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Abstract: The financial crisis of 2007-2008 triggered monetary policy designed to boost nominal demand, including 'Quantitative Easing', 'Credit Easing', 'Forward Guidance' and 'Funding for Lending'. A key aim of these policies was to boost the quantity of bank credit to the non-financial corporate and household sectors. In the previous decade or more, however, policy-makers had not focused on bank credit. Indeed, over the past half century, different variables were raised to prominence in the quest to achieve desired nominal GDP outcomes. This paper conducts a long-overdue horse race between the various contenders in terms of their ability to account for observed nominal GDP growth, using a half-century of UK data since 1963. Employing the 'General-to-Specific' methodology, an equilibrium-correction model is estimated suggesting a long-run cointegrating relationship between disaggregated real economy credit and nominal GDP. Short-term and long-term interest rates and broad money do not appear to influence nominal GDP significantly. Vector Autoregression and Vector Error Correction modelling shows the real economy credit growth variable to be strongly exogenous to nominal GDP growth. Policy-makers are hence right to finally emphasise the role of bank credit, although they need to disaggregate it and specifically target bank credit for GDP-transactions.

## Highlights

- Post-crisis monetary policy has struggled to stimulate nominal demand.
- This paper uses half a century of empirical data to evaluate a broad range of traditional and non-traditional potential monetary policy variables, conducting a horse-race
- The goal of the empirical evaluation is to find out which of the variables is indeed most useful in explaining nominal GDP growth
- The econometric methodology is the 'general-to-specific' approach, to allow the data to speak, without being influenced by priors
- It is found that interest rates and money aggregates do not influence nominal GDP significantly - these variables are beaten in the horse race and drop out as insignificant.
- Instead, bank credit for GDP transactions explains nominal GDP best, and is strongly exogenous to ('Granger-causing') nominal GDP.

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**A half-century diversion of monetary policy?  
An empirical horse-race to identify the UK variable  
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growth rate**

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# **A half-century diversion of monetary policy? An empirical horse-race to identify the UK variable most likely to deliver the desired nominal GDP growth rate**

## **Abstract**

The financial crisis of 2007-2008 triggered monetary policy designed to boost nominal demand, including 'Quantitative Easing', 'Credit Easing', 'Forward Guidance' and 'Funding for Lending'. A key aim of these policies was to boost the quantity of bank credit to the non-financial corporate and household sectors. In the previous decade or more, however, policy-makers had not focused on bank credit. Indeed, over the past half century, different variables were raised to prominence in the quest to achieve desired nominal GDP outcomes. This paper conducts a long-overdue horse race between the various contenders in terms of their ability to account for observed nominal GDP growth, using a half-century of UK data since 1963. Employing the 'General-to-Specific' methodology, an equilibrium-correction model is estimated suggesting a long-run cointegrating relationship between disaggregated real economy credit and nominal GDP. Short-term and long-term interest rates and broad money do not appear to influence nominal GDP significantly. Vector Autoregression and Vector Error Correction modelling shows the real economy credit growth variable to be strongly exogenous to nominal GDP growth. Policy-makers are hence right to finally emphasise the role of bank credit, although they need to disaggregate it and specifically target bank credit for GDP-transactions.

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**JEL classifications:** E5, G2, E3

## 1. Introduction

One highly useful lesson from the crisis is that although we conventionally use the label “monetary policy” to refer to the macroeconomic policy that central banks carry out, the way this policy works revolves around credit, not money... 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: 302)

Since the financial crisis, there has been a revival of interest in macro-financial linkages (see, for instance, Love and Ariss (2014)). The relationship between monetary policy and nominal output has long been an area of controversy in empirical macroeconomics and macro finance.<sup>1</sup> Large-scale credit shocks in the aftermath of the financial crisis placed the spotlight on the role of credit supply (Lou and Yin, 2014) and the impact of quantitative stimulation policies, including ‘Quantitative Easing’ (Girardin and Moussa, 2011), ‘Credit Easing’ and ‘Funding for Lending Schemes’ (FLS) (Churm *et al.*, 2012). Thus finance researchers have increasingly examined the bank lending channel of monetary policy transmission (Nguyen and Boateng, 2013), in line with the research programme to place banks more squarely into macroeconomic models and reflecting their macroeconomic effect in finance models (Werner, 1997, 2012).

Although usually framed as being aimed at boosting growth<sup>2</sup>, the post-crisis monetary policies have targeted intermediate variables, typically medium and long-term interest rates. Empirical studies of QE-type policies have equally focused on such variables. This has been criticized (Lyonnet and Werner, 2012, Goodhart and Ashworth, 2012, Martin and Milas, 2012). The focus on intermediate variables means that the effects on the final target variable of nominal GDP is hypothesized rather than empirically tested – using concepts such as ‘portfolio rebalancing’ (section 2.1).

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<sup>1</sup> For much of the second half of the 20<sup>th</sup> Century this question was dominated by the debate between Keynesian and Monetarist schools, with the former downplaying the role of money in favour of emphasis on fiscal policy counter-balancing private sector fluctuations, whilst monetarists, following Friedman and Schwartz (1963) emphasized the importance of monetary aggregates in determining output and inflation - see Johnson (1971). While much analysis has focused on industrialised economies, recently research analysing these issues in emerging markets has also appeared (Mehrotra and Sánchez-Fung, 2011, Dueker and Kim, 1999).

<sup>2</sup> The Bank of England has been explicit in stating the purpose of its QE program was to “increase nominal spending growth” in order to maintain inflation at the 2% target (Joyce *et al.*, 2011: 1); see also the Bank’s short film, ‘Quantitative Easing Explained’, available online at <http://www.bankofengland.co.uk/monetarypolicy/pages/qe/default.aspx>

Another problem with existing studies is the time period over which analysis is conducted. Many studies, in particular event studies, 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.

A third problem with existing studies is that many do not include credit aggregates or distinguish where credit flows in the economy. This is a criticism that has also been levelled at macroeconomic theory and macroeconomic models more generally, most of which excluded a significant role for money, credit or banks (Buiter, 2008, Goodhart, 2009, Turner, 2013a). This fact may help explain their failure to predict the financial crisis which has been linked to a credit boom in the U.S. and U.K. housing markets (Bezemer, 2009a, Stiglitz, 2011). It is even argued that all boom-bust cycles are due to bank credit growth for non-GDP transactions (the 'Quantity Theory of Credit', Werner, 1997, 2012).

Recently, a number of studies have demonstrated a link between monetary aggregates and output in general (Sousa and Zaghini, 2007), and, more specifically, between credit and financial crises, asset price bubbles and output (Hume and Sentance, 2009, Schularick and Taylor, 2009, Cappiello *et al.*, 2010, Barnett and Thomas, 2013, Aikman *et al.*, 2014). Rondorf (2012) and Leroy (2014) showed that in Europe bank loans are important for output growth. In addition, the Bank of England and UK Treasury have initiated policies designed to boost particular forms of credit such as 'Funding for Lending' to support small businesses. Related policies have been adopted by the Bank of Japan (Bank of Japan, 2014) and the European Central Bank (ECB, 2014).

At the same time, central banks have also begun (re-)introducing policies aimed at restricting certain forms of credit. In particular, macroprudential policies have been introduced to reduce mortgage lending – for example, in June 2014, the first limits on the UK mortgage market in 30 years were implemented by the Bank of England, by the new Financial Policy Committee, restricting the amount that homeowners can borrow relative to their income.<sup>3</sup>

This paper is an empirical study of monetary policy in the United Kingdom which focuses on the above mentioned issues. It conducts a long-overdue horse race between potential variables that have in the past been identified by policy-makers as important in order to influence nominal GDP. Firstly, we examine the impact of various different monetary policy variables, including a real-economy disaggregated credit aggregate, in a general unrestricted single-equation model with nominal GDP growth as the dependent variable.<sup>4</sup> Following Lyonnet and Werner (2011), this allows competing theories, including the monetarist and Keynesian theories, as well as the Quantity Theory of Credit to be tested in a competitive setting. Thus we also include short- and long-term interest rates and

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<sup>3</sup> See Bank of England (2014), Executive Summary, page 1, available at <http://www.bankofengland.co.uk/publications/Pages/fsr/2014/fsr35.aspx> [accessed 15th August 2014].

<sup>4</sup> This follows the approach of Werner (1997) on Japan and Lyonnet and Werner (2012) on the UK, who examined a shorter series from 1995-2010 using a wider range of variables and with the single-equation method only. Nominal GDP is a widely accepted final target variable for central banks and many economists and commentators have argued it should be used instead of inflation – see McCallum and Nelson (1999), Romer (2011), Sumner (2012), Woodford (2014)

a broad money aggregate to represent alternative explanations of the monetary transmission mechanism. Secondly, we use a quarterly time series from 1963q1 (when accurate quarterly monetary aggregate series first becomes available) to 2012q4 (199 observations) to test our hypotheses against multiple regime shifts, time dynamics and effects of shocks. We model location shifts using Impulse and Step-indicator dummy saturation techniques (Santos *et al.*, 2008, Doornik *et al.*, 2013).

Given the failure of hypothetico-deductive equilibrium-based models to predict the financial crisis, including those relying on rational expectations and modeling the financial sector as a ‘friction’ (Driffill, 2011, Goodhart, 2009) we adopt an inductive methodology (Werner, 2005, 2011). Specifically, we employ the ‘General-to-Specific’ OLS econometric method (following Hendry and Mizon, 1978) to test the relative strength of the correlation of the different variables with nominal GDP. We 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- and long-term interest rates play a less significant role in the model with only a very small coefficient. We find similar results when we re-estimate the model in the Vector Autoregressive/Vector Error Correction (VECM) format. We tackle the problem of simultaneity between nominal GDP and credit with exogeneity and augmented Granger causality tests, finding support for unidirectional causation from credit to GDP.

The paper is laid out as follows: Section 2 reviews existing theories of the monetary policy transmission mechanism, focusing on recent developments such as QE and related unconventional monetary policy interventions since the 2007-2008 crisis. Section 3 describes the empirical methodology, data and related modelling decisions. Section 4 describes the results of the single equation ECM and VAR/VECM models. Section 6 concludes with implications for policy and suggestions for further research.

## 2. Developments in monetary policy theory and practise

Monetary policy – and the theory behind it - has undergone considerable change over the past half century. In the 1960s and early 1970s, central banks had multiple targets, paid close attention to the bank lending channel in the UK and many other western economies, with credit controls and credit guidance commonplace, either explicitly in the form of quotas or more implicitly via ‘moral suasion’ (Hodgman, 1973, U.S. Congress, 1981, Goodhart, 1989: 157-163).

In the 1970s, policy was influenced by monetarist theories which focused on the demand for bank liabilities (money) rather than the creation of bank assets (credit) as the key macroeconomic variable influencing consumption and nominal demand (Friedman and Meiselman, 1963, Friedman and Schwartz, 1963). However, these models were criticised for failing to establish causality (as opposed to correlation) between these variables and neglecting simultaneity and omitted variable bias (Ando and Modigliani, 1965, Kaldor, 1970). In addition, attempts to implement monetarist policies, via explicit attempts to control

monetary (but not credit-) aggregates, were largely unsuccessful in terms of stabilizing inflation or nominal demand.

In the 1980s, influenced by the Lucas (1976) critique that the parameters of standard structural equation models of the macroeconomy were not policy-invariant, there was a shift towards models with microfoundations where expectations could be more explicitly incorporated. Coupled with the apparent failure of Keynesian stabilisation policies to deal with the supply side shocks of the 1970s, this led macroeconomics to turn decisively towards a hypothetico-deductive methodological approach (Driffell, 2011). To make such micro-founded models tractable, it is necessary to involve hypothesised universal rules – or axioms – about the functioning of agents in the economy. These include the existence of representative agents with rational expectations operating in rich information environments with near-perfect foresight and frictionless or complete market clearing (Lucas, 1972, Phelps, 1973, Sargent and Wallace, 1975).

This new approach did not lead to an abandonment of the focus on money and the liabilities' side of bank's balance sheets, however. The financial innovations of the 1980s were perceived by some economists as one reason for the observed breakdown in the relationship between money on the one hand and inflation and output on the other, as 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'<sup>5</sup> (NMC) approaches advised that monetary policy should move away from quantities and onto 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 Vector Autoregression (VAR) models 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, based upon publically known rules to guide expectations, over and above other macroeconomic objectives, became the norm in the 1990s period in many developed countries.

## 2.1 BANKS AND CREDIT AS FINANCIAL 'FRICTIONS'

The modelling of monetary policy since the late 1980s, following Bernanke and Blinder (1989), has incorporated credit, banks and balance sheets primarily as 'financial frictions' within micro-founded, equilibrium based frameworks. In such models, economic shocks can be amplified via the 'credit channel', 'bank lending channel', 'balance sheet channel' or 'financial-accelerator' (Bernanke and Gertler, 1995, Kashyap and Stein, 1994, Bernanke *et al.*, 1999), potentially over long periods. Changes in credit are not seen as exogenously causing shocks or major changes to output or inflation, however. As Bernanke and Gertler (1995: 28) state, "the credit channel is an enhancement mechanism, not a truly independent

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<sup>5</sup> Sometimes also referred to as 'New Neoclassical consensus' or 'New Consensus Macroeconomics'.



or parallel channel." The typical empirical approach involves setting up structural models and then calibrating these with data to see if they appear accurate or estimating structural Vector Autoregression models (SVARs) representing reduced forms of these models and tests whether particular restrictions associated with different channels of monetary policy are satisfied in the face of exogenous shocks.

In a post-crisis review of the quantitative performance of a range of different New-Keynesian models with financial frictions, including SVARs, 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. In addition, the financial crisis appeared to be a case of the financial sector generating a shock (as proposed by (1986) rather than amplifying a shock generated from the real economy. 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.

## 2.2 QUANTITATIVE EASING AND THE ‘PORTFOLIO CHANNEL’

With the onset of the 2007-08 crisis, monetary policy underwent major innovations. With short-term base-rates having reached the ‘zero-lower bound’ largely without visibly stimulating economies following the 2007-2008 financial crisis, central banks engaged in large-scale purchases of long-dated assets to push down medium and long-term interest rates. Three main channels or ‘transmission mechanisms’ can be identified in the literature via which this version of ‘QE’ is said to make an impact on the economy (Bernanke and Reinhart, 2004, Bowdler and Radia, 2012).<sup>6</sup> Firstly, as commercial banks hold significantly higher levels of central bank reserves due to ‘QE’, it is argued that additional liquidity and reduced cost of funding enables them to increase their lending to the real economy (with some authors even suggesting that banks can ‘lend out’ those excess reserves). In the UK, the first phase of QE in 2009, when £200 billion was injected in the space of just six months, is said to have supported bank lending, or at least prevented a further fall in credit creation, although the Bank of England has played down this effect in its analysis (Bowdler and Radia, 2012).<sup>7</sup>

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<sup>6</sup> The authors also identify a fourth - via expectations, analysed via event studies linked to policy announcements. QE has been implemented differently in different countries with different types of assets purchased by different central banks. For an international review see (Joyce *et al.*, 2012)

<sup>7</sup> 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 SLS, and the partial nationalisations of RBS and Lloyds Bank via massive tax-payer-funded re-capitalisations. These interventions would appear to support the banking system more directly and hence prevent further contractions in lending.

Secondly, 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 low yielding assets (deposits).<sup>8</sup> It is hoped that investors will rebalance their holdings by seeking out similar kinds of financial assets, in particular corporate assets – bonds or equities (shares) – that will in turn support businesses operating in the real economy. For larger firms in particular, capital markets are considered to be an important substitute for bank credit. Both Keynesians (Tobin, 1969) and monetarists (Brunner and Meltzer, 1973) have in the past argued for such a portfolio substitution effect.

A third potential consequence of portfolio rebalancing is the ‘wealth effect’. This benefits banks, as the value of their capital rises. They may then pass this on via charging lower interest rates. The Bank of England has downplayed such an impact, too, 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 be a wealth effect for households if banks do increase lending against property, resulting in house price-rises. 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)

### 2.3 A CREDIT THEORY OF MONEY

It is now widely accepted that in modern economies, banks create money (deposits) when they expand their balance sheets in the act of lending (McLeay *et al.*, 2014, Ryan-Collins *et al.*, 2011). In this sense lending actually precedes savings and credit creation precedes and determines money balances (Caporale and Howells, 2001). Credit creation can thus be understood as an expansion of purchasing power and the flows of new credit-money shape the macroeconomic trajectory of the economy – they have ‘real’ effects. This ‘credit theory of money’ has a long historical tradition (Innes, 1914, Keynes, 1930, Fisher, 1933, Schumpeter, 1983[1911], Minsky, 1986). Schumpeter stressed the role of the ‘deposit-creating bank’ in ‘financing investment *without any previous saving up of the sums thus lent*’ (1994 [1954]: 1114-1115, italics in original). Similarly, Keynes noted that ‘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).

It has been noted in the literature that credit and banking crises tend to result in longer and more severe recessions or depressions than non-monetary crises (Kindleberger and Laffargue, 1982, Borio and Lowe, 2004, Jordà *et al.*, 2011, Aikman *et al.*, 2014). The idea that credit shocks can have a macroeconomic impact on the economy that is independent of broader aggregate demand shocks rests upon the existence of supply-side credit rationing (Keeton, 1979, Stiglitz and Weiss, 1981, Stiglitz and Weiss, 1992) by banks independently of the state of

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<sup>8</sup> 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.

demand, combined with the role of banks as creators of the money supply (Werner, 1997).

A recent historical study by the Bank of England, which used a credit variable in the context of a six-variable Structural VAR, found that between a third and a half of the fall in GDP relative to its historic trend can be attributed to credit supply shocks and a much weaker role for aggregate demand shocks (Barnett and Thomas, 2013). A study of Spanish bank lending used individual loan application data and controlled for the quality of firm, time of applications, general economic conditions and monetary policy interventions, was able to exclude reverse causality and found robust statistical evidence of credit rationing over the 2002-2008 period of economic expansion in Spain (Jiménez *et al.*, 2012: 6). Similarly, a panel study of the eurozone area 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 in the monetary policy strategy of the ECB” (Ciccarelli *et al.*, 2010: 6).

Whilst in monetarist and New-Keynesian perspectives, an implicit assumption is often made that all credit flows to the real (productive) economy, a significant proportion of bank credit may flow into existing financial assets, for example land or property or financial commodities. The influence of such credit flows on economic growth is at best indirect, since they are more likely to result in asset price inflation rather than new GDP-transactions. This distinction was recognized by Fisher (2006 [1911]) and also by Keynes, who related that whilst income transactions might be closely related to GDP, transactions in 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)

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  $M$  is split into separate credit flow aggregates and only credit created for real-economy transactions contributes to GDP growth, in contrast to credit created for the financial sector.<sup>9</sup> Werner (1997, 2005) provides empirical evidence from Japan that disaggregated credit to the non-financial private sector is a strong predictor of nominal GDP growth and helps explain long-term macroeconomic puzzles, such as the secular decline in the velocity of money and asset price bubbles and crises. Further empirical evidence consistent with the Quantity Theory of Credit is cited in Werner (2012). Moreover, Werner (2014) found that credit creation for GDP transactions in the Eurozone are a significant explanatory variable of nominal GDP growth, while government expenditure not backed by bank credit creation crowds out private demand, so that switching from bond issuance to government borrowing from banks via loan contracts is an effective and simple government policy (dubbed

‘Enhanced Debt Management’) to create a sustainable recovery in countries such as Spain and Greece.

Other disaggregated credit panel studies have also found a stronger correlation between credit to the non-financial corporate sector and economic growth than credit to the household sector (Beck *et al.*, 2008, Büyükkarabacak and Valev, 2010). In the UK case, empirical studies suggest household lending is an important contributor to GDP growth via consumption since the credit liberalization of the early 1980s (Muellbauer, 2009, Aron *et al.*, 2012) – a point further developed in section 3.2. These reforms allowed previously credit-constrained property-owning households to borrow for consumption purposes, using their homes as collateral.

### 3. Modeling approach and data

#### 3.1 THE ‘GENERAL TO SPECIFIC’ METHOD, COINTEGRATION AND EXOGENEITY TESTING

Given the competing theories described above we should be wary of *a priori* theoretical assumptions and restrictions when estimating an empirical model. We instead adopt the ‘General to Specific’ (GETS) methodology (Hendry, 1995, Mizon, 1995, Julia Campos *et al.*, 2005), which is akin to an inductive approach to econometric testing. We commence with a general unrestricted model (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 (2003). Selection is undertaken on the GUM in which valid reductions are applied to reduce the model to a parsimonious congruent specification. We utilize the ‘Autometrics’ search algorithm, which uses a tree-search to detect and eliminate statistically-insignificant variables (Doornik, 2009).<sup>10</sup>

The single equation GUM will be an Autoregressive Distributed Lag model of the general form:

$$y_t = \sum_{i=1}^I \alpha_i y_{t-i} + \sum_{k=1}^K \sum_{l=0}^L \beta_{kl} x_{k,t-l} + \sum_{i=1}^T \delta_i \mathbf{1}_{[t=i]} + \sum_{i=2}^T \gamma_i \mathcal{S}_{[t=i]} + \varepsilon_t \quad (1)$$

where  $\mathbf{x}_t = (x_{1,t}, \dots, x_{N,t})$  is an  $(N \times 1)$  vector of potential explanatory variables,  $\sum_{i=1}^T \mathbf{1}_{[t=i]}$  is a set of saturating indicators defined by  $\mathbf{1}_{[t=i]} = \mathbf{1}$  for observation  $t = i$ , and zero otherwise and  $\sum_{i=2}^T \mathcal{S}_{[t=i]}$  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  $\varepsilon_t$  is a white noise, serially uncorrelated error:  $\varepsilon_t \sim \text{LN}[\mathbf{0}, \sigma_t^2]$  for  $t = 1, \dots, T$ .

<sup>10</sup> 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).

Once a congruent GUM has been identified, a specific, parsimonious model is then estimated via valid reductions based on statistical significance from the general model, allowing 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 Quantity Theory of Credit perspectives (disaggregated credit flows), to be equally represented and encompassed in the GUM (Section 3.2).

### 3.1.1 VECTOR AUTOREGRESSION, VECTOR ERROR CORRECTION MODELS AND TESTING FOR EXOGENEITY

Single-equation modeling imposes assumptions about the exogeneity of the regressors. If there is 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), then a multivariate framework is required. As the contemporaneous values of the regressors are included in the single equation model we test the exogeneity assumption using a Vector Autoregressive (VAR) model, following Engle *et al.* (1983), in order to establish whether a single equation analysis is valid.

Consider a  $p$ -dimensional VAR with linear deterministic terms for  $\mathbf{y}_t$ , where  $\mathbf{y}_t$  is a  $(p \times 1)$  vector of endogenous variables at time  $t$ :

$$\Delta \mathbf{y}_t = \Pi \mathbf{y}_{t-1} + \sum_{i=1}^{i-1} \Gamma_i \Delta \mathbf{y}_{t-i} + \mu + \delta \tau + \varepsilon_t \quad (2)$$

where  $\varepsilon_t \sim IN_p(\mathbf{0}, \Sigma)$ , for  $\tau = 1, \dots, T$ . The starting values  $(\mathbf{y}_{t-1}, \dots, \mathbf{y}_0)$  are fixed,  $\Gamma_i$  are  $(p \times p)$  matrices and  $\Pi = \alpha \beta'$ , where  $\alpha$  and  $\beta$  are  $(p \times r)$  matrices of full rank. For  $I(1)$  cointegration analysis we require the roots of the characteristic polynomial to lie on or outside the unit circle, and we require the reduced rank condition for  $\mathbf{y}_t$  to be  $I(1)$  with  $r$  cointegrating vectors given by:

$$\text{rank}(\alpha_{\perp} \Gamma \beta_{\perp}) = p - r$$

where  $\alpha_{\perp}$  and  $\beta_{\perp}$  are orthogonal complements defined as  $[p \times (p-r)]$  matrices such that  $\alpha'_{\perp} \alpha_{\perp} = 0$  and  $(\alpha, \alpha_{\perp})$  has full rank, and similarly  $(\alpha'_{\perp} \beta_{\perp})$  has full rank.

## 3.2 DATA CHOICES

The original levels' data set runs from 1963(q1)-2012(q4). The data is non-seasonally adjusted and we use Year-on-Year (YoY) growth rates to de-seasonalise the data and concentrate on the medium term dynamics.<sup>11</sup> Our dependent variable is nominal GDP (YoYGDP) and we have four conditional variables: Broad Money (YoYBroadmoney), long- (LT\_Rate) and short- term interest rates (Bankrate) and the variable for credit to the real economy (YoYCreditRE). All data are quarterly since this is the most frequent period

<sup>11</sup> As noted by Cobham and Kang (2012), seasonal adjustment techniques of monetary data remains under discussion - see e.g. Hussain and Maitland-Smith (2003)

available for the variable of interest, nominal GDP. Where data were only available in weekly or monthly frequency, we used the value at the end of every quarter, 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 the table. A full list of all variables, their construction and sources is shown in Table 1.

As already noted, the Bank of England changed the main tools of monetary policy a number of times over the time period in question (credit quantities, monetary aggregates, short-term/long-term interest rates) and its mandate also changed significantly. Hence it is not possible to identify a consistent approach to targetting during the period in question – this might be possible for a shorter time period. Moreover, the point of this empirical test is to let the data tell us what kind of monetary policy tool and approach (monetarist, Keynesian, etc.) is more conducive to stimulate and stabilise nominal GDP growth.

Table 1: Data summary

<b>Variable name and abbreviation</b>	<b>Hypothesised effect</b>	<b>Series name</b> (BoE unless specified)	<b>Period</b>	<b>Code</b> (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	End of quarter	LPQAUYM  LPQAUZI

M4 liabilities to the private sector to 1995(Q3) level.				
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

Inflation is not included as a separate variable in the model, for a number of reasons: Monetary authorities and decision-makers in the economy are exposed to contemporaneous information on nominal, rather than real variables, and entering into contracts denominated in nominal, not real terms. Second, 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. Third, since the CPI is highly correlated with the GDP deflator, and since the latter is not only correlated with nominal GDP but a component of it, an inclusion of a price variable would bias the results.

For nominal monetary and disaggregated credit aggregates a new time series was constructed as the Bank of England does not publish unbroken measures back to 1963. The details with codes are provided in Table 1 above. For money, the Bank of England's 'Broadmoney' (previously M4) measure was used. For the disaggregated credit series, we use lending to Private-Non-Financial-Corporations (PNFCs) and lending to Households, following (Lyonnet and Werner, 2012). Lending to other financial corporations (OFCs) is thus excluded from this measure as our hypothesis is that such loans will not contribute to GDP-transactions. As shown in figures 1 and 2, lending to OFCs is highly volatile and there was a massive build-up in this type of lending prior to the financial crisis in 2007-2008.

Although a large proportion of lending to households will be for mortgages and hence may result in asset-price inflation rather than contributing to GDP-transactions, deregulation of the credit-market in the 1980s enabled households to borrow against the value of their homes – via home equity withdrawal - for consumption smoothing purposes (Muellbauer, 2002). House-price inflation is also thought to have asymmetric 'wealth effects' which will also stimulate consumption (Goodhart and Hofmann, 2008, Aron *et al.*, 2012).<sup>12</sup> As shown in Figure 2, there was a rapid rise increase household lending as a proportion of GDP from the 1980s in contrast to lending the private non-financial sector.

<sup>12</sup> Another form of lending that likely contributes to both GDP transactions and asset-prices is commercial real estate lending, which makes up a significant proportion of lending to non-financial corporations. Again, however, it is difficult to disentangle the effects. One option would have been to use the Bank of England's 'industrial Analysis of MFI lending' series – see <http://www.bankofengland.co.uk/statistics/pages/iadb/notesiadb/industrial.aspx> -which would have enabled the removal of commercial real estate lending. However, this series is only available back to 1986 and excludes non-UK bank sterling lending.

Figure 1 demonstrates the growth rate of lending to households is considerably smoother than lending to private non-financial corporations, supporting the idea that it plays an important role in dampening this pro-cyclicality.

[Figure 1 here]

In the late 1990s and 2000s, there were a number of changes to monetary and credit aggregates caused by changes to the Bank of England'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 into billions, are not captured in the Bank of England's levels data but are captured in the Bank's 'quarterly changes to amounts outstanding' or 'flows' data series.<sup>13</sup> For both Broadmoney and Credit to the Real Economy (CreditRE), we create new, break-adjusted levels' series by indexing against the 1963q1 level.<sup>14</sup> This gives a more accurate picture of the dynamics in monetary aggregates over time and avoids the use of dummies relating to definitional changes for this period.

[Figure 2 here]

Prior to Q2 1975, the Bank of England did not include data on unsecured lending to households, lending to non-incorporated companies or not-for-profit institutions serving households (NPISH) in its measures of lending to the economy.<sup>15</sup> 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.<sup>16</sup> Finally, we exclude the effect of securitization from credit and money series following the Bank of

### 3.3 STATIONARITY, COINTEGRATION AND STRUCTURAL BREAKS

Pre-estimate ocular examination suggested none of the variables were stationary in their levels and there was evidence of exponential trends. To remove trends and de-seasonalise the data, four-quarter or year-on-year (YoY) growth rates were taken for all data series:

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<sup>13</sup> See Bank of England, 'Changes, flows and growth rates', [http://www.bankofengland.co.uk/statistics/pages/iadb/notesiadb/changes\\_flows\\_growth\\_rates.aspx](http://www.bankofengland.co.uk/statistics/pages/iadb/notesiadb/changes_flows_growth_rates.aspx) [accessed 16th December 2013]

<sup>14</sup> 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.

<sup>15</sup> see 'New Banking Statistics', article in Bank of England Quarterly Bulletin, Q2, 1975, pp162-165, available online at

<http://www.bankofengland.co.uk/archive/Documents/historicpubs/qb/1975/qb75q2162165.pdf>

<sup>16</sup> This decision followed consultation with the Bank of England (16<sup>th</sup> January 2014) – email correspondence is available upon request.



$$YoYx = \frac{(x_t - x_{t-4})}{x_{t-4}} \quad (3)$$

This is the close approximate equivalent of the taking the seasonal ( $t-4$ ) difference of the log of each variable (Charemza and Deadman, 1992: 38). Unit-root testing of the growth rates, using the Phillips-Perron (1988) approach that accounts for structural breaks showed that all YoY variables were I(1). Results are available on request.

The GUM is initially specified in YoY growth rates with five lags of each variable. This is sufficient to eliminate residual autocorrelation. Selection tests remain valid with integrated data and most diagnostic tests, excluding heteroskedasticity, also remain valid (Sims *et al.*, 1990, Wooldridge, 1999).

Figure 3 shows that there was considerable volatility in the growth rate series in the 1970s and early 1980s periods. 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 liberalized, enabling consumption smoothing via home equity withdrawal (Aron *et al.*, 2012).<sup>17</sup>

[Figure 3 here]

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) which involves adding an indicator variable for each observation. Castle *et al.* (2012) and Hendry *et al.* (2004) outline the procedure in which selection eliminates the statistically insignificant indicators and retains the most significant. Johansen and Nielsen (2009) show that under the null that there are no outliers,  $\alpha T$  indicators will be retained on average for a significance level  $\alpha$ , and simulations under the alternative demonstrate a high power for location shifts, even in dynamic models. Steps are also included to detect location shifts, denoted step-indicator saturation (Doornik *et al.*, 2013).

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<sup>17</sup> In a comparative study of the relationship between credit, housing collateral and consumption, Aron *et al.* (2012) note that in the UK, prior to the liberalization of credit in the early 1980s, find no evidence of a relationship between consumption-to-income and housing wealth-to-income ratios. Post- the credit liberalization, however, consumption becomes less volatile and clearly correlated with household wealth, providing strong evidence of a consumption smoothing collateral channel. See also Goodhart and Hofmann (2008)

## 4. Empirical results

### 4.1 SINGLE EQUATION MODEL

Rather than jointly selecting the relevant indicators and step-dummies with the variables, we first apply step- and indicator-saturation 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 – and three step-indicators, indicating location shifts, for 1974q1, 1976q4 and 1981q2. These indicators match with the oil shocks and financial liberalization policy changes described above.

We add the indicator variables to our GUM and find a well-specified general model. The general model in levels with YoYGDP as the dependent variable is estimated over 1965q2-2012q4, and includes 5 lags of all conditioning variables, 5 lags of the dependent variable, and the 6 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 test for a break after 1998q4. Graphical inspection (figure 4) shows a good fit of the scaled residuals ( $r$ ), residual distribution and autocorrelation function (ACF), confirming the model is robust. (Full results available on request.)

[Figure 4 here]

Selection is applied using *PCGive's Autometrics* software at a 5% significance level. The final selected model is reported below, where \*\* denotes significance at the 5% level and \*\*\* significance at the 1% level. (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%.

#### 4.1.2 PARSIMONIOUS $I(1)$ SINGLE EQUATION MODEL

OLS, using observations 1965:2-2012:4 (T = 191)

Dependent variable: DYoYGDP

	$\beta$	<i>t-ratio</i>
Const	0.01	3.10
YoYCreditRE	0.23	5.26
YoYCreditRE_2	-0.39	-3.72
YoYCreditRE_3	0.51	4.79
YoYCreditRE_5	-0.26	-5.58
LT_RATE_1	0.00	5.41
ImpD__1975_1_	0.04	2.34

ImpD__1979_1_	-0.03	-2.44
ImpD__1979_3_	0.05	3.39
StepD_1974_1_	-0.07	-9.36
StepD_1976_4_	0.04	6.40
StepD_1981_2_	0.04	6.96
YoYGDP_1	0.51	9.85
YoYGDP_2	0.20	3.60
YoYGDP_4	-0.41	-8.57
S.E. of regression	0.014	
Adjusted R-squared	0.92	

Growth of Broadmoney and short-term interest rates are ejected from our parsimonious model and whilst the long-term rate is retained, it has the opposite sign to what might be expected (positive rather than negative, see Werner, 2005) and a very weak coefficient. By contrast, the growth rate of credit to the real economy (YoYCreditRE) is highly significant with a net coefficient of 13%. Lags of GDP are also significant with a net coefficient of 30%. From this parsimonious model we can deduce a dynamic short run *Error Correction Term* which shows a strong relationship between YoYGDP and YoYCreditRE:

$$ECM = YoYGDP - 0.015 - 0.132 \times YoYCreditRE - 0.0048 \times LT_{Rate} \quad (4)$$

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 (figure 5 – top graph).

[Figure 5 here]

We then transform the GUM to I(0) space by differencing and including the lagged ECM in (9). Rather than including the indicators restrictedly in the cointegrating space, the ECM is entered excluding the indicators and the six indicators are included separately so they enter unrestrictedly. Note that there are now 4 lags of the differences of each variable. We drop Bankrate and Broadmoney from the GUM, as they were dropped from our I(1) GUM but include the same set of indicators. Model selection is again applied using Autometrics and delivers the following parsimonious Error Correction Model (ECM):

#### 4.1.3: SINGLE EQUATION I(0) ERROR-CORRECTION MODEL

OLS, using observations 1965:2-2012:4 (T = 191)

Dependent variable: DYoyGDP

	B	t-ratio
DYoYCreditRE	0.225	*** 2.7602

DYoYCreditR_1	0.091		1.1603
DYoYCreditR_4	0.382	***	5.1779
ImpD_1975_1_	0.0445	**	2.5557
ImpD_1979_3_	0.0497	***	3.1923
StepD_1974_1_	-0.0727	***	-9.7356
StepD_1976_4_	0.044	***	6.6015
StepD_1981_2_	0.0401	***	7.3817
ECM_1	-0.691	***	-12.4924
DYoYGDP_1	0.189	***	3.0897
DYoYGDP_2	0.376	***	6.3274
DYoYGDP_3	0.459	***	7.9243

S.E. of regression            0.014837  
Adjusted R-squared            0.570378

### Diagnostic tests

AR 1-5 test:	F(5,173) =	2.2037 [0.0561]
ARCH 1-4 test:	F(4,182) =	1.6121 [0.1731]
Normality test:	Chi <sup>2</sup> (2) =	1.8919 [0.3883]
Hetero test:	F(17,170) =	2.0336 [0.0119]*
Hetero-X test:	F(38,149) =	1.6926 [0.0141]*
RESET23 test:	F(2,176) =	0.0369 [0.9638]

The lagged Error Correction Term (*ECM\_1*) 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 (4). The long-term interest rate (*LT\_Rate*) falls out of the model (although it is captured in the *ECM* term) and the 1979q1 impulse indicator also falls out. The 1<sup>st</sup> lag of *DYoYCreditRE* 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. Again the model passes all diagnostic tests at the 5% significance level.

## 4.2 VECTOR AUTOREGRESSIVE AND VECTOR ERROR CORRECTION MODELLING

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, as previous studies have found. In addition, this approach makes implicit assumptions about the endogeneity of the variables and there are concerns about reverse feedback from YoYGDP to YoYCreditRE. This leads us to estimate a VAR for the above model.

### *4.2.1 UNRESTRICTED VAR 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 with six lags, we drop the short-run bankrate variable which we have already seen to be relatively insignificant in the single-equation model. We

again initially run indicator saturation across all variables in unrestricted form to ascertain significant impulse and step dummies. We then estimate the VAR with an unrestricted constant and indicators. The VAR is reasonably well specified, see figure 6 for the graphical diagnostics.

[Figure 6 here]

We then run the Johansen (Johansen and Juselius, 1990) multivariate Maximum-Likelihood cointegration test to ascertain the number of cointegrating vectors:

<b>Johansen MLR test for cointegration</b>					
<b>Unrestricted constant</b>					
<b>Lags 6</b>					
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]	

\*\* = reject null hypothesis of a unit root at 1% significance;  
 \* = reject at 5% significance

The trace and max eigenvalue tests suggest the existence of 2 cointegrating vectors at the 1% significance level when using an unrestricted constant and restricted trend.

#### 4.2.2 VECTOR ERROR CORRECTION MODEL AND TESTS FOR WEAK EXOGENEITY

We re-estimate the model as a ‘Vector Error Correction Model’ (VECM) with a rank of 2, an unrestricted constant with no trend and add the indicators in unrestricted form. The long-run cointegrating relations are given in equation (10):

$$\begin{matrix} \hat{\epsilon} \\ \hat{\epsilon} \\ \hat{\epsilon} \\ \hat{\epsilon} \end{matrix} \hat{b} \begin{matrix} YoYGDP \\ YoYCreditRE \\ YoYBroadmoney \\ LT\_Rate \end{matrix} \begin{matrix} \hat{u} \\ \hat{u} \\ \hat{u} \\ \hat{u} \end{matrix} \quad (5)$$

[standard errors in brackets]

We can see in figure 5 (middle graph) that the first cointegrating vector in Equation (5) largely resembles the single equation *ECM* (Equation (4)), confirming the validity of this approach. The second cointegrating vector (bottom graph of Figure 5 and Equation 5) suggests an equilibrium-correction relationship between Credit and Broadmoney growth which we would expect if

we accept the Credit-Theory of money approach - that loans create deposits. ADF-Cointegration tests find both cointegrating vectors are stationary.

We test the restriction that the  $\alpha$  coefficients on YoYCreditRE are zero on both Cointegrating vectors to test for weak exogeneity of Credit growth. This restriction is accepted at the 1% significance level [ $\chi^2(2) = 3.7096 [0.1565]$ ]. We then restrict the short-run coefficients on the long-term interest rate and YoYCreditRE jointly for weak exogeneity and this restriction is also accepted at the 1% level [ $\chi^2(4) = 5.7152 [0.2215]$ ].

Finally, we test for weak exogeneity in the growth of Broadmoney. In this case the restriction that the  $\alpha$  coefficient on YoYBroadmoney is equal to zero is not accepted (although only at the 10% significance level -  $\chi^2(2) = 6.9832 [0.0305]^*$ ), and it would appear that there may be short-term feedback between Broadmoney and the other variables. As a result we re-ran our single equation model 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 very tiny coefficients, so makes little difference to our model.

From a theoretical perspective, short-term feedback from YoYBroadmoney could perhaps be seen as supporting the portfolio-rebalancing or Post-Keynesian 'liquidity-preference' approach (sections 2.3 and 2.5). 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 (Arestis and Howells, 1999).

Our final restricted VECM is presented in Equation 6:

$$\begin{array}{r}
 \hat{\epsilon} \\
 \hat{\epsilon} \\
 \hat{\epsilon} \\
 \hat{\epsilon} \\
 \hat{\epsilon} \\
 \hat{\epsilon}
 \end{array}
 \begin{array}{c}
 \hat{a} \\
 YoYGDP \\
 YoYCreditRE \\
 YoYBroadmoney \\
 LT\_Rate
 \end{array}
 \begin{array}{cc}
 1 & 2 \\
 -0.49(0.06) & 0.032(0.03) \\
 0 & 0 \\
 -0.063(0.05) & 0.111(0.02) \\
 0 & 0
 \end{array}
 \begin{array}{c}
 \hat{u} \\
 \hat{u} \\
 \hat{u} \\
 \hat{u} \\
 \hat{u} \\
 \hat{u}
 \end{array}
 \quad (6)$$
  

$$\begin{array}{r}
 \hat{\epsilon} \\
 \hat{\epsilon} \\
 \hat{\epsilon} \\
 \hat{\epsilon}
 \end{array}
 \begin{array}{c}
 \hat{b} \\
 YoYGDP \\
 YoYCreditRE \\
 YoYBroadmoney \\
 LT\_Rate
 \end{array}
 \begin{array}{cccc}
 1 & 1 & -0.148(0.05) & 0 & -0.005(.00) \\
 2 & 1.279(0.31) & 1 & -1.634(0.21) & 0
 \end{array}
 \begin{array}{c}
 \hat{u} \\
 \hat{u} \\
 \hat{u} \\
 \hat{u}
 \end{array}$$

#### 4.2.3 TESTING FOR STRONG –EXOGENEITY: AUGMENTED GRANGER CAUSALITY TESTS

As our variables are non-stationary and/or cointegrated, we adopt the Toda-Yamamoto (1995) 'augmented Granger causality test' as described in [section 3.1.1](#), which involves adding an additional lag  $m$  to the VAR according to the  $m$ th order of integration to ensure asymptotic properties on the  $\chi^2$  test for the reduction. Using the original unrestricted VAR estimated in section 4.2, we add

one additional lag to the 6 that were originally estimated as our variables are all I(1). We keep the indicators and constant unrestricted as before. The full VAR equations are reported in the appendix. We then conduct Wald-tests on the variables of interest to test for Granger-non-causality and derive strong exogeneity.

The VAR augmented Granger-causality tests 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. Meanwhile, since past occurrences of YoYCreditRE can be excluded from the YoYGDP VAR, we can say that YoYCreditRE is strongly exogenous of YoYGDP as we showed in section 4.2.2 that it was weakly exogenous. 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 Error Correction equations (equations (4) and (6)).

Table 2: Toda-Yamamoto Granger non-causality tests

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

\*Exclusion rejected at 5% significance level

\*\*Exclusion rejected with 1% significance level

The 1% rejection of exclusions of YoYCreditRE on YoYBroadmoney again supports the Quantity of Credit-approach, 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 (nominal) YoYGDP which we would expect in a monetary policy regime which has been mainly focused on inflation for most of the period under question.

## 5. Conclusions

The relationship between monetary policy and output and the monetary policy transmission mechanism are contested areas of macroeconomics, even more so following the financial crisis of 2007-2008. Different theoretical and methodological perspectives have led to diverging propositions concerning the relations between variables. Causality has been difficult to pin down. At the same time, policy has undergone major shifts, reflecting both theory and practical experience.

In this study, rather than constraining our empirical investigation by adopting any particular theoretical perspective, we begin with a general unrestricted model (GUM) that encompasses a wide range of theories, including Monetarist, New Keynesian, QE/portfolio re-balancing and credit approaches, with independent variables representing each approach tested for their correlation with GDP growth in a single equation model.

This study provides a number of innovations. By examining the UK experience over a 47-year period, with multiple regime shifts and shocks, we can better examine underlying long-term relationships in a way that has not previously been undertaken. The GETS approach essentially conducts a horse race between competing explanatory variables in a dynamic setting. Variables that do not add explanatory power are dropped out as insignificant. We check the robustness of our single equation finding by estimating complementary VAR and VECM models which allows us to test for the exogeneity of the variables.

The results suggest a long-run cointegrating relationship between the growth rate of nominal credit to the real economy (non-financial firms and households) and the growth rate of nominal GDP (figure 7). Nominal GDP growth is shown to be strongly exogenous of credit suggesting simultaneity is not a concern. This supports the Quantity Theory of Credit approach whereby credit creation and allocation decisions by the banking sector have an independent impact on the real economy. The research supports earlier empirical studies by Werner (1997, 2005), Voutsinas and Werner (2011) on Japan and Lyonnet and Werner (2012) on the UK that show disaggregated bank credit creation for the real economy is the most important predictor of nominal GDP growth when taking in to account a wide-range of alternative monetary policy instruments and variables. The findings also give further credence to an independent role for bank credit (shocks) in influencing nominal output over and above aggregate demand shocks, supporting 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).

[Figure 7 here]



The fact that short-term interest rates drop out of the model and long-term interest rates appear to have a relatively weak role raises questions about the efficacy of the strong focus on targeting interest rates as the main tool of monetary policy – supporting the findings of Werner and Zhu (2012), Zhu (2011) - whether by manipulation of the base rate, standard open market operations or large scale asset purchases/QE operations. Since QE as practised in the UK effectively bypassed the credit-creating banking system, relying instead on capital markets to buy corporate assets, this may be one explanation for why QE did not enable a more rapid recovery from the financial crisis of 2007-2008. Since short-term interest rates are eliminated in our horse race as failing to add explanatory power, the recent reversion of central bank policy from a focus on quantities to the price of money (interest) even at the zero bound (negative interest) is also not likely to be effective.

Instead, the central bank may wish to consider stimulating lending to the non-financial corporate sector more directly, which, excluding commercial real estate lending, has shown a steady decline (Figure 8) since the mid-1980s in relation to total lending. Policies that have been suggested include reducing capital requirements for SME-lending and raising them for property-related lending (Turner, 2013b), purchasing securitized SME loans, or changing the structure of the banking sector by introducing local banks focusing on SME lending, which is lending to the real economy (Werner, 2013a, 2013b). The latter would appear to have been an important factor in the enduring success of the German economy and its resilience during the recent crisis (ibid). Moreover, credit growth for GDP transactions, and hence nominal GDP growth, can also be enhanced by swapping government bond-finance with borrowing from banks ('Enhanced Debt Management', Werner, 2014).

[Figure 8 here]

A next step for this research would be to attempt a further disaggregation of the credit aggregate data, to wean out consumer and mortgage credit that simply contributes to asset price inflation as opposed to translating into consumption. Looking at Figure 7, with the exception of the highly unstable 1970s period, the periods in time when YoYCreditRE measure is higher than YoYGDP roughly correspond to the two housing booms in the 1980s and 2000-2007 periods, followed by periods where credit growth was slower than output growth. Finally, if data was available, a cross-country panel study would test the robustness of the findings across different institutional settings and monetary regimes.

Given our findings, it would seem that Benjamin Friedman's comment cited at the beginning has been accurate: the profession - and more so, the people of many countries - have lost a half-century in inferior economic performance to misguided monetary policy. It is high time policy-makers utilise the powerful role of bank credit in a fruitful way and for the common good.

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Figure 1: Credit aggregate to Private Non-Financial Corporations, Households and Financial corporations (Year-on-Year growth rates)

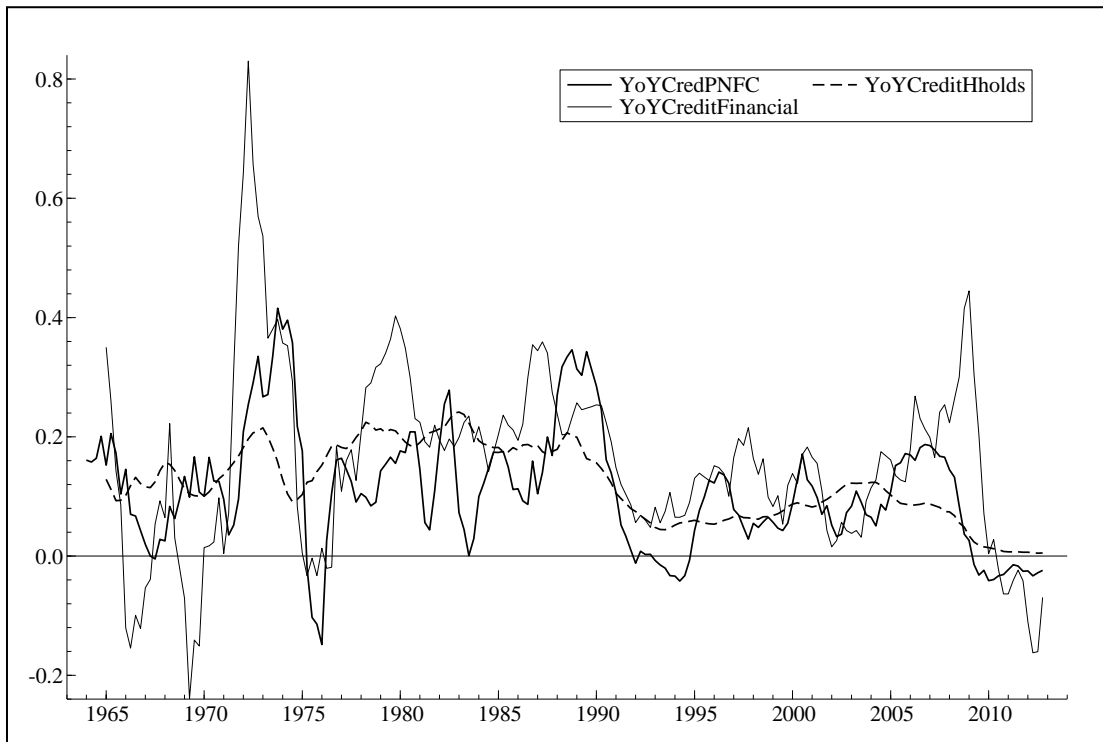


Figure 2: Credit aggregates (net lending outstanding) as a proportion of GDP growth, 1963q1-2012q1

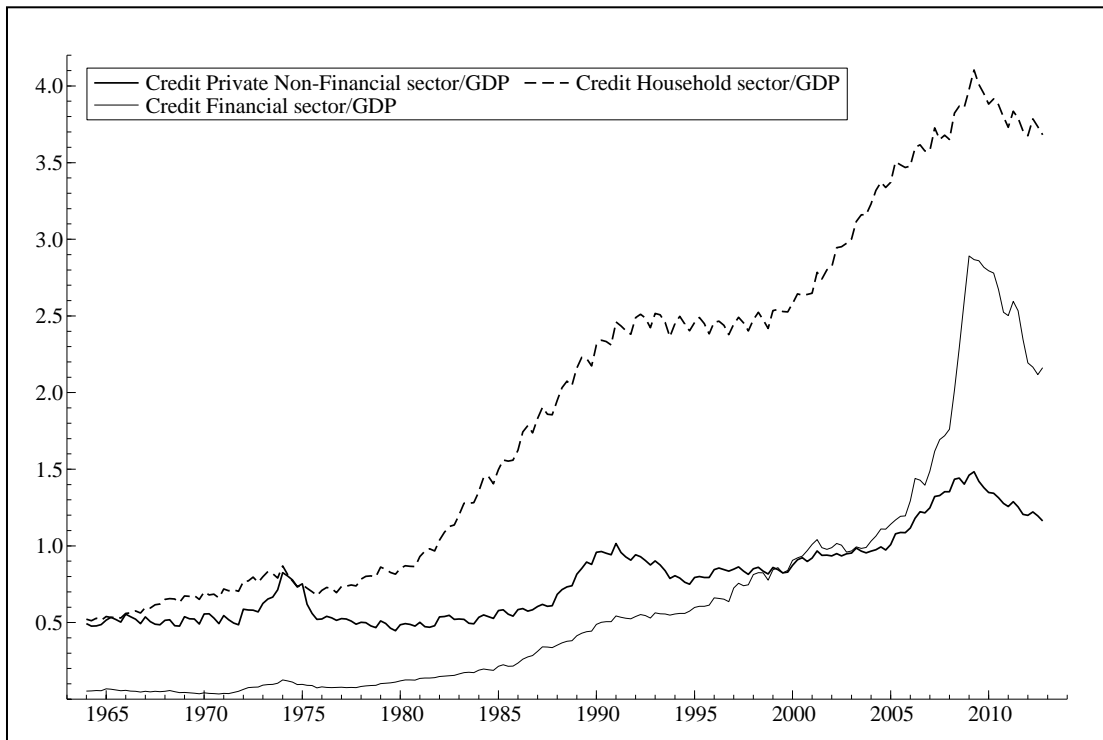


Figure 3: Time series plots of Year-on-Year growth rates and interest rate variables

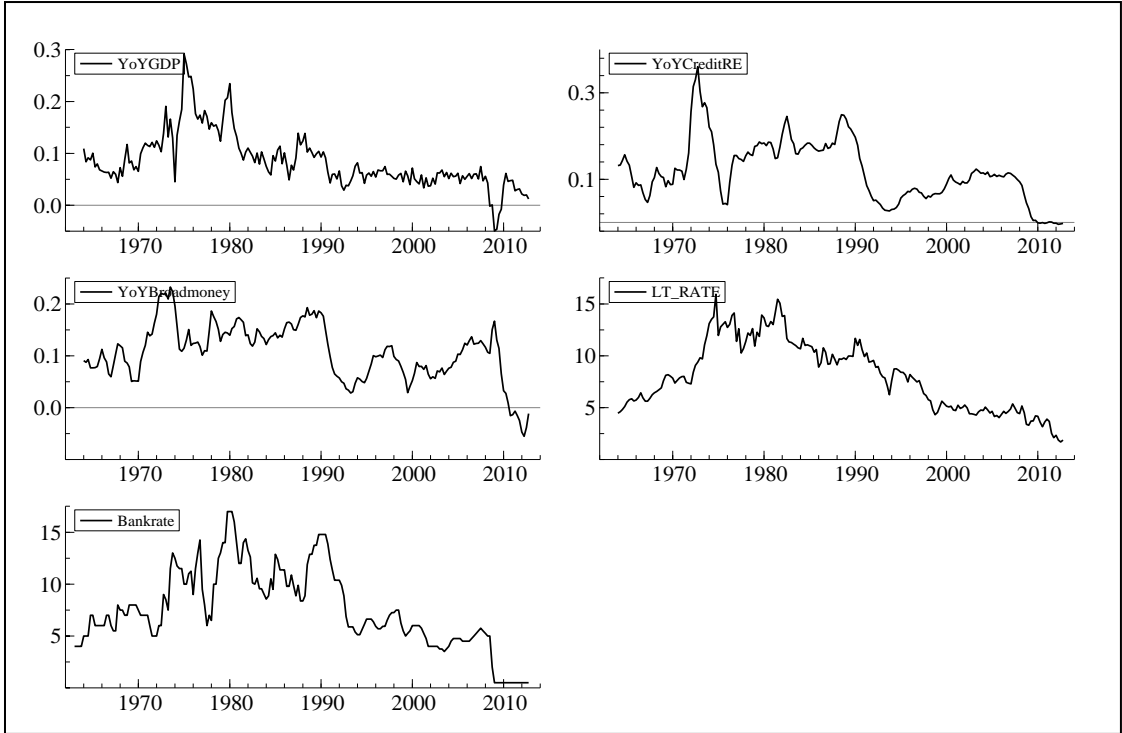


Figure 4: GUM 1 Diagnostic test plots

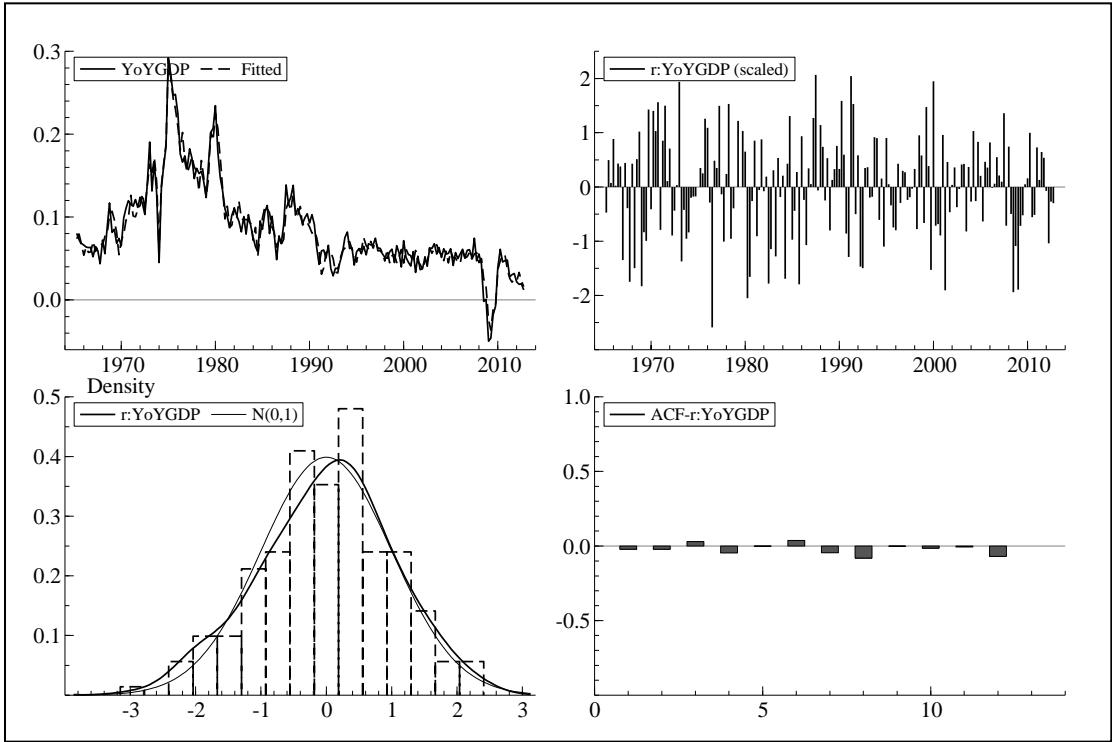


Figure 5: Error Correction and Cointegrating Vector plots

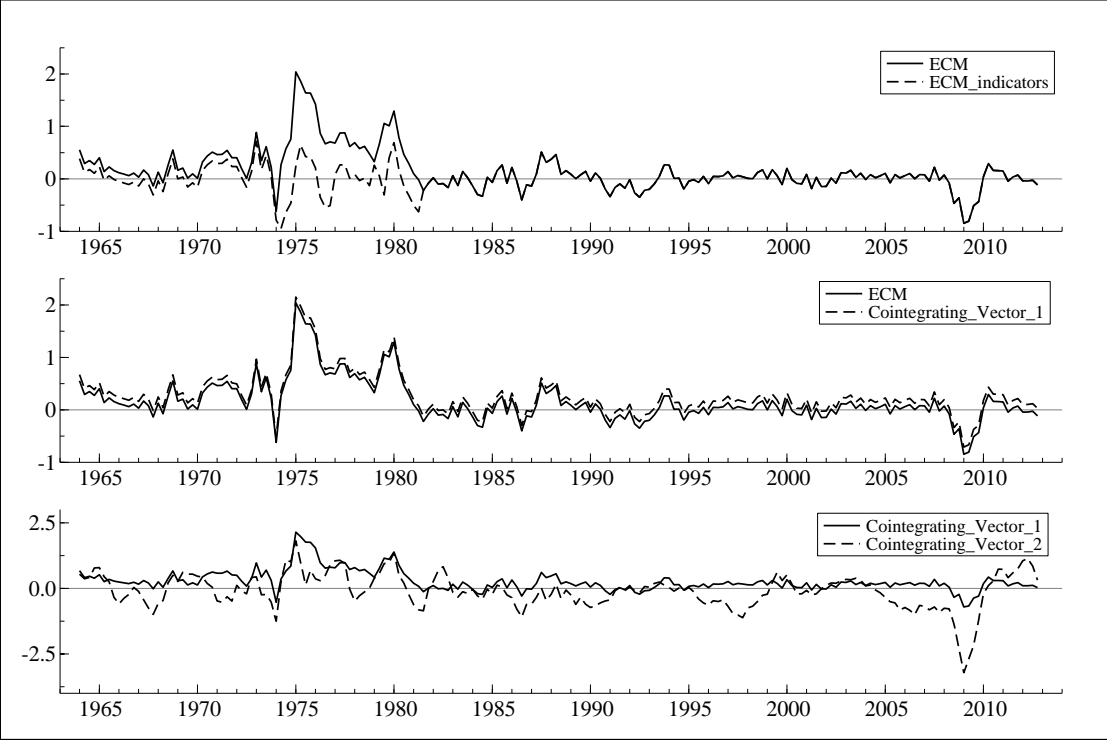


Figure 6: Unrestricted VAR(6) - diagnostics

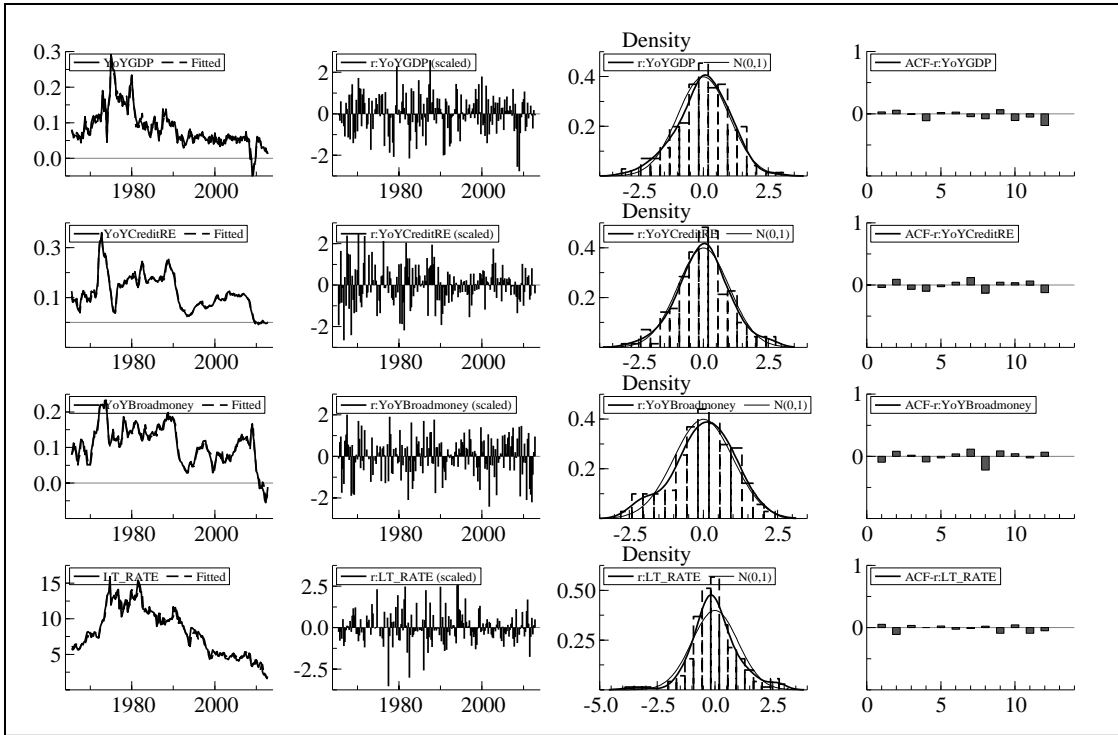


Figure 7: Plots of YoYCreditRE and YoYGDP

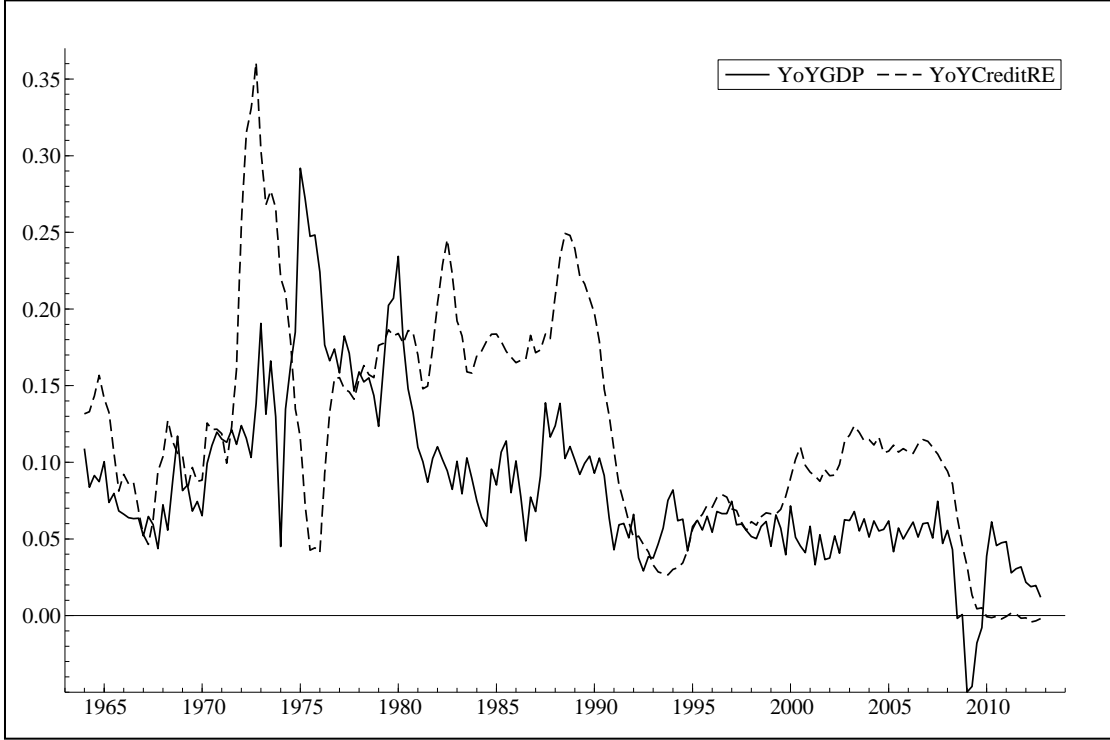
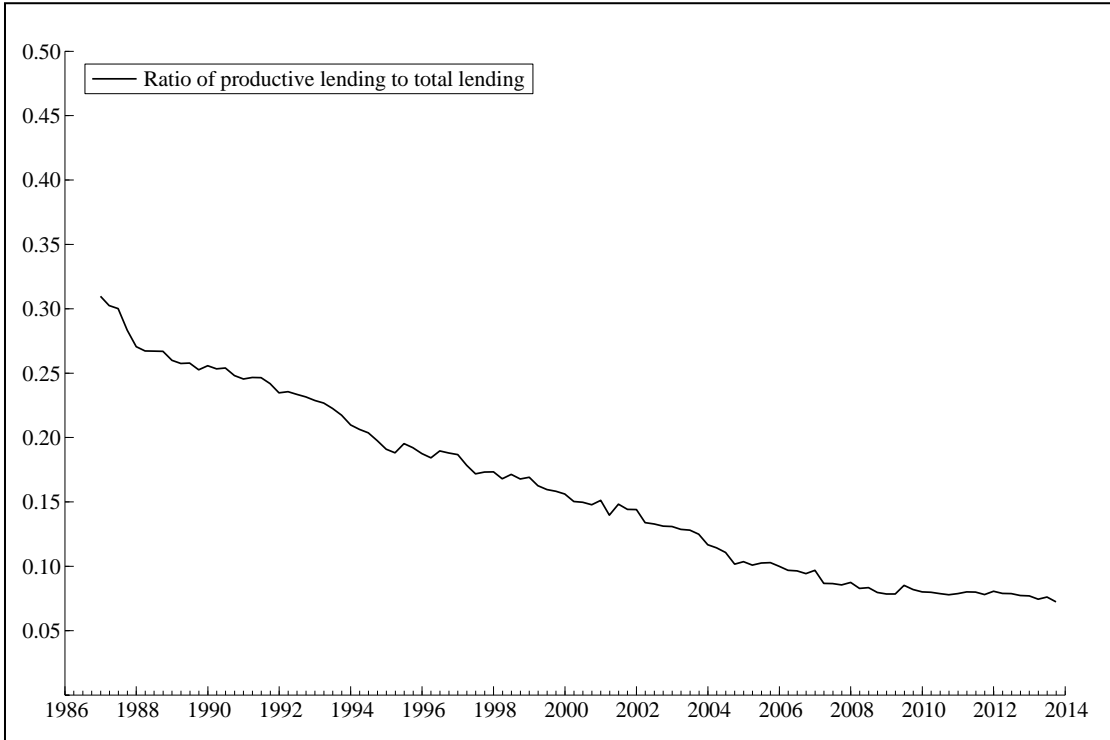


Figure 8: Ratio of UK domestic bank lending to non-financial corporations to total lending (excluding commercial real estate loans)<sup>1</sup>



<sup>1</sup> Bank of England's 'industrial Analysis of MFI lending' series – see <http://www.bankofengland.co.uk/statistics/pages/iadb/notesiadb/industrial.aspx> . Productive lending is made up of This series allows a more disaggregated breakdown of credit for GDP transactions, enabling us to remove commercial real estate. However, it was not used for the main study as it is only available back to 1986 and excludes non-UK resident bank lending.