asset markets in a study of 46 economies over 1990–2011 but positive growth effects of credit flows to non-financial business and insignificant growth effects of credit flows to asset markets, including real estate. In their study of 17 advanced economies since 1870, Jordà *et al.* (2014) find that real estate credit has become a ‘more important predictor of impending financial fragility in the postwar era’ and that ‘since WWII, it is only the aftermaths of mortgage booms that are marked by deeper recessions and slower recoveries’. Relatedly, in a study of 37 economies over 1970–2012, Bezemer and Zhang (2014) find that mortgage-dominated credit booms are more likely to lead to subsequent credit growth contractions. Similar findings have been found in studies of the causes of US post-crisis recession at a regional level (Mian and Sufi, 2010, Mian *et al.*, 2013).

⁴⁸ See Werner (2014a) for an empirical study showing banks individually can create money; see Mcleay *et al.* (2014) for the BoE recent explanation of money creation in modern economies and also Ryan-Collins *et al.* (2011).

3.2.1 Causation in regard to credit, asset prices, and economic activity

In Werner's Quantity Theory of Credit, causation in the credit cycle runs from banks to economic activity and asset prices as the demand for credit is considered very large and banks' quantity ration to avoid adverse selection (Werner, 2005). The policy solution is thus to ensure as far as possible banks only lend for productive, GDP-related activities. Werner (2012: 4) cites the examples of Germany, Japan, Taiwan, and Korea in the period from the 1930s to the 1970s, when governments intervened heavily to guide bank credit creation via a range of formal and informal tools, as evidence of success.

Other approaches, for example the post-Keynesian school (Moore, 1983, Graziani, 1989, Lavoie, 1984), place a stronger role on the demand for credit. In these approaches, the general state of the economy and aggregate demand, themselves influenced by actual and future perceived asset prices, are important determinants of credit supply. Explanations for the financial crisis of 2007–2008 have drawn in particular on Hyman Minsky's (1986a) 'financial instability' hypothesis. With this approach, a capitalist system with credit creating banks is prone to endogenously generated positive and procyclical feedback effects. For Minsky, during periods of relative stability, confidence would build in both borrowers and banks leading to increases in credit creation which in turn leads to asset prices rises, leading to looser collateral requirements and increased lending, increased prices, and so on until eventually there is a bust and the process goes in to reverse. Although there are similarities in the latter processes with the financial accelerator models of the New-Keynesian school, a key difference is that the financial cycles are continuously generated by the financial system and the economy itself, rather than being amplified by shocks from the 'real economy'.

Such financial cycles occur because economic agents – banks, households, firms – are limited in their knowledge about the future. Building on Keynes's (1936) notion of liquidity preferences, Minsky (1993b: 79) argues that this leads to a situation where changes in asset prices can play a key role in macroeconomic dynamics whereby:

...a small increase in the failure of assets to perform can lead to large changes in available financing because the models of the economy that guide the behaviour of agents change. An episode of say, overindebtedness can lead to an increase in the utility derived from the asset whose market value seems secure relative to the utility derived from holding an asset whose income earning capacity is greater but whose market value seems less secure. Such relative prices of assets are in turn inputs in the determination of investment.

With such an approach, the economy is best understood not as being in a state of self-correcting equilibrium but as a set of bank, household, and firm balance sheets that interact dynamically over time to affect bank credit creation, consumption, and investment decisions. Minsky's policy solutions included an active stabilising role for 'Big Government' in ensuring sufficient demand in the economy when asset prices begin to fall and private sector investment declines (Minsky, 1986a: 22:37) and a 'Big Bank' to provide liquidity in the financial system (Minsky, 1993a).

Minsky became concerned in later writings that banks in the USA were shifting away from lending to non-financial firms towards consumer lending for household purchases or credit card debt as financial innovations – in particular securitisation – enabling them to avoid capital and liquidity regulation by shifting such loans off their balance sheets (Minsky, 1987, Wray, 2009).⁴⁹ As noted, it is becoming increasingly clear that the majority of bank lending is now flowing towards real estate. There is a substantial empirical literature analysing the role of credit and asset prices on an individual basis in the context of business cycle fluctuations and systemic crises (see, e.g., Canova and Menz, 2011, Jordà *et al.*, 2011, Dell'ariccia *et al.*, 2012). But surprisingly less attention has been paid to the interaction between these two variables. This is despite the fact that, as noted by the Bank of International Settlement's Claude Borio (2014: 183):

...combining credit and property prices appears to be the most parsimonious way to capture the core features of the link between the financial cycle, the business cycle and financial crises... Analytically, this is the smallest set of variables needed to replicate adequately the mutually reinforcing interaction between financing constraints (credit) and perceptions of value and risks (property prices)...

Empirical work finds evidence of a correlation between credit, asset prices and output growth, but causality remains contested. As with many macroeconomic time series, these variables display strong co-movements and endogeneity. This means it may be possible to consider several different explanations for observed correlations, as discussed by Goodhart and Hofmann (2008) and Assenmacher-Wesche and Gerlach (2008b). For example, with regard to credit and asset prices, Hofmann (2003) analyses the relationship between bank lending and property prices based on a multivariate empirical framework and find multidirectional causality. Setzer and Greiber (2007) examine broad money and house prices in the USA and the euro area and also finds that that causality runs in both directions, whilst Gerlach and Peng (2005) find that

⁴⁹ Minsky (1987) argued this was a response to Chairman of the Federal Reserve Paul Volcker's decision to push the Fed funds rate above 20% in 1979. This meant that no financial institution could afford to be stuck with long-term fixed-rate mortgages. Hence, regulators 'freed' banks and thrifts to pursue higher return and riskier activities (Wray, 1994).

causality runs from property prices to lending in Hong Kong. Goodhart and Hofmann (2008) find multidirectional causality between house prices, credit and output in a Fixed Effects PVAR analysis on 17 advanced economies from 1973 to 2006 but in a shorter panel from 1985 find that credit does not Granger cause output or house prices. Assenmacher-Wesche and Gerlach (2008b) in a similar study but using a Pooled Mean Group Estimator for the PVAR, find that asset prices affect credit but not vice versa.

One concern with these studies is that they all use a broad credit measure (usually credit to the private sector) that includes mortgage credit but also credit for consumption and to non-financial firms. This contrasts to the studies mentioned above that disaggregate credit.

3.2.2 Regulatory and institutional factors

There may also be institutional and country-specific affects influencing the credit cycle. Many empirical studies find that institutional variation both between countries and over time account for major differences in linkages between credit, house prices, and economic activity (Muellbauer and Murphy, 2008, Duca *et al.*, 2010, Aron *et al.*, 2012). Of particular importance seems to be the structure of the mortgage market, including whether interest rates are floating or fixed, the regulation of home equity withdrawal, average LTV ratios, whether loans are marked-to-market and/or securitised and the degree of owner occupation – see Table 9 for a summary for our sample of nine countries.⁵⁰

Aron *et al.* (2012) find that credit availability for UK and US but not Japanese households has undergone large shifts since 1980 with the result that the average consumption-to-income ratio rose in the UK and the USA as mortgage down-payment constraints eased and as the collateral role of housing wealth was enhanced by financial innovations, such as home equity loans. Calza *et al.* (2013) report similar dynamics. In their PVAR study of 17 advanced economies, Assenmacher-Wesche and Gerlach (2008a: 4), find that mortgage market structure does condition the responses of asset prices to monetary policy but also that ‘the differences between country groups are less important than perhaps commonly thought’. In a study of the USA, Grydaki and Bezemer (2013) find that increases in mortgage credit enabled consumption ‘smoothing’ that enabled the ‘Great Moderation’. Mian and Sufi (2008) found that US subprime ZIP codes experienced strong relative growth in mortgage credit from 2002 to 2005 despite negative relative, and in some cases absolute, income growth. They argue the increase in mortgage credit was predominantly driven by the increase in securitisation and thus innovation in the financial system more generally; similar results are found by Favara and Imbs (2015).

⁵⁰ See Calza *et al.* (2013), MacLennan *et al.* (1998), and Assenmacher-Wesche and Gerlach (2008a) for detailed discussions of different criteria.

Beyond the mortgage market, there is also evidence that the banking structure may affect the monetary transmission mechanism – or may constitute the main channel of monetary transmission (Werner, 2005). Gambacorta and Marques-Ibanez (2011) study 1000 banks across 14 EU countries and the USA using quarterly data over the period 1999–2011 (the first 13 years of common monetary policy) and show that new factors, such as changes in banks’ business models and market funding patterns, modified the monetary transmission mechanism prior to the crisis, and demonstrate the existence of structural changes during the period of financial crisis. Ferri *et al.* (2014) analyse the relationship between bank ownership type and lending practices, controlling for bank balance sheet health and demand conditions, using micro-level data on Eurozone banks over the same period. They find that ‘stakeholder’ banks (including cooperative banks, savings banks, and mutuals) decreased their loan supply to a lesser extent than shareholder-owned banks in the face of a monetary contraction, both during and outside the crisis period. The authors’ hypothesise that this was due to such banks being less driven by profit-maximisation and their practising ‘relationship banking’ meaning they are more likely to grant credit to financially constrained borrowers to maximise the long-term value of their borrower-lender relationship (see, for example, Petersen and Rajan, 1994, Boot, 2000, Greenham and Prieg, 2013).⁵¹ Similar findings are reported by Ayadi *et al.* (2010) in a study of European cooperative banks. Bertay *et al.* (2015), in a panel study of 111 countries, find that lending by state-owned banks, which feature strongly in Germany and Austria for example, is less procyclical than commercial bank lending and in fact countercyclical in advanced economies.

In summary, this brief review of recent research demonstrates that whilst something of a consensus is being reached that there are important links between credit, asset prices, and the macroeconomy, a number of questions around causality and temporal dynamics remain open. One way of shining new light on these dilemmas may be to use a more precise definition of credit in this analysis; as noted, the majority of the discussed studies conceptualise and study credit in an aggregate form. In this study it is hypothesised that the composition of credit matters and that certain forms of credit may be more strongly influenced by asset prices and monetary policy, and themselves influence such variables in different ways. If this is found to be so, this could have important policy implications for monetary and macroprudential policy.

⁵¹ Petersen and Rajan (1994) study small businesses which build relationships with creditors in the USA using data from the Small Business Administration Survey. They find that building close ties increases the availability of financing but has smaller effects on the price of credit. Attempts to widen the circle of relationships by borrowing from multiple lenders increases the price and reduces the availability of credit.

3.3 Data

3.3.1 Data choices

The sample in this study includes nine advanced economies: Australia, Belgium, Canada, France, Germany, Japan, Spain, Switzerland, and the UK. The period covered is 1990–2014, with between 93 and 98 quarterly observations for each country. The sample was limited by the availability of quarterly disaggregated credit data, the construction of which is detailed in Section 3.2. A shorter time series (e.g. from 1998) would have enabled a wider panel but given the lower frequency of the financial cycle compared to traditional business cycles – estimates put it at around 16 years;⁵² the longer series therefore felt more important. Also, although this is a relatively small population N for a panel study, the sample incorporates a good range of institutional diversity, particularly in regard to banking and mortgage market structure. Tables 8 and 9 summarise this heterogeneity, which has been discussed in Section 2.3.

Table 8: Banking market structure: % retail deposits held by type of bank (6 countries)

| Country | Type of Bank | | |
|---------|--------------|--------------|----------------|
| | Commercial | Co-operative | Public savings |
| Canada | 89% | 10% | 1% |
| France | 45% | 55% | 0% |
| Germany | 36% | 24% | 40% |
| Japan | 85% | 15% | 0% |
| Spain | 40% | 60% | 0% |
| UK | 86% | 14% | 0% |

Source: World Bank Financial Access Survey 2010, available online at <http://www.cgap.org/data/financial-access-2010-database-cgap>; Figures show 2009 data.

⁵² See Drehmann *et al.* (2012) who study six economies from 1960–2011 and find a financial cycle – best characterised as the co-movement between credit and residential property prices – of 16 years since the 1980s.

Table 9: Mortgage market structure across sample of six economies

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|-----|----------------------------------|---------------------------|-----------------------------|---|-------------------------|--|-----------------------------------|
| | Interest rate adjust- ment | Equity with- drawal | Average LTV ratio (%) | Mtgage- debt-to- GDP ratio (%) | Valuatio n method | Mtgage- backed securitis- ation | Owner occup- ation share |
| AUS | Variable | Yes | 80 | 74 | Market value | Yes | 70 |
| BEL | Fixed | Not used | 83 | 28 | Market value | No | 72 |
| CAN | Fixed | Yes | 75 | 43 | Lending value | Yes | 66 |
| FRA | Fixed | Not used | 75 | 26 | Market value | Limited | 56 |
| GER | Fixed | Not used | 70 | 43 | Lending value | Limited | 42 |
| JAP | Fixed | Not used | 70-80 | 36 | Market value | No | 61 |
| SPA | Variable | Limited use | 70 | 40 | Market value | Yes | 85 |
| SWI | Variable | Not used | 66 | 116 | Lending value | Limited | 36 |
| UK | Variable | Yes | 80-90 | 74 | Market value | Yes | 70 |

Source: Adapted from Assenmacher-Wesche and Gerlack (2008a: 27) and Calza *et al.* (2013: 104) and the sources therein.

For our PVAR there are six variables:

- Consumer Prices, *cpi*
- Nominal bank credit for production and consumption or ‘productive credit’, (the aggregate of lending to non-financial corporations and lending to households for consumption), C_r
- Nominal bank credit to asset markets, (the aggregate of lending to domestic real estate and to the non-bank financial sector), C_f
- Real GDP (nominal GDP/CPI), *rgdp*
- Nominal house prices, *hprices*
- Interest rates, *irate*

For all variables except interest rates the YoY or four-quarter growth rate of the variable (the close equivalent to the log of the fourth difference) is used. There are three main reasons for using this transformation.

First, from a theoretical perspective, as was noted in the introduction (Section 1.2), using the growth rate means that credit flows rather than stocks are examined. Credit flows allow firms and consumers to finance immediate expenditure and transactions and thus can be seen to have a first round positive impact on output, whilst credit stocks simply show banks' outstanding assets at a certain point of time, telling us less about the dynamics of the economy (Biggs *et al.*, 2009, Bezemer, 2014). As mentioned, at a certain point the stock of total credit to GDP seems to reach a tipping point whereby increases in the ratio actually have a negative relationship to output.⁵³ Credit stocks are also stocks of debt and at a certain point they may reach a level that begins to negatively affect investment and consumption as firms and consumers de-leverage, resulting in a 'balance-sheet recession' (Minsky, 1986b, Palley, 1994, Koo, 2011). Secondly, this transformation enables us to reduce short-term noise and concentrate on the medium-term dynamics associated with the credit cycle (Drehmann *et al.*, 2012, Cobham and Kang, 2012: 66). Thirdly, it enables us to de-seasonalise the credit data, which was only available in NSA form, in a transparent fashion. Seasonal adjustment procedures for monetary data are still under discussion (see e.g. Gilhooly and Hussain, 2010) and different countries use different seasonal adjustment techniques.

Although the Quantity Theory of Credit mentioned earlier in Section 3.2 argues for the use of nominal GDP when assessing the links between credit and economic growth, real GDP is used here following the empirical cross-country growth literature and related studies by Goodhart and Hofmann (2008), Assenmacher-Wesche and Gerlach (2008b), and Bezemer *et al.* (2014). It is well noted that nominal GDP values often change pattern over time and are subject to country-specific macro/trade idiosyncrasies. In addition, such a transformation also enables us to include consumer price inflation in the VAR which is important given that monetary policy (adjustments to short-term interest rates) were mainly targeted at consumer price inflation across the countries in the VAR for the time period specified.

There are, of course, a range of other indicators that could have been included in such a broad study. However, any kind of VAR analysis imposes limits on the number of variables that can be used before the system becomes too large. Drehmann *et al.* (2012), and Borio (2014) find that the financial cycle is most parsimoniously analysed by examining the co-movement between credit and domestic property prices. They find, for example, that equity prices move at a considerably higher frequency.

⁵³ Biggs *et al.* (2009) find that credit flows tend to be more positively correlated after crises to GDP than credit stocks. This explains the paradox of the so-called credit-less recoveries when output improves without any increase in credit-to-GDP ratio.

3.3.2 Data sources and construction

Quarterly YoY consumer prices was taken from the OECD MEI (code *CPAL...*) for all countries. Real GDP was calculated by dividing nominal GDP by the same OECD CPI, a transformation frequently used in cross-country growth studies. It was not possible to find a consistent real GDP series across the nine economies or a consistent GDP deflator. The sources for nominal GDP were as follows:

- Eurozone, UK, Switzerland and Japan: Eurostat “GDP and main components – Current prices [namq_gdp_c]”, NSA, extracted 12 February 2015 from http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database (pre euro-national currencies converted to euro by Eurostat);
- Australia: Australian Bureau of Statistics, code A2302467A;
- Canada: CANSIM, Table 380-0064 GDP, expenditure-based, quarterly (dollars x 1,000,000).

One break adjustment was made to the nominal GDP data series for Belgium. Here there was a change in classification of GDP in 1995q1.⁵⁴ The data was adjusted by using the median of the quarter-on-quarter growth rate of real GDP for the first quarter of 1993, 1994, 1996, and 1997 to create a revised 1995q1 level and then back-dating the series using this revised level. This follows the methodology used to adjust the credit series, described below.

Quarterly nominal house prices are taken from the Bank of International Settlements (BIS) Residential Property Price database,⁵⁵ ‘Long series on nominal property prices’. The long series has been constructed by the BIS using data provided by various national sources, including central banks, national statistical offices, research institutes, private companies, and academic studies. The underlying series makes use of different methodologies and covers different geographical areas and types of dwellings. The House Price data is in index form (1995=100) and the underlying levels data was not available from the BIS.

⁵⁴ This was confirmed following a conversation with the European Statistical Agency Eurostat who stated that: ‘The difference to previous time series is due to several methodological or estimation changes, of which e.g. the transition to NACE Rev 2 data.’ Email correspondence 14 November 2014 13:43:59 GMT.

⁵⁵ National sources, BIS Residential Property Price database, <http://www.bis.org/statistics/pp.htm> , accessed 2 October 2014.

Interest rates are measured by the 3-month or 90-day interbank rate from the OECD MEI (code (.IR3T.....) back-dated with data from the BoJ for Japan for 1990q1–2002q1.⁵⁶

Credit is defined as net lending outstanding and taken, in all cases except Belgium, from the asset side of the consolidated balance sheets of Monetary Financial institutions (MFIs) excluding the central bank for each country (the same definition as was used in Chapter 2). MFIs⁵⁷ are defined as institutions whose major role is to take deposits from and issue loans on their own account to households and the private sector. As well as commercial banks, they also include building societies, savings and loans organisations, cooperative banks, and credit unions. For Belgium, the MFI balance sheet data was not available and the liability side of the consolidated balance sheets of households and private non-financial corporations (PNFCs) was used. For financial corporations, the liability side was again used but sourced from the Belgian Financial Accounts series.

For countries that are members of the European Union (EU), the European Sectoral Accounts (ESA) definition is used to define the four credit receiving sectors (Table 10), which are then further aggregated into two forms of credit for parsimony and to prevent the VAR analysis becoming unmanageable. This approach follows Bezemer *et al.* (2014) who base their definition on the US National Accounts ‘FIRE’ (Financial, Insurance, and Real Estate) sectors. They note that whilst other combinations of the four aggregates are possible, in terms of the correlation with GDP growth, the major distinction is between lending to non-financial firms and domestic mortgage lending. The four categories of credit are defined following the ESA 1995 (ESA1995)⁵⁸ institutional unit definitions as follows:

⁵⁶ Bank of Japan Time Series Database, “Call Rates, Uncollateralised 3 Months/Average over period” code STSTRACLUC3M, accessed 23 October 2014 from http://www.stat-search.boj.or.jp/ssi/cgi-bin/famecgi2.cgi?nme_a000_en&lstSelection=5

⁵⁷ MFIs are also referred to as ‘Other MFIs/OMFIs’ or ‘Credit institutions’ or ‘Credit Financial Intermediaries/ CFIs’.

⁵⁸ Downloadable from <http://ec.europa.eu/eurostat/en/web/products-manuals-and-guidelines/-/CA-15-96-001> [accessed 2 July 2015]; the accounts were updated during the course of the data collection process to 2010 but not backdated prior to 1995, hence the 1995 definitions were preferred.

Table 10: Credit composition definitions

| Final credit aggregate | Sub-aggregate | ESA Description | ESA code |
|-------------------------------|--|--|-----------------------|
| Productive credit | Credit to Private non-financial corporations | Lending to private non-financial corporations (PNFCs) | S.11 |
| | Credit for household consumption | Lending to households for the purpose of consumption and ‘other lending to households’, understood to mean lending to sole proprietors and non-incorporated associations | (see ECB definitions) |
| Asset market credit | Domestic mortgage credit | Lending to households for the purpose of home purchase | S.14 |
| | Credit to non-bank financial corporations | Other financial intermediaries, except insurance corporations and pension funds | S.123 |
| | | financial auxiliaries | S.124 |
| | | insurance corporations and pension funds | S.125 |

A number of caveats apply to the credit data. First, for the non-EU countries in the sample – Japan, Switzerland, Canada, and Australia – the sectoral categorisation of credit did not always fit exactly to the ESA1995 definitions so it was necessary to approximate. Secondly, commercial real-estate lending is included in the general PNFC category. This is not ideal as, whilst a proportion of such lending will support new physical development, some is simply the leveraged purchase of already existing buildings, as noted by (Turner, 2013a) and there is evidence that such lending can be highly speculative (Crowe *et al.*, 2013). In addition, equity withdrawal is included in domestic mortgage credit. In both cases, data limitations meant it was not possible to disaggregate these types of lending for the nine countries in the sample for the required period.⁵⁹

Excluded from the series as far as possible are the following types of loan:

1. Loans to central and local government
2. Loans to the public sector
3. Loans to not-for-profit institutions serving households

⁵⁹ Other types of business credit might also be candidates for removal from ‘productive’ credit aggregate at certain times in the credit cycle, for example construction which Werner (2005) excludes from his measure of productive credit in his study of the effects of disaggregated credit in Japan. However, across nine countries and for such a long period it is very challenging to identify such patterns.

Bezemer *et al.* (2014) note these three categories make up a very small proportion of total lending in each country. Lending to other MFI/credit institutions is excluded from the financial corporation sector as it is assumed that the majority of such loans will be for interbank-settlement purposes rather than for any form of autonomous non-bank sector economic activity. This includes inter-bank transfers, repos, and reverse repos undertaken for settlement purposes.

Securitised loans are, where possible, included in the series. In most countries, the central bank began recording securitisations in the late 1990s or early 2000s as a separate balance sheet item and then later regulatory change in many countries forced banks to record the loans on their balance sheets.

‘Breaks’ in the credit series are understood to be unobserved components that are not related to economic transactions and do not appear in the amounts outstanding reporting of banks. They pose a challenge in putting together comparable cross-country series. Breaks could be caused by changes in the reporting requirements of banks, expansions of the reporting universe of the statistical authority, changes in the definition of banks or lending, or structural changes in the banking system, for example mergers or bank collapses. Breaks were also evident when separate series needed to be spliced together.

Nearly all central banks publish consolidated unadjusted lending levels (stocks or amounts outstanding) series. Many also publish a flows series (period-to-period changes) or alternatively growth rates (period-to-period percentage changes) that *are* adjusted for breaks. This enables the construction of a break-adjusted levels series. There are three main approaches:

- Where break-adjusted growth rates are published, the 2014q2 level is taken and divided by $1 + \text{the growth rate at 2014q2}$ to calculate the 2014q1 break-adjusted level. This is then continued recursively back to 1990q1.
- Where a break adjusted flow is published but not the growth rate, a break adjusted growth rate is calculated using the flow during the period and the amount outstanding at the previous period, following the BoE's methodology.⁶⁰ The reference period will be the latest available period, T . First, the break-adjusted levels series, Z , is set equal to the published value, L , for the amount outstanding in the reference period, $t=T$. Break-adjusted levels for preceding periods are then defined recursively as follows:

⁶⁰BoE, 'Break-adjusted levels data', available online at http://www.bankofengland.co.uk/statistics/Pages/iadb/notesiadb/Break_adjusted_levels_data.aspx

$$Z_t = L_t$$

$$Z_{t-1} = Z_t / \left(1 + \frac{flow_t}{level_{t-1}}\right), t \leq T$$

- Where break-adjusted flow data are not available, or where even after using the techniques described above it is clear that there are still major breaks in the series, level shifts are adjusted for by replacing the quarterly growth rate in the period when the shift occurred with the median of the growth rate of the two periods prior to and after the level shift, following Stock and Watson (2003) and Goodhart and Hoffman (2008). The level of the series is then adjusted by backdating the series based on the adjusted growth rates as described in the first approach.

3.3.3 Descriptive statistics and graphical analysis

Summary statistics for the six variables across the nine countries are presented in Table 11.

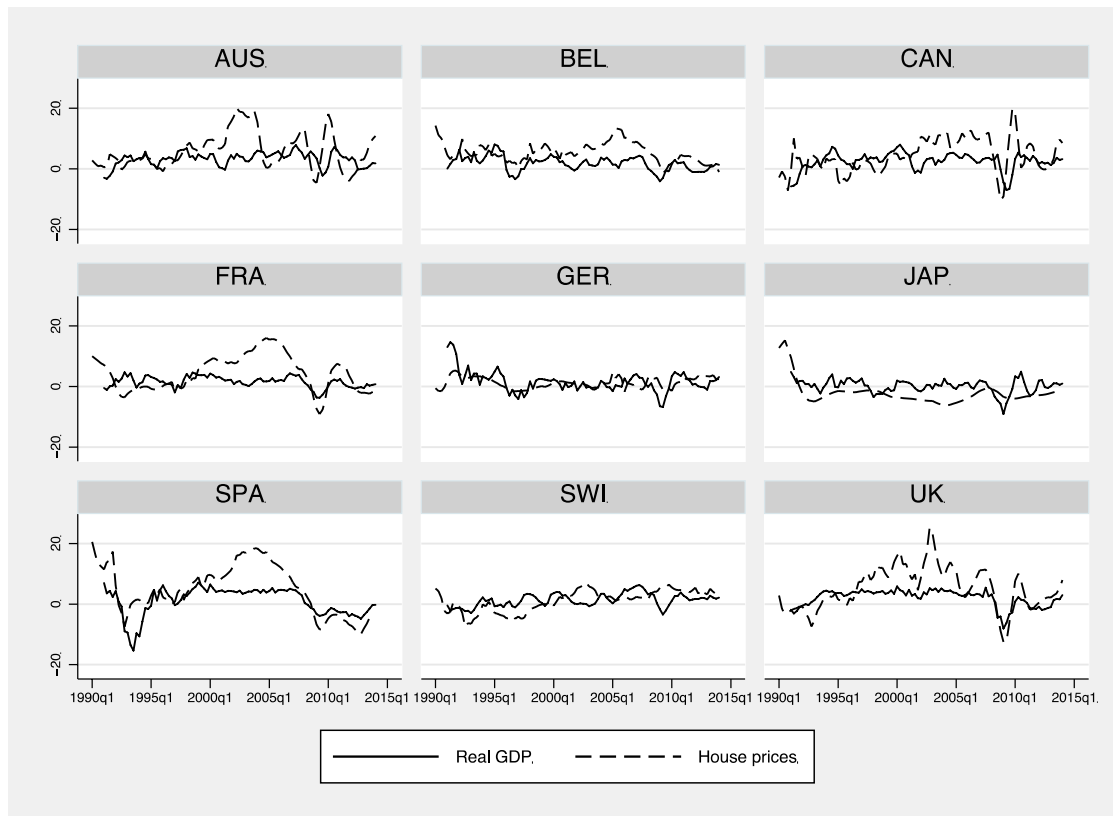
Table 11: Panel summary statistics

| Variable | | Mean | Std. Dev. | Min | Max | Obs | |
|----------------------|---------|-------|-----------|---------|--------|---------|-------|
| <i>rgdp</i> | overall | 1.696 | 2.971 | -15.331 | 14.654 | N = | 837 |
| | between | | 0.884 | 0.148 | 3.254 | n = | 9 |
| | within | | 2.852 | -14.651 | 14.787 | T = | 93 |
| <i>cpi</i> | overall | 2.191 | 1.701 | -2.200 | 8.700 | N = | 882 |
| | between | | 0.902 | 0.470 | 3.563 | n = | 9 |
| | within | | 1.473 | -2.472 | 7.895 | T = | 98 |
| <i>irate</i> | overall | 4.415 | 3.513 | 0.020 | 18.170 | N = | 882 |
| | between | | 1.546 | 1.574 | 6.513 | n = | 9 |
| | within | | 3.196 | -1.122 | 16.072 | T = | 98 |
| <i>hprice</i> | overall | 3.370 | 5.958 | -12.436 | 25.204 | N = | 873 |
| | between | | 2.682 | -2.145 | 5.847 | n = | 9 |
| | within | | 5.394 | -14.215 | 23.425 | T = | 97 |
| <i>C_r</i> | overall | 4.202 | 6.684 | -17.756 | 27.052 | N = | 812 |
| | between | | 3.089 | -1.443 | 7.727 | n = | 9 |
| | within | | 6.000 | -20.900 | 23.908 | T-bar = | 90.22 |
| <i>C_f</i> | overall | 7.353 | 6.275 | -10.905 | 35.334 | N = | 812 |
| | between | | 3.334 | 1.950 | 12.695 | n = | 9 |
| | within | | 5.427 | -16.246 | 29.992 | T-bar = | 90.22 |

The summary statistics show that consumer price inflation (*cpi*) as measured by the CPI was close to the 2% that many advanced economy central banks have targeted since the 1990s. But average YoY house price growth was 1.5 times higher at 3.37% and twice as strong as average real GDP. Credit growth was even stronger, with productive credit (C_r) at 4.2% and credit to assets markets (C_f) at 7.35%, supporting the findings discussed in the introduction about the changing composition of bank lending. These average figures hide considerable heterogeneity across our country sample however, as demonstrated in Figure 6.

Figure 6 shows real GDP and house prices. House price volatility and bubbles are noticeable in Australia, the UK, Spain, France, and Canada with all five economies experience a steep rise in house prices in the first five years of the twentieth century. In contrast in Germany, Japan, and Switzerland house price growth was much more stable during the observation period. There is some evidence of co-movement with real GDP although it is noticeable that the boom of the early 2000s has little affect on output growth, suggesting a detachment of asset prices from the business cycle during this period.

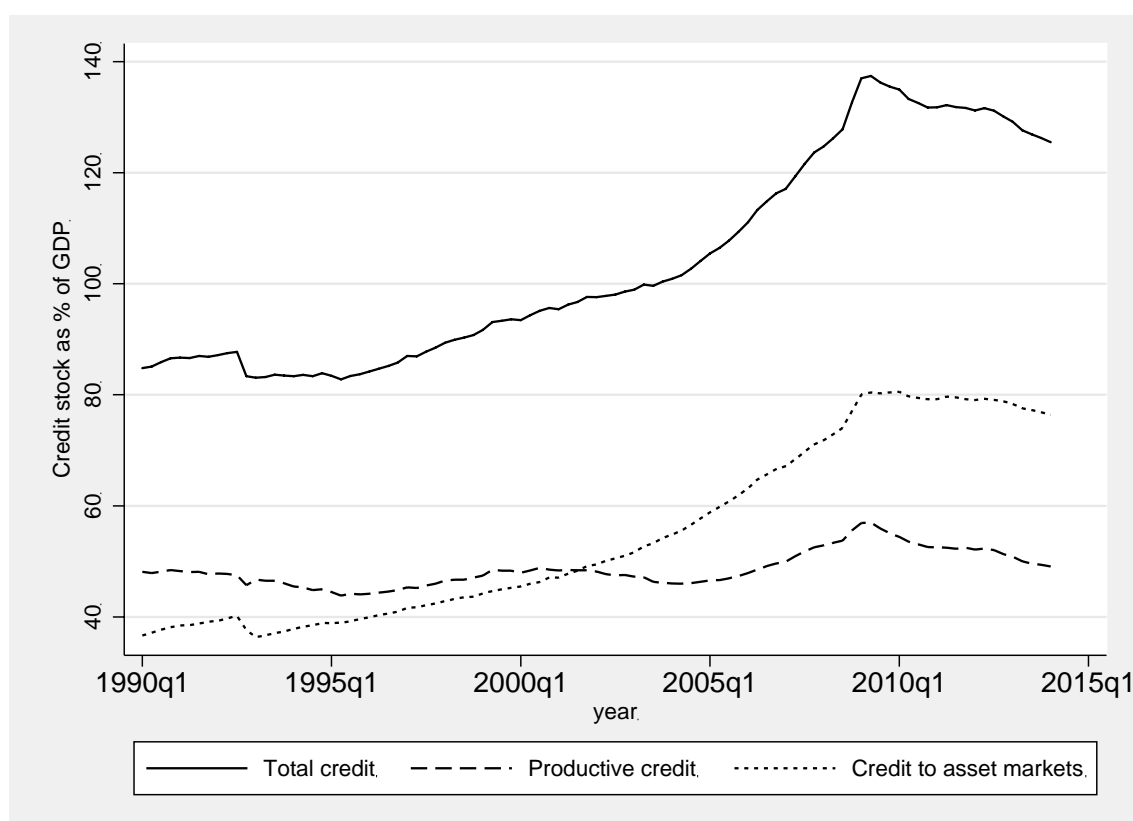
Figure 6: Real GDP and house prices, YoY growth rates



Let us now examine credit. Figure 7 shows the total and disaggregated stocks of credit-to-GDP ratios averaged across our nine economies. The rapid rise in the total average credit-to-GDP ratio

since the late 1990s can be seen from around 80% of GDP to 140% of GDP by the time of the financial crisis in 2007. This is well above the optimum level of around 80–100% identified in recent research (Arcand *et al.*, 2012, Cecchetti and Kharroubi, 2012). It is clear from Figure 7 that this rise was mainly driven by increases in credit to asset markets rather than productive credit (to non-financial firms and to households for consumption). The former credit aggregate doubles in size between 1990 and 2010 and remains close to 80% of GDP.⁶¹ In contrast, productive credit averaged across the nine economies rose from 50% to almost 60% of GDP and has now returned, post-crisis, to around 50% of GDP.

Figure 7: Total nominal credit-to-nominal-GDP ratios, averaged across nine economies



These averages hide significant cross-country heterogeneity. Figure 8 shows productive credit and Asset-market credit stocks as a percentage of GDP for each country, excluding Spain which is shown in Figure 10 to allow better scale comparison. It can be seen that whilst there is a general pattern of credit to asset markets increasing across all countries, in Germany and Japan this increase is less than 10%, whilst in Australia, Canada, France, Switzerland, and the UK, the increase is around 50% or more.

⁶¹ Although the United States is not included in the analysis for data reasons, a very similar pattern has been noted there in other studies (Hudson, 2010, Bezemer, 2014).

Japan is the only country where the total credit-to-GDP ratio has fallen in the period under observation, which may be related to the fact that it is still recovering from a credit-driven property bubble in the mid-1980s⁶² (Koo, 2011). Productive credit is more stable, although there are noticeable falls in Japan and Switzerland over the period, with evidence of some convergence towards 50% of GDP.

Figure 8: Productive credit and asset market credit stocks as % of GDP (excluding Spain)

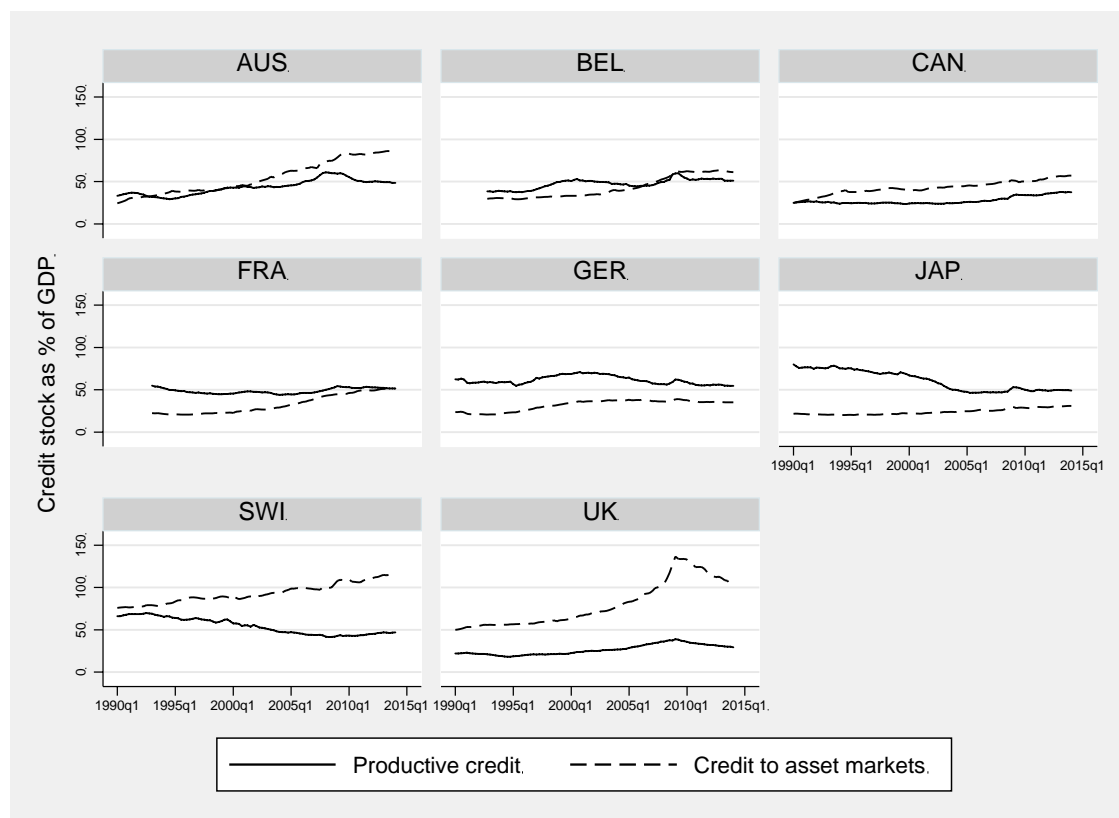


Figure 9 shows that the common trend of increasing credit to assets markets is mostly made up of increases in domestic mortgage lending although for some countries, such as the UK and Belgium, credit to other financial corporations becomes an important contributor in the late 2000s. Spain's enormous asset market bubble is clearly shown in Figure 10, with mortgage credit quadrupling from 40% in 1993 to 160% of GDP by 2008.

⁶² Japanese housing prices rose by 36% from 1986Q1 to 1991Q1 and then declined continually to 2011Q1 by 45% (Miao *et al.*, 2014: 2).

Figure 9: Disaggregated credit stocks as % of GDP, 1990–2014 (excluding Spain)

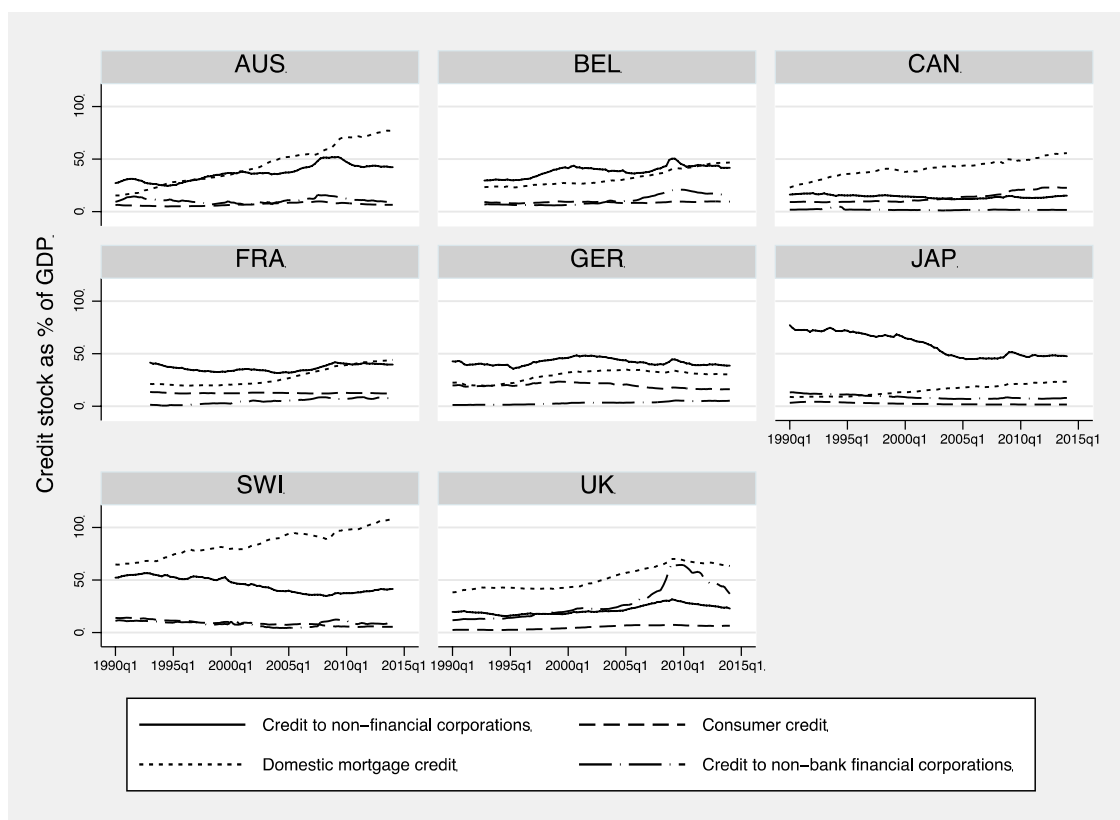


Figure 10: Disaggregated credit stocks as % of GDP in Spain, 1990–2014

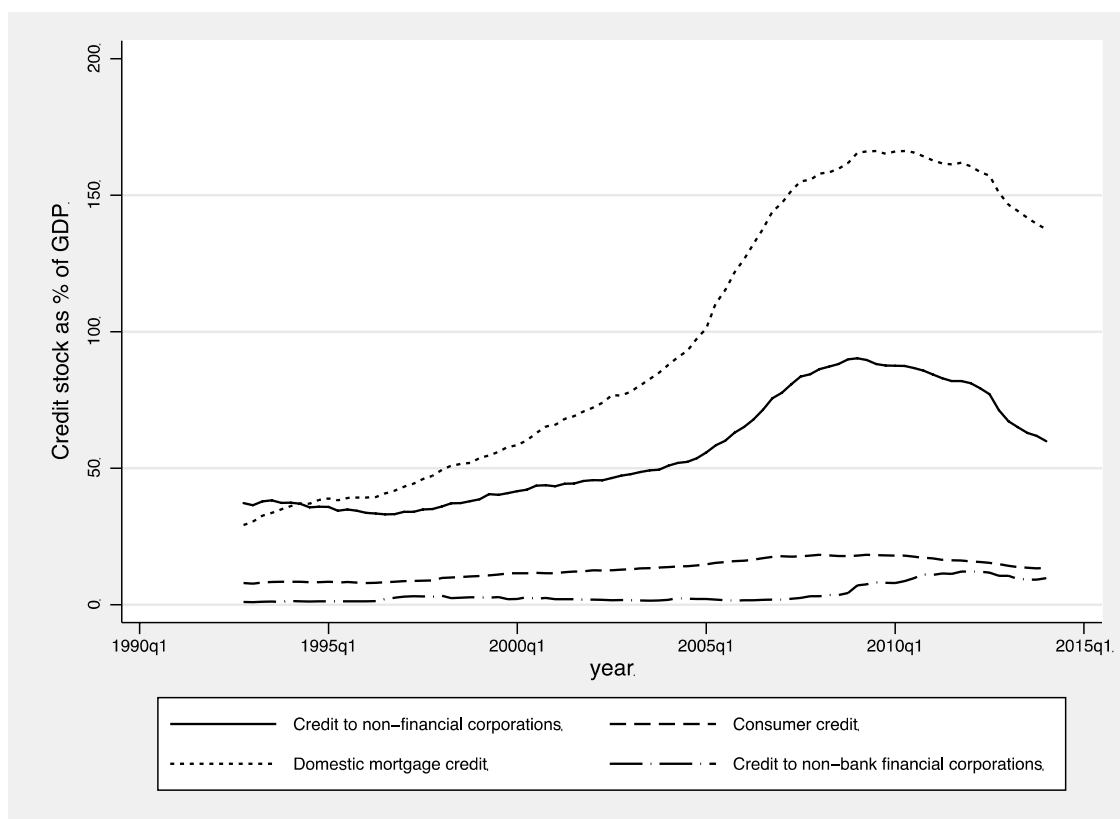
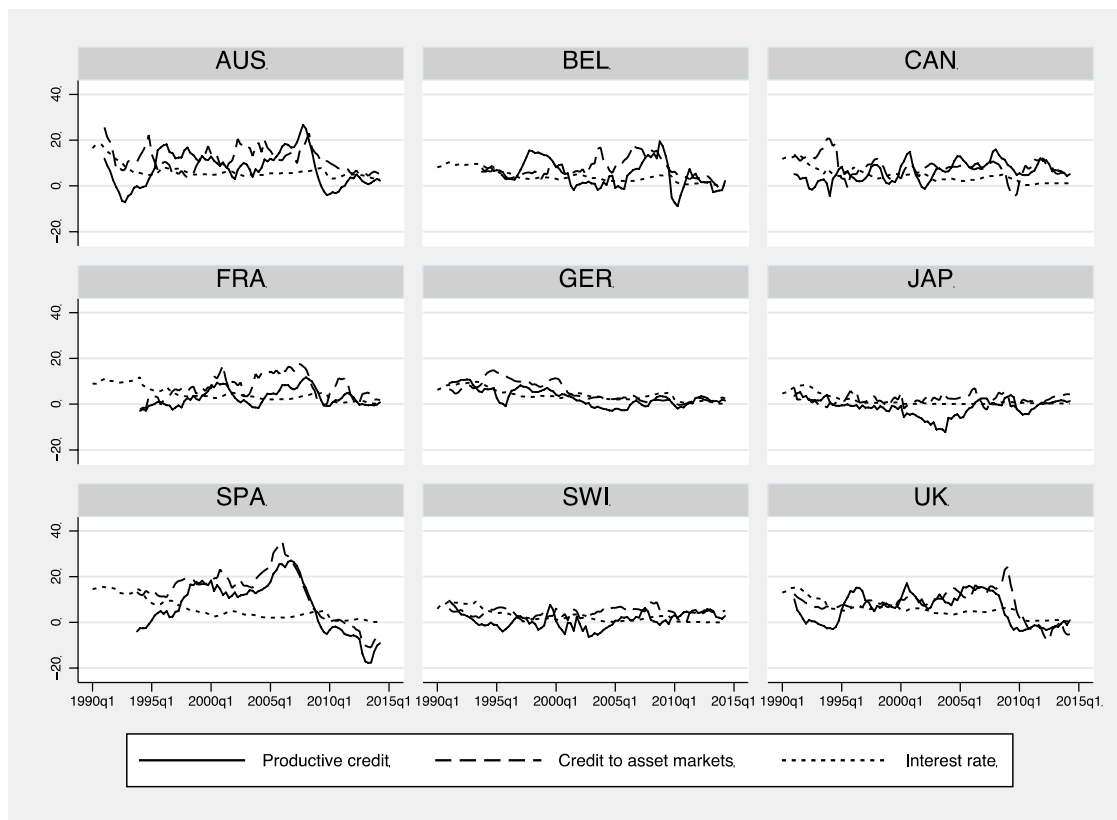


Figure 11: Productive credit, credit to asset markets and three-month interest rates, YoY growth rates (%)



It might be expected that the growth rates of our two credit aggregates are closely correlated but as shown in Figure 11 they often diverge, justifying the disaggregation this study employs in contrast to most of the literature. Considerable volatility is also noted of the credit variables across time and heterogeneity across countries. Notably, growth rates in Germany, Japan, and Switzerland are less volatile than the other countries, the same pattern as found with asset prices (Figure 6).

There is no evidence of co-movement between the two credit aggregates and interest rates. Interestingly, there is also little evidence of any harmonisation in terms of credit growth rates or stocks-to-GDP for our four Eurozone countries post the introduction of the euro, fixed-exchange rates, and a common monetary policy in 1999.

What of the relationship between different credit aggregates and output and house prices? Figure 12 shows real GDP and productive credit growth rates. There is some co-movement but not a clear relationship and considerably more volatility in the growth of productive credit growth than real GDP growth. Figure 13 shows the growth of credit to asset markets and house price growth. Here there would appear to be a strong correlation with evidence of house prices leading credit

growth, a finding also reported by Assenmacher-Wesche and Gerlach (2008b). The existence of a long ‘financial cycle’ of asset and credit co-movement is evident in a number of countries, notably Spain and France. In contrast, in the Anglo-Saxon economies of Australia, Canada, and the UK, there is evidence of more regular boom-bust patterns and any kind of financial or credit cycle is more difficult to discern.

Figure 12: GDP and productive credit, YoY growth rates (%)

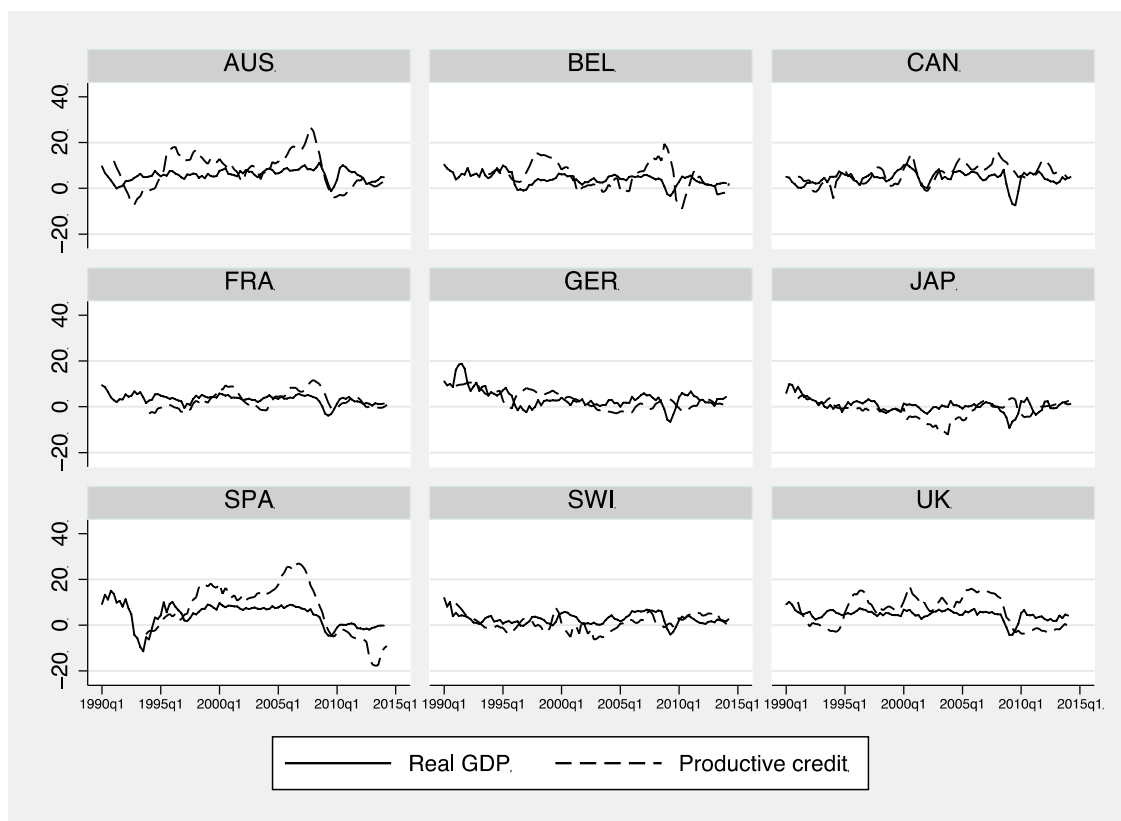
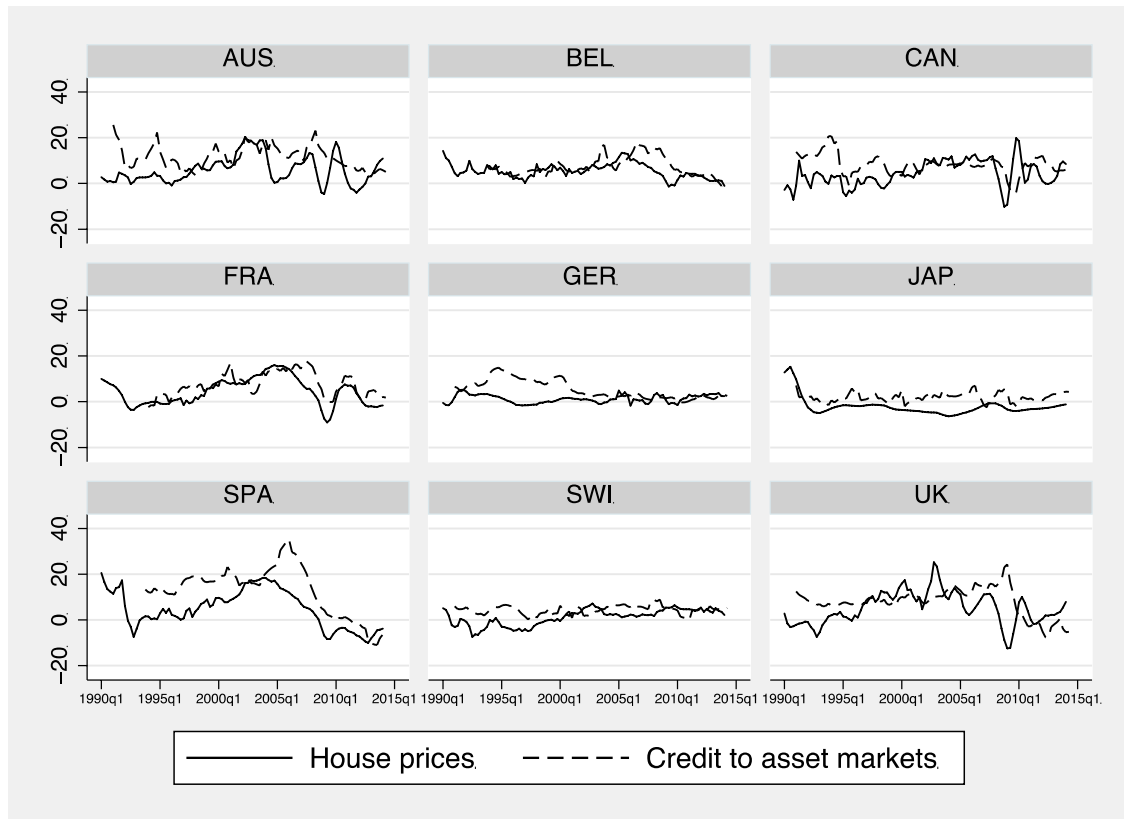


Figure 13: House prices and asset credit to asset market credit, YoY growth rates (%)



This visual inspection of the data highlights some important trends. First, the findings support the recent more comprehensive panel studies of developments in disaggregated credit discussed in Section 1 – i.e., that banks are becoming primarily lenders against assets rather than lenders to firms. Secondly, that splitting credit into these two composites seems worthwhile given the heterogeneity in credit growth/flows over time between them. Thirdly, that there appears to be considerable heterogeneity across advanced economies for our two credit composites, suggesting a role for institutional differences in explaining the credit cycle. Fourthly, there is little evidence that traditional monetary policy changes to short- to medium-term interest rates correlate with either credit growth composite or on asset price growth. Let us now move on to the econometric analysis of the data.

3.3.4 Stationarity considerations

Univariate time series methods for testing unit roots and cointegration typically have low power and provide imprecise point estimates of the cointegrating relationships. By combining inferences across multiple cross-section units, panel data methods can offer more powerful inference in these problems. They also allow for heterogeneity across the cross-section units.

Two second-generation panel unit root tests are employed on this data.⁶³ The first is the Fisher-type approach of averaging p -values rather than the cross-section specific unit root test statistics, following Maddala and Wu (1999). The p -values of country-specific (A)DF tests are transformed into logs and summed across panel members. The sum is then multiplied by -2 which gives a chi-square distribution with $2N$ degrees of freedom under the null of non-stationarity in all panel members/series.

Secondly, Pesaran's (2007) test is used, which assumes/allows for heterogeneity in the autoregressive coefficient of the Dickey-Fuller regression and allows for the presence of a single unobserved common factor with heterogeneous factor loadings in the data. The statistic is constructed from the results of panel-member-specific (A)DF regressions where cross-section averages of the dependent and independent variables (including the lagged differences to account for serial correlation) are included in the model. This are referred to as 'Cross-section ADF regressions' or CADF. The averaging of the group-specific results follows the procedure in the Maddala and Wu (1999) test and the test is sometimes referred to as the 'Cross-section-IPS' test or 'CIPS'. Under the null of non-stationarity, the test statistic has a non-standard distribution. Since the data is quarterly, four lags are used for both MW and CIPS tests.

The results suggest the majority of variables are stationary in their YoY growth rates with some uncertainty over credit and house price growth depending on the lag chosen (full results are reported in Appendix B.1). Similar mixed results were reported by Assenmacher-Wesche and Gerlach (2008b) who assumed all variables to be $I(1)$ in their levels and $I(0)$ in growth rates. The same assumption is made here.

3.4 Empirical strategy

3.4.1 Country level VAR analysis

Given our narrow N and long T and concerns over institutional heterogeneity, both country-level and panel analysis are employed with the dataset. Because of concerns over endogeneity and simultaneity bias – common problems with macroeconomic variables – for both our country-level and panel analysis, the data is examined using the VAR method that does not make assumptions about the exogeneity of the right-hand side variables. A simple multivariate VAR can be represented as:

⁶³ These tests were implemented using the Stata command – `multipt` – developed by Marcus Erberhardt (2008a: 6-7) and builds on panel unit root tests implemented in Stata by Scott Merryman – `xtfisher` – and Piotr Lewandowski – `pescadf`.

(15)

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + \varepsilon_t$$

where y_t is a vector of endogenous variables for each country, A_1, \dots, A_p are matrices of the coefficients to be estimated, and where ε_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variable (Hamilton, 1994: 291-302). In our case, the vector of endogenous variables comprises the YoY growth rate of: real GDP (*rgdp*), the CPI (*cpi*), nominal residential house prices (*hprice*), nominal productive credit (*C_r*), nominal credit to assets markets (*C_f*). In addition, the level of the three-month interest rates (*irate*) is included. This approach follows Goodhart and Hofmann (2008), although they use the log of the first difference rather than YoY growth rates (see Section 3.3.1 for discussion of this transformation).

Using the VAR equations, the temporal dynamics of the variables are tested via block non-Granger causality tests, where each of the six endogenous variables are taken and Wald tests conducted to see if previous instances (lags) of the other five variables can be excluded from the equation without a significant loss of information; i.e., if past instance of z tells us no information about the present value of ω then z is not ‘Granger caused’ by ω (Granger, 1969).⁶⁴

3.4.2 PVAR analysis

Panel data provide important advantages over typical cross-section or time series analyses. First, they allow for better modelling of heterogeneity, whether observed or unobserved, across individuals and through time. Secondly, as datasets are typically larger, panel data provide stronger inference, assuming that the relationship between the dependent variable and at least some of the independent variables remains stable over time. Panel data are also useful for policy analysis since individual behaviour before and after a policy change or exogenous shock can be analysed.

Large T and moderate sized N macroeconomic datasets are relatively unusual in macroeconomic panel studies, as data are most often on an annual basis with good quality data prior to the 1980s difficult to obtain. Where quarterly data is available, however, as is the case with monetary policy variables of interest such as our own, PVARs are generally viewed as the preferred approach given the substantial issues of endogeneity with macroeconomic variables. Canova and

⁶⁴ See Hamilton (1994: 302-305) for formal presentation of VAR Granger causality methodology and derivations.

Ciccarelli (2013) provide a survey of PVAR methods in a macroeconomic context. In a review of PVAR approaches, they summarise the main advantage of the method being:

Panel VARs seem particularly suited to addressing issues that are currently at the center stage of discussions in academics and in the policy arena as they are able to (i) capture both static and dynamic interdependencies, (ii) treat the links across units in an unrestricted fashion, (iii) easily incorporate time variation in the coefficients and in the variance of the shocks, and (iv) account for cross sectional dynamic heterogeneities (Canova and Ciccarelli, 2013: 653).

In particular this study follows the methodological approach taken by Goodhart and Hofmann (2008) and Assenmacher-Wesche and Gerlach (2008b) both who both use PVAR approaches to examine the relationships between credit growth, real GDP, inflation and property prices across 17 industrialised countries.⁶⁵

Our PVAR takes the following form, following Canova and Ciccarelli (2004):

$$y_{i,t} = A_0 a_{i,t} + L_1 y_{i,t-1} + \dots L_p y_{i,t-p} + u_{i,t} \quad (16)$$

where $y_{i,t}$ is $K \times 1$ vector of K panel data endogenous variables [cpi , $rgdp$, $hprice$, C_r , C_f , $irate$], i is our index of countries, $a_{i,t}$ is a vector of deterministic terms such as linear trend, dummy variables or a constant, A_0 is the associated parameter matrix and the L 's are $K \times K$ parameter matrices attached to the lagged variables $y_{i,t}$ and p denotes the lag order. The error process consists of three components:

$$u_t = \mu_i + \gamma_t + \varepsilon_{i,t} \quad (17)$$

where μ_i represents the country specific effect, γ_t captures the time d (quarterly in this case), and $\varepsilon_{i,t}$ the disturbance term.

PVARs address the problem of endogeneity by allowing for the simultaneous analysis of the evolution of a system of endogenous variables, with each variable regressed against lags of itself and the lags of all other variables up to a pre-chosen order p . The VAR allows first for standard Granger causality (Granger, 1969) analysis as described in Section 3.4.1. The approach also allows for the dynamic impact of a shock to any particular variable to be evaluated across the

⁶⁵ The former also includes money and the latter equity prices.

system of variables, keeping the shocks of the other variables equal to zero using impulse response function (IRF) analysis.

In addition, the cross-country dimension of the PVAR, as with any form of panel analysis, allows for unobserved, time invariant heterogeneity of the countries in our sample to be controlled for with fixed effects (FE) via time de-meaning the variables. A well established criticism of panel FE--type approaches is that they suffer from small sample Hurwicz-type bias, caused by the inclusion of lagged endogenous variables, as shown by Nerlove (1971) and discussed by Holtz-Eakin *et al.* (1988). This is not a major problem given our large T ; however even where T is large, the standard FE estimator is inconsistent in dynamic panels if the coefficients on the lagged endogenous variables differ across units. This is because restricting the slope coefficients to be the same across groups induces serial correlation in the residuals when the regressors are autocorrelated. Slope heterogeneity is very likely to be the case in our panel because of the consequence of divergent financial structures described in Section 2.1.

To address this problem, one can assume cross-sectional slope heterogeneity and provide a consistent estimate of the mean effects by averaging the coefficients across countries, following Pesaran *et al.* (1999). Another option is to use the forward mean-differencing technique, also referred to as the ‘Helmert procedure’, following Arellano and Bover (1995). Rather than mean-differencing the entire series, this procedure removes only the *forward mean*, i.e., the mean of all future observations available for each country-quarter. This transformation preserves the orthogonality between transformed variables and lagged regressors, which allows the use of lagged regressors as instruments and the estimation of the coefficients by system Generalised Method of Moments (GMM).⁶⁶ Such a technique has been used in a number of macroeconomic PVAR studies, for example Love and Zicchino (2006), Tiwari (2011), Gravier-Rymaszewska (2012), and Feyen *et al.* (2014). The stata program -pvar-, written by Inessa Love and Michael Abrigo, which incorporates the Helmert transformation, was used to run the Granger causality and IRF analysis presented in section 3.5 below.

3.5 Results

3.5.1 Country-level VAR Granger causality testing

Given the possibility of mixed order of integration of our variables, for our country-level analysis the Toda-Yamamoto (1995) ‘augmented Granger causality test’ is adopted which involves adding

⁶⁶ Decker (2014) provides a formal presentation of the Helmert transformation and shows that time-demeaning the data prior to the Helmert transformation has no effect on the final result.

an additional lag m to the VAR according to the m th order of integration to ensure asymptotic properties on the χ^2 test for the reduction. For each of the nine countries, one additional lag is added to those that were originally selected using standard AIC, HQIC, and SBIC information criteria (the full VAR equations are available on request). Wald tests are then conducted on the variables of interest to test for augmented Granger causality. The findings are summarised in Table 12 for the two credit composites (C_r and C_f), $rgdp$ and $hprice$.⁶⁷

Table 12: Augmented Granger causality tests on disaggregated credit, house prices and real GDP YoY growth rates

| N | Lags | 1 | 2 | 3 | 4 | 5 |
|-----|------|--------------------|------------------------|--------------------------|--------------------------|---------------------------|
| | | C_r & $rgdp$ | C_f & $rgdp$ | C_r & $hprice$ | C_f & $hprice$ | $hprice$ & $rgdp$ |
| AUS | 3 | \Leftrightarrow | $C_f \rightarrow rgdp$ | \nLeftrightarrow | \Leftrightarrow | \Leftrightarrow |
| BEL | 2 | \nLeftrightarrow | $rgdp \rightarrow C_f$ | \nLeftrightarrow | $hprice \rightarrow C_f$ | \nLeftrightarrow |
| CAN | 2 | \Leftrightarrow | \nLeftrightarrow | \Leftrightarrow | \Leftrightarrow | \Leftrightarrow |
| FRA | 2 | \Leftrightarrow | \nLeftrightarrow | $C_r \rightarrow hprice$ | $hprice \rightarrow C_f$ | \nLeftrightarrow |
| GER | 3 | \nLeftrightarrow | \nLeftrightarrow | \nLeftrightarrow | $hprice \rightarrow C_f$ | $rgdp \rightarrow hprice$ |
| JAP | 3 | \nLeftrightarrow | $rgdp \rightarrow C_f$ | $C_r \rightarrow hprice$ | \nLeftrightarrow | $rgdp \rightarrow hprice$ |
| SPA | 2 | \Leftrightarrow | \Leftrightarrow | $C_r \rightarrow hprice$ | $hprice \rightarrow C_f$ | \Leftrightarrow |
| SWI | 2 | \Leftrightarrow | \Leftrightarrow | $C_r \rightarrow hprice$ | $hprice \rightarrow C_f$ | \Leftrightarrow |
| UK | 2 | \nLeftrightarrow | $rgdp \rightarrow C_f$ | \nLeftrightarrow | \Leftrightarrow | $hprice \rightarrow rgdp$ |

Note: \nLeftrightarrow = no Granger causality in either direction; \Leftrightarrow = bi-directional Granger-causality. Toda-Yamamoto Augmented Granger causality tests – one additional lag is added to m th order of integration, chosen using AIC, HQIC, and SBIC with HQIC as a tie-breaker and a maximum lag length of 4. Significance of Chi-square non-granger causality test = 5%

There is considerable heterogeneity in the temporal dynamics of our variables, suggesting any credit cycle or credit transmission mechanism is likely to be strongly affected by institutional dynamics, a finding also reported by (Aikman *et al.*, 2014). Only Spain and Switzerland share

⁶⁷ The results for inflation and interest rates are not reported here but are available on request.

exactly the same pattern of dynamic linkages across the five combinations illustrated. This of course makes generalisations difficult and questions the usefulness of the country-level approach as the lack of consistency may be due to unobserved heterogeneity and omitted variable bias that country-level modelling is unable to account for.

Nevertheless, there are some tentative findings that one could draw. First, it would appear that house price growth (*hprice*) does influence – and is influenced by – our two credit aggregates but in different ways. *hprice* Granger causes C_f (growth in credit to asset markets) in all of our economies except Japan (column 4), suggesting a strong collateral channel from changes in asset prices to bank lending against real estate. There is bi-directional Granger causality in Australia, Canada, and the UK suggesting feedback also from increased lending to asset prices in these more liberalised mortgage markets. Only in Canada, however, is there evidence of *hprice* Granger causing C_r . These dynamics suggest the existence of a balance sheet channel, as discussed in Section 3.2, but one which feeds mainly into asset-market rather than productive credit, leading to potentially unsustainable levels of household debt. With regard to output (*rgdp*) there is strong evidence of a relationship to house prices except in France and Belgium, although only in UK is there one-way Granger causality from *hprice* to *rgdp*. The latter finding supports the arguments made in Chapter 2 (Section 2.3.2) about a strong relationship between house prices, housing collateral and consumption, via wealth effects and equity withdrawal, in Britain (Aron *et al.*, 2012).

3.5.2 PVAR with forward-mean differencing

As discussed in Section 3.4.2, the PVAR was adopted with a forward-mean differencing approach to examine the dynamic relations in the dataset. A range of tests were first utilised to establish an appropriate lag-order for the PVAR. Table 13 reports the overall coefficient of determination (CD), Hansen's (1982) J statistic (J) and corresponding p-value (J pvalue), and moment model selection criteria (MMSC) developed by Andrews and Lu (2001): MMSC-Bayesian information criterion (MBIC), MMSC-Akaike's information criterion (MAIC), and MMSC-Hannan and Quinn information criterion (MQIC) for PVAR with lag order 4 (four lags were chosen as the data was quarterly).⁶⁸ As with the maximum likelihood-based information criteria AIC, BIC, and HQIC, the model which minimises the MAIC, MBIC, or MQIC is the preferred model.⁶⁹

⁶⁸ The Stata program 'pvarsoc' was used to test for appropriate lag use, written by Inessa Love, see e.g. Love and Zicchino (2006)

⁶⁹ Andrews and Lu's MMSC is based on Hansen's J statistic, which requires the number of moment conditions to be greater than the number of endogenous variables in the model.

Table 13: PVAR moment model lag selection criteria

| lag | CD | J | J pvalue | MBIC | MAIC | MQIC |
|-----|-----------|----------|----------|----------|----------|----------|
| 1 | 0.9999963 | 4.91e-29 | . | 4.91e-29 | 4.91e-29 | 4.91e-29 |
| 2 | 0.9999982 | 5.64e-29 | . | 5.64e-29 | 5.64e-29 | 5.64e-29 |
| 3 | 0.9999985 | 2.79e-28 | . | 2.79e-28 | 2.79e-28 | 2.79e-28 |
| 4 | .9999976 | 2.69e-28 | . | 2.69e-28 | 2.69e-28 | 2.69e-28 |

Note: 758 observations, 9 panels, Average number of $T = 84.222$

Four lags is the preferred option. The results of PVAR Granger causality and IRFs were then examined.

3.5.2.1 Granger causality test results

The Granger causality test results for the PVAR are presented in Table 14 below. The most notable finding is the strong influence of house price growth on the future value of all other variables. The result supports the argument, discussed in Section 2, that asset prices play a vital role in modern advanced economies, influencing credit creation, consumption, and investment decisions and thus real output and inflation. The finding also supports the PVAR studies of Goodhart and Hoffman (2008) and Assenmacher-Wesche and Gerlach (2008b) of 17 countries over the earlier 1985–2006 period.

How traditional monetary policy should attempt to address this is not particularly helped by these PVAR findings however, since neither changes to interest rates or inflation help predict the future value of *hprice*. In fact, the only variable that Granger causes *hprice* is C_r (productive credit) which policymakers would be particular reluctant to suppress.

Real GDP growth is Granger caused by inflation and productive credit as well as house prices but not by credit to asset markets, results that seem intuitive. This suggests policymakers can have some confidence in targeting the asset markets, for example through LTV or LTI limits, without negatively impacting potential output. Complicating matters, however, it is also found that productive credit, more than asset-market credit, Granger causes *Hprice*.

Table 14: PVAR Granger non-causality tests

| Equation \ Excluded | χ^2 | Prob > χ^2 |
|----------------------|----------------------|-----------------|
| <i>cpi</i> | <i>rgdp</i> | 18.136 |
| | <i>hprice</i> | 10.888 |
| | <i>C_r</i> | 8.989 |
| | <i>rr</i> | 3.448 |
| | <i>irate</i> | 13.761 |
| | ALL | 67.431 |
| <i>rgdp</i> | <i>cpi</i> | 14.740 |
| | <i>hprice</i> | 40.202 |
| | <i>C_r</i> | 9.790 |
| | <i>C_f</i> | 5.457 |
| | <i>irate</i> | 8.957 |
| | ALL | 97.674 |
| <i>hprice</i> | <i>cpi</i> | 2.606 |
| | <i>rgdp</i> | 5.089 |
| | <i>C_r</i> | 9.832 |
| | <i>C_f</i> | 3.537 |
| | <i>irate</i> | 1.512 |
| | ALL | 31.701 |
| <i>C_r</i> | <i>cpi</i> | 1.151 |
| | <i>rgdp</i> | 7.698 |
| | <i>hprice</i> | 28.232 |
| | <i>C_f</i> | 17.200 |
| | <i>irate</i> | 1.654 |
| | ALL | 73.167 |
| <i>C_f</i> | <i>cpi</i> | 4.174 |
| | <i>rgdp</i> | 8.470 |
| | <i>hprice</i> | 26.011 |
| | <i>C_r</i> | 2.199 |
| | <i>irate</i> | 10.017 |
| | ALL | 53.143 |
| <i>irate</i> | <i>cpi</i> | 6.905 |
| | <i>rgdp</i> | 34.701 |
| | <i>hprice</i> | 20.391 |
| | <i>C_r</i> | 15.097 |
| | <i>C_f</i> | 11.942 |
| | ALL | 102.298 |

Note: H_0 = Excluded variable does not Granger cause equation; H_A = Excluded variable does Granger cause equation; Four lags were used for each PVAR equation. Significant test statistics (at the 5% level) are in bold.

Monetary policy, proxied by three-month interest rates, Granger causes inflation, as might be expected, and credit to asset markets. It does not, however, Granger cause real output (at the 5%

significance level) nor productive credit, nor house prices. This suggests mortgage demand/supply is more sensitive to interest rates than non-financial credit, which is also generally found in the literature.

3.5.2.2 *Impulse response functions and identification*

IRFs display a point estimate of the response and a corresponding confidence interval for several post-shock periods.⁷⁰ The response is statistically significant if the confidence interval does not include the horizontal (zero) axis of the IRF. Impulse responses take into consideration the estimated coefficients matrix, as well as the correlation of residuals across equations.

As the errors across in the variables in the system are typically correlated, this inhibits the attribution of the impact of an innovation of a single variable to that variable only. To isolate the impact of innovations, it is necessary to decompose the residuals in such a way that they become orthogonal. This is usually achieved via choosing a variable ordering that assumes that variables that come earlier in the order affect all following variables contemporaneously; in contrast, variables that come later affect previous variables only with a lag, i.e., they have a delayed response on the variables that come earlier. As a result of the ordering process, the correlation between the residuals of two variables is allocated to the variable that comes first in the ordering. The ordering can therefore have implications for the shape of IRFs and for variance decompositions.

In the monetary policy literature it is standard to order output and prices before the monetary policy instrument (the short-term interest rate), since the authorities can react swiftly to changes in these variables but there tends to be a lag in the opposite direction. The remaining credit and house price variables pose more of a challenge, since there is little theoretical consensus on the causal ordering between credit, house prices, and interest rates. In their PVAR study of monetary policy variables, Assenmacher-Wesche and Gerlach (2008b) order credit last, after house prices, assuming that these are stickier than credit. In contrast, Goodhart and Hofmann (2008) order house prices after credit and interest rates, assuming the former react quite swiftly to monetary policy and credit shocks. Given the considerable heterogeneity amongst the countries in this study (as described in Section 3.3) the ordering is somewhat arbitrary but the former approach is followed and the variables ordered as follows:

$$cpi, rgpd, hprice, C_r, C_f, irate$$

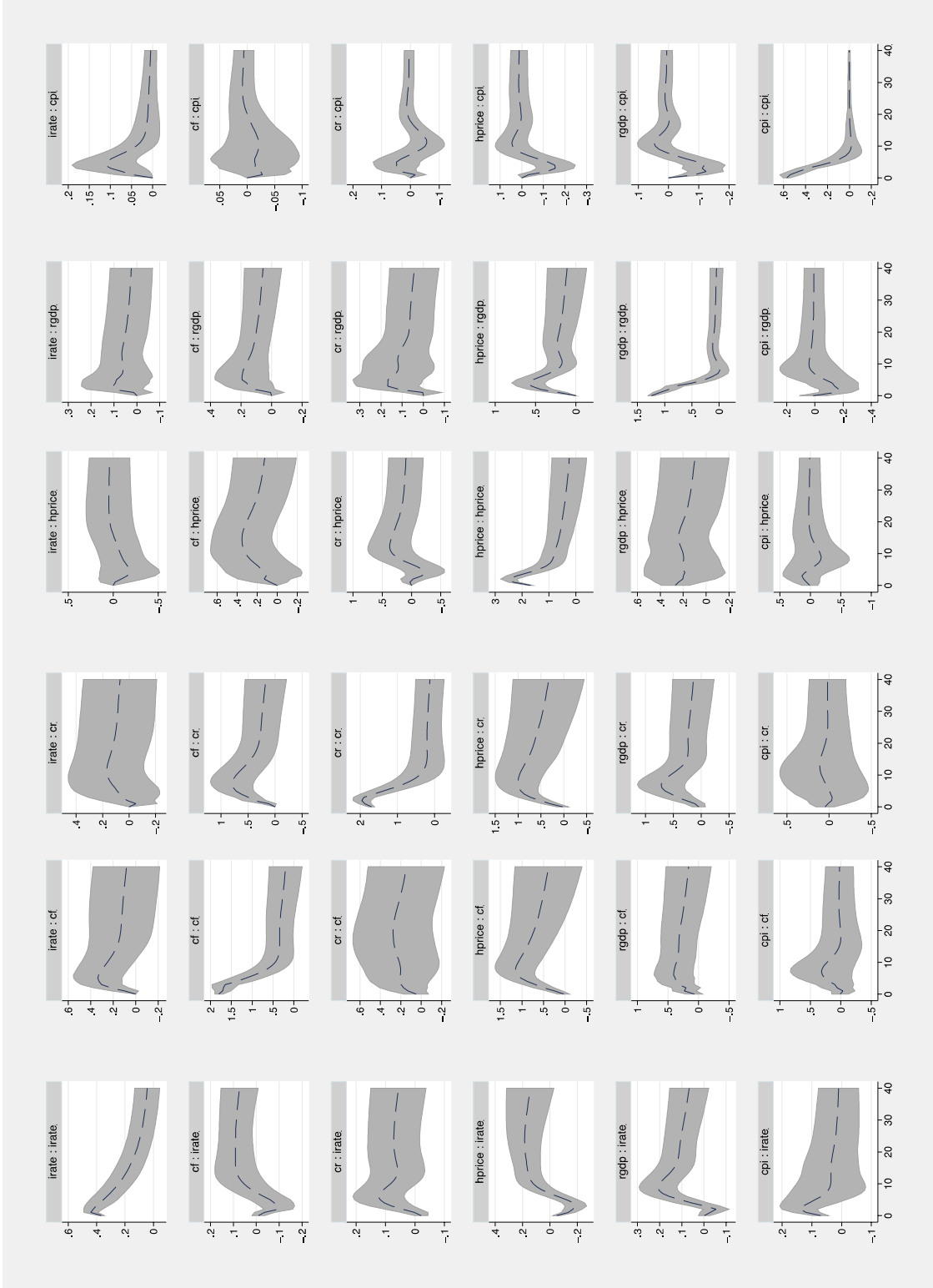
⁷⁰ See Hamilton (1994) for formal presentation of IRF analysis.

As a robustness check, different combinations of house prices, credit, and interest rates were tried but they made little difference to the IRF results (results available on request).

Figure 14 shows ($6 \times 6 = 36$) orthogonalised impulse-response functions (OIRFs) for our baseline model. Each column corresponds to a particular variable and shows six IRFs which display how this variable responds to an isolated shock of each of the variables in the system (i.e., including the variable itself). Each response is traced for 40 periods (10 years) after which the shock has subsided and any residual impact is minimal.

The OIRFs broadly support our Granger causality tests finding that shocks to house price growth have the most significant effect on the other variables in the system, as shown in the fourth row of Figure 14. A house price shock has a rapid and significant effect on the other variables which lasts for around 2.5 years (10 quarters) for real output and inflation and over 5 years in its effect on the credit variables and interest rates. In contrast, monetary policy only affects inflation, where it impacts after three quarters for a three-year period and credit to asset markets, where it impacts rapidly and for a 2.5 year period. A shock to productive credit has a relatively short-lived impact on real output, peaking at around a year after the shock. A shock to assets market credit, in contrast to the Granger causality tests, significantly impacts house prices after 10 quarters and lasts around 2 years. This is a more intuitive finding and lends greater support to macroprudential policy tools seeking to dampen mortgage credit and asset prices, particularly when interest rates are already low.

Figure 14: OIRFs for PVAR with four lags (impulse: response) (n.b. Y-axes are scaled for ease of view)



Note: Figure shows OIRFs over 40 quarters (10 years) ordered as follows: *cpi*, *rgdp*, *hprice*, *C_r*, *C_f*, *irate*. Grey shading shows the 95% confidence interval calculated through Monte Carlo draws of 200 repetitions. Impulse variables run across the rows, response variables run down the columns.

3.6 Conclusion

The interaction between credit, asset prices, and economic activity is now centre stage in monetary policy debates. This study has attempted to shed light on elements of a credit cycle by analysing credit not in aggregate form as is standard in the literature but via two composites: productive credit (businesses and for consumption) and credit to asset markets (mainly real estate financing and lending to other financial corporations) using a newly collected quarterly dataset and by including asset prices in our analysis.

This is only a first attempt at such an analysis and there are a number of caveats. The credit aggregates could, with better data, be made more precise in terms of their macroeconomic effects. For example, commercial real estate lending, included in the productive credit aggregate, could potentially be identified and shifted to asset-backed lending in some cases – for example in the UK such lending has been identified as being particularly pro-cyclical (Benford and Burrows, 2013). Similar arguments could be made for other forms of business credit, such as lending for construction. Equally limitations about data quality apply to asset prices. For example many of the countries in the sample will have strong regional property dynamics that country-level analysis cannot reflect (Mian and Sufi, 2010).

Nevertheless, this study broadly supports the argument originally made by (Schumpeter, 1983[1911]) (section 1.4.6) and more recently Werner (1997, 2005) that different credit flow composites have different impacts on output growth and asset prices. The findings justify analyzing these composites separately and support the panel studies that employ the same or similar composites (Beck *et al.*, 2008, Büyükkarabacak and Valev, 2010, Bezemer *et al.*, 2014). Our findings also suggest a powerful role for asset prices in influencing and being influenced by both credit flow composites, supporting the Minsky/Keynes notion of changing liquidity preferences and disequilibrium dynamics under conditions of uncertainty. Empirically, traditional monetary policy – the targeting of inflation via adjustments to short-term interest rates – only seems to influence asset market credit and has no effect on productive credit. The recent interventions by some central banks to stimulate SME lending, for example via the BoE's FLS, are thus supported by these findings as, indeed, are macroprudential policies to dampen asset market credit when interest rates reach the zero lower bound.

One possible explanation for the significant role of house prices in impacting other macroeconomic variables in the PVAR is that the banking system in industrialised countries has been turning increasingly towards collateralised – or asset-backed lending – over and above relational or 'patient-capital' business lending based on perceived future risks and cash-flow profits (Inderst and

Mueller, 2007, Steijvers and Voordeckers, 2009). There are a number of potential explanations for this shift. Deregulation and advances in ICT have enabled retail banks to generate significant profits from non-traditional activities, in particular via the securitisation and selling on of loans – the ‘originate and distribute’ model. Asset-backed loans are much more amenable to this kind of ‘market-based finance’ (see, e.g. Pozsar *et al.*, 2010, Hardie *et al.*, 2013 for discussions). In addition, the Basel agreements on capital adequacy ratios of banks, which favour mortgage lending over business lending, may strengthen the impact of asset prices on endogenous credit creation (MacLennan *et al.*, 1998: 5, Arestis and González, 2014).

Our single country findings also showed considerable cross-country heterogeneity in terms of the size of credit stocks to GDP, the speed of their growth over the past 24 years, and their impact on macroeconomic variables. A one-size-fits-all monetary policy or theoretical approach is likely to run in to problems given such heterogeneity. There is little support for the continued narrow focus on consumer price inflation via the targeting of short-term interest rates as the sole tool of monetary policy across institutionally diverse nations. These concerns apply particularly to the ECB given the huge variation of banking and mortgage structure across the Eurozone economies.

Chapter 4: Monetary financing as a tool of monetary policy: A case study of the Canadian economy, 1935–1975

4.1 Introduction

What is the appropriate role for monetary policy in economies – such as today’s developed nations – with low or stagnant nominal growth and high levels of private and public debt, much of it externally owned?⁷¹ As discussed in earlier chapters, there is limited room for manoeuvre in regard to short-term interest rates which have been at record lows in most advanced economies since 2008. Medium- and longer-term interest rates have already been reduced via QE policies and concerns have been raised that low interest rates may lead to a further growth in the kind of unsustainable private debt and/or asset price booms that helped cause the 2008 crisis (Mian and Sufi, 2010, Stein, 2013, B.I.S., 2014). This problem would appear to be more acute given the evidence in previous chapters that commercial banks are increasingly shifting towards asset-market credit creation over and above productive credit creation.

One alternative that has been proposed by a number of economists in the post-crisis era is for central banks to engage in ‘monetary financing’ (Benes and Kumhof, 2012, McCulley and Poszar, 2013, Turner, 2013b, Wolf, 2013, Dyson and Jackson, 2013, Muellbauer, 2014). This involves the creation of central bank money on a permanent basis⁷² to either finance government deficits or to provide an injection of funding to citizens – so-called helicopter money. Such a policy was also advocated by former Federal Reserve Governor Ben Bernanke (2003) as a means of boosting nominal GDP in Japan in the early 2000s and earlier by Richard Werner (2004). Monetary financing can also involve requiring private banks to buy and hold government debt or lend directly to governments. This policy is recognised as an important means by which governments were able to reduce debt-to-GDP ratios in the post-Second World War period, particularly when combined with higher inflation levels, and was labelled ‘financial repression’ (Shaw, 1973, McKinnon, 1973). In contrast to previous chapters which limited their focus to the empirical dynamics of commercial bank credit creation, this chapter focuses on the possibility of the state and central bank playing a larger role in the process and the historical and political dynamics that enabled it.

The policy of large-scale monetary financing has historical antecedents in both monetarist and Keynesian traditions. The term helicopter money was proposed by Milton Friedman (1948) whilst early Chicago School economists writing during the Great Depression argued that money creation should only be conducted by governments/central banks via a ‘full-reserve banking’ policy (Fisher,

⁷¹ Reinhart and Rogoff (2013: 6) examine gross public debt-to-GDP ratios going back to 1800 and find that the current level of central government debt in advanced economies is approaching a two-century high-water mark. They also find that gross total (public plus private) external debt as a percentage of GDP to be on average 260% of GDP in 22 advanced countries, compared to just 25% in 1970.

⁷² By making the monetisation permanent (i.e., committing not to sterilise the effects via open-market sales of bond sales at a later date), the ‘Ricardian equivalence’ problem that consumers will increase their savings assuming a later increase in taxes to fund the resulting deficit may be avoided, see for example Reichlin *et al.* (2013) for a discussion.

1936, Douglas *et al.*, 1939). However, there are also parallels with the ‘Functional Finance’ approach of Lerner (1943), a variant of which has been recently revived under the label of ‘Modern Monetary Theory’ (Wray, 1998, 2012), itself strongly influenced by Keynes. The latter approach emphasises that since the ultimate source of monetary authority lies with the state/central bank in a sovereign fiat-currency regime, it does not make sense for governments to ‘borrow’ via bond financing; rather there should be no limits on a state’s ability to fund socially agreed upon objectives, such as full employment, via sovereign money creation. The main purpose of government bond issuance is to combat inflation in the private sector by sucking liquidity out of the economy.

From one perspective, the current QE programmes (now totaling around \$11 trillion (Ecri, 2015)), which mainly involved the purchase of government debt, can be seen as an implicit form of monetary financing if it is accepted that central banks are unlikely to ever completely unwind their purchases. This has certainly been the case in past episodes of crisis-induced balance sheet expansion.⁷³ Given such central banks are owned by the same governments that issue the purchased debt, no net public liability exists, whilst the interest expense, as a profit of the central bank, returns to the government (Turner, 2014b, Johnston and Pugh, 2014).⁷⁴ Sbrancia (2011) and (Reinhart and Sbrancia, 2011) have argued that current QE policies should be viewed a form of financial repression that is being conducted to try and reduce the public debt that resulted from the 2007–2008 financial crisis.

Monetary financing has, however, come to be seen as dangerously inflationary in both the public perception and in mainstream economic theory. Up until the 2008 crisis, the policy had virtually disappeared in advanced economies, although it is still widely used in emerging markets – see, for example, Catao and Terrones (2005). This was due to the dominance of NMC policies (Section 1.4.3) which focused on inflation targeting over and above other objectives and argue that CBI was key to the credibility of monetary policy. Such independence would not be possible under conditions where governments could demand that central banks monetise a portion of government deficits – hence these were prohibited. But viewed in the broader sweep of the last 300 years since the emergence of modern central banking, such policies appear exceptional (Epstein, 2006, Cobham, 2012). From a political economy perspective, some have argued that, rather than becoming truly ‘independent’ since the 1990s, central banks have rather supported one particular sector – the (international) financial sector – over the state, industry, and production (Epstein, 1992, Posen, 1995, Posen, 1998, Ingham, 2004). Others have argued that central banks themselves

⁷³Ferguson *et al.* (2014) examine central bank balance sheets in 12 countries since 1900 and find that, following major expansions following crises, ‘central banks have rarely reduced the size of their balance sheets in nominal terms’ and that ‘reductions are predominantly achieved relative to output by holding nominal positions stable for long periods.’

⁷⁴ This type of transfer of seigniorage profits from the central bank has been standard practice in the USA, Japan, and Canada for some time. The UK adopted the same policy in November 2012.

encouraged ‘independence’ as a means of increasing their own institutional power base (Goodman, 1991, Werner, 2003, Forder, 2005).

Monetary financing may also have come to the forefront of political debate because of an awareness that the current monetary ‘system’ – involving a virtual monopoly on the creation of new purchasing power by deposit-taking banks, with their liquidity needs fully accommodated by the central bank – has come under scrutiny. As shown in Chapter 3, modern banks are increasingly shifting their lending towards existing assets rather than supporting GDP transactions and business investment. The GFC showed the danger of relying on such a system. As the *Financial Times* Chief Economics Commentator Martin Wolf (2013) commented:

...it is impossible to justify the conventional view that fiat money should operate almost exclusively via today’s system of private borrowing and lending. Why should state-created currency be predominantly employed to back the money created by banks as a byproduct of often irresponsible lending? Why is it good to support the leveraging of private property, but not the supply of public infrastructure? ...in the present exceptional circumstances, when expanding private credit and spending is so hard, if not downright dangerous, the case for using the state’s power to create credit and money in support of public spending is strong.

The period 1930–1970s offers some interesting and little studied examples of monetary activism by governments and central banks to support economies in a situation, much like today, with very low interest rates and very high debt-to-GDP ratios. In the period 1930–1970 central banks financed expansionary government spending and capital investment focused on economic development and full employment. Today QE is instead being combined with the very opposite in many countries – fiscal austerity policies. A political economy perspective is useful in understanding the historical dynamics involved in the earlier period. In countries which already had central banks, the deflation and unemployment of the Great Depression led to a re-think of monetary authorities’ role vis-à-vis government and the financial sector. In addition, in a number former colonies, such as Canada, New Zealand, Australia, and India, new central banks were set up to help establish national monetary sovereignty from Great Britain.⁷⁵ Their origins thus do not fit the classic explanation of central bank emergence as a means of supporting sovereign war efforts, the more efficient running of the financial system, or existing private banking interests via providing the ‘lender of last resort’ function (Goodhart, 1988, Capie *et al.*, 1994).

These origins in the desire for greater monetary sovereignty and public job creation gave encouragement to instances of monetary financing. These included direct financing of government debt by central banks and requiring private banks to purchase and hold government debt. Central

⁷⁵ On New Zealand, see Sinclair (1976) and Hawke (1973); on Australia, see Brown (2013: ch15).

banks in these states worked collaboratively with governments and, as will be shown with the example of Canada, played an important role in reflation following the Depression, financing the war effort, and post-war reconstruction and industrialisation more generally. The policies would appear to have helped enable reductions in public debt levels.

Analyzing monetary policy in the period 1930–1970 poses empirical and theoretical challenges. There is a lack of reliable macroeconomic data and the existence of fixed exchange rates and a range of other controls on domestic and international capital markets make comparison with today's more financially liberalised and globalised economies difficult. In addition, the Great Depression and Second World War are massive economic dislocations that affected different countries in quite different ways, making comparative generalisations across the period difficult.

To partially address these limitations, an institutional case-study approach is taken to the only major country that operated under a flexible exchange rate through the majority of the period 1945–1975: Canada. By the end of 1951, Canada had also eliminated all remaining controls on foreign exchange transactions and most, if not all, controls on foreign investment inflows (Thiessen, 2001: 5). Whilst its close connection to the USA clearly makes Canada a somewhat unique case, to some degree at least it can be seen as having parallels to a modern day small open economy. Canada also makes a topical case since its Central Bank is currently being sued for failing to fulfill its mandate to provide interest-free loans for public projects undertaken by federal, provincial, and city governments.⁷⁶ To complement the case study analysis, a GETS empirical econometric model of Canadian inflation is presented, using a newly collected historical dataset going back to the 1950s, to examine the extent to which the persistent monetisation of debt contributed to inflationary pressures.

The chapter is laid out as follows. Section 2 reviews the literature on government money creation, its relationship to inflation and the development of the current policy framework which essentially prohibits monetary financing. Section 3 is the institutional case study. Section 4 presents the empirical model of Canadian inflation and Section 5 concludes.

4.2 Historical and theoretical context

4.2.1 The state origins of money and the turn to commercial-bank money

⁷⁶ The case is being pursued by the constitutional lawyer Rocco Galati on behalf of the Committee on Monetary Reform (COMER) campaign group. See Whittington (2015) and www.comer.org for more information.

Historical, anthropological, and numismatic evidence points to the origins of money in the role of the state or related authority and its ability to determine the unit of account function of money via the imposition of liabilities on citizens (Knapp, 1905, Innes, 1913, Grierson, 1978). This ‘Chartalist’ explanation of money lies in contrast with the ‘Metallist’ conception that remains more prevalent in the economics literature, where money emerges as a more efficient private medium of exchange than barter (Jevons, 1875, Menger, 1892). In fact the historical evidence suggests barter was virtually non-existent in primitive and ancient societies (Humphrey, 1985, Wray, 1998, Goodhart, 1998, Ingham, 2004, Graeber, 2011). Rather, the first commercial transactions took place on the basis of credit clearing systems whose denomination was typically in agricultural commodities, including cattle, weighted grain, and tools (Grierson, 1978). Reviewing the two accounts of the origins and nature of money, Goodhart (1998: 425) concludes that the main advantages of the Metallist version, ‘appear to be technical, in that it lends itself better to mathematical formalisation, and ideological, in that it is based on a process of private sector cost minimisation, rather than a messier political economy process’.

Prior to the invention of modern banking at the end of the seventeenth century, many states used simple accounting techniques, such as tally sticks, minted coins, or printed paper money to fund their activities and ensured their widespread adoption through taxation (Knapp, 1905, Grierson, 1978, Ingham, 2004, Graeber, 2011). In Britain, for example, for hundreds of years prior to the establishment of the BoE’s monopoly on the right to create banknotes in 1844, the state and Kings issued a mixture of gold and silver coinage or recorded credit and debts in the form of notches on Hazelwood sticks – so-called tally sticks (Astle, 1997, Richards, 1929: 58-59). Although historical data is somewhat limited, government created monetary regimes in the UK and the USA up to the late seventeenth century seem to have been reasonably stable (Benes and Kumhof, 2012: 14-15, Zarlenga, 2004). The governments of Germany, Japan, and the USA also issued significant amounts of government money during the eighteenth and nineteenth centuries (Zarlenga, 2004, Werner, 2005, Benes and Kumhof, 2012, Brown, 2013).

The phenomenon of private banks effectively monopolising credit creation and allocation – via fractional reserve banking and interest-bearing debt – is relatively recent.⁷⁷ In the UK, for example, from 1870 to about 1970, the central bank was responsible for issuing between 18% and 21% of the total money supply in the form of interest-free bank notes and coins (Capie and Webber, 1985). Since the 1970s, the emergence of electronic forms of payment has led to a reduction in the use of notes and coins and now only around 3% of money in circulation is created by the central bank with the remainder being commercial bank liabilities in the form of customer deposits as discussed

⁷⁷ Fractional reserve banking itself has a much longer history. The earliest records of modern European banking, involving widely circulating promissory notes and fractional reserves, dates back to the *Medicis* of the sixteenth century and became prominent in Britain in the seventeenth century.

in Chapter 1. Similar ratios of currency to bank deposit money can be found in most advanced economies, whilst in developing countries, closer to 10% of circulating money is in the form of currency (B.I.S., 2009: 106)

4.2.2 Inflation and monetary financing – a short history

Why then has government (or central banks) creating money come to be viewed as inflationary? One explanation is that many of the modern examples of large-scale direct government money creation were for the purposes of raising funds to fight wars. Wartime typically involves very high levels of inflation as production of standard goods and services is slowed and productivity levels drop at the same time as a massive increase in the money supply, which is required to fund the destructive activities of war (Pigou, 1941, Davies, 2002: 646-648).⁷⁸ Such inflation often persists in the post-war period when resources return to productive use as governments rarely choose to reduce the money supply.

A popular US example used to justify criticism of government created money is the ‘Continental’ that were used raise funds to fight the War of Independence against the British and fell to one-thousandth of their nominal value by the end of the war (Davies, 2002: 647, Lester, 1938: 3). In Europe, the stigma associated with government money is perhaps stronger, with examples including the *assignats* of the French Revolution, the post-WWI hyper-inflation in Germany and Austria and the world’s largest ever hyper-inflation in Hungary in 1946 (Hanke and Kwok, 2009). In the UK, the First World War and its aftermath saw the first and only experiment in government issued paper money since the medieval tally sticks – the Treasury issuance of ‘Bradbury Bills’ (Higgins, 1949) – but also very high levels of inflation.

Public and political concerns about the inflationary consequences of government money creation were not complemented in economic thinking, however, until the monetarist ‘counter-revolution’ of the 1970s and 1980s. Keynes (1933: 23), for example, keen for Depression-era governments to boost demand through direct money creation (‘loan-expenditure’) rued that ‘hitherto war has been the only object of government loan-expenditure on a large scale which governments have considered respectable.’ Lerner (1943) argued for a ‘Functional Finance’ whereby a sovereign state with a fiat currency should always create sufficient money to support full employment and use

⁷⁸ Pigou (1941) argued there are two ‘types’ of inflation associated with war: 1) wage inflation driven by reduced yield of goods per given quantity of resources engaged in producing them accompanied by an increase in the money supply; and 2) deficit inflation, whereby governments are unable to fund the necessary increase in the money supply through borrowing from citizens – which would reduce money income and wages - and instead creates new money through taking loans from the banking sector (monetary financing).

taxation and borrowing, not as a means for raising funds, but for controlling inflation by withdrawing money from firms and households.

Even amongst pro-free-market economists, it was widely accepted that monetary authorities had two valid options when it came to funding fiscal deficits: bond financing or money financing via central bank or private bank purchase of government debt (monetisation). A number of early Chicago School economists including Irving Fisher (1936), a (younger) Milton Friedman (1948), and Henry Simons (1951 [1948]) argued that monetary financing of government deficits would create greater stability than bond financing. The so-called Chicago Plan, written after the Great Depression by Fisher and a number of other Chicago School economists (Douglas *et al.*, 1939) argued that private bank credit creation via fractional reserves was inherently unstable, damaging to industry, and should be outlawed via the imposition of a 100% reserve ratio – i.e., a return to a public monopoly on money creation.

These proposals were not taken up by governments, however.⁷⁹ The period between the Great Depression and the 1970s saw the survival of private sector money creation but it was subjected to significant formal and informal regulatory controls and complemented by both direct and indirect forms of monetary financing, explored further in Sections 3 and 4. Keynesian ‘fiscal dominance’ was a result not just of the fixed-exchange-rate regime but also the fact that government spending was the most significant contributor to aggregate demand in many countries (Cobham, 2012: 730). This was enabled by highly accommodating debt-management policies by central banks. Indeed, central banks were often subordinated to ministries of finance and had a wide range of goals aside from price and financial stability, including the maintenance of historically low interest rates on government debt and bank debt and the maintenance of exchange-rate parities (Epstein, 2006, Cobham, 2012: 730).

The Keynesian ‘Golden Age’ came to an abrupt end in the 1970s following the collapse of the Bretton Woods system of fixed exchange rates and the OPEC oil shocks. Explanations for the ‘great inflations’ of the 1970s remain contested today but at the time they were associated with excessively lax monetary policies and fiscal profligacy rather than the exogenous shocks of the oil crises, the collapse of Bretton Woods, and the resulting volatility in international capital flows. Monetarism re-emerged, building on new empirical evidence linking the money supply to inflation (Friedman and Schwartz, 1963). Friedman (1962) argued that governments were prone to generating excessive inflation by manipulating monetary policy as part of the ‘political business cycle’ (see also Nordhaus, 1975) and proposed fixing a target rate of growth for monetary expansion. It was an attractive theory for Conservative politicians such as Margaret Thatcher and

⁷⁹ The Chicago Plan was considered seriously by President Roosevelt during debates over the New Deal Banking reform acts and perhaps helped to establish the separation of investment and retail banking activities (Phillips (1994).

Ronald Reagan determined to link inflation to the failure of the Keynesian policies of incumbent governments (Johnson, 1971, Tobin, 1981).

The academic sphere also saw the emergence of neo-classical models of supply-demand equilibrium, grounded in micro-foundations with agents with rational expectations, perfect foresight and the long run ‘neutrality’ of money (Lucas, 1972, Phelps, 1973, Sargent and Wallace, 1975), and discussed in Chapter 1, Section 1.4.3. In such models, it is assumed that government expenditure must be financed either by taxes, by borrowing from the private sector (bond-financing) which increases the public deficit, or via money creation by the central bank, which increases the money supply when it purchases government bonds.⁸⁰ When deficits are bond-financed, it is assumed that the government competes with the private sector for limited funds and as a consequence interest rates are pushed up. Higher borrowing costs discourage investment and economic activity slows down – the so-called crowding out effect. When deficits are financed by money creation (or printing money), it is assumed that all money is created by the central bank so that the change in the money supply is equal to the change in the monetary base.⁸¹

Under the assumption of rational expectations, budget deficits financed by money creation could lead to prolonged high inflation episodes and eventually hyperinflation as rational agents would keep reducing their real money balances in favour of non-monetary assets with higher yields, such as government bonds. This would increase the velocity of money meaning ever more inflationary financing would be required (see, e.g., Cagan, 1956, Kiguel, 1989, Dornbusch, 1992). Even with bond-financing, neo-classical models argued that as deficits became larger, the amount of interest required to service an increasing public debt would eventually become unsustainable and central banks would then have no option but to monetise the debt (Sargent and Wallace, 1981). Indeed, even before any monetisation took place, if budget deficits had been persistent and large, agents’ would begin to *expect* future monetisation and reduce their money balances accordingly, thereby increasing the velocity of money and fulfilling the inflationary expectation. Governments thus face a trade-off between future and present monetisation and persistent budget deficits will almost always lead to inflation (Edwards and Tabellini, 1991).

4.2.3 Central Bank Independence (CBI) as a solution to inflation

These dynamics were theorised as creating a ‘time inconsistency’ problem in the monetary policy sphere (Kydland and Prescott, 1977). Since there are benefits to bursts of ‘surprise’ low-level inflation which tend to increase economic activity and reduce unemployment in the short run,

⁸⁰ Many models do not distinguish between governments and central banks, assuming the latter is part of the former.

⁸¹ See Seccareccia and Sood (2000) for a formal presentation of this argument.

politically influenced central banks will be prone to short-term monetary easing at certain times in the electoral cycle. Agents with rational expectations will begin to adjust the anticipated inflation in to their pricing decisions and labour contracts. The only way monetary expansion can be effective under such circumstance is for it to exceed such expectations, resulting in a positive feedback of ever higher expected and actual inflation with resulting welfare costs (Barro and Gordon, 1983b).⁸² Optimal monetary policy is therefore better obtained via the imposition of publically announced rules – which may be determined in consultation with governments but last at least the length of the electoral cycle – but central banks should be operationally independent to pursue such rules as they wish (Walsh, 1995).

These theories began to gain traction in the late 1980s following the publication of a number of empirical papers showing a negative correlation between indices of CBI and inflation, with prohibition or restrictions on central bank financing of government debt included as one of the indices of CBI (Alesina, 1988, Grilli *et al.*, 1991, Cukierman *et al.*, 1992, Alesina and Summers, 1993). In addition, the repeated inflationary episodes of the 1980s and 1990s in South America (Sachs, 1986), Eastern Europe, and Russia were strongly associated with high budget deficits.

The process of nation states gradually abandoning monetary financing in the 1980s and 1990s may also be related to the globalisation of capital and credit flows, presenting new opportunities to lever in foreign funding for investment. Supra-national institutions – such as the IMF, the World Bank, and the Bank of International Settlements – emerged to administer and monitor such flows. Their judgements began to legitimise the viability of nation states in the eyes of increasingly important international financial market investors (Maxfield and Schneider, 1997, Strange, 1998). Following the emergence of fluctuating exchange rates after the collapse of Bretton Woods in the 1970s, the IMF in particular reinvented itself as an institution with a much wider and more intrusive role in monitoring countries fiscal and monetary policies (Pauly, 1997:98-130). Most notably, the Fund became a major multinational lender to countries whose public or private debts were seen to be unsustainable. The IMF conditioned its lending to such countries on the basis of demonstrable efforts by the receiving country to adopt market-friendly domestic economic policies, in particular the liberalisation of domestic markets and their exposure to international competition. A key part of this was the removal of explicit restrictions on central bank lending to governments which was seen as an important form of ‘financial repression’ (Blejer *et al.*, 2002, Epstein and Heintz, 2006). Although the IMF has recently questioned the approach of its earlier structural adjustment programmes, in a recent survey of central bank lending to governments, it makes clear its strong attachment to prohibiting such activity:

⁸² In such theories, it is usually assumed that inflation has no permanent effect on real outcomes, i.e., that there is a vertical long-run Phillips Curve and non-accelerating inflation rate of unemployment (NAIRU) (Friedman, 1968, Phelps, 1973, Gordon, 1997).

With governments relying extensively on money to finance public expenditure, central banks' political and operational autonomy is inevitably undermined for the fulfillment of their policy objective of preserving price stability... As a first best, central banks should not finance government expenditure (Jácome *et al.*, 2012: 4).

In advanced economies since the 1990s CBI and inflation targeting – with a heavy emphasis on expectations – have become the primary focus of monetary policy above and beyond other macroeconomic objectives (Woodford, 1995, Bernanke and Mishkin, 1997). The New Macroeconomic Consensus (NMC) (see also Section 1.4.3) approach has three key elements:⁸³ 1) that the main task of the central bank should be a focus on price stability and the central bank should publically commit to an 'inflation target', normally around a (historically low) rate of 1–3% rate; 2) that to achieve this, the central bank should be operationally and institutionally independent of government or ministries of finance, including being free of any obligation to lend to governments or buy government securities; and 3) that indirect methods of monetary policy (in particular adjustments to interest rates) as opposed to more direct methods of deficit or monetary-financing, credit controls or guidance are appropriate (Bernanke and Mishkin, 1997, Blinder, 1999, Epstein, 2006, Arestis and Sawyer, 2008). Inherent in such an approach is a clear separation of monetary and fiscal policy.

The NMC policies have been institutionally embedded via constitutional and operational changes to the roles of central banks *vis-à-vis* governments. In Europe, the Treaty of Maastricht, signed in 1992, put in place the prohibition of the direct financing of government spending by any EU member state's central bank. This includes any overdraft or credit facility and the direct purchase of any debt instrument (i.e., gilts, treasury bonds). The policy applies to all EU members, even those, like the UK, outside of the Eurozone.⁸⁴ By 2008, inflation targeting had been adopted by 24 central banks and many more, including those in developing countries, were expressing an interest (Epstein and Yeldan, 2008). While the financial crisis of 2007–2008 has led a few central banks (most notably the BoE) to significantly boost their macroprudential role and monitor more closely asset prices, the strong focus on consumer price-inflation and CBI (and relatedly prohibition of monetary financing) has, by and large, remained unchanged. In a post-crisis review of central bank governance by the Bank of International Settlements, an organisation jointly founded by major central banks, states that:

⁸³ This definition draws on Arestis and Sawyer (2008). See that article for a detailed critical account of the NMC framework.

⁸⁴ Consolidated Version of the Treaty on the Functioning of the EU. Retrievable from <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2008:115:0047:0199:EN:PDF> [accessed 14 June 2011].

An important potential channel for an inflationary monetary expansion is central bank financing of budget deficits. Much of the inflationary risk is removed if central bank loans to the government are made at full market rates, particularly when those rates are influenced by the sterilisation operations used to offset the monetary impact (B.I.S., 2009: 67).

4.2.4 Critiques of the NMC and CBI frameworks

The NMC/CBI position has been criticised from a range of perspectives: empirical, theoretical, and methodological. Empirically, both panel (Seccareccia and Sood, 2000, Catao and Terrones, 2005, Lin and Chu, 2013) and single-country time series (King and Plosser, 1985, Protopapadakis and Siegel, 1987, Barnhart and Darrat, 1988) studies from a wide variety of countries, historical periods, and different inflation rates fail to find a statistically significant connection between fiscal deficits and inflation, regardless of whether deficits are ‘funded’ via private sector bond-purchases or central bank monetisation. The CBI indices themselves have been criticised for being overly selective by focusing on the period 1970–1990, characterised by a number of inflationary shocks which may have had non-monetary causes, including the OPEC crises of the 1970s and relatedly, balance of payment crises related to the recycling of loans and build up of Third World debts in the 1980s (Hervey, 1990: 466, Frieden, 2006: 364, Klomp and De Haan, 2010). Studies that have included more recent data tend not to find a clear correlation between CBI and inflation (Crowe and Meade, 2007).

With regard to hyperinflations, the most comprehensive study available of all 56 recorded cases is that of (Hanke and Krus, 2013).⁸⁵ The authors report that the vast majority occurred either during or after major wars or other exogenous shocks: ‘Hyperinflation is an economic malady that arises under extreme conditions: war, political mismanagement, and the transition from a command to market-based economy – to name a few’ (ibid.: 12). Only two of the 56 examples, Peru (1990) and the Weimar Republic (1922–1923), can be viewed as occurring under stable democracies (Salmon, 2012). With regard to Weimar, there were extraordinary pressures on the country due to the requirement to repay its debts in foreign denominated currency whilst also opening up its capital markets to damaging speculation (Keynes, 1920, Schacht and Butler, 1927). In both the US Continentals and French *assignat* examples mentioned in Section 2.2, there was major counterfeiting operations by enemy states during the respective wars (Levasseur, 1894, Newman, 1958).

⁸⁵ The authors use Cagan’s (1956) widely accepted definition of hyper-inflation as a price-level increase of at least 50% per month. When the monthly inflation rate drops below 50% and stays there for at least one year, the episode is said to end.

The ‘political inflation’ explanations of the developing world (in particular Latin America) inflations of the 1980s have also been called in to question. Rather than ‘demand-pull’ explanation caused by monetary financing of increasing government deficits, a number of scholars have emphasised structuralist explanations resulting from the concentrated structure of land ownership and balance-of-payments constraints these regions’ experienced as their economies developed (see Vernengo, 2006: 482-485 and the references therein). Under these approaches, industrialisation leads to a reduction in agricultural produce and a shift towards imported capital goods, creating supply-side constraints. This can lead to an increase in food prices (Cardoso, 1981) and a resultant reduction in real wages, which may in turn lead to pressures to increase wages above the indexation norm and wage-price spirals. A lack of foreign reserves means that developing countries have recurrent balance of payment problems as they try to import the necessary capital goods. Unable to bear down further on prices or wages because of resistance from both capitalists and workers, governments resort to repeatedly depreciating their currencies, resulting in further inflation. (Hyper)-inflation in developing countries thus is a political phenomenon but not one related to money creation – rather it is related to the social conflicts and structural change that naturally arises in a developing economy context.

Finally, it is worth noting that, despite many dire warnings of the inflationary potential of QE programmes, there has not been a single example of a hyperinflation since 1997, with inflation in the UK, the Eurozone and the USA barely reaching 4% and even lower levels in Japan.

Even if the existence of a correlation between CBI and low inflation is accepted, this does not imply causation. A number of studies suggest that CBI is more an *effect* of low inflation preferences than a cause (De Haan and Van't Hag, 1995, Acemoglu *et al.*, 2008, Mann, 2010); some studies emphasise the intensity of public expectations to fight inflation (Hayo, 1998) or the strength of political forces demanding low inflation (Posen, 1998) as causal factors. Other scholars have argued that the (low) inflation targeting regime that has spread rapidly across the world in the 1990s is a result of the increased power of the financial sector to assert its (creditor) interests over those of households and industry (debtors), since an increase in inflation redistributes real income from creditors to debtors (Bowles and White, 1994, Epstein, 1992, Ingham, 2004, Posen, 1995). Such a view is supported by the fact that there is little empirical evidence that moderate inflation – even at 5% – actually impedes growth (Wray, 2007, Epstein and Yeldan, 2008). A recently published IMF working paper based on a new database of central bank laws in 150 countries found the expected negative correlation between central bank lending to government and inflation but also a *positive* correlation between central bank lending to government and real GDP growth in developing countries (and, unsurprisingly, inflation and real GDP growth in such countries) (Jácome *et al.*, 2012: 17). This suggests there is a trade-off between low inflation and growth.

From a theoretical perspective, there are problems with the NMC/CBI focus on money rather than credit. The ‘credit theory of money’ approach, outlined in Section 1.4.5, which builds on the Chartalist origins of money outlined in Section 4.2.1, argues that the quantity of *money* (mainly in the form of bank liabilities or deposits) in an economy appears residually as an accounting by-product of the *credit* flows created by either central banks or private banks (Werner, 1997, Parguez and Seccareccia, 2000, Graziani, 2003). Given that modern credit creation is dominated by commercial banks, it is the quantity of new *credit* demanded and created by such banks and its *allocation* in to the economy, and resulting impact on resource allocation that is a key determinant of macroeconomic dynamics, including consumer and asset prices.

One reason less attention may have been paid to the credit creation decisions of private banks is because of the assumption in New Keynesian/NMC models that 1) the majority of lending by banks goes to non-financial firms and 2) that (independent) central banks are able to influence such credit flows via adjustments to the short-term interest such that the economy is able to return to an equilibrium or ‘natural’ rate of interest at which point the market clears (Wicksell, 1936 [1898], Barro and Gordon, 1983a).⁸⁶ Both of these assumptions are questionable. First, as discussed in preceding chapters, it has become clear that modern banks in advanced economies actually lend considerably more against existing assets, mainly real estate, than they do to non-financial firms. Secondly, there is little evidence of a correlation between the quantity of base money or ‘loanable funds’, or the short-term interest rate (‘bankrate’) that banks base their interbank lending rate on, and the quantity of credit created by the banking sector. The ‘money multiplier’ seems to have broken down if, indeed, it ever existed (Goodhart, 2009, Carpenter and Demiralp, 2012). As central banks have dropped demands for compulsory reserve or liquidity ratios over the past thirty years, increasingly it is accepted that central banks main role is to *accommodate* the demand for reserves by the banking system via ensuring there is sufficient liquidity in the system – described by post-Keynesian economists as ‘endogenous money’⁸⁷ (Kaldor, 1982, Moore, 1988, and see Howells, 2006 for empirical evidence).

Examining monetary aggregates in relation to inflation is also empirically challenging because it is not entirely clear what the best aggregates to measure are. Indeed, this was a central difficulty for monetarist policies as noted in Chapter 1, Section 1.4.2. Meanwhile assuming that government or central bank money creation will be inherently inflationary whilst ignoring the impact of private bank credit creation makes little sense unless assumptions about the efficiency of market (i.e., commercial bank) credit allocation over monetary financing are brought in to the argument. In the

⁸⁶ See Pilkington (2014) for a recent critique of the natural rate hypothesis.

⁸⁷ See Chick (1996) for a useful discussion of the evolution of the banking system in the UK from one where reserves did actually constrain lending to a system where the central bank must accommodate the demand for reserves from commercial banks to maintain the policy rate of interest.

light of the 2008 financial crisis, when excessive bank credit creation in particular for mortgages was a key cause of the crisis and resulting recession, such assumptions would seem problematic.

Relatedly, the measure of inflation that is used in most of the studies supporting CBI is consumer-price inflation rather than asset price inflation. The neglect of asset price inflation by monetary authorities is now widely recognised as a mistake, including by central bank staff themselves (Aikman *et al.*, 2014). As discussed in Chapter 3, a number of empirical studies show a very strong relationship between inflated asset prices and financial crises (Cecchetti, 2008, Hume and Sentance, 2009, Schularick and Taylor, 2009).

In summary, the relationship between the state and money creation has changed radically over the past 400 years. Only in the past few decades have we seen the establishment of a consensus around the need to restrict public monetary financing and debt monetisation to a negligible level in favour of a private sector monopoly regulated by an independent central bank that, for the most part, restricts its activities to inflation targeting via adjustments to short-term interest rates. Empirical support for such an approach is limited and the theoretical basis for such policies is flawed. As mentioned in the introduction, such arrangements have come under scrutiny following the financial crisis of 2007–2008. QE policies – which clearly involve the creation of central bank money on a vast scale – have not led to the kind of inflation such theories predict and raise questions about CBI because of the implicit subsidisation of government debt involved. Given these findings, what can we learn from a more in-depth examination of the period 1930–1970 when a different set of policies, much less concerned with the inflationary effects of government or central bank money creation, were common place?

4.3 A case study of non-inflationary monetary financing: the Canadian Central bank, 1935–1975

4.3.1 Monetary policy in the period 1930–1970

The period 1930–1970s saw significant formal and informal regulatory controls on private bank credit creation complemented by both direct and indirect instances of monetary financing in many countries. It is, perhaps, best described as a period of ‘mixed economy’ of monetary production. Economic historians studying the period have paid less attention to monetary than fiscal policy, however, describing the period as one of Keynesian ‘fiscal dominance’ enabled by a fixed-exchange-rate regime, regulation of capital flows, and high levels of government spending and investment driving aggregate demand (see, e.g., Eichengreen, 1998, Cobham, 2012: 730). But these

fiscal policies were enabled by accommodating debt-management policies by central banks. Indeed, central banks were often subordinated to ministries of finance and had a wide range of goals aside from price and financial stability, including the maintenance of historically low interest rates on government debt and bank debt and the maintenance of exchange-rate parities (Epstein, 2006, Goodhart, 2010a:2-4, Cobham, 2012: 730, Pixley *et al.*, 2013:39-41). Without supportive domestic monetary policy, it is not clear how such policies could have been enacted given the very high debt-GDP ratios facing most countries in the post-Second World War period.

Mainstream economists who have paid more attention to monetary policy during the period have tended to describe such policies as damaging to free market growth, using pejorative terms such as ‘financial repression’ – see, for example, Shaw (1973), McKinnon (1973) and, more recently, Roubini and Sala-i-Martin (1992) and Reinhart and Sbrancia (2011). A limited number of political economists have emphasised the important role of monetary policy in the period and how it supported industrial policy (Zysman, 1983, Epstein and Schor, 1991, and Tilly, 2007).

4.3.2 Case study: Canada

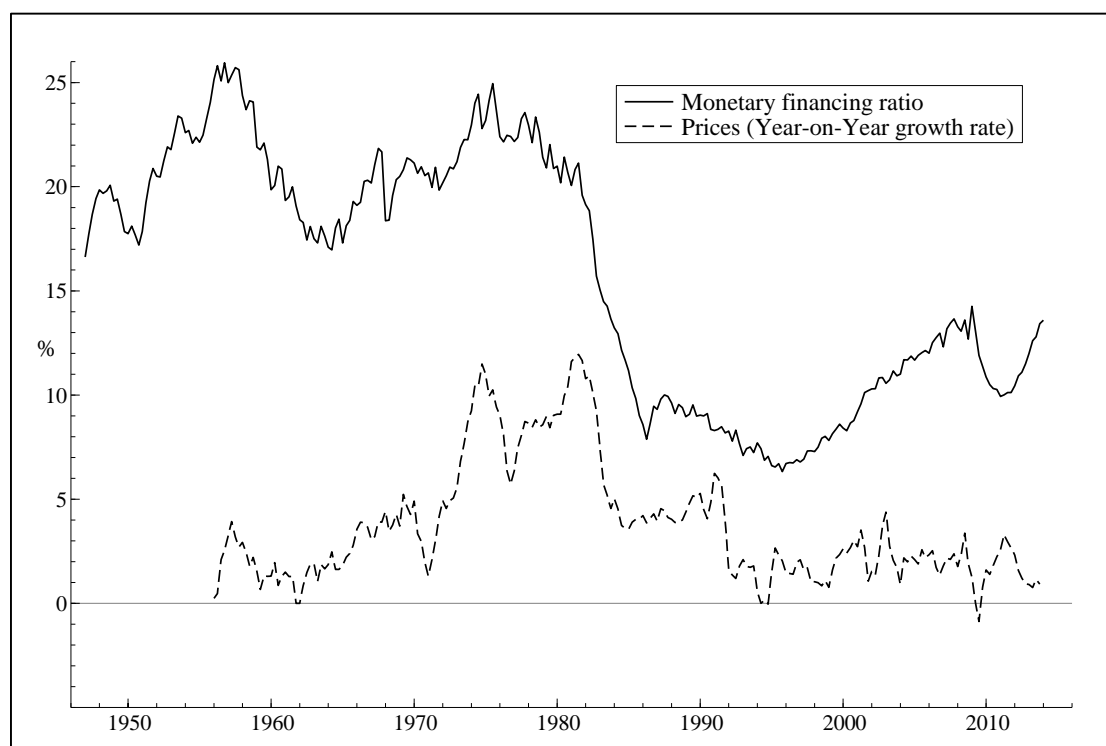
The activities of the Canadian central bank from the period of its inception in 1935 to the early 1970s constitute an example of how a central bank, working closely with the state, used indirect and direct monetary financing policies to support industrial development, debt management, and macroeconomic goals that go significantly beyond financial stability and price stability. As shown in Figure 15, between 20 and 25% of Canadian public debt was financed and held by the central bank and government from the end of the Second World War up to the early 1980s but inflation was below 5% right up until the early 1970s, casting doubt on the NMC and CBI hypotheses. This thesis is tested empirically in Section 4 but in this section the historical and institutional dynamics that led Canada to use monetary financing as a key plank in its economic policy during the period are elaborated

The Bank of Canada is a pertinent case to investigate when looking at the monetary financing-inflation hypothesis for a number of reasons. First, as explained below, its origins lie in domestic political pressures following the Great Depression so from the outset it had a strong mandate to support the wider economy and public interest, rather than as a body supporting domestic or international financial interests.⁸⁸ Second, Canada was almost unique at the time in having a floating exchange rate for the majority of the period 1951–1975 and few other capital controls, making its monetary policy choices more amenable to comparison to modern economies. Whilst Canada was

⁸⁸See Goodhart (1988) for a classic account of the evolution of central banks as institutions serving the interests of commercial banks via the provision of ‘Lender of Last Resort’ functions.

of course heavily influenced economically by its neighbour, the USA, it had a very different banking and political system, heavily influenced by European and particularly British traditions (Bordo *et al.*, 1996, Calomiris and Haber, 2014: 153-329). In comparison to other potential examples of monetary financing during the period, for example Japan and New Zealand, the period involved is considerably longer and data availability and historical records of higher quality.

Figure 15: Monetary financing and inflation in Canada, 1958–2012



Sources: Monetary financing ratio is the proportion of total public debt held by the Bank of Canada or government from Canadian Statistics, CANSIM Table 176-022; Prices are the YoY growth rate of the Canadian Consumer Price Index (2010=100) from the OECD (2010) MEI.

Here let us focus on how the monetary financing activities of the Bank of Canada supported the economy in three areas. First, lifting Canada out of the Great Depression of the 1930s and the subsequent war mobilisation, which involved substantial direct and indirect (via chartered banks) credit creation to fund government war spending. Secondly, post-war recovery and industrialisation in the 1950s and 1960s, which saw the central bank support government spending through the maintenance of fixed low rates of bond and Treasury Bill financing. And finally, support for the Canadian small business sector is examined through the creation of the Industrial Development Bank (IDB) of Canada, a wholly owned subsidiary of the Central Bank. Before moving on to these episodes, some historical context is provided.

4.3.3 Historical origins

Canada was a late adopter of government-issued money and central banking. Competitive fractional-reserve banking with note-issuing banks and without an indigenous central bank was the norm well in to the twentieth century and proved to be remarkably stable, in contrast to the experience of their southern neighbour, the USA.⁸⁹ Rather than the relatively independent unit banks that emerged in the USA, Canada developed a national branch bank network with a relatively small number of large and diversified commercial banks.⁹⁰ The nationwide branch system also suited the needs of a largely agricultural-and-lumber-based economy, with its requirements for seasonal liquidity and with capital spread widely and thinly across a vast continent (Watts, 1972: ch1).

The Bank of Canada's creation in 1934 can be viewed as being driven more by domestic political, rather than economic or international, pressures (Bordo and Redish, 1987, Cain, 1996).⁹¹ Domestically, there was considerable hostility amongst the Canadian public towards the private banking system, which was held responsible for the deflation experienced during the Great Depression. The Canadian banking system in 1930 was highly concentrated with the three largest banks controlling 75% of industry deposits. There was evidence of collusion within the industry body, the Chartered Bank Association, to artificially constrain the money supply (Bordo and Redish, 1987: 415).

The Bank of Canada Act of 1934, which gave the Bank the sole right to issue bank notes, determined that the function of the newly formed central bank would be:

to regulate credit and currency in the best interests of the economic life of the nation, to control and protect the external value of the national monetary unit and to mitigate by its influence fluctuations in the general level of production, trade, prices and employment (Bank of Canada, 2008 [1934]).

The Act also assigns the Bank an exploitative role in providing monetary financing, stating that “The Bank may...

⁸⁹ See Bordo *et al.* (1996), Gorton and Huang (2002), and Calomiris and Haber (2014) for discussions.

⁹⁰ There were 40 highly branched banks in Canada between 1870 and 1914 compared to around 18,000 in the USA in 1890 (2014: 283-327).

⁹¹ Bordo and Redish (1987) reject the more traditional arguments for the creation of the Bank – that a lender of last resort was required for a competitive banking system or that the Bank was needed to stabilise the economy following the abandonment of the gold standard – and find historical and econometric evidence to support a more political motivation for its inception.

- (i) make loans or advances for periods not exceeding six months to the Government of Canada or the government of a province on taking security in readily marketable securities issued or guaranteed by Canada or any province;
- (ii) make loans to the Government of Canada or the government of any province, but such loans outstanding at any one time shall not, in the case of the Government of Canada, exceed one-third of the estimated revenue of the Government of Canada for its fiscal year... and such loans shall be repaid before the end of the first quarter or after the end of the fiscal year of the government that has contracted the loan.;⁹²

Despite vociferous opposition from the Canadian representatives on the British dominated Macmillan Commission that helped set up the Bank and the progressive Liberal party, the Bank of Canada was initially set up with private shareholders following the BoE model. However shortly afterwards the Liberal Party won power in the federal election of 1935 and set about nationalising the Bank.⁹³ The Ministry of Finance was given a majority of stock and the board enlarged with government-appointed directors, each of whom had two votes. By 1938, all private holders of stock were forced to sell their shares to the government. In the same year, the first Governor of the Bank, the Canadian Graham Towers asserted the primacy of the state in the conduct of the central banks' monetary policy, which:

...must conform to the policy of their respective governments. No other conception of the situation is possible in this day and age, nor would any other state of affairs be desirable in view of the vital effects which monetary policy can have on the affairs of the country.⁹⁴

The Bank's governance structure ensured a close relationship to the government. The Board of Directors was appointed for three years by the government whilst the governor and the chair of the board were appointed by the directors with the approval of the government, for a seven-year term depending on good behaviour. The Deputy Minister of Finance also sat on the Board of Directors but without a vote. Under this arrangement it was generally understood that, in case of a serious and basic difference of opinion, a determined government could force the resignation of the governor (Neufeld, 1958a: 10-13). This happened only once in 1961 when the government requested the resignation of Governor James Coyne following a breakdown in relations with the Treasury.

⁹² Bank of Canada Act 2008 [1934], sections 18(i) and (j). Adapted from COMER submission to the Bank of Canada, Amended Claim, 26 March 2015, accessible from www.comer.org

⁹³ Leader of the Party, W. L. Mackenzie King stated that: '...In no sense should the bank be, or be permitted to become, a banker's bank. It is and ought to be a government bank, the government being representative of the interest of the country as a whole...' (Williamson, 1989).

⁹⁴ G. F. Towers, in an address to the Montreal Junior Board of Trade, as reported in *The Gazette*, Montreal, 15 March 1938, in Neufeld, 1958, p11.

4.3.4 Early operations and recovery from the Great Depression

The Bank of Canada commenced operations on 11 March 1935 and immediately began to help the Canadian economy out of depression via expansion of the money supply and the maintenance of low interest rates. The Bank pursued a cheap-money policy with the Governor, Graham Towers, strongly rejecting inflationary warnings from monetary conservatives and adopting a stance that appears much closer to the ‘credit theory of money’ discussed in earlier chapters:

...in stimulating business activity the vital matter is not the amount of money in existence, it is the size of people’s income, in other words, the size of the national income. This can grow, and does grow, without any definite connection between such growth and a growth in bank deposits or note circulation (Bank of Canada, 1936: 12).

Expansion was initially achieved through direct central bank money creation via advances to the state: \$4 million was advanced to the government in 1935 in four installments, all of which were eventually repaid. However, the vast bulk of financing was achieved through the Bank’s active participation and shaping of the Canadian government bond market.

The Bank conducted four main kinds of activity in this area (Neufeld, 1958a: 81-111). First, it undertook direct deficit-financing through purchases of government securities from the government; secondly, it pumped large quantities of cash reserves into the chartered banks via bond purchases and maintained a low bank rate to ensure they had sufficient liquidity to further finance the government via direct purchase of securities. This can be seen as a form of indirect monetary financing via private bank monetisation of government debt (Watts, 1972: 54). Thirdly, via these two operations and the development of a short-term Treasury Bills market, the Bank ensured low yields on government bonds throughout the period, thus reducing the cost of deficit-financing; fourth, working with the Department of Finance, it developed illiquid ‘deposit certificates’ – usually with a six-month maturity – that enabled the government to raise short-term finance directly from the chartered banks (Ascah, 1999: 108-111).

In the pre-war period, between 1935 and 1939, the Bank played a major role in Canada’s recovery from the Great Depression, funding over two-thirds of government expenditure over these five years.⁹⁵ Nominal GNP expanded by 77% in contrast to the 70% contraction in the previous five

⁹⁵ It purchased a total of \$852 million of government debt, almost one-third of which was Treasury bills. Government expenditure in the same period was \$2,476 million Source: Statistics Canada, Series J55-74: Bank of Canada, assets and liabilities, 1935 to 1977. <http://www.statcan.gc.ca/pub/11-516-x/sectionj/4147440-eng.htm#2>; Bank of Canada Review, Series J471-480: Bond and stock yields, annual averages, 1934–1977, Table 20.

years, with a sharp increase in capital investment and private expenditure.⁹⁶ Bank deposits expanded by a similar amount, while currency in circulation increased by 70%.⁹⁷ Deflation was reversed but inflation remained stable despite the massive expansion in the money supply.

4.3.5 War-time financing

During the war, monetary and fiscal policy effectively became one as the Bank of Canada supported the government's efforts to mobilise resources without resistance. With still considerable levels of unemployment and spare productive capacity, the government initially embarked on a policy of 'deliberate monetary expansion', mainly via loans from chartered banks (Mcivor, 1958: 176). This was enabled by the Bank's controlling role of both chartered private bank cash and more general influence on the banks and the bond market (Mcivor, 1958: 176) (Section 4.3.6.2).

The Bank also enabled Canada to nationalise its debt, reducing the non-resident holdings of government debt from one-third of the total to a few percent after negotiations with the British government for the repatriation of Canadian foreign pay securities (Fullerton, 1962: 59) (Table 15; Figure 16). A number of large Victory war loans saw a rapid expansion in residential and institutional holdings of government debt, around a quarter of which was monetarily financed via credit creation through an expansion in bank loans to households for such purchases (Neufeld, 1958a: 155),⁹⁸ as well as the central bank expanding its purchases. As shown in Figure 17, the Bank engineered a long period of 'cheap money', with long-term rates staying around 3% until the late 1950s and shorter-term rates at less than 1%.

During the war period, \$517.8 million of securities were bought directly from the government with newly created central bank money and by converting numerous maturing securities into new Government of Canada issues (Neufeld, 1958a: 145, Mcivor, 1958: 174). As Plumptre (1941: 155-156) remarks, the effect of this increase in note issue was to provide 'a sort of interest-free loan to the Government through the medium of the Bank of Canada'. The Bank issued the notes at virtually zero cost to itself, whilst the profits paid to it by the government for holding government debt were all paid back to government which owned all of its stock.

⁹⁶ Downloaded from IMF 'Public Finances in Modern History' database – see International Monetary Fund (2013).

⁹⁷ Statistics Canada, section J, Table J1-10 and J11-20, available online at <http://www.statcan.gc.ca/pub/11-516-x/sectionj/4147440-eng.htm#1>

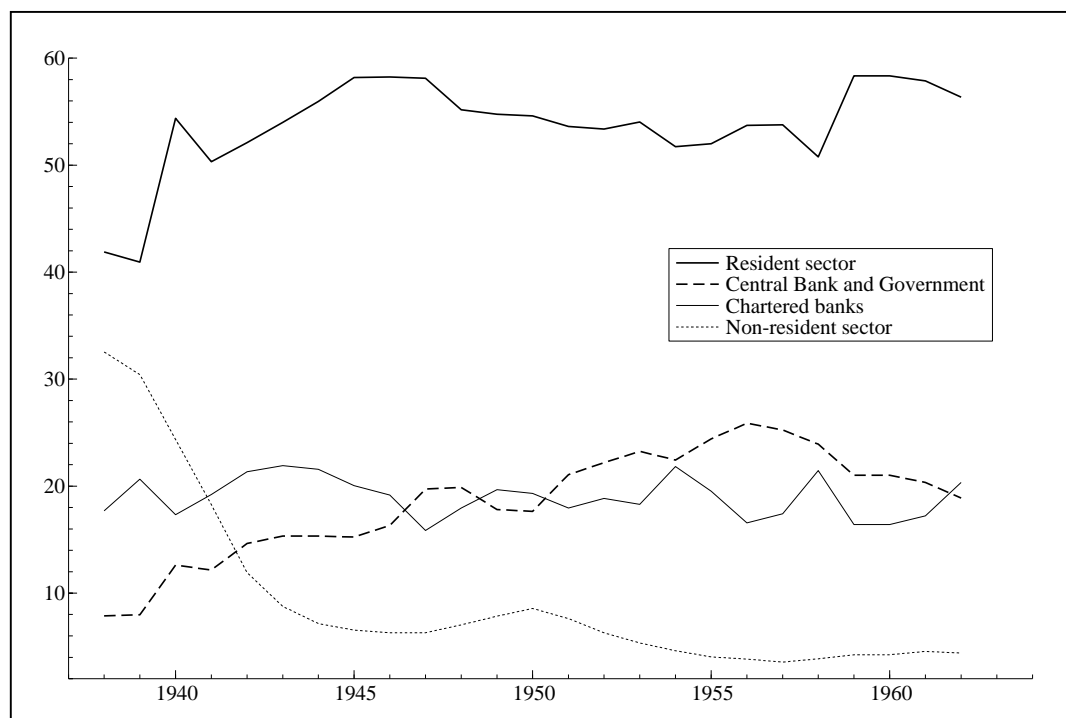
⁹⁸ Bank loans for the first Victory war loan of June 1941 were \$135,978,539 out of a total subscription of \$730,000,000, whilst for the Second Victory Loan they were \$209,800 out of a total subscription of \$845,000,000 (Kindleberger, 1942: 4). Figures for later loans were not available.

Table 15: Federal government funded debt operations during the Second World War (millions of Canadian dollars)

| Fiscal Year (March 31) | 1940 | 1941 | 1942 | 1943 | 1944 | 1945 | 1946 |
|--|------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Borrowing: | | | | | | | |
| General public war loans and certificates | 200 | 358 | 1659 | 1050 | 2732 | 2948 | 3598 |
| Chartered banks | 200 | 250 | — | 820 | 170 | 112 | — |
| Central bank | — | 325 | — | 193 | — | — | — |
| Treasury Bills | | 75 | 40 | 30 | 60 | 20 | 70 |
| Loan retirements: | | | | | | | |
| domestic | 100 | 110 | 36 | 42 | 60 | 252 | 761 |
| foreign | 84 | 147 | 180 | 113 | 106 | — | 155 |
| Total increase in funded debt | 216 | 676 | 1492 | 2121 | 2951 | 3027 | 2823 |
| Average interest rate payable on debt | 3.4 | 3.06 | 2.9 | 2.6 | 2.55 | 2.51 | 2.49 |

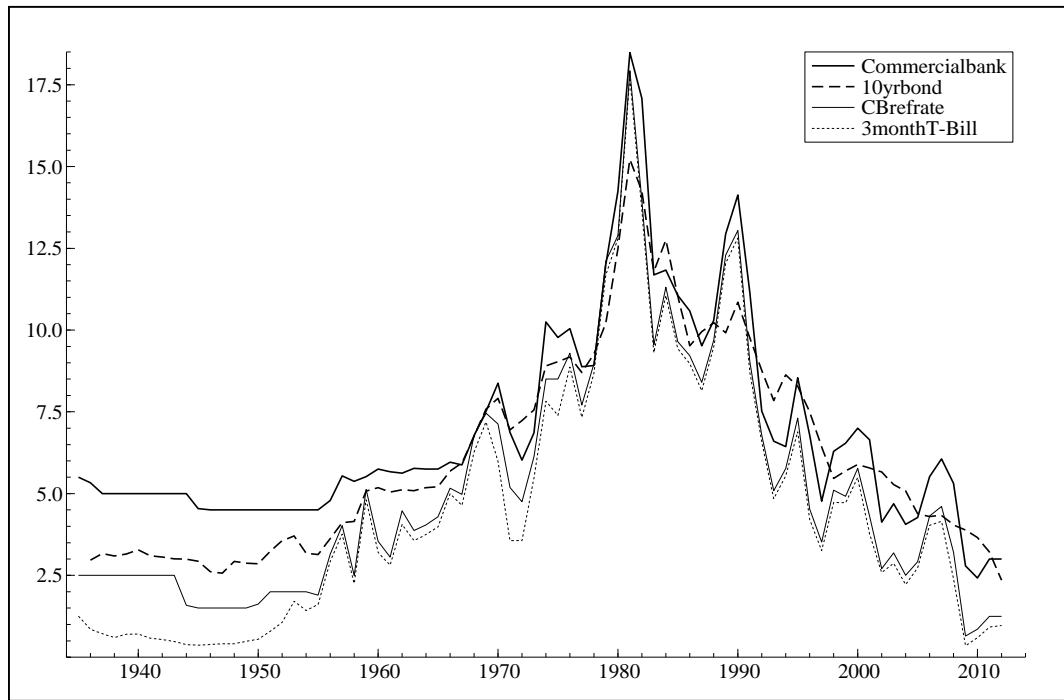
Sources: Adapted from Mcivor (1958: 174-175); original sources: Dominion of Canada, Public Accounts 1940-1946; Budget Speeches 1940-1946; National War Finance Committee, Statistics and Information on Dominion Government Public Borrowing Operations from September 1939 to December 1945 (Ottawa, 1946).

Figure 16: Distribution of Canadian federal government debt (annual), 1938-1962



Sources: 'Government of Canada Direct and Guaranteed Securities: Annual Distribution of Government debt holdings', Bank of Canada, Statistical Summary, Financial Supplement 1959, p56, available online at <https://archive.org/stream/statisticalsumma1959bank#page/n619/mode/1up>, p620

Figure 17: Canadian key interest rates (annual), 1935-2012



Source: Canadian Statistics, CANSIM Table 176-0043: 'Financial market statistics, last Wednesday unless otherwise stated, monthly (percent unless otherwise noted)'

From 1941 to 1943, the government borrowed \$1,165 million directly from the chartered banks, of which \$715million were illiquid deposit certificates issued at $\frac{3}{8}$ ths of 1% (Neufeld, 1958a: 133).⁹⁹ The central bank accommodated such purchases and maintained a low yield on government debt (2.2%) by providing the chartered banks with sufficient liquidity to enable them to maintain their preferred cash ratio of 10% (Neufeld, 1958a: 134). This policy continued in 1944 when the government reduced the bank rate and provided the banks with 'more reserves than they had ever had before' (Neufeld, 1958a: 138). As a result, the chartered banks bought huge quantities of government securities and ensured easy money conditions for the government and general public.¹⁰⁰

There was little evidence that such war-time spending was inflationary, despite the historical precedents described in Section 2.3. The huge increases in the money supply and credit engineered by the Bank were mainly absorbed by a vast expansion in industrial production, which increased by 28% between 1939 and 1941, matched by a similar increase in employment (Parkinson, 1941: 42, Mcivor, 1958: 184). As the war went on and as production and employment began to reach near

⁹⁹ The deposit certificates were based on a similar policy instigated by Keynes in the UK to support Britain in the War - see Howson (1985: 252-253). As they were non-marketable, they prevented banks from using them to expand their balance sheets by trading them for T-bills or cash (Tily, 2007: 205). For a discussion, see Ascah (1999: 108-111) who notes the initial resistance of the chartered banks to the low rate of interest they would earn.

¹⁰⁰ See Mcivor (1958:165-201) for a detailed account of the role of the Bank of Canada in financing the war, including statistical tables.

capacity, the government increased taxation or non-monetised borrowing from the public and reduced borrowing from the banking sector which was effective in relieving inflationary pressures, without any raising of interest rates (Mcivor, 1958: 184).

4.3.6 The post-war period, 1945–1975

The White Paper on Employment and Income of 1945 described the Canadian government's immediate post-war fiscal and economic policies (Canadian Parliament, 1945). It outlined the government's intention to adopt Keynesian expansionary economic policies to maintain the high level of employment and income that had been reached during the war period. Deficits would be incurred and national debt increased when unemployment threatened, but would be balanced by surpluses in periods of prosperity (Franks, 2006 [1945]). Furthermore, the government stated that it 'proposes to pursue a monetary policy which will encourage, through low interest rates, the investment of funds in productive capital contributing to employment' (Deutsch, 1957: 222). The 15-year period that followed was one of most prosperous in Canadian history, with high growth, the maintenance of full employment, and budgetary surpluses for most of the period.

4.3.6.1 *The Industrial Development Bank*

In terms of business funding, one of the Bank's key post-war innovations was the creation of a subsidiary institution, the national IDB, with a specific remit to support the SME sector in Canada. The IDB, created in 1944, was one of the first ever development banks and became one of the largest and most successful (Business Development Bank of Canada, 2014). The important role of the central bank and monetary policy in the IDB's creation is made clear in the preamble to the Parliamentary Act which saw the IDB come in force, with the purpose of the bank:

...to promote the economic welfare of Canada by increasing the effectiveness of monetary action through ensuring the availability of credit to industrial enterprises which may reasonably be expected to prove successful if a high level of national income and employment is maintained, by supplementing the activities of other lenders and by providing capital assistance to industry with particular consideration to the financing problems of smaller enterprises (Canadian Parliament, 1945: 383, quoted in Clark, 1985: 21).

There were concerns in the Canadian parliament that the IDB would create a conflict of interest for the central bank which was also charged with regulating the country's economy. However, the then Deputy Minister of Finance did not see this as a concern, arguing that the link between the two banks would be beneficial to the central bank. It would have 'more intimate contact... with the

conditions and the problems of small and medium sized industries'. Further, 'the operations of the IDB will naturally have to dovetail into the country's monetary policy', and a corporate link between the two banks would make this easier (House of Commons, 1944: 1441-3, in Clark, 1985: 21).

Figure 18: IDB loans and investments as a proportion of total Canadian domestic bank lending to the private non-financial sector, 1954–1975



Sources: IDB loans and assets: Clark (1985: 390-391); Domestic Lending to PNFCs: Dembiermont *et al.* (2013), code Q:CA:B:P:A (adjusted for breaks) and author's calculations.

In its 31 years, the IDB authorised 65,000 loans totaling \$3 billion for 48,000 businesses (Clark, 1985: 7). Well over 90% were successful in establishing themselves and retiring their IDB loans and it was estimated that they employed close to 900,000 people (*ibid.*). Most of the Bank's borrowers were small with the average loan \$47,000 and 48% of the loans authorised were for \$25,000 or less (*ibid.*). The volume of loans made by the IDB stayed relatively stable throughout this period even as economic conditions fluctuated (*ibid.*: 6). The IDB's importance to the commercial sector grew throughout the 1950s and 1960s and during its last ten years the bank provided the equivalent of 25% of total domestic bank lending to the private non-financial sector (Figure 18).

In contrast to most public development banks which were capitalised with tax-payer funds and leverage-in private finance, the IDB was entirely funded via money creation by the Bank of Canada during its 31-year existence. The IDB was initially funded by the purchase of \$25 million equity stock by the Bank of Canada. By end of 1947, all \$25 million of stock had been taken down

leaving the IDB with significant surplus funds which were invested in government securities. By 1951, virtually all equity funds had been used up in the IDB's loans. It made a number of further sales of bonds to the Bank of Canada to maintain its capital at the same rate as Canadian government three-year bonds. In the early 1970s, the federal government recommended that the IDB's link with the Bank of Canada be severed and a separate Crown corporation, owned and funded directly by the federal government, be created.

4.3.6.2 *The Bank's support for government finance and credit controls*

As well as supporting SME financing, the Bank of Canada continued its policy of ensuring easy and cheap finance for government to support fiscal expansion and maintain the policy of full employment. Monetary policy during this period contrast significantly with the approaches outlined in Sections 4.2.2 and 4.2.3. Changes to the short-term interest rate were generally not seen as a useful policy instrument (Neufeld, 1958b) and fiscal policy took on much of the responsibility for dampening the inflationary surges that inevitably followed the war, via increases in taxation and repeated budget surpluses (Deutsch, 1957). Although the bank did make use of open market operations, it also employed more direct methods. In a review of this activity in the post-war period, Chant and Acheson (1972: 18) note that the Bank either obtained new agreements or altered existing agreements with chartered banks in 12 of the 24 years from 1946 to 1969 and that many of the agreements extended beyond the year in which they were made. These included limits on the holdings of government securities by chartered banks, limits or credit ceilings on total loans and term loans, minimum liquid asset ratios, limits on lending to consumer finance companies, special consideration to small borrowers and mortgages for new homes, maximum interest rates on term deposits, ceilings on 'swap' deposits, special attention to small businesses and to borrowers in 'less prosperous areas of the country' as well as a number of interventions to support the balance of payments in the late 1960s (Neufeld, 1958a: 75-80, McIvor, 1958: 156-157, Chant and Acheson, 1972). A full historical breakdown is provided in Appendix C.1.

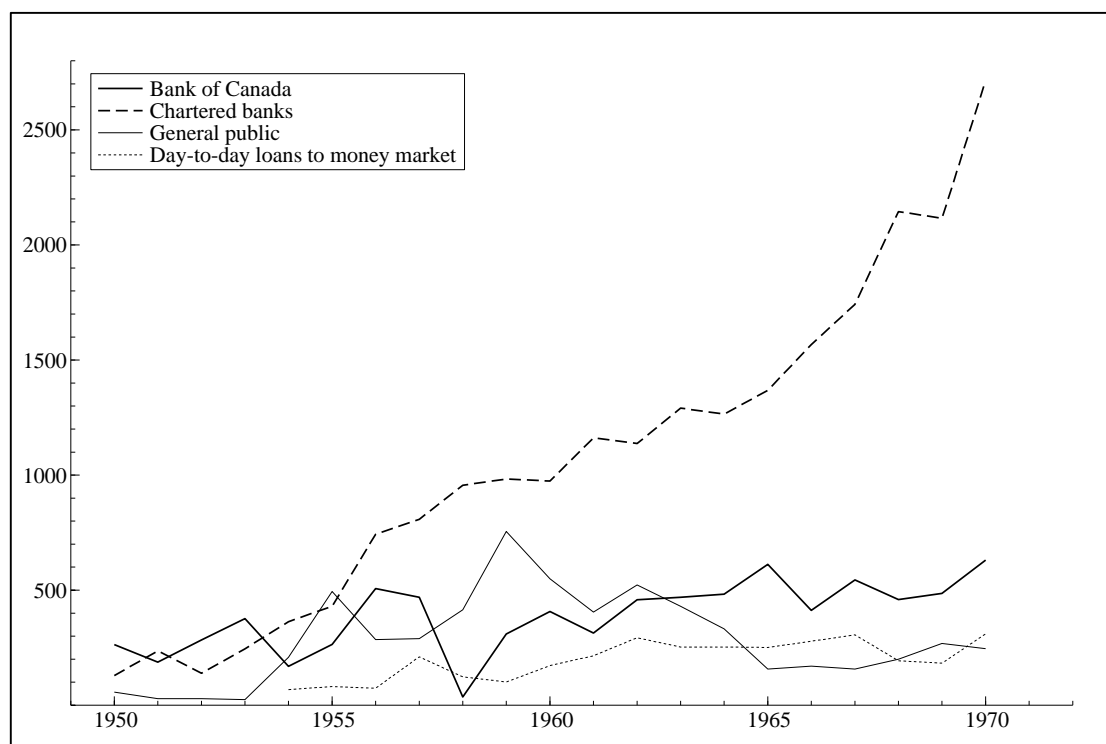
In addition, more informal 'moral suasion' was also used, defined by the Bank as: 'a wide range of possible initiatives by the central bank designed to enlist the co-operation of commercial banks or of other financial organisations in pursuit of some objective of financial policy' (Bank of Canada, 1962: 37). These initiatives varied from a 'general exchanges of views' to 'efforts by the central bank to achieve, through suggestion, discussion and persuasion, specific changes... in policies or practices of private financial institutions' (ibid.:38). McIvor (1958: 156-7) notes that the high concentration of ownership among the chartered banks made moral suasion effective in Canada in contrast to other countries with more diversified ownership structures. The important role of the

Bank in the war appeared to considerably strengthen the Bank's credibility and ability to influence lending.

One particularly interesting example that illustrates the Bank's focus on supporting government finance over other objectives is its role in the introduction of the short-term money market in 1954. Ostensibly, the purpose was to enhance the overall efficiency and flexibility of monetary policy by broadening the public's holdings of government debt or Treasury Bills (Wilson, 1966: 295). Another interpretation, however, put forward by Acheson and Chant (1973) is that the introduction of the money market was a means for the Bank to further subsidise the cost of government debt by increasing the quantity of short-term government debt held by chartered banks. Such an interpretation helps explain why one year after the introduction of the money market, the Bank enforced a 15% ratio of liquid assets to deposits ratio on a daily average basis for chartered banks. At the same time the Bank encouraged the money market dealers to hold Treasury Bills rather than cheaper Banker's acceptances as a form of collateral for their day-to-day loans which chartered banks used to maintain their cash positions. Depending as they did on the Banks' lines of credit for their dealings, the money market dealers did just this – at a financial loss to themselves – but the effect was to force the chartered banks to also hold Treasury Bills as their main liquid asset rather than relying on cheaper acceptances (Chant and Acheson, 1972).

As shown in Figure 19, chartered bank holdings of Treasury debt expanded 6-fold, whilst the public's holdings of Treasury Bills actually declined over the period. Thus short-term government borrowing for this period was largely funded via enforced private bank credit creation rather than from public savings – again a form of 'private bank monetisation'. The policy can also be seen as a tool of monetary policy of course, since the subsidy provided by the banks was equally a cost to them that reduced their profits and thus capital (Neufeld, 1958b: 210).

Figure 19: Distribution of holdings of Treasury bills, 1950–1970 (\$ millions of Canadian dollars)



Source: Bank of Canada Statistical Summary Supplement in Acheson and Chant (1973: 648)

When inflation did threaten Canada, the Bank used quantitative credit controls rather than raising interest rates. Two bouts of serious inflation occurred in the period 1947–1953 and can be mainly attributed to very large capital inflows from the United States generated by investment opportunities in the resource sector and accelerated by the onset of the Korean War (Neufeld, 1958a: ch.VI, Bordo and Redish, 2006).¹⁰¹ In response, in February 1951 the Bank imposed a credit ceiling on all chartered banks which was effective, with deposits stabilising until the removal of the control in May of 1952 (Mcivor, 1958: 220). Reviewing the policy, Mcivor notes that it permitted ‘declines in long-term bond prices to well below par, without excessive disorganisation of the market. With the credit ceiling to prevent the banks from using the additional cash, the Bank could continue to “cushion” the market by absorbing bonds as required’ (1958: 219).

The 1957 Annual Report of the Bank indicates that it remained actively concerned with the allocation of credit, despite the inflationary pressures, and in particular ensuring that there was sufficient finance for smaller businesses and households:

... During 1957, as in 1956, we have in discussions with the chartered banks expressed concern for the position of these small borrowers... Even if small borrowers are assured of non-discriminatory treatment by the banks they may be handicapped relative to large

¹⁰¹ The Canadian dollar was fixed against the US dollar during the war, and in July 1946, was revalued to parity against the US dollar. In late 1949, Canada joined Britain and a number of other countries in devaluing against the dollar, returning to the wartime rate of 90 cents.

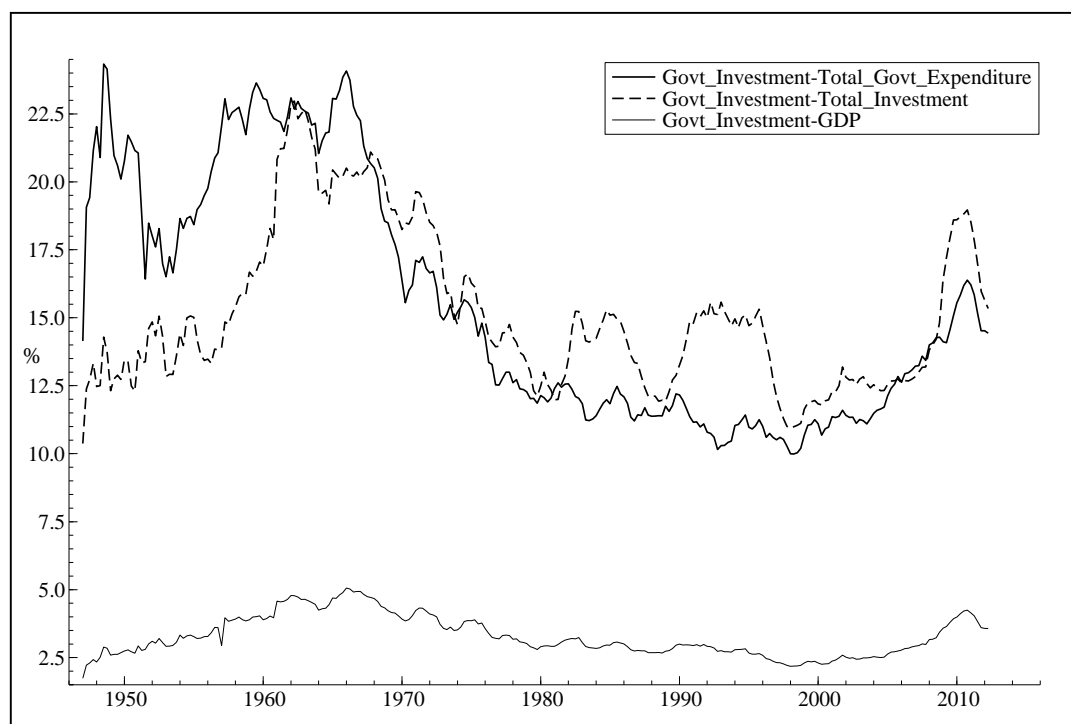
borrowers.... The first call on the resources of the national branch banking system must, I think, be to fill the creditworthy needs for banking accommodation of small businesses, institutions, farmers and individuals-including a reasonable level of loans for housing in all the various localities across Canada (1957: 20-21).

More serious domestic inflationary pressures also arose in the late 1950s and led the Bank to impose more restrictive monetary policies in earnest for the first time since the war, raising interest rates and selling securities in to the market along with new liquidity reserve ratios. Such policies continued in to the 1960s leading eventually to a crisis with rising unemployment and the resignation of the Governor, James Coyne, in 1961 (Coleman, 1991: 721). This in turn led to a collapse of the currency against US dollar and the decision to re-join the Bretton Woods system in 1962. For the remainder of the 1960s, monetary policy was once again subservient to the full employment agenda of the government and the Bank continued to maintain low interest rates on government debt through its controlling role in the bond market and credit controls.

The low interest rates engineered by the Bank's control of the bond market supported a huge expansion in production in the period 1945—1970, a good part financed by government capital spending which reached was around 20% of total fixed capital investment for most of the 1960s (Figure 20). Federal government capital expenditure funded highways, airports, bridges, schools, hospitals, and other physical infrastructure. The rates of growth of both GDP and productivity followed the pattern of public capital formation during this period (Seccareccia, 1995) but then begun to decline in the late 1960s and 1970s. According to Wylie (1995) the growth of labour productivity in Canadian goods production slowed from an average 5.29% per annum in 1947–1972, to 1.87% in 1973–1991, whilst public infrastructure capital accumulation per person-hour worked fell from 5.93% to 1.21% per annum.¹⁰² A range of other studies, using alternative production functions, find a positive relationship between the ratio of public capital investment and productivity growth in Canada (Mintz and Preston, 1993, Harchaoui and Tarkhani, 2003, Paul *et al.*, 2004). Aschauer (1989) found a similar relationship for the United States and the relationship has also been found to hold in cross-country studies (Romp and De Haan, 2007, Munnell, 1992).

¹⁰² Wylie uses both Cobb-Douglas and translog aggregate production functions and estimates a time series from 1946 to 1991. Infrastructure is postulated to be an input to aggregate goods production, along with traditional direct labour and capital inputs.

Figure 20: Canadian government fixed capital investment measures, 1947–2012



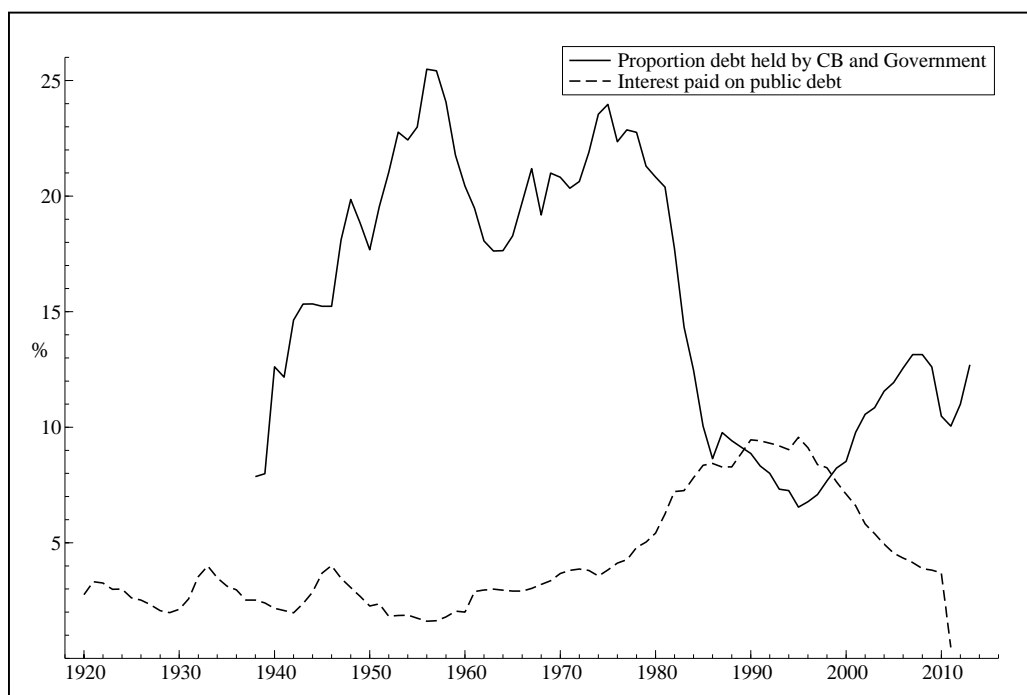
Source: Statistics Canada. Table 380-0002 - GDP, expenditure-based, quarterly (millions of dollars), seasonally adjusted at market prices.

During the period 1960–1975, the federal government also introduced virtually all of the major policy innovations that make up Canada’s system of social programmes: Canada-wide medicare, universal pensions, the modern Unemployment Insurance system, and cost-sharing with the provinces for higher education and welfare. Despite this massive expansion in spending, budgets remained roughly balanced. The average federal deficit from 1950 to 1980 was an insignificant 0.3% of GDP (Stanford, 1995: 116). Inflation also remained low and stable, ranging between 2 and 5% (Figure 15).

4.3.7 The move towards monetarism and inflation targeting

By the mid-1970s, however, inflation had become a serious issue (hitting 14% CPI in 1975). Economists puzzled over the simultaneous rise in unemployment that also occurred. The government imposed wage and price controls and the Bank abandoned its support for government financing via the indirect monetisation of debt and related policies. Interest rates were allowed to rise (Figure 17) and large quantities of government debt were sold on to the market to reduce liquidity as the Bank adopted the monetarist policies of monetary aggregate targeting outlined in Section 2.3 (Drainville, 1995).

Figure 21: Proportion of public debt held by the central bank and government and interest paid on public debt-to-GDP ratio in Canada, 1920–2012 (Annual %)

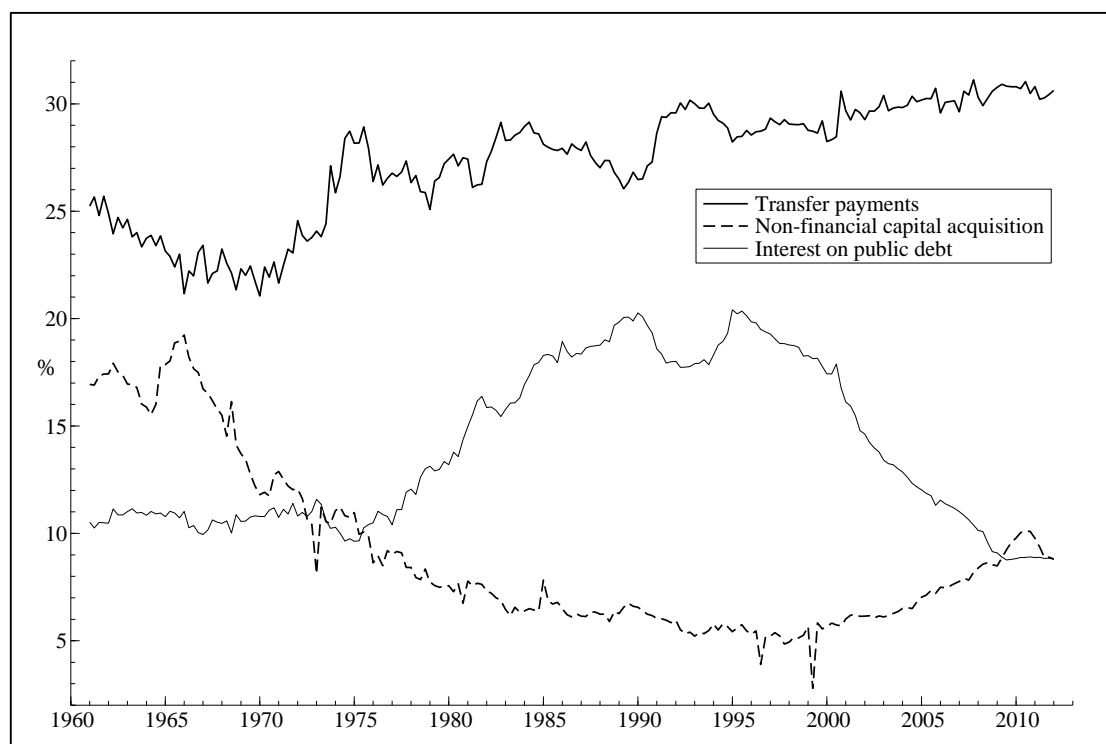


Sources: Interest paid on public debt/GDP from (International Monetary Fund, 2013); Debt held by Bank of Canada and Government 1938–1945: ‘Government of Canada Direct and Guaranteed Securities: Annual Distribution of Government debt holdings’, Bank of Canada, Statistical Summary, Financial Supplement 1959, p56, available online at <https://archive.org/stream/statisticalsumma1959bank#page/n619/mode/1up>, p620; from 1946–2012, Statistics Canada, Table 176-0022 Government of Canada direct and guaranteed securities and loans, monthly, converted to annual via averaging, available online at www.statcan.gc.ca

This policy remained in place for close to seven years, despite increasing opposition as interest rates rose to record levels. Accompanying the monetary targeting, the proportion of government debt held by the Bank was reduced from 20% to 7% in the space of just three years (Figure 21). With double-digit interest rates on long- and short-term government debt (Figure 17), this inevitably led to a jump in the proportion of government spending that had to be committed to interest payments that leaked out of the public purse. Rather than such interest payments returning to the government as central bank profits, they were now flowing to the private sector.

The major casualty of this shift appears to have been government capital investment, which, as noted by (Seccareccia, 1995: 57) and as can be seen in Figure 22, collapsed from a peak in the mid-1960s down to levels not seen since the Great Depression years of the 1930s. The 1980s and 1990s saw a more gradual reduction in public expenditure and privatisations but transfer payments actually grew as a proportion of total government expenditure as unemployment rose (Figure 22). Federal programme spending (excluding interest payments) declined, however, as a share of GDP from 18% in 1975 to just over 15% by the first half of 1995 (Stanford, 1995: 116).

Figure 22: Sectoral distribution of public expenditure (% of total)



Source: Statistics Canada, National GDP by Income and by Expenditure Accounts -1901, Table 380-0007, 'Sector accounts, all levels of government, quarterly'. Data is seasonally adjusted at annual rates.

Whatever its effects on government spending, the monetarist experiment was unsuccessful in bringing down inflation. The policy was finally abandoned in November 1982, in the face of a return to double-digit inflation despite a growth rate of M1 that was less than the target rates for most of the period 1975–1980.¹⁰³ The Bank officially ended M1 targeting in November 1982 and by 1983, inflation was back under control, despite the lack of an explicit nominal anchor. One explanation is that the Bank piggybacked on the US anti-inflation policies by adopting an implicit exchange rate target with the US dollar (Bordo and Redish, 2006: 11) or 'exchange rate monetarism' as it has also been called (Chorney and Hansen, 1992: 113). As the USA raised interest rates, and the US dollar appreciated, Canada followed suit and the result was a negative rate of real money growth (M2), a 4% decline in real GDP, and a fall in inflation from 12.5% in 1981 to 5.8% in 1983. Indeed, it was not until the late 1980s that the Bank of Canada turned towards price stability as its overriding policy goal, with inflation having been under control for seven years.

Beginning in the early 1990s, the Bank began to increase its purchases of government debt (Figure 21) via open market operations although this was, officially, part of its new inflation targeting mandate. In comparison to the period 1935–1975, however, levels of debt monetisation were still

¹⁰³ Explanations for the 1970s inflationary period in Canada – and other advanced economies – remain contested. A combination of oil shocks, imported US inflation, very high nominal interest rates and financial innovations that allowed banks to circumscribe existing reserve and liquidity requirements all seem to have played a role (Bordo and Redish, 2006: 9)

considerably lower. Output growth has also been lower across the period and the average unemployment rate has been almost double that of the period 1946–1974 – 4.7% as against 8.6%.¹⁰⁴

4.3.8 Summary

It is clear from this historical analysis that the Canadian central bank in the period 1935–1975 played a key role in the economic development of the country that went well beyond the traditional central bank role of maintaining price or financial stabilisation. The central bank used its money creating powers to support the government and wider economy through direct advances to the state, or direct or indirect forms of government debt monetisation, including forcing private banks to monetise government debt at very low interest rates. During the period, the bank employed a variety of tools to achieve these objectives including credit controls and moral suasion which today might be viewed as unorthodox. Finally, the Bank directly supported the SME sector through the creation of the IDB as a subsidiary and again capitalised this through central bank money creation rather than tax payer funding.

The Bank during this period was thus clearly not ‘independent’ in the sense described in Section 4.2.3. Rather than price stability or even financial stability, its overriding objective was the support of the government’s policies of high employment and growth. Yet, contrary to the monetisation-inflation hypothesis outlined in Section 2.4, it does not appear that these activities resulted in excessive inflation (Figure 15). In the next section an empirical test of this hypothesis is conducted.

4.4 Empirical test: Did monetisation of the debt influence inflation in Canada?

The qualitative evidence of the case study suggests the Bank of Canada’s monetary financing activity did not have inflationary effects, contrary to the NMC/CBI framework. An empirical test of this hypothesis is now conducted by estimating an econometric model of consumer-price inflation in Canada using quarterly observations between 1955 and 2007. If the monetisation of debt by the central bank leads to inflation, as proposed by the NMC and CBI policy frameworks, a

¹⁰⁴ Sources: 1946–1977: Statistics Canada, Unemployment Series D190-204 and Labour Force Series D463-469, available online at <http://www.statcan.gc.ca/pub/11-516-x/index-eng.htm#U>; 1975–2013: OECD, Main Economic Indicators - complete database, Main Economic Indicators (database), <http://dx.doi.org/10.1787/data-00052-en> [accessed 29 July 2014] OECD descriptor ID: LRUNTTTT

significant and positive relationship between the two variables over the long-run would be expected.

4.4.1 Empirical strategy

Inflation has proved a challenging variable to model and a wide range of different explanations are found in the literature. There are two broad theoretical approaches: first, ‘cost-push’ inflation, generated by labour costs, foreign prices, exchange rates, and interest rates; and secondly ‘demand-pull’ inflation, typically created by excess demands for money, debt, goods, and labour (Vernengo (2006). Empirically, there is evidence that both types of inflation are active. Hendry (2001) for example, finds multiple explanations of inflation in the UK over a 120-year period in a General to Specific (GETS) model, including the excess demand for goods and services, world price inflation, the short-long interest-rate spread, the price-mark-up, nominal money growth, commodity price inflation, and interest rate changes.

The GETS approach is followed here, as was used in Chapter 2, and includes a wide range of candidate variables in a GUM that best represents the data-generating process (DGP). Selection is then undertaken on the GUM via valid reductions to a parsimonious form, allowing conditioning of later inferences on the congruent model specification. As in Chapter 2, the *Autometrics* search algorithm is utilised, which uses a tree-search to detect and eliminate statistically insignificant variables. To deal with the many shocks and regime shifts over the period, the ‘indicator saturation’ method is again adopted, following Hendry *et al.* (2004), which involves adding a dummy variable for each observation and testing for their statistical significance (Doornik, 2009) (see Chapter 2, section 2.4.3 for a formal presentation of the approach). The indicator saturation algorithm in *Autometrics* analyses across multiple different combinations of blocks of indicators to find those that are most statistically significant.

4.4.2 Data

Data were collected on a wide range of potential explanatory variables on a quarterly basis from 1955q1 to 2007q3, including some archival data that was manually inputted. The dependent variable is the Year-on-Year (YoY) growth rate of Canadian Consumer Price Inflation (*Can_Prices*). This is regressed on to nine explanatory variables that encompass the ‘cost-push’ and ‘demand-pull’ literature: US Consumer Price Inflation (*US_Price*), the Canadian-US dollar exchange rate (*US_FX*), the Monetary Base (*BaseM*), Broad money (*BroadM*), a measure of monetisation – public debt outstanding held by the Bank of Canada and the government –

(*Monetiz*), total public debt outstanding held by all sectors (*Debt*), the unemployment rate (*Unemp*), nominal GDP (*Output*) and an opportunity cost of money measure – the spread between the bank rate and chartered bank rate (*R-Spread*). One concern was collinearity between broad money and base money, but with a pairwise correlation of 0.54 this was judged not to be a major issue (see Table 20, Appendix C.2.2).

The time period was limited by the quarterly series on Canadian and US prices and Canadian unemployment which are only available from 1955q1 and the historical quarterly broad money series which was terminated in 2007. The Canadian Statistics Office has only published quarterly series for many variables going back to 1961, hence for a number of series data was inputted manually from physical government publications.¹⁰⁵

To de-seasonalise and de-trend the data, the 4th difference of the log of the non-seasonally adjusted nominal level was used (the equivalent of the YoY growth rate). The exceptions are the interest rate measure and the unemployment rate, with the latter seasonally adjusted. Full data sources and construction are shown in Table 16 and plots of the series are shown in Figure 23 (summary statistics are provided in Table 20, Appendix C.2.1). It was found that eight lags were required to remove autocorrelation.

¹⁰⁵ These were sourced from the London School of Economics library in the ‘official statistics’ and ‘central bank statistics’ sections.

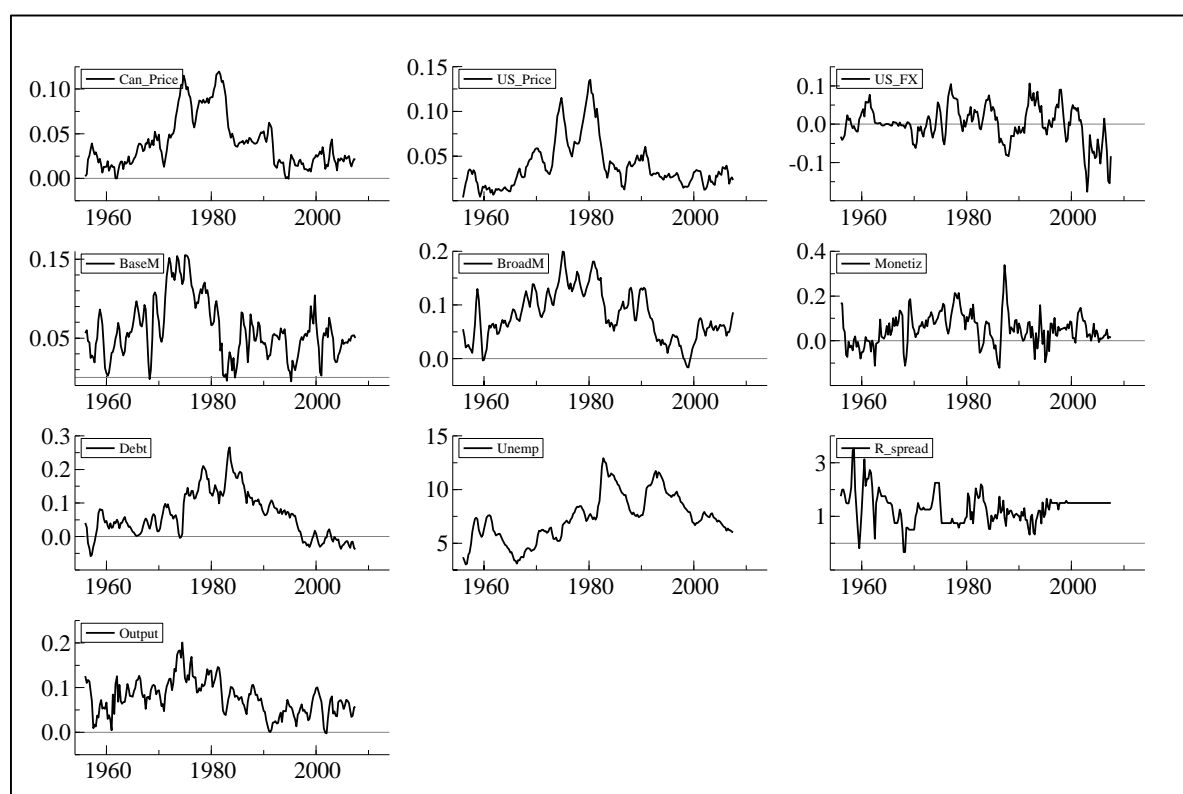
Table 16: Data sources for econometric model

| Variable name | Description (4th difference of the log, NSA, unless stated) | Source | Code |
|----------------------|---|--|------------------------------|
| <i>Can_Price</i> | CPI: All Items for Canada, Index 2010=100 | OECD (2010), 'Main Economic Indicators – complete database' | OECD: CANCPIALL MINMEI |
| <i>US_Price</i> | CPI: All Items for the United States , Index 2010=100 | OECD (2010), 'Main Economic Indicators – complete database' | OECD: USACPIALL MINMEI |
| <i>US_FX</i> | United States dollar exchange rate in Canadian dollars, noon spot rate, average (dollars) | CANSIM: Table 176-0064 | Bank of Canada – 7502 |
| <i>BaseM</i> | Monetary base (notes and coins in circulation, chartered bank and other Canadian Payments Association members' deposits with the Bank of Canada) (excluding required reserves), monthly average, quarterly (dollars x 1,000,000)' | CANSIM: Table 176-0020: 'Currency outside banks and chartered bank deposits' | Bank of Canada – 7502 |
| <i>BroadM</i> | From 1947 to 1967q4 'M2'; 1968q1–1968q3 – interpolated using cubic spline filter; 1968Q4–2007q3 – 'M2 (NET): Currency outside banks and chartered bank deposits', monthly average, quarterly (dollars x 1,000,000) | 1947-1967q4: Metcalf <i>et al.</i> (1998); 1968Q4-2007q3 – CANSIM: Table 176-0020 | |
| <i>Monetiz</i> | Government of Canada direct and guaranteed securities and loans held by Bank of Canada and Government of Canada, quarterly (dollars x 1,000,000) | CANSIM- Table 176-0022: 'Government of Canada direct and guaranteed securities and loans' | |
| <i>Debt</i> | 'Distribution of Government of Canada holdings, total outstanding' quarterly (dollars x 1,000,000) | CANSIM - Table 176-0022 'Government of Canada direct and guaranteed securities and loans' | |
| <i>Unemp</i> | Unemployment Rate: Aged 15 and Over: All Persons for Canada®, Quarterly, Seasonally Adjusted | OECD (2010), "Main Economic Indicators – complete database" | OECD: LRUNTTTTC AQ156S |

| | | | |
|-----------------|---|---|--|
| <i>R-Spread</i> | Spread between bank rate and Chartered bank administered interest rates - prime business. | CANSIM: Table 176-0043: 'Financial market statistics, last Wednesday unless otherwise stated, monthly (percent unless otherwise noted)' | Bank of Canada – 7502 |
| <i>Output</i> | Nominal GDP, expenditure based, quarterly (dollars x 1,000,000), | 1947-1961Q1: Statistics Canada, 'National Income and Expenditure Accounts, Vol. 2, the Quarterly Estimates, 1947–1974', Published by the Minister of Industry (February 1976), Trade and Commerce [manually inputted from original publication, May 2014]. 1961Q2-2012-2007Q3: CANSIM Table 380-0002 'GDP, expenditure-based'. | National Income and Expenditure Accounts - 190 |

Note: OECD Main Economic Indicators available at: <http://dx.doi.org/10.1787/mei-data-en>; CANSIM (Statistics Canada) tables available at: <http://www5.Statcan.gc.ca/cansim/a01?lang=eng>

Figure 23: Canadian inflation time series' plots



By including the growth rate of base money and the growth rate of the monetisation of the debt and total debt in this model the monetarist and NMC models discussed in Sections 2.2 and 2.3 are tested. By including eight lags the intertemporal rational expectations effects that such theories emphasise are allowed for. US prices and exchange rates are used rather than an index of international prices since a range of empirical studies suggest Canada imports significant consumer

price inflation from the USA, by far its most important trading partner (Cushman and Zha, 1997, Johnson, 1990).

As is clear from the plots, there is evidence of mean shifts in many of the variables in the early 1970s, likely related to the OPEC oil crisis and collapse of Bretton Woods. Unit-root tests using the Phillips and Perron (1988) test (reported in Table C.4.1 in the Appendix) suggested the variables were $I(1)$ in the YoY growth rate form, with *Monetiz* the only variable that appeared to be $I(0)$. Following Hendry's (2001) study of long-term UK inflation, the working assumption used here is that the growth rates series are $I(0)$ with superimposed major breaks, so 'appear' to be $I(1)$ series, with measurements having $I(1)$ deviations from the desired theoretical counterparts. This approach is consistent with the effects of revisions on post-war quarterly inflation time series as discussed by Hendry (1995: 14) Further differencing in such non-stationary processes may induce non-constancy in derived econometric models, and make it hard to obtain cointegration (Nowak, 1991 in Hendry 2001: 256).

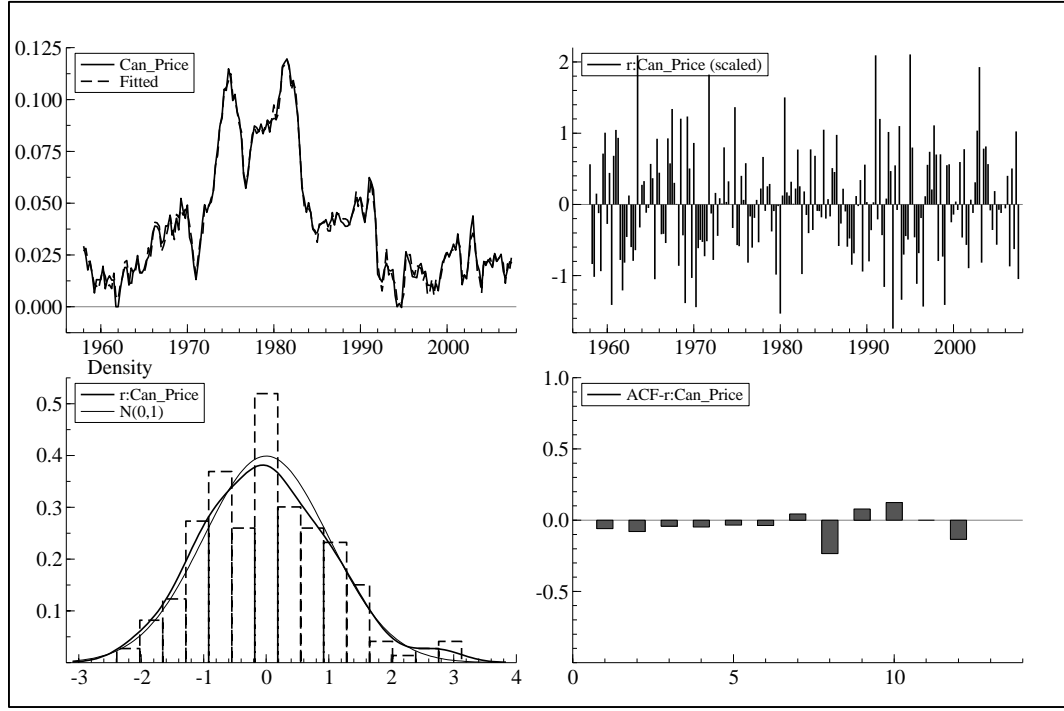
A well-specified GUM was established with the inclusion of just one impulse indicator in 1974q2, coinciding with the 1973 oil crisis, suggesting the conditioning variables and their autoregressive lags were effective in picking up the many other shocks that occurred during the period. Rather than jointly selecting the relevant indicators and step-dummies with the variables, a step- and indicator-saturation is first applied to the GUM with all regressors held unrestricted with eight lags. Selection of the indicators was undertaken at the 1% significance level.

The general model in levels with *YoYGDP* as the dependent variable is estimated over 1958q1–2007, and includes eight lags of all conditioning variables, eight lags of the dependent variable, and the 1974q2 indicator (the solved static long-run equation is provided in Appendix C.2.2). The GUM delivers an equation standard error of 4.3% and passes all the standard statistical tests relating to Autoregressive errors (AR 1–5 test), Autoregressive Conditional Heteroskedasticity (ARCH 1–4), Normality, White's tests for heteroskedasticity, Ramsey's Reset test for functional form, and the Chow test for a break after 1992q4. Graphical inspection (Figure 24) shows a good fit of the scaled residuals (r), residual distribution and autocorrelation function (ACF), confirming the model is robust.

Diagnostic testing of GUM for Canadian Inflation

AR 1–5 test: $F(5,103) = 1.2143$ [0.3077]
ARCH 1–4 test: $F(4,191) = 0.47442$ [0.7545]
Normality test: $\chi^2(2) = 3.3863$ [0.1839]
Hetero test: $F(178,19) = 1.3640$ [0.2187]
Chow test: $F(59,49) = 1.3632$ [0.1330] for break after 1992(4)

Figure 24: GUM diagnostic plots and tests



Selection was then applied using *PCGive's Autometrics* software at a 1% significance level. The final selected model is reported below in Equation (18), with Standard Errors in brackets. The model passes all diagnostic tests described (shown below) at the 5% level (i.e., congruence is maintained) and the equation standard error is close to that of the GUM at 4.6%:

$$\begin{aligned}
 \text{Can_Price} = & 0.93*\text{Can_Price}_1 - 0.55*\text{Can_Price}_4 + 0.56*\text{Can_Price}_5 & (18) \\
 (\text{SE}) & (0.037) & (0.062) & (0.081) \\
 & - 0.16*\text{Can_Price}_6 + 0.48*\text{US_Price} - 0.4*\text{US_Price}_1 \\
 & (0.055) & (0.06) & (0.063) \\
 & + 0.11*\text{US_Price}_8 - 0.055*\text{US_FX} + 0.064*\text{US_FX}_1 + \\
 & (0.028) & (0.014) & (0.014) \\
 & 0.044*\text{BroadM}_1 - 0.00079*\text{Unemp}_2 - 0.002*\text{Unemp}_6 + \\
 & (0.012) & (0.000) & (0.000) \\
 & 0.0024*\text{Unemp}_8 + 0.017*I:1974(2) \\
 & (0.001) & (0.005)
 \end{aligned}$$

Diagnostic tests

AR 1–5 test: $F(5,180) = 3.1194$ [0.0100]*
ARCH 1–4 test: $F(4,191) = 2.9897$ [0.0201]*
Normality test: $\chi^2(2) = 2.6523$ [0.2655]
Hetero test: $F(26,171) = 1.0481$ [0.4085]
Hetero-X test: $F(104,93) = 1.0825$ [0.3491]
RESET23 test: $F(2,183) = 3.0962$ [0.0476]*

From this parsimonious model a static long run model can be derived as follows:

$$\begin{aligned} Can_Price = & 0.913722*US_Price + 0.0412716*US_FX + 0.206158*BroadM \\ & - 0.00173678*Unemp + 0.0807856*I:1974(2); \end{aligned} \quad (19)$$

Two robustness checks were carried out. Firstly, recursive parameter stability tests, shown in Figures 25 and 26, suggest the model parameters are relatively stable. The one-step-ahead sequential Chow tests only exceed the 1% bands on four occasions. A further step-dummy was added to the regression to reflect the apparent outlier in 1991 in the Chow test but did not improve the model fit. Secondly, GETS modelling was carried on out on two sub-samples of the dataset (around the 1974q2 impulse indicator). In both samples, the monetization variable (*Monetiz*) falls out of the model suggesting it is not significant. In the earlier (1958q1-1974q1) sample, the first lag of the monetary base is included in the parsimonious model suggesting there may be a relationship between monetary expansion by the central bank and inflation in this period. In the later sample the monetary base falls out of the model. This suggests the central bank may have had some element of exogenous control over the money supply via reserve ratios in the earlier period when it had moral suasion and credit control policies in place (see section 4.3.6.2). Full results are available on request.

Figure 25: Specific model recursive coefficients with +/- 2 standard error bars

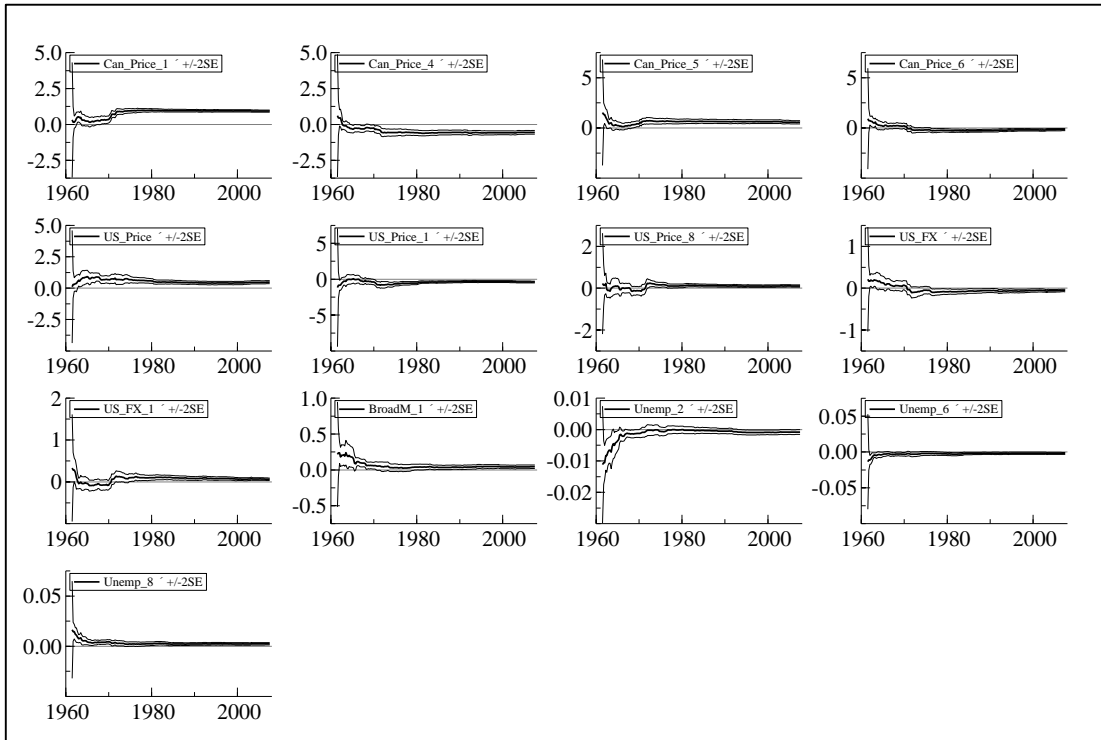
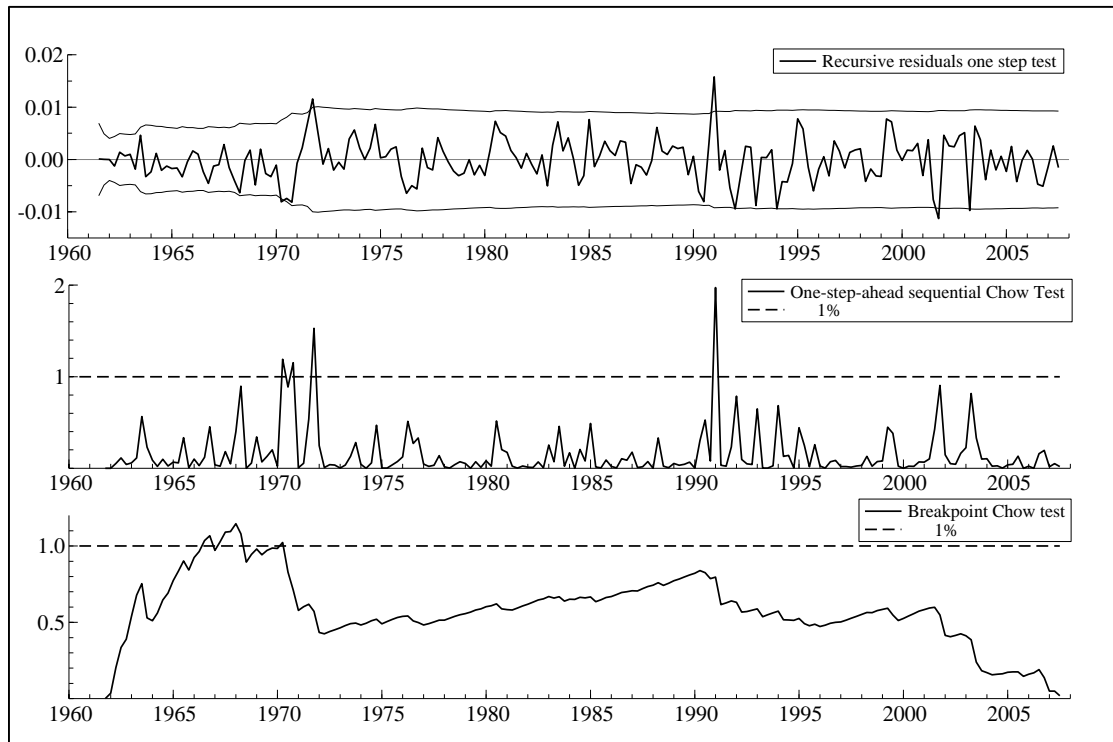


Figure 26: Specific model – recursive parameter stability tests on equation residuals



4.4.3 Interpretation

In the parsimonious model, the growth rate of monetisation, the monetary base and total public debt drop out suggesting these variables are not correlated with the growth rate of inflation. This result casts doubt on the monetarist and rational choice models described earlier that rising monetisation and/or public debt will lead to increases in inflation as agents adjust their portfolios away from money holdings in expectation of inflation and further debt monetisation. The robustness of these findings were tested by re-running the GETS selection but this time including all eight lags of the growth rate of monetisation in unrestricted form in the GUM and then running exclusion F -tests. The exclusion is accepted ($F(9,175) = 1.6202$, p -value 0.1126).

The parsimonious model instead suggests a strong cointegrating relationship between US and Canadian inflation. ADF cointegration tests show that the two variables are cointegrated at the 5% level (τ -statistic: = 3.4257, p -value 0.03962).¹⁰⁶ In addition, there is also evidence of a positive relationship with the growth rate of the U.S. exchange rate and a negative relationship to the rate of unemployment, as standard theory predicts. The 1974q2 impulse dummy also remains and the inclusion of the 8th lag of both *US_Price* and *Unemp* justifies the long lag choice. Whilst the growth rate of central bank-created, base money (BaseM) is not statistically significant, the growth

¹⁰⁶ ADF Cointegration tests use Mackinnon (2010) critical values.

rate of broad money (*BroadM*) does remain in the parsimonious model. As discussed, the majority of this monetary aggregate is created by private banks via credit expansion. Following the ‘credit theory of money’ approach described in 1.4.5, it could be hypothesised that some bank credit creation has been for non-productive activities (e.g. consumption) beyond the productive capacity of the economy independently of the growth of the monetary base.

4.5 Conclusions and discussion

The public and political taboo on monetary financing by government central banks has its roots in long-held fears of war and hyper-inflation. Monetarist and rational expectations theories emerged in the 1960s and 1970s which held that ‘political inflation’ due to time inconsistency problems would be inevitable in democracies without strict rules to prevent government deficit monetisation. Following the high inflations of the 1970s and 1980s, these theoretical arguments were given policy backing in the form of the move towards CBI in the 1990s, a key element of which was a prohibition of monetary financing.

However, monetary financing, taking various guises, was a relatively standard aspect of economic policy over the past 300 years. The empirical and theoretical basis for the CBI/NMC positions appears built on shaky foundations. Empirical correlation between monetary financing and inflation is, at best, weak and selective, whilst causation has not been demonstrated. The theoretical approach rests on assumptions about the workings of the monetary system – including that banks predominantly create money that businesses invest and that central banks can influence such credit creation via changes to short-term interest rates – assumptions that no longer appear to hold.

Theoretical positions advocating monetary financing were proposed following the Great Depression in the form of the ‘100% sovereign money’ arguments of the early Chicago School and later the Keynes’ influenced Functional Finance and related Modern Monetary Theory frameworks. More recently, a number of economists have proposed that monetary financing of deficits may be a means of stimulating demand without increasing already very high levels of private and public debt across the world (McCulley and Poszar, 2013, Turner, 2014b). This chapter has presented original empirical evidence to support such this policy.

This chapter has taken an institutional case study approach to analyse one historical example of monetary financing – the Bank of Canada during the period 1934–1975 – and shown that such policies can have a positive and non-inflationary macroeconomic outcome. The 1935–1970 period saw the Canadian economy recover quickly from the Great Depression, weather the Second World War, make a rapid transition from war to peace and then enjoy a 25-year period of relatively stable

and high growth with rapid industrialisation. The period also saw declining public debt, consistent budget surpluses and full employment. The Bank of Canada played a key supporting role by directly and indirectly financing government debt, controlling government debt markets and domestic credit creation via quantitative controls and ‘moral suasion’. For the majority of the period, the Bank was not independent of the government and its primary objective was full employment and growth rather than price stabilisation. Yet prices were relatively stable. Our empirical test fully supports the qualitative findings. Of course, the debt monetisation of the central bank was not the only explanation for Canada’s stable and high growth during the period and further empirical research is required to model its true contribution. However, our finding suggested that when monetisation of the debt declined, it was capital investment rather than revenue spending by the government which is reduced with resulting negative impacts on productivity.

Canada is, of course, just one example of debt monetisation. An interesting further research avenue would be to examine other countries which used similar techniques, to see if Canada’s experience was exceptional in some way or whether there are institutional and political economy parallels. There were a number of interesting parallels in other countries during the same period that have received little attention in the literature on monetary policy and macroeconomics. These include the BoJ under former finance minister Korekiyo Takahashi who engaged in direct debt monetisation between 1931 and 1934, helping the Japanese economy out of recession and supporting a major expansion in public infrastructure, particularly public works for rural areas (Nakamura, 1997: 135-137, Cha, 2003). Interestingly, Takahashi appears to have been the inspiration for the current combined QE and fiscal expansion policies of the Japanese Prime Minister Abe (Abe, 2013, Evans-Prichard, 2013) which appear to be an example of implicit debt monetisation (Turner, 2015).¹⁰⁷ Another example is New Zealand, where, following its nationalisation in 1936, the Reserve Bank of New Zealand (RBNZ) made advances available for the building of state housing, public works activities and export guarantees, equivalent to almost 20% of total fixed capital investment and 4% of GDP¹⁰⁸ (Sinclair, 1976: 157, Hawke, 1985).

The topic of monetary financing thus appears a rich one for further empirical and theoretical investigation. That the US\$11 trillion created since the financial crisis via QE programmes has not resulted in the desired inflation or growth raises questions about whether this is the most

¹⁰⁷ Bern Bernanke who was then Chairman of the Federal Reserve, also advocated such an approach for Japan. In a speech (Bernanke, 2003) in Japan 2003, he argued that ‘BOJ purchases of government debt could... support spending programs, to facilitate industrial restructuring, for example. The BOJ’s purchases would mitigate the effect of the new spending on the burden of debt and future interest payments perceived by households, which should reduce the offset from decreased consumption.’

¹⁰⁸ New Zealand Long Term Data Series, Series E.3.5 Gross Capital Formation. Retrieved from http://www.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/long-term-data-series/national-income.aspx

appropriate use of central bank balance sheet expansion. In contrast to the Canadian example, QE has generally involved the purchase of government debt and other financial assets on the secondary markets and been accompanied not by fiscal expansion but fiscal contraction, with Japan the one exception. The Canadian example offers a glimpse of how fiscal and monetary policy can be combined with more direct and positive macroeconomic impacts.

Chapter 5: Conclusion

Credit is the pavement along which production travels; and bankers if they knew their duties, would provide the transport facilities to just the extent that is required in order that the productive powers of the community can be employed to their full capacity.

John Maynard Keynes (1930: 220)

Monetary policy in advanced economies prior to the financial crisis of 2007–2008 paid little attention to dynamics of bank credit creation and the quantities of credit and debt building up in the economy. Instead, the focus was on consumer price inflation and the main tool to influence this was adjustments to the policy interest rate. Monetary policy's role was to mediate the effects of frictions that prevented the economy reaching a natural rate of interest where markets would clear and equilibrium would be restored.

This approach and the macroeconomic theory behind it were fundamentally challenged by the crisis. It became clear that it was the build-up of excessive quantities of credit, in particular lending against real estate and related asset price inflation, that lay at the heart of the catastrophe that overwhelmed financial markets in 2007–2008. Post-crisis, there was insufficient credit to enable a full recovery from the crisis. Mainstream DSGE macroeconomic models had turned away from analysis of these dynamics because in order to calibrate such models, it was necessary to incorporate axioms – such as the representative agent and rational expectations – that assumed away credit relations. Now it has become clear that credit does matter, a new approach to macroeconomic theory and modelling is also required. As Benjamin Friedman has noted:

If all agents were identical, there would of course be no reason for any one of them to borrow from, or lend to, another. Hence turning our focus toward credit, at the substantive level, also bears immediate methodological implications. The resulting analysis needs to be more subtle and, regrettably, more complicated than if what mattered were simply money. But the crisis has usefully reminded us that what mostly matters for macroeconomic outcomes is instead credit – something we really should have known all along (Friedman, 2012: 302-303).

This thesis is a small step in furthering our knowledge of the dynamics of credit in advanced economies. Our focus has been on the empirical relationship between credit and monetary policy – both orthodox and unorthodox approaches – and the macroeconomy. A largely inductive methodological approach has been taken, constructing new historical datasets and then interrogating them using the latest econometric methods to shed light on underlying dynamic

relationships. In taking credit seriously, the financial and institutional structures that shape commercial and central bank credit and money creation are also taken seriously, including, in the final study, the political economy of a particular monetary policy regime via a detailed case study analysis. What are the main findings?

5.1 Summary of findings

First, it was found that bank credit creation is empirically highly significant and potentially the most important variable for monetary policy and macroprudential policymakers to focus on. The first study on the UK economy analysed different monetary policy targets – money growth, short- and longer-term interest rates as well as credit growth – and their relationship to nominal GDP since 1963. A long-run cointegrating relationship between the growth of credit to households and firms and nominal GDP was identified. This measure of credit was found to be strongly exogenous to – and Granger causing – nominal output. In contrast, our other variables, proxies for monetarist, New-Keynesian and portfolio rebalancing theoretical frameworks, either fell out of the GETS model or had a much weaker relationship to nominal output. During the 50-year period under analysis, there were many changes in technology and government policy – from Keynesian demand management, to monetarist monetary aggregate targeting, to exchange rate targeting and inflation targeting – and changes to national and international financial regulation. It is thus powerful evidence for an independent and policy-invariant role long-run relationship for this particular credit growth aggregate.

Our second study examined the idea that there may be a ‘credit cycle’ of greater macroeconomic significance than the traditional business cycle. To do this, data on two different credit flow aggregates across nine advanced economies were gathered and the dynamic linkages between these variables, asset prices, and macroeconomic activity examined – the first attempt to combine such variables in the literature at a quarterly level. It was found that banks in advanced economies were creating an increasing proportion of credit for the purchase of existing assets (mainly domestic real estate) rather than for consumption or to non-financial firms (‘productive credit’), a finding also reported in a number of other comprehensive panel studies (Büyükkarabacak and Valev, 2010, Jordà *et al.*, 2014, Bezemer *et al.*, 2014) as well as single-country studies (Werner, 2012).

These different credit flow composites had different impacts on output growth and asset prices, justifying them being analysed separately in contradistinction to the mainstream credit growth literature. ‘Productive credit’ seemed to have a stronger impact on real GDP growth than asset-market credit. Asset prices played a powerful role in influencing – and being influenced by – both credit flow-composites. Indeed this was the most striking finding from the PVAR analysis,

suggesting the existence of a powerful credit cycle linked to domestic house prices in advanced economies (Aikman *et al.*, 2014, Borio, 2014). Traditional monetary policy – the targeting of inflation via adjustments to short-term interest rates – only seemed to influence asset market credit growth and has no effect on productive credit growth.

If the proportion of bank credit flowing to asset markets has increased at a faster rate than that funding GDP transactions and output growth, this may eventually lead to a slowdown in consumption once household-debt-to-income ratios reach a certain point. Under such circumstances, for advanced economies in particular where consumption makes up around two-thirds of the overall contribution to GDP growth, the result may be a fall in nominal aggregate demand that continues for a long period as households deleverage. This may in turn lead to a decline in profits and thus demand for credit from businesses who may also choose to de-leverage, further contributing to the general decline in productive credit (Turner, 2014a). This may help provide an answer to the ‘secular stagnation’ puzzle that some economists (e.g. Summers, 2013) have raised in reaction to the insipid recovery from the financial crisis of 2007–2008.

Whilst macroprudential policy has focused on repressing asset market credit creation and there have been widespread efforts to improve bank balance sheets to enable them to increase their lending, it is not clear that monetary policy post-the GFC has tackled the challenge of boosting repressed demand. As was discussed in Chapter 2, the transmission mechanism for QE-type policies is highly uncertain, as there are number of alternative uses for the increased liquidity that financial markets receive, apart from investing in corporate debt or equity. The standard Keynesian response in such a scenario would be to embark on a fiscal expansion via government borrowing. However, governments in many advanced economies have built up (perceived) high deficits and debt-to-GDP ratios.¹⁰⁹ This is limiting the options for deficit-driven fiscal expansion. In the Eurozone, member states must work with even more constrained fiscal space given the possibility of sovereign default as was made clear by the recent experience of Greece.

The final study attempted to shed light on an alternative option for monetary policy under such challenging conditions. Rather than lowering market interest rates and boosting asset prices via money creation, as under QE policies, an alternative option for central banks is to monetise deficits or enlist the commercial banking sector to do so. Such a policy was adopted by the Canadian central bank for the first 40 years of its existence when around 25% of all Canadian government debt was monetised by the central bank and more by commercial banks. The main objection to such a policy – that it would inevitably lead to inflation as money holders shift to other assets in expectation of further money creation – did not hold in the Canadian case. Rather, the Canadian

¹⁰⁹ Public debt-to-GDP levels post Second World War were considerably higher than now in many advanced economies.

government achieved high levels of growth and, for the most part, stable prices as well as full employment. The policy appeared to help the government reduce its large post-war debt-to-GDP ratio as it was able to run surpluses on a regular basis.

The findings also suggested a strong role for institutional and political dynamics in impacting credit creation and the credit cycle. In Chapter 2 it is noted how the liberalisation of the mortgage and banking sectors in the UK allowed financially constrained homeowners to borrow against the value of the homes. In Chapter 3, considerable heterogeneity is noted across nine different advanced economies in terms of the relationship between asset price growth, credit growth, and real output, supporting research that suggests mortgage and banking market structures may affect lending and the credit transmission mechanism (Berger *et al.*, 2005, Ferri *et al.*, 2014) independently of traditional monetary policy interventions. The third study showed how monetary policy and fiscal policy can be combined to good effect, showing how a central bank can also target productive investment and full employment without spiraling inflation even when it lacks full operational independence.

In summary, the empirical findings, based on an inductive methodological approach that encompassed different theoretical explanations, largely support the ‘credit theory of money’ approach outlined in Chapter 1, Section 1.4.5. In this theory, banks are understood not as passive intermediaries recycling and reallocating existing scarce resources from one part of the economy (typically households) to another (typically firms) but as creators of new purchasing power (in the form of credit) that determines the allocation of resources in the real economy. With this approach, it is not the stock(s) of money, as in monetarist theory, or the price of money (the rate of interest) as in New-Keynesian theory, which is the key determinant of macroeconomic outcomes but the quantity of credit and to where in the economy such credit flows (Werner, 1997, Werner, 2005). However, Chapter 3 of this thesis suggests that modern bank credit creation for both asset market and productive credit may be driven more by changes to asset prices (in particular real estate that is increasingly used as collateral for lending) than by developments in the real economy. Bank lending would appear to have disconnected from the business cycle.

5.2 Research implications

Identifying and modelling credit creation and credit flows for this thesis was challenging and a number of data limitations have been identified. It is difficult to find clean definitions of credit that contribute to GDP transactions (Chapter 3’s ‘productive credit’) and credit that is used simply to transfer ownership of existing assets (asset market credit). A major challenge is the extent to which mortgage credit is actually used to finance consumption – via equity withdrawal – rather than for

property purchases. A next step for this research would be to find ways of estimating this. This might involve more complex modelling of mortgage market structures and their relation to credit and consumption (see e.g. Aron *et al.*, 2012) or perhaps by exploiting more recent central bank data that disaggregate mortgage lending according to whether it was for house purchase or equity withdrawal. Similar approaches could perhaps be taken to commercial real estate lending which is another fuzzy category, potentially supporting both productive and asset market activity. In addition, there is evidence, particular in the USA, that non-financial businesses are using their profits to themselves purchase financial assets rather than investment as part of a more general process of ‘financialisation’ (Krippner, 2005, The Economist, 2014).¹¹⁰ This development again calls for more a more nuanced definition of productive credit. Whatever the data challenges, however, the findings of this thesis suggest central banks would better served focusing more of their considerable research resources on credit creation rather than on detailed analyses of inflation forecasts or monetary aggregates.

Aside from these credit data issues, a key task for future research is to better understand the dynamics that drive banks’ decision-making and help explain the secular shift. This thesis – and other studies – has observed a move towards increasing asset-market credit creation and decreasing, as a share of the total, credit being extended to non-financial firms. There are a range of explanations that merit further investigation.

One candidate is that this change was driven primarily by the deregulation and globalisation of the banking sector. This led to banks being subjected to increasingly strong competition for profits which led them in to new types of activity, such as originating, distributing, and trading securitised mortgage loans or extending credit to other financial corporations. Both activities may be more profitable than generating income via the interest rate spread on loans held to maturity (see e.g. Hardie *et al.*, 2013, Lapavitsas, 2013, Mazzucato and Wray, 2015). Relatedly, recent research suggests countries with more liberalised and globalised banking systems have greater access to foreign wholesale funding markets which may make securitisation and trading activities more viable – and at the same time make such economies more prone to shocks in such funding markets (Aiyar (2011), Feyen *et al.* (2014). It was clear that the internationalisation of bank funding played an important role in the GFC of 2007–2008 (Aiyar (2011). There is also evidence that the very large expansion of credit in some of the peripheral countries of the Eurozone may have been related to structural imbalances within the Eurozone (Uxó *et al.*, 2011, Gros, 2012). This thesis did not attempt to incorporate such dynamics in its second study given the limitations imposed by VAR

¹¹⁰ The Economist (2014) notes that ‘The companies in the S&P 500 index bought \$500 billion of their own shares in 2013, close to the high reached in the bubble year of 2007, and eating up 33 cents of every dollar of cashflow... buy-backs have usurped dividends as the main way listed American firms give money back to their owners, accounting for 60% of cash returns last year.’

modelling but this could be a useful future research avenue, for example by employing Spatial VAR techniques (Beenstock and Felsenstein, 2007).

A second candidate driving and being driven by credit creation dynamics may be the distribution of income and wealth. Increasing inequality and stagnating median wages in advanced economies may provide an important demand-side explanation for increases in mortgage and consumer credit as households seek to maintain their consumption levels; conversely, increasing household-debt-to-GDP ratios may repress consumption demand and lead to less demand from firms for borrowing for capital investment (Stockhammer, 2004, 2013, Perugini *et al.*, 2015, Kumhof *et al.*, 2015). Increasing asset-market credit creation is also likely to be a driver of wealth inequality, particularly given an inelastic supply of locationally desirable land in many advanced economies, if it drives up property prices. The effect may be to substantially increase the wealth-to-income ratio of those with only small initial endowments whilst increasing the debt-to-income ratio of those without such endowments (Turner, 2013a, Stiglitz, 2015).

Finally, our findings on the potential for central bank monetisation of deficits would of course benefit from other examples where such activity was effective and less effective. Given that many countries engaged in such activity to some degree or another during the two decades after the Second World War, a multiple-country study might perhaps be possible, although much would depend on data availability. An increasing amount of historical data on public and private debt is now being published, including by international institutions such as the IMF (Abbas *et al.*, 2011), which may make the data challenge less arduous.¹¹¹

5.3 Policy implications

What are the implications for central banks and monetary policy more generally from these findings? First, this research certainly supports central banks' refocus post-crisis on financial stability as well price stability. Macroprudential policies, including the imposition of limits on certain types of asset-market credit (e.g. LTV and LTI ratios on mortgage credit) as well as subsidies for productive credit (Funding for Lending-type schemes) all make sense in the light of the findings. Nevertheless, it is not clear that the theoretical frameworks that central banks use to base policy decisions have fundamentally changed. For example, nearly all advanced economy central banks still have a consumer price inflation measure as their primary policy target rather than, for example a nominal GDP target or an asset price inflation target. The strategy has instead been to develop a range of macroprudential policy tools to deal with asset price inflation as and

¹¹¹ Two studies venturing in this direction are (Reinhart and Rogoff, 2013, and Ferguson *et al.*, 2014).

when it arises. But whilst policies aimed at dampening undesirable forms of credit creation, including counter-cyclical capital requirements at an international level, are to be welcomed and may reduce the magnitude of future crises, it is not clear they will reverse this secular trend in the trajectory of credit creation at a macro level. The fundamental issue is how to increase the flow of productive credit in to the economy, since it is this form of purchasing power that generates GDP transactions, income, investment, employment, and more sustainable levels of private debt. This may require more radical and structural interventions.

Three complementary approaches present themselves for further investigation. First, as noted in Chapter 3, there may be important institutional dynamics relating to banking market structure at work that policymakers could examine. In Germany, for example, there has not been the relative decline in productive credit noted in most other countries. One thesis is that this is to do with the structure of the German banking system, which, unlike Anglo-Saxon market economies, is actually dominated by cooperative and publically owned banks rather than shareholder banks. As discussed in Section 3.2.2, the ‘relationship lending’ employed by these banks and their multistakeholder objectives and ownership structures may be better suited to productive ‘patient capital’ lending than the larger, shareholder-owned banks which may require considerably higher returns on equity. Macroprudential policy could perhaps extend its remit to investigate whether such models could be replicated in countries, such as the UK, which lack these types of banks (Ferri *et al.*, 2014, Greenham and Prieg, 2013).

A second approach is to enact policies at a central level that directly influence credit flows. Credit guidance or credit controls by central banks and ministries of finance were widespread during the 1945–1970 post-war period in Europe (Hodgman, 1973, U.S. Congress, 1981) and has been recognised as a key feature of the rapid growth of East Asian economies between the 1970s and 1990s (World Bank, 1993, Arestis *et al.*, 2002, Demetriades and Luintel, 2001, Werner, 2005: 267–294). The standard arguments against such interventions in the credit market – that it would lead to sub-optimal allocation of investment – appear to lack foundation given secular drift towards unproductive credit creation (Werner, 2005, Mazzucato and Wray, 2015) and empirical research suggests there is not a clear link between liberalisation or privatisation of banking markets and increases in economic growth and productivity (Costantini *et al.*, 2013, Andrianova *et al.*, 2012).

A third policy option, related closely to both the aforementioned, is the creation of state- or public-investment banks that could perhaps be financed via central bank credit creation following the Canadian IDB model. Two interesting examples that perhaps deserve greater attention from western monetary policymakers are the Brazilian *Banco Nacional de Desenvolvimento Economico e Social* and the German *Kreditanstalt fur Wiederaufbau* (KfW). These institutions have provided billions of dollars in productive credit and subsidies for private sector lending to SMEs and for

infrastructure. Both have been held up as exemplars of how public bodies can stimulate innovation and growth in new markets that commercial banks may be reluctant to invest in, such as green energy infrastructure and climate change related financing (Mazzucato, 2013, Mazzucato and Penna, 2015).¹¹²

Ultimately, as suggested in Chapter 4 of this thesis, a more general rethink of monetary-fiscal relations may be in order. If commercial-bank-based systems of credit creation are not providing sufficient investment in the economy and public deficits are politically already too high for significant fiscal expansion, it is logical that central banks and governments consider the monetisation of deficit spending. Indeed, it could be argued that such a process is perhaps already under way in all the major advanced economies to a greater or lesser extent. Whilst Japan is the only country that has explicitly combined a major government debt monetisation programme (QE) with an expansion of infrastructure investment, the central banks of the USA, the UK and the Eurozone have also purchased massive quantities of government bonds and show little interest in reducing their holdings, even as some economies begin to recover. As noted in Chapter 2, the transmission channel for QE can be uncertain if there is a lack of demand in the economy, meaning that deficit financing for more direct spending – for example for infrastructure – might be a more direct way of boosting nominal growth. Our findings in Chapter 4 suggest that concerns over CBI and inflation arising from such policies have little empirical support.

Overall, the findings of this thesis suggest monetary policy needs a more radical rethink than has yet been undertaken. Policymakers and scholars alike need to move well beyond the narrow confines of a concern with the quantity or price of money and focus instead on credit flows and commercial and central bank credit creation and its relation to asset prices. Much challenging empirical and theoretical work will be required to inform policy and policy itself will need to be more experimental, drawing on lessons from the post-war period and from Asia. With such an approach, it may be possible to engineer not only a more stable economy but perhaps also help address the secular stagnation that has haunted advanced economies since the global financial crisis.

¹¹² In 2012, state investment banks provided 34% of the total financing for global climate change investment, compared to just 6% from ‘all types of private financial institutions’ (including private banks) (Mazzucato and Penna, 2015: 2).

Appendix A Monetary policy and nominal GDP in the UK: an empirical analysis

A.1 Multivariate equation modelling – full diagnostics

A.1.1 Unrestricted VAR(6) system

The estimation sample is: 1965(3) - 2012(4)

Single-equation diagnostics using reduced-form residuals:

YoYGDP : Portmanteau(12): $\chi^2(6) = 15.920$ [0.0142]*
YoYGDP : AR 1-5 test: $F(5,151) = 1.5539$ [0.1766]
YoYGDP : ARCH 1-4 test: $F(4,182) = 0.36779$ [0.8314]
YoYGDP : Normality test: $\chi^2(2) = 3.1780$ [0.2041]
YoYGDP : Hetero test: $F(50,132) = 0.96764$ [0.5414]
YoYCreditRE : Portmanteau(12): $\chi^2(6) = 15.856$ [0.0145]*
YoYCreditRE : AR 1-5 test: $F(5,151) = 2.2777$ [0.0497]*
YoYCreditRE : ARCH 1-4 test: $F(4,182) = 8.1834$ [0.0000]**
YoYCreditRE : Normality test: $\chi^2(2) = 2.6979$ [0.2595]
YoYCreditRE : Hetero test: $F(50,132) = 2.2514$ [0.0001]**
YoYBroadmoney: Portmanteau(12): $\chi^2(6) = 20.184$ [0.0026]**
YoYBroadmoney: AR 1-5 test: $F(5,151) = 2.4442$ [0.0367]*
YoYBroadmoney: ARCH 1-4 test: $F(4,182) = 1.2484$ [0.2921]
YoYBroadmoney: Normality test: $\chi^2(2) = 5.5582$ [0.0621]
YoYBroadmoney: Hetero test: $F(50,132) = 1.0574$ [0.3923]
LT_RATE : Portmanteau(12): $\chi^2(6) = 7.5836$ [0.2702]
LT_RATE : AR 1-5 test: $F(5,151) = 1.7829$ [0.1196]
LT_RATE : ARCH 1-4 test: $F(4,182) = 1.2693$ [0.2837]
LT_RATE : Normality test: $\chi^2(2) = 25.805$ [0.0000]**
LT_RATE : Hetero test: $F(50,132) = 1.7509$ [0.0062]**

Vector Portmanteau(12): $\chi^2(96) = 150.39$ [0.0003]**
Vector AR 1-5 test: $F(80,527) = 1.4080$ [0.0161]*
Vector Normality test: $\chi^2(8) = 35.287$ [0.0000]**
Vector ZHetero test: $F(200,517) = 1.4918$ [0.0002]**
Vector RESET23 test: $F(32,536) = 1.5649$ [0.0266]*

A.1.2 Cointegrated VAR (6) with long-run identification – full diagnostics

Single-equation diagnostics using reduced-form residuals:

YoYGDP : ARCH 1-4 test: $F(4,182) = 0.33641$ [0.8532]
YoYGDP : Normality test: $\chi^2(2) = 3.3396$ [0.1883]
YoYGDP : Hetero test: $F(50,132) = 0.98421$ [0.5128]
YoYCreditRE : ARCH 1-4 test: $F(4,182) = 7.9521$ [0.0000]**
YoYCreditRE : Normality test: $\chi^2(2) = 2.9315$ [0.2309]
YoYCreditRE : Hetero test: $F(50,132) = 2.2348$ [0.0001]**
YoYBroadmoney: ARCH 1-4 test: $F(4,182) = 1.1974$ [0.3135]
YoYBroadmoney: Normality test: $\chi^2(2) = 5.4153$ [0.0667]
YoYBroadmoney: Hetero test: $F(50,132) = 1.0761$ [0.3637]
LT_RATE : ARCH 1-4 test: $F(4,182) = 1.0389$ [0.3885]
LT_RATE : Normality test: $\chi^2(2) = 30.115$ [0.0000]**

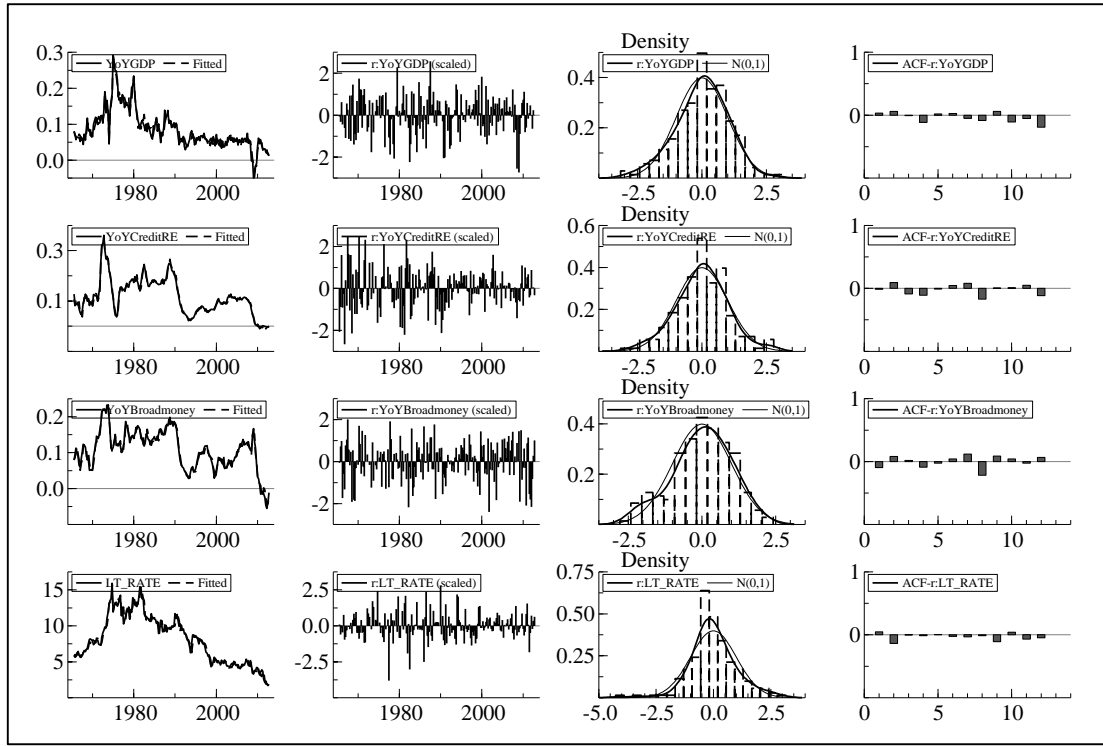
LT_RATE : Hetero test: $F(50,132) = 1.8193 [0.0037]**$

Vector Normality test: $\chi^2(8) = 39.843 [0.0000]**$

Vector ZHetero test: $F(200,517) = 1.4928 [0.0002]**$

Scan error: Unexpected end of code on line 3

Figure 27: Diagnostic plots of cointegrated vectors



A.1.3 Single-equation GETS model excluding the contemporaneous value of *YoYBroadmoney*

a) General unrestricted model

Modelling YoYGDP by OLS

The estimation sample is: 1965(4) - 2012(4)

| | β | t-ratio | | β | t-ratio |
|------------------------|---------|---------|----------------------|---------|---------|
| <i>YoYGDP_1</i> | 0.580 | 8.97 | <i>LT_RATE</i> | 0.000 | 0.0583 |
| <i>YoYGDP_2</i> | 0.104 | 1.48 | <i>LT_RATE_1</i> | -0.002 | -0.958 |
| <i>YoYGDP_3</i> | 0.050 | 0.73 | <i>LT_RATE_2</i> | 0.002 | 0.956 |
| <i>YoYGDP_4</i> | -0.473 | -6.49 | <i>LT_RATE_3</i> | 0.001 | 0.235 |
| <i>YoYGDP_5</i> | 0.075 | 1.16 | <i>LT_RATE_4</i> | 0.000 | -0.108 |
| <i>Constant</i> | 0.011 | 2.8 | <i>LT_RATE_5</i> | 0.002 | 1.26 |
| <i>YoYCreditRE</i> | 0.337 | 3.64 | <i>Bankrate</i> | 0.001 | 0.787 |
| <i>YoYCreditRE_1</i> | -0.179 | -1.15 | <i>Bankrate_1</i> | 0.003 | 1.71 |
| <i>YoYCreditRE_2</i> | -0.255 | -1.66 | <i>Bankrate_2</i> | -0.005 | -2.46 |
| <i>YoYCreditRE_3</i> | 0.337 | 2.2 | <i>Bankrate_3</i> | 0.003 | 1.59 |
| <i>YoYCreditRE_4</i> | 0.236 | 1.5 | <i>Bankrate_4</i> | -0.003 | -1.68 |
| <i>YoYCreditRE_5</i> | -0.365 | -3.77 | <i>Bankrate_5</i> | 0.001 | 0.999 |
| <i>YoYBroadmoney_1</i> | -0.324 | -3.55 | <i>ImpD: 1975(1)</i> | 0.065 | 3.27 |
| <i>YoYBroadmoney_2</i> | 0.482 | 3.47 | <i>ImpD: 1979(1)</i> | -0.051 | -3.04 |
| <i>YoYBroadmoney_3</i> | -0.178 | -1.3 | <i>ImpD: 1979(3)</i> | 0.049 | 3.04 |
| <i>YoYBroadmoney_4</i> | -0.002 | -0.0153 | <i>StepD:1974(1)</i> | -0.071 | -7.57 |
| <i>YoYBroadmoney_5</i> | -0.023 | -0.254 | <i>StepD:1976(4)</i> | 0.043 | 5.94 |
| | | | <i>StepD:1981(2)</i> | 0.042 | 6.0 |

Standard Error of the regression: 0.01408

Adjusted R²: 0.931774

Diagnostic tests

AR 1-5 test: F(5,149) = 0.29362 [0.9159]

ARCH 1-4 test: F(4,181) = 0.44843 [0.7735]

Normality test: Chi²(2) = 1.1336 [0.5673]

Hetero test: F(59,126) = 1.1260 [0.2873]

Chow test: F(56,98) = 0.68191 [0.9403] for break after 1998(4)

Summary of autometrics search

initial search space 2³⁵;

final search space 2²⁶

no. estimated models 258;

no. terminal models 10;

target size Small:0.01

GUM0 tie-breaker SC;

diagnostics p-value 0.01;

b) *Specific model*

Modelling YoYGDP by OLS

The estimation sample is: 1965(4) - 2012(4)

| | β | t-ratio |
|------------------------|---------|---------|
| <i>YoYGDP_1</i> | 0.522 | 10.20 |
| <i>YoYGDP_2</i> | 0.195 | 3.51 |
| <i>YoYGDP_4</i> | -0.407 | -8.55 |
| <i>Constant</i> | 0.009 | 2.66 |
| <i>YoYCreditRE</i> | 0.255 | 5.58 |
| <i>YoYCreditRE_2</i> | -0.412 | -4.00 |
| <i>YoYCreditRE_3</i> | 0.533 | 5.13 |
| <i>YoYCreditRE_5</i> | -0.274 | -5.72 |
| <i>YoYBroadmoney_1</i> | -0.228 | -2.91 |
| <i>YoYBroadmoney_2</i> | 0.223 | 2.81 |
| <i>LT_RATE_5</i> | 0.003 | 4.33 |
| <i>Bankrate_1</i> | 0.004 | 3.33 |
| <i>Bankrate_2</i> | -0.003 | -2.91 |
| <i>ImpD: 1975(1)</i> | 0.053 | 3.21 |
| <i>ImpD: 1979(1)</i> | -0.044 | -2.98 |
| <i>ImpD: 1979(3)</i> | 0.050 | 3.33 |
| <i>StepD:1974(1)</i> | -0.072 | -9.15 |
| <i>StepD:1976(4)</i> | 0.043 | 6.41 |
| <i>StepD:1981(2)</i> | 0.044 | 7.46 |

Standard Error of the regression: 0.014034

Adjusted R²: 0.932219

Diagnostic tests

AR 1-5 test: F(5,165) = 0.63153 [0.6759]

ARCH 1-4 test: F(4,181) = 0.35749 [0.8386]

Normality test: Chi²(2) = 2.9442 [0.2294]

Hetero test: F(27,158) = 0.85579 [0.6727]

Hetero-X test: F(93,92) = 2.0614 [0.0003]**

RESET23 test: F(2,168) = 4.5122 [0.0123]*

Error correction model

ECM = YoYGDP - 0.0131654 - 0.147454*YoYCreditRE + 0.0074456*YoYBroadmoney –

0.00410633*LT_RATE - 0.000620903*Bankrate – 0.0762167*ImpD: 1975(1) +

0.0644186*ImpD: 1979(1) – 0.0722775*ImpD: 1979(3) + 0.10396*StepD:1974(1) –

0.0615872*StepD:1976(4) – 0.0635723*StepD:1981(2);

WALD test: Chi²(10) = 1024.37 [0.0000] **

A.1.4 Toda-Yamamoto VAR(7) Granger causality testing: diagnostic tests

Estimating the VAR system by OLS

The estimation sample is: 1965(4) - 2012(4)

Single-equation diagnostics using reduced-form residuals:

YoYGDP : Portmanteau(12): $\chi^2(5) = 13.373$ [0.0201]*

YoYGDP : AR 1-5 test: $F(5,146) = 1.2198$ [0.3028]

YoYGDP : ARCH 1-4 test: $F(4,181) = 0.45401$ [0.7694]

YoYGDP : Normality test: $\chi^2(2) = 3.0293$ [0.2199]

YoYGDP : Hetero test: $F(58,123) = 0.87919$ [0.7048]

YoYCreditRE : Portmanteau(12): $\chi^2(5) = 18.651$ [0.0022]**

YoYCreditRE : AR 1-5 test: $F(5,146) = 2.8678$ [0.0168]*

YoYCreditRE : ARCH 1-4 test: $F(4,181) = 4.8292$ [0.0010]**

YoYCreditRE : Normality test: $\chi^2(2) = 5.7303$ [0.0570]

YoYCreditRE : Hetero test: $F(58,123) = 2.2146$ [0.0001]**

YoYBroadmoney : Portmanteau(12): $\chi^2(5) = 20.372$ [0.0011]**

YoYBroadmoney : AR 1-5 test: $F(5,146) = 2.7920$ [0.0194]*

YoYBroadmoney : ARCH 1-4 test: $F(4,181) = 1.7256$ [0.1462]

YoYBroadmoney : Normality test: $\chi^2(2) = 3.5283$ [0.1713]

YoYBroadmoney : Hetero test: $F(58,123) = 0.89619$ [0.6754]

LT_RATE : Portmanteau(12): $\chi^2(5) = 9.4862$ [0.0912]

LT_RATE : AR 1-5 test: $F(5,146) = 1.8446$ [0.1077]

LT_RATE : ARCH 1-4 test: $F(4,181) = 1.2036$ [0.3109]

LT_RATE : Normality test: $\chi^2(2) = 18.381$ [0.0001]**

LT_RATE : Hetero test: $F(58,123) = 1.6762$ [0.0088]**

Vector Portmanteau(12): $\chi^2(80) = 143.16$ [0.0000]**

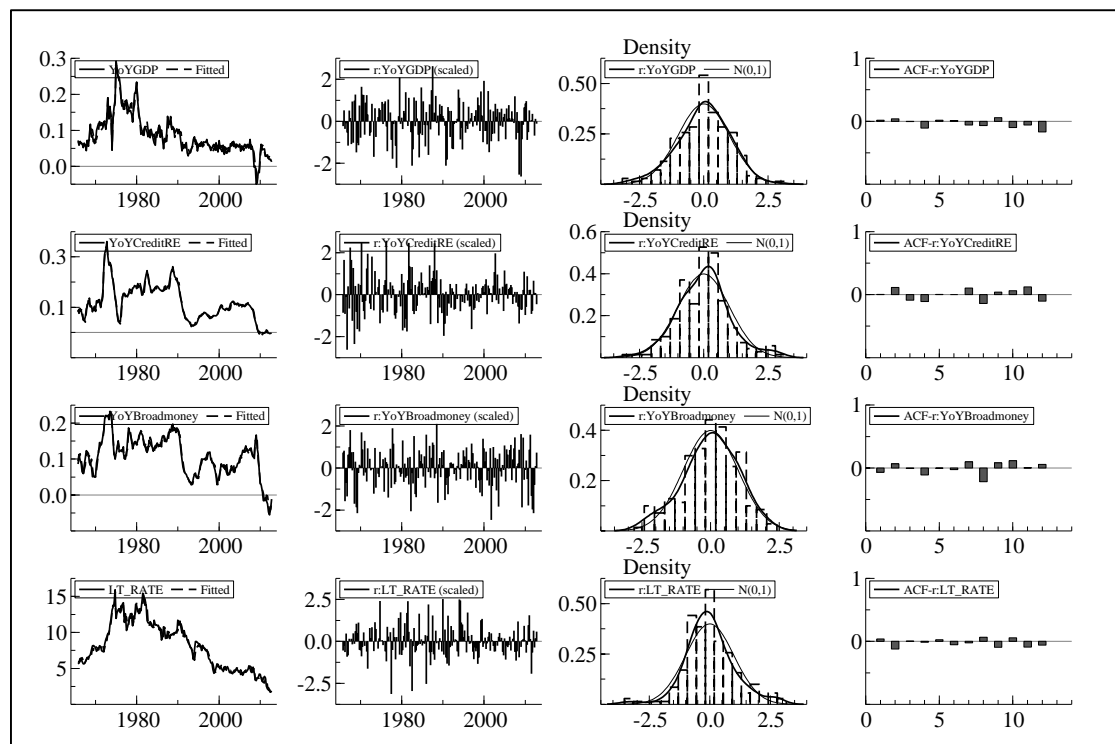
Vector AR 1-5 test: $F(80,507) = 1.5988$ [0.0016]**

Vector Normality test: $\chi^2(8) = 28.719$ [0.0004]**

Vector ZHetero test: $F(232,482) = 1.3953$ [0.0013]**

Vector RESET23 test: $F(32,517) = 1.5108$ [0.0379]*

Figure 28: VAR(7) Granger causality tests diagnostic plots



Appendix B Disaggregated credit, asset prices, and economic activity: a PVAR approach

B.1 PVAR unit root tests

Table 17: Maddala Wu (1999) unit root tests for PVAR

| Variable | lags | With trend | | Without trend | |
|----------------------|------|------------|-----------------|---------------|-----------------|
| | | χ^2 | <i>p</i> -value | χ^2 | <i>p</i> -value |
| <i>rgdp</i> | 0 | 82.264 | 0.000 | 64.136 | 0.000 |
| <i>rgdp</i> | 1 | 127.528 | 0.000 | 108.378 | 0.000 |
| <i>rgdp</i> | 2 | 142.379 | 0.000 | 126.457 | 0.000 |
| <i>rgdp</i> | 3 | 160.197 | 0.000 | 153.393 | 0.000 |
| <i>rgdp</i> | 4 | 73.681 | 0.000 | 65.967 | 0.000 |
| <i>cpi</i> | 0 | 49.935 | 0.000 | 33.147 | 0.016 |
| <i>cpi</i> | 1 | 82.840 | 0.000 | 62.888 | 0.000 |
| <i>cpi</i> | 2 | 90.749 | 0.000 | 70.916 | 0.000 |
| <i>cpi</i> | 3 | 103.442 | 0.000 | 84.415 | 0.000 |
| <i>cpi</i> | 4 | 49.877 | 0.000 | 30.985 | 0.029 |
| <i>hprice</i> | 0 | 103.631 | 0.000 | 73.795 | 0.000 |
| <i>hprice</i> | 1 | 100.437 | 0.000 | 80.525 | 0.000 |
| <i>hprice</i> | 2 | 99.593 | 0.000 | 79.146 | 0.000 |
| <i>hprice</i> | 3 | 56.937 | 0.000 | 40.373 | 0.002 |
| <i>hprice</i> | 4 | 17.806 | 0.468 | 7.970 | 0.979 |
| <i>C_r</i> | 0 | 25.837 | 0.104 | 15.715 | 0.612 |
| <i>C_r</i> | 1 | 46.530 | 0.000 | 35.370 | 0.008 |
| <i>C_r</i> | 2 | 61.011 | 0.000 | 48.503 | 0.000 |
| <i>C_r</i> | 3 | 60.168 | 0.000 | 50.301 | 0.000 |
| <i>C_r</i> | 4 | 25.000 | 0.125 | 16.107 | 0.585 |
| <i>C_f</i> | 0 | 56.672 | 0.000 | 41.414 | 0.001 |
| <i>C_f</i> | 1 | 48.268 | 0.000 | 34.476 | 0.011 |
| <i>C_f</i> | 2 | 60.197 | 0.000 | 51.448 | 0.000 |
| <i>C_f</i> | 3 | 79.575 | 0.000 | 68.678 | 0.000 |
| <i>C_f</i> | 4 | 29.792 | 0.040 | 20.271 | 0.318 |
| <i>irate</i> | 0 | 76.662 | 0.000 | 42.930 | 0.001 |
| <i>irate</i> | 1 | 73.118 | 0.000 | 63.628 | 0.000 |
| <i>irate</i> | 2 | 71.657 | 0.000 | 60.537 | 0.000 |
| <i>irate</i> | 3 | 72.164 | 0.000 | 62.100 | 0.000 |
| <i>irate</i> | 4 | 60.696 | 0.000 | 52.323 | 0.000 |

Notes: Null hypothesis is that the series is non-stationary. Test assumes cross-section independence. Number of panels: 9; Obs: 803; Average no. obs: 89.54; lags: 4.

Table 18: Pesaran (2007) panel unit root test (Cross-section IPS test) for PVAR

| Variable | lags | Without trend | | With trend | |
|---------------|------|-----------------------|------------------|-----------------------|------------------|
| | | $Z_{\tau}\text{-bar}$ | $p\text{-value}$ | $Z_{\tau}\text{-bar}$ | $p\text{-value}$ |
| <i>rgdp</i> | 0 | -6.542 | 0.000 | -5.624 | 0.000 |
| <i>rgdp</i> | 1 | -7.930 | 0.000 | -7.292 | 0.000 |
| <i>rgdp</i> | 2 | -7.949 | 0.000 | -7.536 | 0.000 |
| <i>rgdp</i> | 3 | -7.471 | 0.000 | -7.251 | 0.000 |
| <i>rgdp</i> | 4 | -3.869 | 0.000 | -3.271 | 0.001 |
| <i>cpi</i> | 0 | -4.335 | 0.000 | -3.446 | 0.000 |
| <i>cpi</i> | 1 | -4.966 | 0.000 | -4.420 | 0.000 |
| <i>cpi</i> | 2 | -5.325 | 0.000 | -4.632 | 0.000 |
| <i>cpi</i> | 3 | -5.661 | 0.000 | -5.286 | 0.000 |
| <i>cpi</i> | 4 | -3.292 | 0.000 | -2.190 | 0.014 |
| <i>hprice</i> | 0 | -5.004 | 0.000 | -4.978 | 0.000 |
| <i>hprice</i> | 1 | -5.186 | 0.000 | -5.365 | 0.000 |
| <i>hprice</i> | 2 | -4.172 | 0.000 | -4.631 | 0.000 |
| <i>hprice</i> | 3 | -3.900 | 0.000 | -4.592 | 0.000 |
| <i>hprice</i> | 4 | -0.786 | 0.216 | -0.579 | 0.281 |
| C_r | 0 | 0.361 | 0.641 | 1.957 | 0.975 |
| C_r | 1 | -1.749 | 0.040 | -0.707 | 0.240 |
| C_r | 2 | -2.510 | 0.006 | -1.651 | 0.049 |
| C_r | 3 | -2.324 | 0.010 | -1.842 | 0.033 |
| C_r | 4 | 0.891 | 0.813 | 2.505 | 0.994 |
| C_f | 0 | -3.717 | 0.000 | -3.501 | 0.000 |
| C_f | 1 | -3.894 | 0.000 | -3.825 | 0.000 |
| C_f | 2 | -5.390 | 0.000 | -6.096 | 0.000 |
| C_f | 3 | -6.060 | 0.000 | -7.251 | 0.000 |
| C_f | 4 | -2.265 | 0.012 | -2.683 | 0.004 |
| <i>irate</i> | 0 | -5.431 | 0.000 | -3.719 | 0.000 |
| <i>irate</i> | 1 | -4.838 | 0.000 | -3.947 | 0.000 |
| <i>irate</i> | 2 | -4.576 | 0.000 | -3.664 | 0.000 |
| <i>irate</i> | 3 | -5.591 | 0.000 | -4.970 | 0.000 |
| <i>irate</i> | 4 | -5.366 | 0.000 | -4.841 | 0.000 |

Notes: Null hypothesis is that the series is $I(1)$. Test assumes cross-section dependence is in form of a single unobserved common factor. Number of panels: 9; Obs: 803; Average no. obs: 89.54; lags: 4.

Appendix C Monetary financing as a tool of monetary policy: a case study of the Canadian economy, 1935–1975

C.1 Use of credit controls and moral suasion by the Bank of Canada: 1946–69¹¹³

| Year | Purpose |
|-------------|---|
| 1946 | Limit on government security holdings of chartered banks to 90% of Canadian personal savings deposits. |
| 1948 | Limit on term loans. |
| 1951 | Limit on total loans. Limit on term loans. |
| 1955 | Limit on terms loans in amount exceeding \$250,000. Minimum liquid asset ratio. |
| 1956 | Limit on lending to consumer finance companies. Special consideration for small borrowers. |
| 1957 | Encouragement to mortgage loans. Restrictions on term lending. |
| 1958 | Term loan agreement revised to \$2,000,000 ceiling. |
| 1959 | Term loan agreement revised to \$1,000,000 ceiling. |
| 1965 | Accommodation to finance companies. Request to discourage US subsidiaries from switching to Canadian sources of funds because of US balance-of-payment guidelines. |
| 1967 | Agreement on maximum interest on term deposits. Request to refrain from extending credit for the purchase of gold. |
| 1968 | Request to discourage use of bank credit to make abnormal transfers of funds or to replace funds normally obtained from parent companies by US subsidiaries. Request to restrict the outflow of funds through certain currency deposit transactions. |
| 1969 | Ceiling on ‘swap’ deposits accepted by chartered banks. Special regard for borrowers in less prosperous areas of the country. Special attention to loan applications from small businesses without alternative sources of credit. |

¹¹³ Reproduced from Chant and Acheson (1972: 19). Original source: Bank of Canada, *Annual Report*, various issues.

C.2 Modelling Canadian inflation

C.2.1 Summary statistics and unit root testing on Canadian inflation modelling

Table 19: Summary statistics – Canadian inflation

| Variable | minimum | mean | maximum | std.dev |
|------------------|---------------|------------|---------|----------|
| <i>Can_Price</i> | 0 -0.00038722 | 0.039789 | 0.11952 | 0.029519 |
| <i>US_Price</i> | 0.0037383 | 0.039364 | 0.13545 | 0.026846 |
| <i>US_FX</i> | -0.17636 | 0.00034388 | 0.10629 | 0.0474 |
| <i>BaseM</i> | -0.0047147 | 0.060458 | 0.15495 | 0.037155 |
| <i>BroadM</i> | -0.016178 | 0.080965 | 0.19983 | 0.046102 |
| <i>Monetiz</i> | -0.12094 | 0.051667 | 0.33856 | 0.071685 |
| <i>Debt</i> | -0.058453 | 0.062713 | 0.26583 | 0.067883 |
| <i>Unemp</i> | 3.03 | 7.3759 | 12.93 | 2.2183 |
| <i>R_spread</i> | -0.33333 | 1.3046 | 3.5333 | 0.56873 |
| <i>Output</i> | -0.0023841 | 0.076756 | 0.20062 | 0.039029 |

Notes: t=207, time period: 1956(1)-2007(3)

Table 20: Pairwise coefficient correlation matrix – Canadian inflation

| | <i>Can_ Price</i> | <i>US_ Price</i> | <i>US_FX</i> | <i>BaseM</i> | <i>BroadM</i> | <i>Monetiz</i> | <i>Debt</i> | <i>Unemp</i> | <i>R_ spread</i> | <i>Out- put</i> |
|-----------------------|-----------------------|----------------------|--------------|--------------|---------------|----------------|-------------|--------------|----------------------|---------------------|
| <i>Can_ Price</i> | 1.000 | | | | | | | | | |
| <i>US_ Price</i> | 0.875 | 1.000 | | | | | | | | |
| <i>US_FX</i> | 0.116 | 0.122 | 1.000 | | | | | | | |
| <i>BaseM</i> | 0.463 | 0.438 | -0.007 | 1.000 | | | | | | |
| <i>BroadM</i> | 0.821 | 0.740 | -0.007 | 0.546 | 1.000 | | | | | |
| <i>Monetiz</i> | 0.383 | 0.373 | -0.013 | 0.515 | 0.426 | 1.000 | | | | |
| <i>Debt</i> | 0.549 | 0.435 | 0.299 | 0.151 | 0.504 | 0.225 | 1.000 | | | |
| <i>Unemp</i> | 0.074 | 0.033 | 0.276 | -0.330 | -0.106 | -0.085 | 0.538 | 1.000 | | |
| <i>R_ spread</i> | -0.149 | -0.175 | -0.081 | -0.151 | -0.213 | -0.163 | -0.293 | -0.056 | 1.000 | |
| <i>Output</i> | 0.576 | 0.551 | 0.030 | 0.621 | 0.537 | 0.346 | 0.238 | -0.401 | -0.095 | 1.000 |

Notes: t=207, time period: 1956(1)-2007(3)

Table 21: Unit root tests – Canadian inflation

| | | PP Z(t) Statistic | | | Outcome |
|------------------|-------------------------|-------------------|----------------------------------|-------------|----------------------------|
| Variable | YoY growth rate (t=195) | | Δ YoY growth rate (t=194) | | |
| | With constant | No constant | With constant | No constant | |
| | | constant | | | |
| <i>Can_Price</i> | -2.166 | -1.148 | -11.093 | -11.119 | <i>I</i> (1) |
| <i>US_Price</i> | -2.542 | -1.300 | -9.181 | -9.203 | <i>I</i> (1) |
| <i>US_FX</i> | -3.935 | -1.300 | -11.495 | -11.530 | <i>I</i> (0)/ <i>I</i> (1) |
| <i>BaseM</i> | -3..351 | -1.708 | -10.787 | -10.816 | <i>I</i> (0)/ <i>I</i> (1) |
| <i>BroadM</i> | -2.669 | -1.198 | -8.055 | -8.074 | <i>I</i> (1) |
| <i>Monetiz</i> | -5.756 | -4.607 | -15.114 | -15.151 | <i>I</i> (0) |
| <i>Debt</i> | -1.904 | -1.570 | -10.186 | -10.209 | <i>I</i> (1) |
| <i>Unemp</i> | -2.166 | -0.357 | -7.707 | -7.719 | <i>I</i> (1) |
| <i>R_Spread</i> | -5.046 | -1.787 | -12.558 | -12.596 | <i>I</i> (0)/ <i>I</i> (1) |
| <i>Output</i> | -3.851 | -1.833 | -15.140 | -15.175 | <i>I</i> (0)/ <i>I</i> (1) |
| Critical values | | | | | |
| | | 1% | 5% | 10% | |
| | With const | -3.48 | -2.88 | -2.57 | |
| | No const | -2.59 | -1.95 | -1.62 | |

Notes: Dependent variable = *Can-Price*; period: 1956q1-2007q3; Observations: 205; Lags for Phillips-Perron (Phillips and Perron, 1988) test chosen using Newey–West (Newey and West, 1994) automatic bandwidth selector applied by Hobijn, Philip, and Ooms (1998).

C.2.2 Detailed estimation results and diagnostic testing

a) General unrestricted model

Solved static long-run equation for Y = Canadian Inflation

| | β | t -ratio |
|------------------|---------|------------|
| <i>I:1974(2)</i> | 0.083 | 2.47 |
| <i>Constant</i> | -0.003 | -0.141 |
| <i>US_Price</i> | 0.959 | 4.2 |
| <i>US_FX</i> | -0.051 | -0.827 |
| <i>BaseM</i> | 0.128 | 1.06 |
| <i>BroadM</i> | -0.0378 | -0.247 |
| <i>Monetiz</i> | 0.0475 | 0.9 |
| <i>Debt</i> | 0.165 | 2.03 |
| <i>Unemp</i> | -0.002 | -1.09 |
| <i>R_spread</i> | 0.008 | 1.76 |
| <i>Output</i> | -0.067 | -0.391 |

Long-run Std. Error = 0.0161112

Error Correction Model

ECM = *Can_Price* - 0.0831036**I:1974(2)* + 0.00285074 –

0.959161**US_Price* + 0.0509723**US_FX* - 0.127925**BaseM* +

$$0.0377505 * \text{BroadM} - 0.047484 * \text{Monetiz} - 0.16495 * \text{Debt} + \\ 0.00242847 * \text{Unemp} - 0.00804767 * \text{R_spread} + 0.0676822 * \text{Output};$$

b) Specific model

Summary of Autometrics search

initial search space 2^{91} ;
 final search space 2^{31}
 no. estimated models 912;
 no. terminal models 13
 test form LR-F;
 target size: Small:0.01
 diagnostics p-value 0.01;

Solved static long-run equation for Canadian inflation

| | β | t-ratio |
|------------------|---------|---------|
| <i>US_Price</i> | 0.914 | 8.560 |
| <i>US_FX</i> | 0.041 | 1.140 |
| <i>BroadM</i> | 0.206 | 3.850 |
| <i>Unemp</i> | -0.002 | -3.850 |
| <i>I:1974(2)</i> | 0.081 | 3.110 |

Long-run Std. Error = 0.0216843

$$\text{ECM} = \text{Can_Price} - 0.913722 * \text{US_Price} - 0.0412716 * \text{US_FX} - 0.206158 * \text{BroadM} + 0.00173678 * \text{Unemp} \\ - 0.0807856 * \text{I:1974(2)};$$

WALD test: $\text{Chi}^2(5) = 961.442$ [0.0000] **

Diagnostic tests

AR 1-5 test: $F(5,180) = 3.1194$ [0.0100]*
 ARCH 1-4 test: $F(4,191) = 2.9897$ [0.0201]*
 Normality test: $\text{chi-sq}(2) = 2.6523$ [0.2655]
 Hetero test: $F(26,171) = 1.0481$ [0.4085]
 Hetero-X test: $F(104,93) = 1.0825$ [0.3491]
 RESET23 test: $F(2,183) = 3.0962$ [0.0476]*

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