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EXPLORING THE STEADY-STATE RELATIONSHIP BETWEEN CREDIT AND GDP FOR A SMALL OPEN ECONOMY

THE CASE OF IRELAND

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Abstract

The rapid increase in credit in an economy is now commonly perceived to be one of the leading indicators of financial instability. This view has been reinforced by the aftermath of the international financial crisis, which commenced mid 2007. A key policy response has been to focus on the ratio of private sector credit to GDP for an economy, observing, in particular, significant deviations between the actual and long-run trends of the ratio. This paper examines the issue of the steady-state relationship between private sector credit and GDP in the case of Ireland, a country which, even by international standards, experienced a sizeable expansion in credit over the past 10 years.

JEL classification: G01, E51, E63.

Keywords: Credit, GDP, Indicator.

Non-technical Summary

A rapid increase in credit in an economy is now commonly perceived to be one of the leading indicators of financial instability. In the aftermath of the recent crisis, a key policy response has been to focus on the ratio of private sector credit (PSC) to GDP. In particular, the Basel Committee on Banking Supervision has proposed that banks hold additional capital at times when the ratio of private sector credit to GDP grows more quickly than its long-run trend (the 'PSC-to-GDP gap'). Given the important role this indicator may therefore have in policy setting, it is important that the identification of periods of 'excessive credit growth' is accurate. This paper examines the measurement of the relationship between PSC and GDP for policy purposes in the case of Ireland.

In examining calculation methods for the PSC-to-GDP gap, this paper distinguishes between European countries which experienced a rapid build-up in credit before the crisis and those that did not. The paper argues that for those countries which did experience a rapid build-up in credit the current, most commonly proposed approach to calculating the gap (using a Hodrick-Prescott filter) may be particularly inappropriate. Specifically, this approach tends to be impacted by the recent history of the credit-to-GDP series. This may be unhelpful around a period of financial distress, such as a financial crisis, when the paths of the macroeconomy and financial sector are likely to change significantly in a short time period.

An alternative approach to measuring the PSC-to-GDP gap is developed in the case of Ireland, one of the countries which experienced the most rapid increases in credit before the crisis. Specifically, the paper identifies periods when the relationship between credit and GDP is stable (credit and GDP are growing at approximately the same pace) and periods when it is not (credit is growing significantly faster than GDP). By contrasting these differing periods, the paper provides an alternative method of calculating this indicator which may be more appropriate in countries that have experienced rapid build-ups in credit in recent years. Improving the calculation of this relationship is a key contribution of the paper, particularly given the potential role this ratio may play in policy-setting and as an early-warning indicator of financial instability.

Using the alternative calculation method outlined above, the paper develops a counterfactual scenario to examine the broader policy impact of targeting a PSC-to-GDP ratio. Specifically, the counterfactual scenario examines the impact of restricting PSC in the Irish economy to grow in line with household and non-financial corporate deposits. Traditionally, the amount of credit provided by banks was directly related to the level of deposits they held. However, over the past 10 to 15 years, financial innovation broke the link between credit and deposits. The resulting increase in credit has been identified by many as one of the main contributing factors to the 2007 financial crisis. The paper finds that, while restricting credit to grow in line with deposits would have resulted in a lower level of GDP preceding the boom period, the level of GDP post the onset of the crisis in late 2008/early 2009 would have been higher than what actually prevailed.

1 Introduction

As a result of the established link between credit booms and financial crises, excessive credit growth is now generally considered a reliable 'early warning indicator'. Traditionally, for most western countries, the amount of credit provision in an economy was directly related to the level of deposits within the financial system. However, over the past 10 to 15 years, financial innovation saw the link between credit and deposits broken with the consequent result of a general increase in credit provision. This sizeable build-up of credit has been identified by many as being one of the main contributing factors to the financial crisis, which orginated in mid 2007. As a result, greater attention is now focussing on determining what the *steady-state* level of credit should be for an economy and benchmarking this against the actual levels which pertain at a point in time.

From a macro prudential perspective, the ratio of private sector credit to GDP has become an increasingly popular benchmark of the sustainable levels of credit. Most recently, the Basel Committee on Banking Supervision (2010)[1] has issued a proposal to incorporate this approach into the regulatory system, by using the deviation from long-run trend of the PSC/GDP ratio (the 'credit gap') to calibrate a countercyclical capital buffer. In the first instance, this method uses the ratio of credit to GDP, thus allowing credit to grow naturally in line with overall economic activity. Trending techniques are then employed to generate a long-run mean for the ratio and the actual position is then contrasted with this mean.

In this paper we examine, in a rigorous manner, the nature of the credit to GDP relationship in an Irish case. Ireland, in many regards, represents the classic example of a country where a rapid and sustained accumulation of private sector credit resulted in deep financial instability. Since the mid 1990's, the Irish economy experienced profound economic change, having, in the 1980's, witnessed negligible economic growth, an average unemployment rate of 15 per cent and high levels of personal taxation. The emergence of the so-called *Celtic Tiger* in the mid 1990s led to a sustained period of economic growth. Between 1995 and 2007, the size of the economy doubled with the total number of people employed in the country increasing by approximately 64 per cent. This sustained increase

[1] See also, Drehmann et al (2010)

in income levels was coupled with a stable, low interest rate environment. At the same time, a considerable degree of financial liberalisation was taking place in the Irish credit market. Almost inevitably, a housing boom occurred, which, in terms of price increases and relative activity levels, was probably the largest across OECD countries for the period 1995 - 2008. The sharp contraction in the Irish property sector post 2008 has also been amongst the most significant in the western world with ensuing difficulties for the Irish financial sector.

In examining the ratio of Irish credit to GDP, we determine the presence of a number of different states in the relationship between these variables over the period 1982 - 2010. Based on this analysis, we determine the steady-state relationship between credit and GDP in the Irish economy and then perform scenario analysis to see what would have happened to Irish GDP between 1998 and 2010 if credit in the economy had grown more in line with deposit level growth over this period. Specific loan to deposit rates are used in this context as much of the sizeable increase in credit extended by the Irish financial system over the past 10 years was funded by access to wholesale money markets. When solvency issues concerning Irish institutions arose during the financial crisis, these markets were practically inaccessible for funding purposes.

In examining the Irish case, we think the results we obtain have a number of interesting policy implications. Firstly, they call into question the use of simple private sector credit to GDP ratios for countries who have experienced significant credit increases over the past 10 years. As we will see, while the Irish case may be somewhat extreme in terms of the growth of credit, it was by no means the exception in an European context. Indeed, it would appear that there has been an emergence of two clubs across European countries in terms of the growth rate of the PSC to GDP ratio. In modelling a relationship between credit and GDP, our results also suggest that there may have been significant benefits to linking credit expansion with that of deposits. Our analysis suggests that had credit growth been set relative to deposits in the pre-crisis period, by late 2008/early 2009 the level of GDP would have been higher than the actual level. This result is of particular interest from a policy perspective, as the program of support between Ireland and the IMF and EU agreed in Autumn 2010 specifically envisages a financial sector where credit expansion is more closely linked to deposit levels.

The rest of the paper is structured as follows; in the next section the relationship of credit and GDP is discussed in a broad policy context. The role of financial liberalisation in an Irish context is then examined. In particular we focus on the residential property market. An empirical section examines the issue of a structural break in the Irish ratio and a subsequent section presents a model of credit and GDP with a counterfactual simulation. A final section offers some concluding comments.

2 Credit to GDP and the policy environment

2.1 The role of credit in crises

The incidence of high credit growth in advance of financial crises has been recognised for some time. Numerous case studies have pointed to the incidence of high credit growth before crises (see, for example, Kaminsky's (1999) discussion of the Asian and Latin American crises in 1990s). In the empirical literature, there is significant evidence of a link between rapid credit growth increasing defaults. For instance, Dell'Ariccia and Marques (2006) predict that episodes of future defaults are more likely in the aftermath of periods of strong credit expansion. Segoviano Basurto et al (2006) show that credit to GDP is a good predictor of future defaults, while Clair (1992), Keeton (1999) and Salas and Saurina (2002) all link rapid credit growth with loan losses. Jimenez and Saurina (2006) find a direct, lagged relationship between credit cycles and credit risk.

Generally, this link between rapid credit growth and increasing defaults is linked to over-exuberant lending in the upswing of a cycle. During an upswing, the risk associated with loans may become underestimated. It has long been shown that there is an empirical link between GDP and credit growth. Additionally, there is evidence that banks' lending mistakes are more prevalent in economic booms (when GDP is increasing) than in recessions. There are a number of channels through which this link between rapid credit growth and increasing defaults may operate.

Asset prices play a key role in this. From a demand perspective, increasing asset prices during the upswing of a business cycle will increase the value of (property) collateral against which households and corporates can borrow. In addition, increases in other asset classes

can increase the net worth of borrowers. From the supply-side point of view, taking a stylised balance sheet in which assets equal liabilities and equity, an increase in asset prices will push up the value of equity enabling a bank to expand the asset side of its balance sheet by increasing lending (see, for instance, Adrian and Shin (2008)). The role of securitisation is also important in this process. For instance, the ability to move assets off balance sheet in such a situation allows banks to continue to expand the asset side of their balance sheet without a concurrent increase in liabilities.

A number of potential channels through which lending standards may decline in an upswing have also been put forward.[2] For instance, the traditional principal-agent problem may apply to the relationship between bank managers and shareholders. As shareholders have imperfect information, once the bank manager attains a rate of return which satisfies the shareholders, he may pursue objectives (for instance a growth objective) other than those which maximise the firm's value. Herd mentality (Rajan (1994)) relates to the requirement for managers to compete with others in the market. Credit mistakes are judged more leniently if they are common to the whole industry, while managers are likely to be punished by shareholders if they continually lose market share. As such, if competitors are pursuing market share objectives, it is in the interests of the individual bank manager to follow suit. The institutional memory hypothesis (Berger and Udell (2004)) posits that overtime banks weight less the experience of the last crisis. As crises generally happen irregularly, the longer the time period since the last crisis, the fewer staff there are who recall that experience. For staff that still remember the last crisis, there is the 'this time it's different' problem.

Finally, financial liberalisation, and the associated reduction in reserve requirements, and expansion of international flows of cheap money is another important means through which credit may expand.[3]

All the above factors may lead to a decline in the creditworthiness of borrowers which will increase the vulnerability of banks' loan portfolios to a shock to asset quality. When

[2]For a more detailed discussion of the literature, see Saurina and Jimenez (2006).

[3]Pill and Pradhan (1995) find that the ratio of private-sector credit to GDP best captures financial liberalisation, while Demirguc-Kunt and Detrgiache (1998) find limited evidence of the predictive power of this ratio of financial crises, when used as a proxy for financial liberalisation).

such a shock occurs, depositors (traditionally retail, but more recently, wholesale depositors) must reassess the safety of their savings in the bank, leading to funding liquidity pressures, and ultimately, insolvency, for those banks that are affected.

2.2 Credit as an early warning indicator

As a result of the established link between credit booms and financial crisis, excessive credit growth is now generally considered a reliable 'early warning indicator'. The issue in calibrating an early warning indicator is identifying credit growth that is justifiable based on economic fundamentals, and credit growth that may be deemed 'excessive'.

A number of different approaches have been taken to estimate this in the literature. Perhaps the most predominant method, in many respects, is the signalling approach, which is used in Kaminsky (1999), Borio and Lowe (2002), Hilbers et al (2005), Borio and Drehman (2009) and Alessi and Detken (2009). Most recently, the Basel Committee on Banking Supervision (2010)[4] has issued a proposal to hard wire this approach into the regulatory system, by using the deviation from long-run trend of the PSC/GDP ratio (the 'credit gap') to calibrate a countercyclical capital buffer. In the first instance, this method uses the ratio of credit to GDP, thus allowing credit to grow naturally in line with overall economic activity. The series is then de-trended using a Hodrick-Prescott (HP) filter, and a threshold level is then set, which weights in some way the relevant importance of type I (failing to give a signal when a crisis occurs) and type II errors (giving a positive signal when no crisis happens).[5]

There are a number of drawbacks associated with the hodrick-prescott approach. First, the HP filter fits a trend through all the observations of real GDP, regardless of any structural breaks that may have occurred. Such structural breaks could easily occur in long-run data. For instance, Rajan and Zingales (1998) among others, show that credit growth is stronger in developed economies than in less-developed economies. As such, many emerging

[4] See also, Drehmann et al (2010)

[5] Probably the most popular method is to minimise the noise-to-signal ratio; however, other methods can be used: Borio and Drehman (2009) examine two alternative approaches: minimise the weighted sum of type I and type II errors given weights of alpha and one minus alpha for type I and type II errors, respectively; and minimise the noise-to-signal ratio subject to predicting some minimum percentage of crises, X.

economies can rapid increases in credit related to a 'catch-up' process as the economy becomes more financially sophisticated. Such increases could be a perfectly appropriate and indeed necessary for the development of an economy, but could trigger a signal using the HP filter.

HP filters are also sensitive to end-point bias, as the trend line is fitted symmetrically through the data. If the beginning and the end of the data set do not reflect similar points in the cycle, then the trend will be biased upwards or downwards depending on the actual path of the series for the earliest and latest observations (Giorno et al., 1995). This issue may be reduced using ARIMA forecasts. In addition, HP filters are also sensitive to a time length selection; results from rolling HP filters may differ significantly from ex-post trend estimation (see Gourichas et al (2001)). Further, in the specific case of the PSC/GDP ratio, if GDP declines, but credit remains constant, a boom can be detected.

Finally, the outcome from a HP filter is sensitive to the smoothing parameter used. For instance, Borio and Lowe (2002) and Borio and Drehman (2009) use a lambda of 1600, the typical smoothing parameter for a business cycle. The BCBS use a smoothing parameter of 400,000, thus assuming that the credit cycle is 3-4 times the length of the business cycle. Figure 1 documents the gap between realised and trend for the Irish PSC/Credit ratio,with the trend estimated from a HP filter across a selection of lamda values. It is clearly evident that this change in smoothing parameters has a significant impact on the volatility of the detrended series. Drehman et al (2010) show these findings are repeated at the international level.

Other methods have also been used to estimate the steady-state level of credit. While a number of models have examined the determinants of credit demand or credit supply separately, modelling and estimation techniques in this area are complicated by the difficulty of disentangling supply and demand side effects. Hofmann (2001) uses a cointegrating VAR model on an individual basis for 16 industrialised countries. The findings are interpreted as long-run extended credit demand relationships, although some credit supply effects may also be captured. An error correction model is used to analyse dynamic interactions by computing orthogonal impulse responses. Eller et al (2010) estimate the long-run (demand-side) and short-run (supply side) determinants of private sector credit developments, first

identifying structural breaks in the data, then estimating a cointegrating VAR for a panel dataset, and then modelling short-run dynamics as an markov-switching error correction model allowing coefficients to vary in different unobservable states. Egert et al (2006) use an out-of-sample panel model to estimate the equilibrium level of credit in transition economies. Arguing that in-sample estimates are biased due to low initial levels of credit in what were once centralised economies, and because equation estimates for these economies are unstable, the authors use small open developed economies to benchmark equilibrium credit in transition economies.

The growing literature on DSGE models also includes some estimation of equilibrium levels of credit. For instance, using Baysan techniques, Gerali et al (2010) estimate a model in which impatient corporates and households demand loans supplied by imperfectly competitive banks using both deposits and capital (which is accumulated from reinvested earnings). Margins charged on loans depend on elasticities of loan and deposit demand, interest rate stickiness and banks' capital-to-assets ratio. Banks' balance sheet constraints establish a link with the business cycle, which affects profits and capital, and therefore the supply of credit.

3 Property prices and financial liberalisation - the case of Ireland

Since the early part of the last decade, the Irish economy and the property market, in particular, present as classic examples of excessive credit growth. Rapid expansion in private sector credit went hand in hand with a surge in both house prices and activity levels. In this section we briefly outline some of the changes in credit provision in the Irish banking sector and the impact this has had on the residential mortgage market.

The significant increase in the availability of mortgage credit in an Irish context can be observed in Table 1. The total value of mortgages issued increased threefold between 2000 and 2005. The total number of new mortgages went from just under 50,000 in 1995, to 80,000 in 2000 and to over 120,000 mortgages by 2005. The average size of a mortgage also increased considerably over the period. In 1995 the average mortgage extended by

an Irish credit institution was 54,094 euros, by 2005, this had climbed to 231,206 euros. Inevitably with such an expansion in credit, house prices increased substantially over the period. Between 2000 and 2007, prices rose by almost 65 per cent. The peak in house prices occurred in 2007 quarter two and since then the residential market has witnessed a substantial decline in activity as both housing supply and prices have fallen considerably.

This surge of increased credit availability came after a period of considerable financial deregulation and liberalisation in the Irish market. The mid to late 1980s and the 1990s saw the ending of the formal guidelines on bank lending to the private sector and the indicative guidelines on the sectoral allocation of credit by banks; the introduction of new interest-rate arrangements in 1985; a major relaxation of exchange controls in 1988 with a further relaxation in 1992. The primary liquidity ratio was also subject to liberalising measures as it was reduced four times from a level of 10 per cent in 1991 to 2 per cent in 1999, in conformity with the requirements of the new operational framework of the Eurosystem. The removal of credit and interest-rate controls would have given banks more freedom in determining the level and allocation of credit that they would like to supply. Furthermore, the removal of exchange-rate controls would have increased banks ability to attract deposits from non-residents.

Another seminal influence has been monetary union in Europe, which was quickly followed by the full integration of the euro area money market. A further feature of the liberalisation of the loan market was the cessation of Central Bank guidelines on the sectoral allocation of credit. This is highly relevant in the context of residential lending patterns as the Bank had consistently favoured the supply of credit to so-called *productive* enterprises and accordingly had discouraged its supply to the property market, which it had not perceived as being *productive*.

Traditionally, credit institutions total domestic deposit liabilities has been the main funding source for credit supply in the Irish market. However, an additional source of funding available over the past 10 years has been cross-border funding in the form of interbank borrowing and debt issuance. Such a source of funding was negligible before the mid-1990s but has grown exponentially since then. Both the timing of its emergence and its subsequent rate of growth would suggest that the funding rate has had a significant

influence on domestic economic activity and particularly that in the mortgage and housing markets. This issue is commented in more detail in Section 4 below. An exact chronology of the control and subsequent liberalisation of the Irish credit market is discussed in detail in Kelly and Everett (2004). See, in particular, Box 1 pgs 96 and 97, which illustrates the building and dismantling of controls over the period 1973 to 1999. Although many of these liberalising measures took place a long time ago, up to 20 years ago in some cases, their full effects may have taken some time to fully materialise. The relationship between house prices and greater availability of mortgage credit is examined in some detail in an Irish context by Fitzpatrick and McQuinn (2007). Using a variety of econometric techniques, they found a mutually reinforcing relationship between house prices and mortgage credit. In a related piece, Addison-Smyth, McQuinn and O'Reilly (2009) clearly demonstrate that the emergence and substantial increase in the ability of domestic banks to source funds from abroad had a significant impact on house prices post 2003.

4 Empirical examination

Our primary focus is on the relationship between GDP and private sector credit (PSC) in the Irish economy over the period 1982 - 2010.[6] In this analysis, private sector credit is defined as credit extended vis-a-vis private Irish residents by all resident credit institutions in Ireland. 'Private Irish residents' refers to individuals living in the State for at least one year, private non-profit making bodies and enterprises, which operate within the State. A 'resident credit institution' is one which is incorporated and located in the Republic of Ireland, including subsidiaries of parent companies located outside the Republic of Ireland; and branches of institutions that have their head office outside the Republic of Ireland. Reporting institutions report the data in respect of their resident offices only.

In Table 2 a summary of the data for certain sub-periods is presented. In Figure 2 we plot the real annual growth rates of GDP and PSC over the period. What is evident is that for much of the sample, the growth rates would appear to be highly correlated suggesting the possiblity of a long-run equilibrium relationship. However, for certain sub-periods it

[6] 1982 is the earliest date that data for PSC is available.

is apparent that any such relationship between the variables breaks down. From 1997 to 2001 and from 2003 to 2009 it is obvious that annual growth rates of PSC considerably exceeded that of GDP. This can be seen from Figure 3, which plots the ratio of PSC to GDP i.e. financial deepening. While the ratio is relatively stable between 1982 and 1997, thereafter, the growth rate would appear to experience two sharp increases. Particularly, from 2003 onwards, this period of PSC growth was funded primarily through cross-border funding in the form of interbank borrowing and debt issuance. Traditionally, in the Irish economy, a relatively stable relationship existed between PSC and retail deposits. However, the extent to which this relationship broke down can be gleaned from Figure 4. This plots both the actual level of credit and deposits in the left panel and the percentage difference (or funding gap) on the right. The scale of this funding gap suggests that in the absence of a significant increase in future deposit levels, the Irish banking system is facing into a period of considerable deleveraging, which unless focussed solely of non-core loans, mostly outside the Republic of Ireland, will have knock on implications for the domestic real economy.

While the build up of credit in an Irish circumstance has been somewhat extreme, the last 10 years has seen many European countries also experience significant increases. Figure 5 plots the degree of financial deepening for a sample of European countries from 1999 to the present. What is evident is the emergence of two clubs for this sample of countries. On the left hand side of the figure, the ratio is plotted for Ireland, the United Kingdom, Spain, Portugal and the Netherlands, while the remaining seven countries (Germany, France, Italy, Finland, Greece, Belgium and Austria) are plotted on the right. For the former set of countries, the ratio of private sector credit to GDP is around 200 per cent by 2010. This follows a period of sustained growth in the ratio, mainly from about 2003 onwards. While some countries in the latter category also experience growth, most of these countries have a ratio of approximately 100 per cent by 2010.

4.1 Structural break analysis

Earlier sections outline the shortcoming of basing new counter-cyclical capital requirements on HP filter techniques and argue targeting a steady state level would be more efficient. The problem is determining periods when the PSC/GDP ratio is at steady state level and

periods of deviation. In a formal, statistical manner, the possibility of multiple states in a relationship can be explored using a Markov Switching framework.

A regime-switching model combines two or more sets of parameters into one system and also the likelihood of each regime at a given time. We define a two state[7] Markov-switching model which allows for different means in the growth rate of PSC/GDP, taking the form,

$$\left(\frac{PSC}{GDP}\right)_t = \begin{cases} \alpha_1 & s(t) = 1 \\ \alpha_2 & s(t) = 2 \end{cases}$$

where $s(t)$ denotes the state the economy is in at time t. $s(t)$ is determined by a Markov chain which itself depends on a transition matrix. The transition matrix gathers the probabilities that one particular state is followed by another particular state. These transition probabilities are assumed to be time stationary.

Table 3 shows the growth rate of the PSC/GDP ratio moves discretely between two regimes; one characterised by a stable ratio oscillating around zero growth (state 1) and another defined as highly positive and more volatile (state 2). In fact, estimates show annualised quarterly growth of more than 12 per cent for state 2. This results in a credit boom any time the economy is in state 2. The model is well defined as the transition probabilities show the level of persistence in each regime is quite high indicating that when the economy is in a particular regime in one period, it is highly likely to remain in the next time period.

Figure 6 presents the time series dimension, showing a high and consistent probability of being in state 1 for the period 1983-1997. The model then estimates a switch, with PSC outpacing GDP until 2001 when a US recession stifled the Irish credit boom. In 2003, another switch occurs with PSC again outpacing GDP until the financial crisis of 2007/2008. This provides solid justification for estimating the steady-state relationship over the period 1983-1997.

[7]The regime classification measure (RCM) of Ang and Bekaert (2002) indicates that both regimes are clearly defined.

4.2 Empirical model

The results from the Markov switching regime approach are used to motivate the econometric analysis. In particular, these results suggest the presence of a clear structural break in the PSC to GDP relationship around 1998. In Table 3 we present the results of Granger causality tests for the period 1983 to 1997. Standard F-Tests would suggest that, in the long-run, credit appears to be a determinant of both itself and GDP, while GDP would only appear to be a determinant of itself. This is not an altogether surprising result given the manner in which credit was regulated in the Irish economy.

Based on this, we run a series of long-run regressions with GDP as the dependent variable and PSC as the regressor. Given the results from the structural break analysis, we conduct the estimation over the entire (1982 - 2010) period and over the sub-period 1982 - 1997. The results are summarised in Table 4.

In the interests of robustness, we use two long-run estimators. Along with OLS estimates, we also use the dynamic ordinary least squares (DOLS) methodology of Stock and Watson (1993). The DOLS estimator falls under the single-equation Engle Granger (Engle and Granger (1987)) approach to cointegration while allowing for endogeneity within the specified long-run relationships. Single equation approaches have been used in other models of the housing market, such as Muellbauer and Murphy (1997), Fitzpatrick and McQuinn (2007), McQuinn and O'Reilly (2007) and McQuinn and O'Reilly (2008).

The Stock and Watson (1993) DOLS approach explicitly allows for potential correlation between explanatory variables and the error process. It involves adding both leads and lags of the differenced regressors to the hypothesised long-run specification to correct for correlation between the error process.[8] In our application, the error term is assumed to follow an AR(2) process, while the number of leads and lags is set equal to 2.[9]

[8]The error term is liable to be serially correlated so the covariance matrix of the estimated coefficients must be adjusted accordingly. This involves modifying the covariance matrix of the original regressors by specifying and estimating an AR(p) model for the error term. See Fitzpatrick and McQuinn (2007) for more on this.

[9]We experimented with alternative values of k and length of the AR() process, however, our results were not significantly changed. Parameter estimates for the leads and lags in the DOLS estimation are available, upon request, from the authors.

The results clearly demonstrate a significant relationship between the variables. With both OLS and DOLS, the private sector variable is highly significant. Clearly, over the period 1982 - 1997, the coefficient on the PSC variable is somewhat greater than what it is when estimated over the entire period. As GDP doesn't grow at the same rate as PSC after 1998, the size of the coefficient on the PSC variable is, consequently, smaller for this period. Figure 4 plots the OLS residuals from the regression over the two sample periods. In comparison with the residuals estimated over the entire sample period, those estimated over the period 1982 - 1997 appear to be well-behaved and stationary.

4.3 Counterfactual scenario

Based on the long-run model estimated for GDP over the period 1983 - 1997, we also estimate the equivalent short-run model for both GDP and private sector credit. For the error-correction term, we use the residuals from the OLS regression of GDP on PSC. The results are summarised in Table 5 and it is evident, in the case of GDP, that the error correction term is negative and significant. Both short-term models have relatively high R^2s.

We then use the short-run model for GDP to perform a counterfactual simulation. The question asked is what would have happened to Irish GDP, post 1997, if credit in the economy had grown more in line with deposit level growth over this period. Two scenario levels of credit are accordingly used: (i) where PSC grew on a one-to-one basis with deposits (Scenario 1), and (ii) where credit grew by 1.2 times deposit levels (Scenario 2).

Specific loan to deposit (LTD) rates are used in this context as much of the sizeable increase in credit extended by the Irish financial system over the past 10 years was funded by access to wholesale money markets. When solvency issues concerning Irish institutions arose during the financial crisis, these markets were practically inaccessible for funding purposes. In the case of this first scenario, the explicit assumption is that lending in the domestic Irish banking system would have been funded entirely through domestic deposit levels and that institutions did not have recourse to wholesale funding over the period. The recent program of support agreed between the Irish Government and the IMF and EU sets out specific LTD targets for Irish financial institutions over the next three years.

The three different series for PSC are plotted in Figure 8. It is evident that under each scenario, the level of credit growth post 1998 is going to be substantially less than what actually occurred. In conducting the simulation, the results for the error correction model are used. Thus, given the moderate rate of credit growth assumed under the simulation, the assumption is that the economy responds in a steady-state like manner to this growth. In Figure 9 we then plot the actual level of GDP and the two simulated levels from the short-run model, as well as the percentage difference between the actual and scenario.

Under both scenarios, between 1998 and 2007, actual GDP levels were significantly higher than under the alternative credit level paths - for some years the difference is over 30 per cent. For the more conservative assumption on credit growth (the 1:1 relationship with deposits), it is evident that by 2010, actual GDP and the scenario level are pretty much the same. However, where credit grows relative to deposits, it can be observed that by late 2008/early 2009, the scenario level of GDP is greater than the actual level.

This contractionary impact of private sector credit on GDP has recently been the focuss of some interest. In a cross-country context, Lane and Milesi-Ferretti (2010) examine whether the significant build up in the ratio of credit to GDP prior to 2007 impacted negatively on the growth rate of GDP post 2008. Connor and O'Kelly (2010), in a counter-factual exercise, estimate the effect on Irish GDP between 2003 and 2008 if a stricter financial system regulatory regime had been in place during this period. The greater regulatory controls are simulated through lower levels of private sector credit levels due to reduced activity levels in the Irish residential and commercial property market.

5 Conclusions

A wealth of literature now links rapid credit growth with financial crises. Empirically, this has prompted a number of attempts to exploit data on credit growth to build early warning indicators of financial crises. From a policy perspective, the most recent example of this has been the proposed countercyclical capital buffer proposed by the Basel Committee on Banking Supervision. The proposal is to calibrate this buffer based on the deviation from trend (as calculated using a HP filter) of the PSC/GDP ratio.

We examine the use of such an approach in an Irish context. Even by international standards, post 2003, the accumulation of credit in the Irish economy has been considerable. The most obvious manifestation of this credit boom was through the residential housing market, where increases in Irish house prices were the largest over the last 10 years across OECD countries.

In examining the Basel proposal, the paper makes two contributions. First, it provides an alternative to the HP filter trending techniques by using a Markov switching framework. This determines periods of stability in the PSC to GDP ratio, thus allowing one to estimate the steady state relationship. A capital buffer to prevent excess credit can be based on deviations from this estimate. This would seem to be particularly warranted where a country experienced a rapid build up of credit. While Irish credit growth increased markedly over the past 10 years, it is worth noting that other European countries also experienced significant increases. Indeed the paper notes the emergence of a "twin club" development across Europe in that regard. Thus, we feel the notion of alternative states in the GDP to PSC ratio needs to be allowed for in applying the Basel proposal across countries.

Additionally, the paper examines a counterfactual scenario in which the expansion in credit is linked to that of deposits. The analysis suggests that there may have been significant benefits associated with such a link. Specifically, in such a scenario our results suggest that GDP would have been higher than the actual level from 2008/early 2009.

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Table 1: Summary Irish Residential Mortgage Market Statistics

Variable	Unit	1985	1995	2000	2005	2007	2009
Outstanding Level of Residential Lending	euros million	6,470	11,938	32,546	98,956	139,842	147,623
Total Value of Mortgages Issued	euros million	880	2,666	9,004	27,753	24,064	6,431
Average Mortgage Issued	euros	28,192	54,094	111,355	231,206	271,154	230,309
Total Number of Mortgages Issued		31,203	49,288	80,856	120,037	88,747	27,922
House Prices	euros	46,542	77,994	169,191	276,221	322,634	242,033
Housing Supply		23,948	30,575	49,812	80,957	78,027	27,142

Table 2: Descriptive Statistics of Irish Macroeconomic Variables %

Series	1983:4-2010:1	1983:4-1997:4	1998:1-2010:1	2003:1-2010:1	2007:2-2010:1
GDP	4.2	4.6	8.6	0.6	-4.7
Private Sector Credit (PSC)	9.5	6.1	16.1	11.7	5.6
Financial Deepening	98.2	61.4	97.0	171.4	219.2
Inflation	3.4	3.9	3.6	2.1	0.6
Funding Gap	28.6	11.6	29.1	61.6	77.1

Notes: The figures for GDP and PSC are real annualised growth rates, while the rest of the variables are actual rates. Private sector credit is defined as credit extended vis-a-vis private Irish residents by all resident credit institutions in Ireland. "Private Irish residents' refers to individuals living in the State for at least one year, private non-profit making bodies and enterprises, which operate within the State. A 'resident credit institution' is one which is incorporated and located in the Republic of Ireland, including subsidiaries of parent companies located outside the Republic of Ireland; and branches of institutions that have their head office outside the Republic of Ireland. Reporting institutions report the data in respect of their resident offices only.

Table 3: Estimates from Markov Switching Model

Variable	State	Estimate
σ	Non-Switching	5.875
		(0.000)
α_1	1	0.3244
		(0.22)
	2	3.335
		(0.000)
Expected Duration (time periods)		
	1	29.38
	2	13.66

Note:P-values are in parenthesis.

The transition probabilities matrix is given by,

$$\begin{pmatrix} 0.97 & 0.07 \\ (0.00) & (0.17) \\ 0.03 & 0.93 \\ (0.17) & (0.00) \end{pmatrix}$$

Table 4: Granger causality tests in levels: 1983:1 - 1997:4

Dependent Variable: *psc*		
Variable	F-Stat	P-value
psc	5.80	0.00
gdp	4.76	0.00
Dependent Variable: *gdp*		
Variable	F-Stat	P-value
psc	0.43	0.79
gdp	16.53	0.00

Table 5: Long Run Estimates of Irish GDP

	OLS	DOLS
	1982:4 - 2010:1	
psc	0.506	0.489
	(0.011)	(0.064)
	1982:4 - 1997:4	
psc	0.758	0.774
	(0.014)	(0.038)
	Cointegration test	
	6.3	
	Structural break test	
Test	Break-Points	
Bai-Perron	1997:03	2006:01

Note: Standard errors are in parentheses. The cointegration test refers to the Engle-Granger (1987) test and the statistic is the t-stat on the lagged residual term from the long-run regression run over the 1982:4 - 1997:4 time period.

Table 6: Short-Run Estimates of GDP and PSC 1983:1-1997:4

Dependent Variable	$\triangle gdp_t$	$\triangle psc_t$
ECT_{t-1}	-0.27	0.49
	(-2.37)	(3.75)
$\triangle gdp_t$		0.58
		(5.40)
$\triangle gdp_{t-1}$	-0.35	
	(-5.96)	
$\triangle psc_t$	0.48	
	(5.25)	
$\triangle psc_{t-4}$	0.26	0.38
	(2.78)	(3.40)
$\overline{R^2}$	0.91	0.82

Note: ECT = error correction term, t-statistics are in parenthesis.

Figure 1
Gap between the Realised and Trend Irish PSC/GDP Ratio using HP Filter for a Selection of Lamda Values

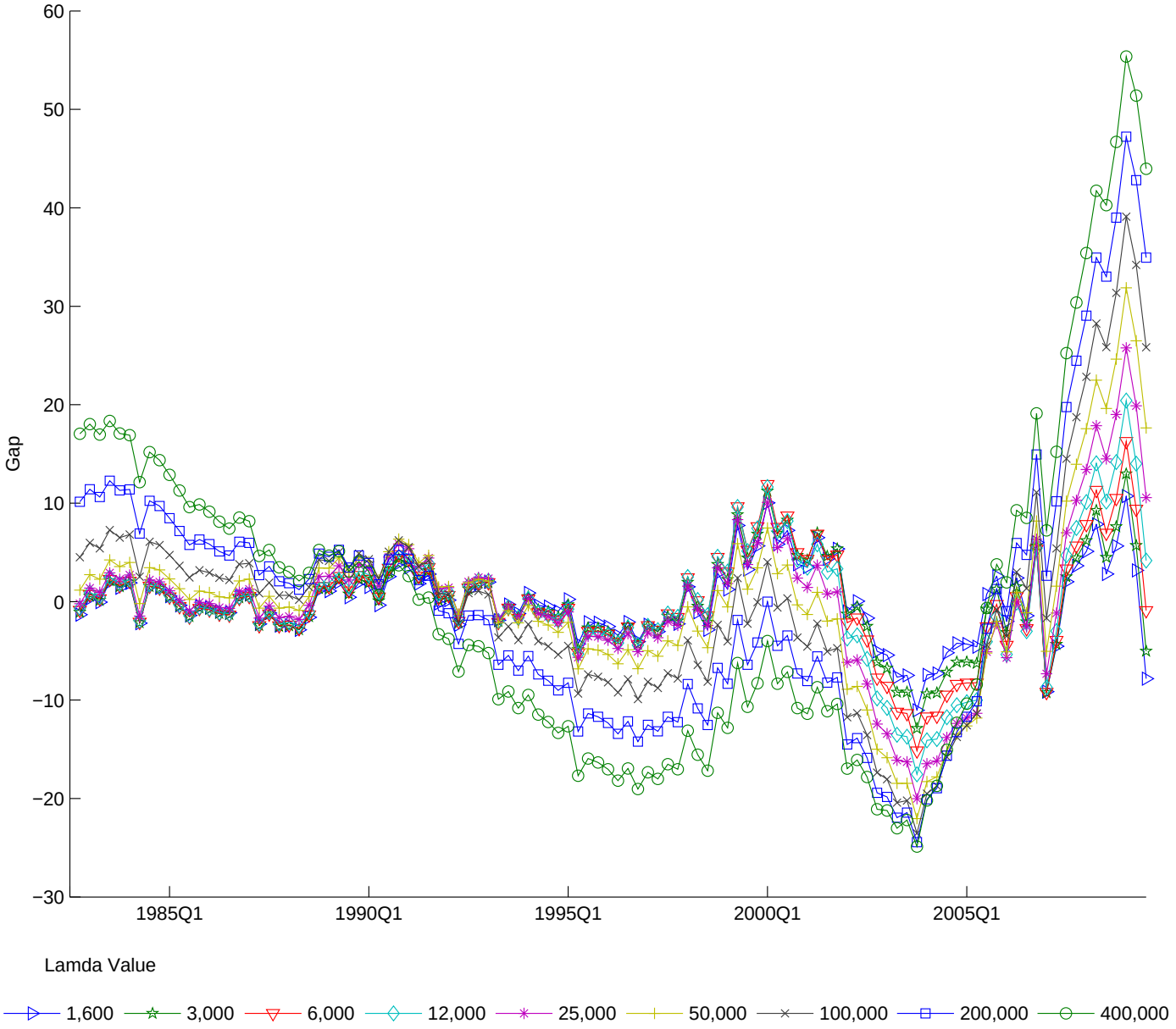

Figure 2
Annual Real Irish GDP and PSC Growth1983−2010

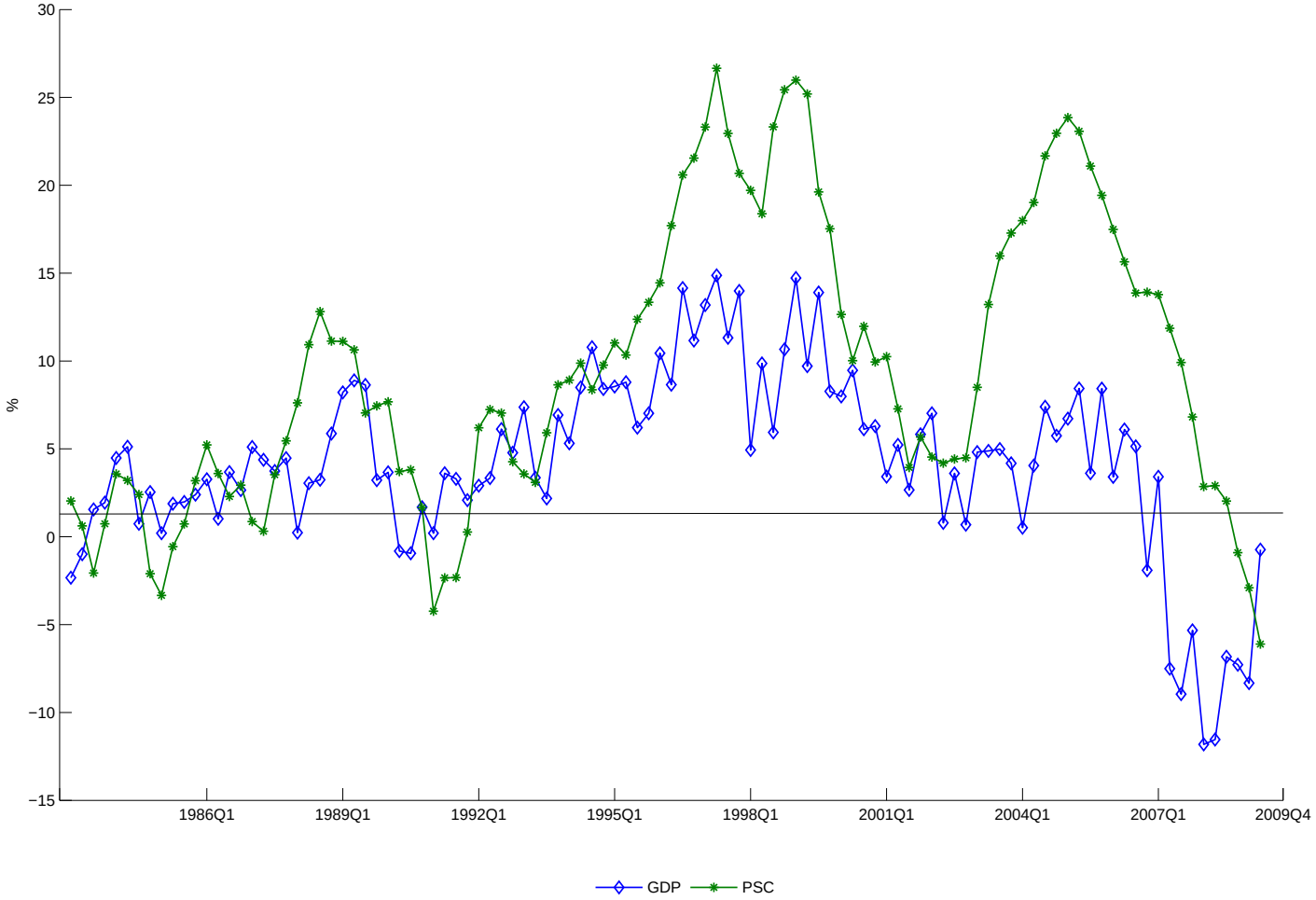

Figure 3
Irish Financial Deepening (1983−2010)

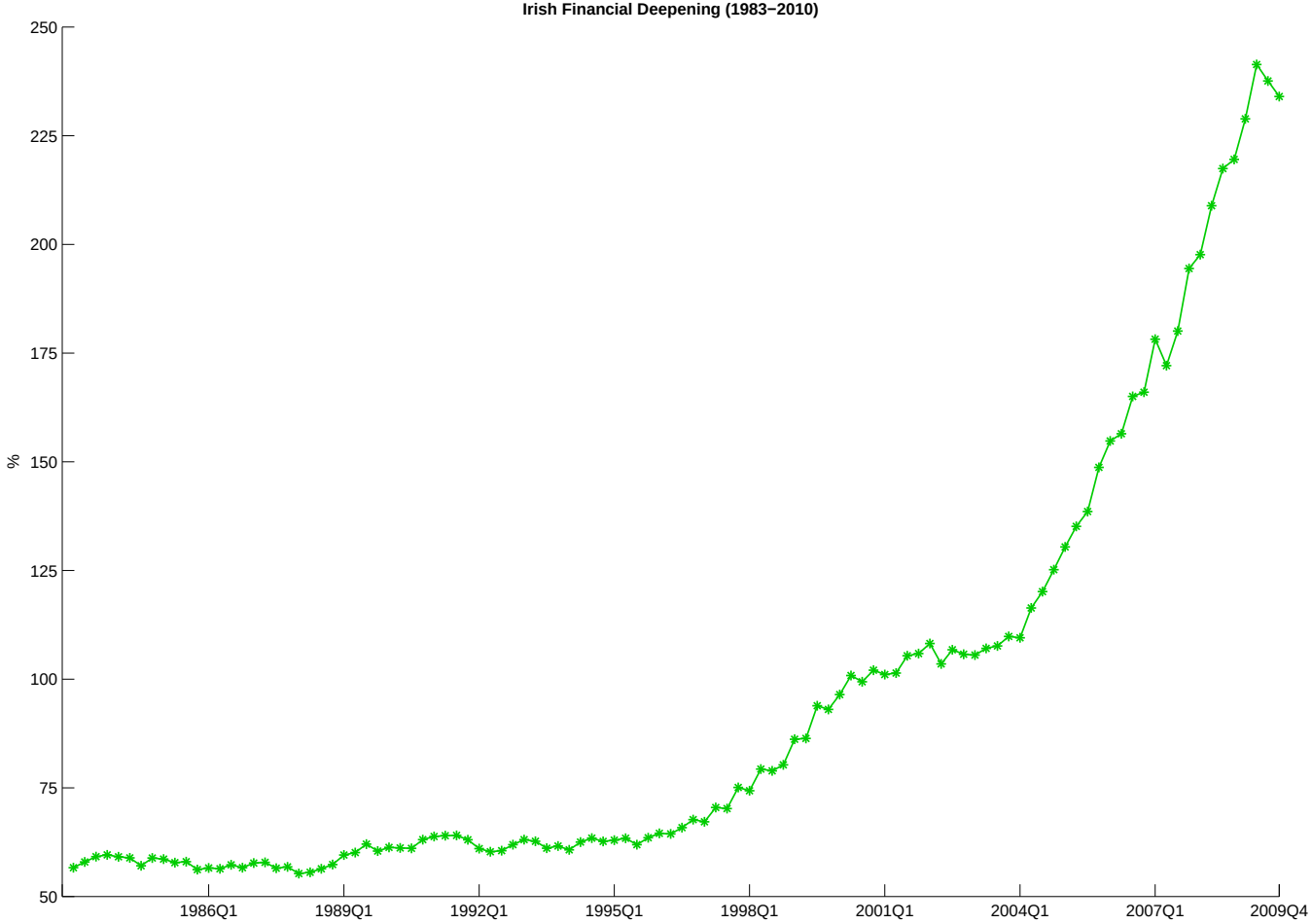

Figure 4
Private Sector Credit and Deposit Levels in the Irish Banking System (1983−2010)

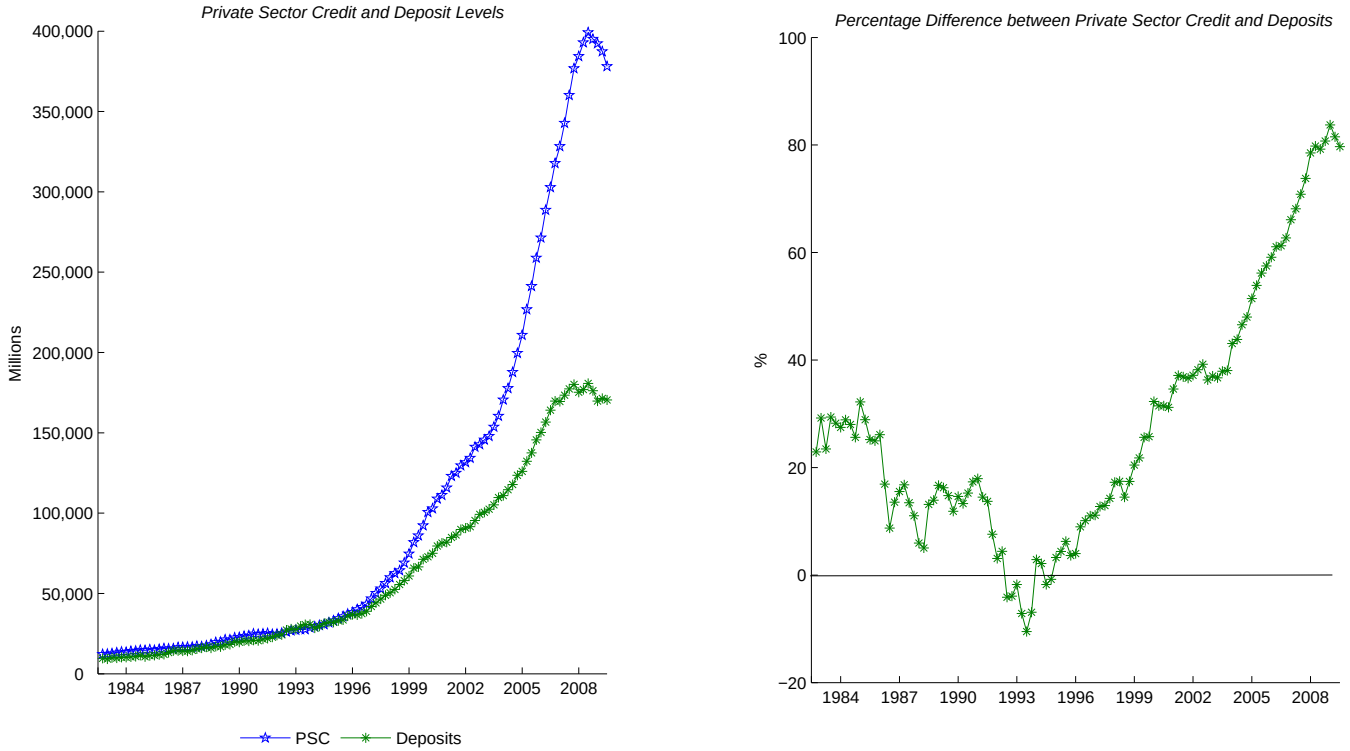

Figure 5
Select European Countries Levels of Finanical Deepening (1999−2010)

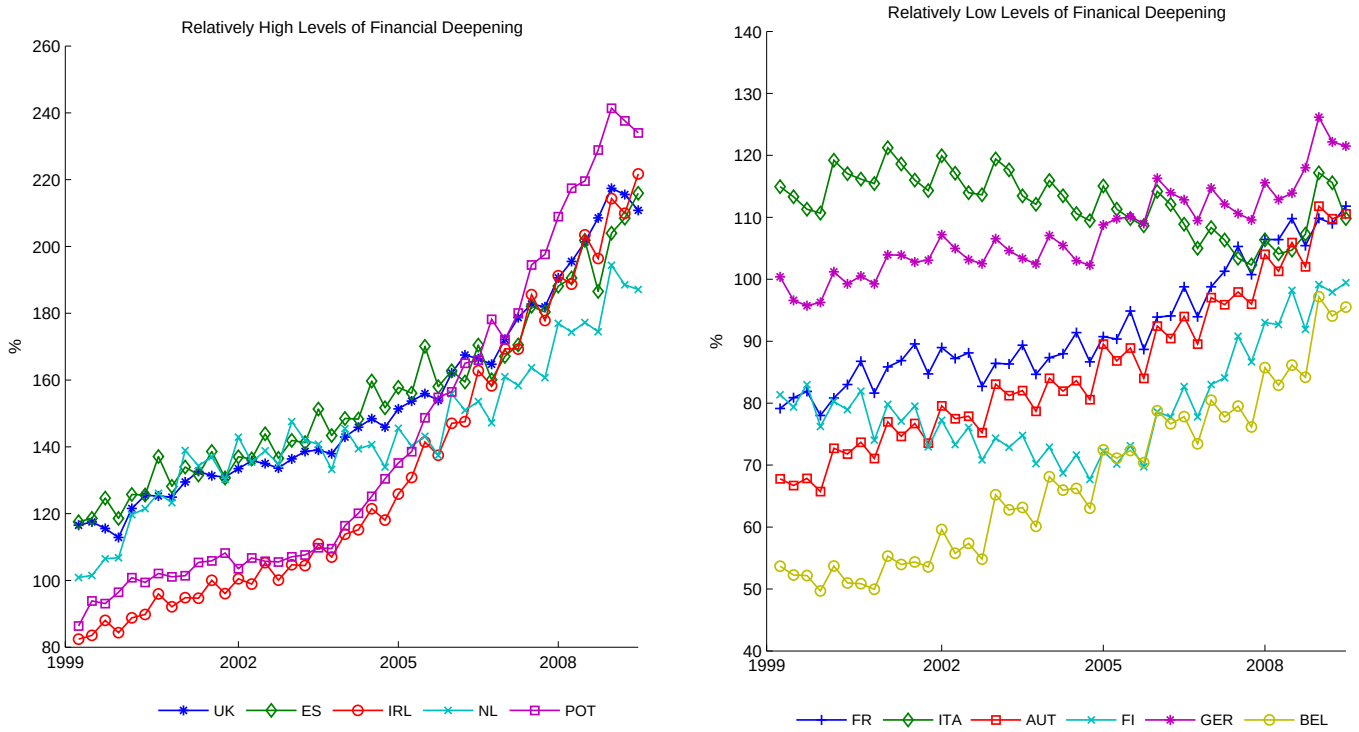

Figure 6
State Probabilities for the Change in Mean of the Ratio PSC/GDP in Ireland 1982−2010

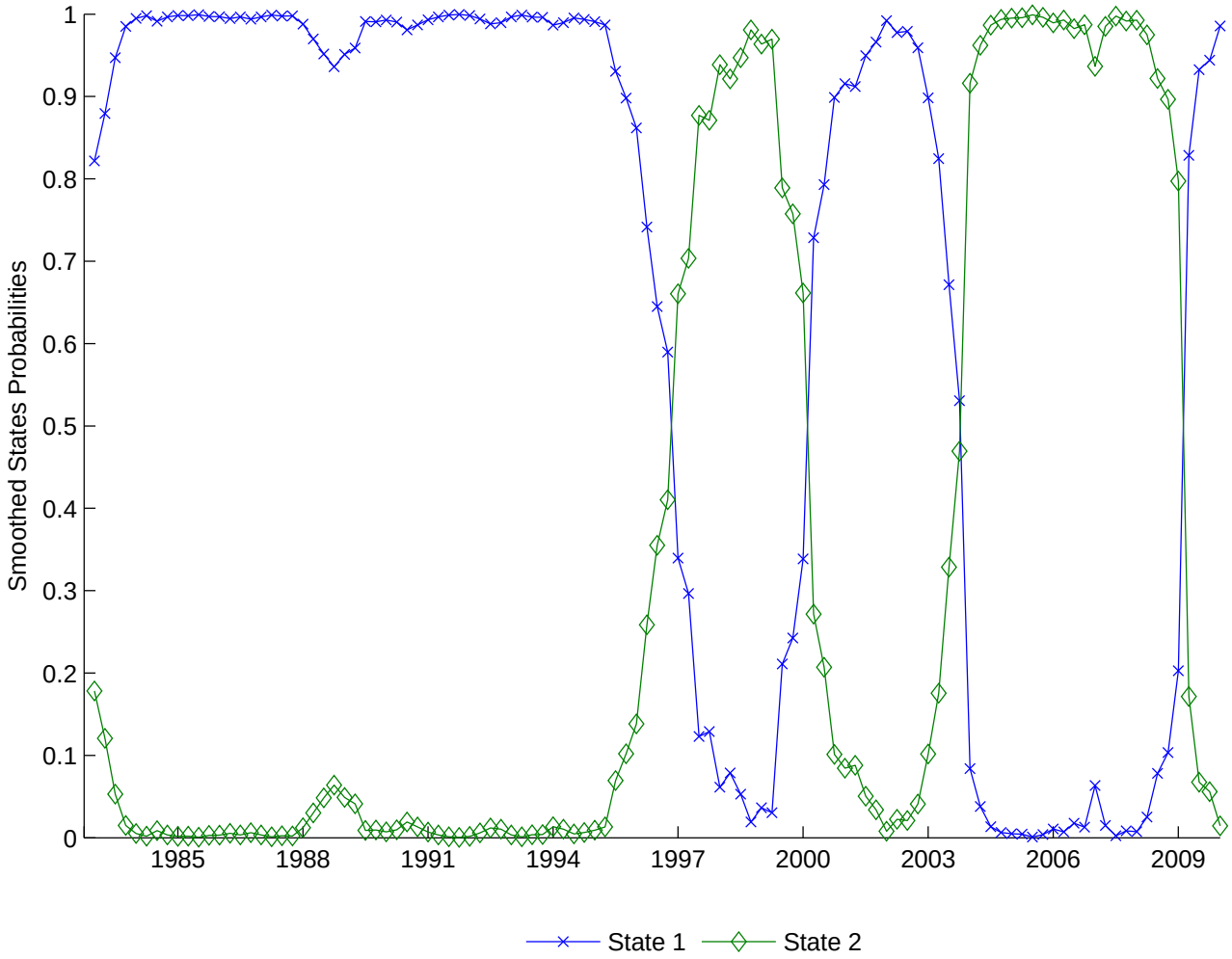

Figure 7
Residuals from GDP on Private Sector Credit

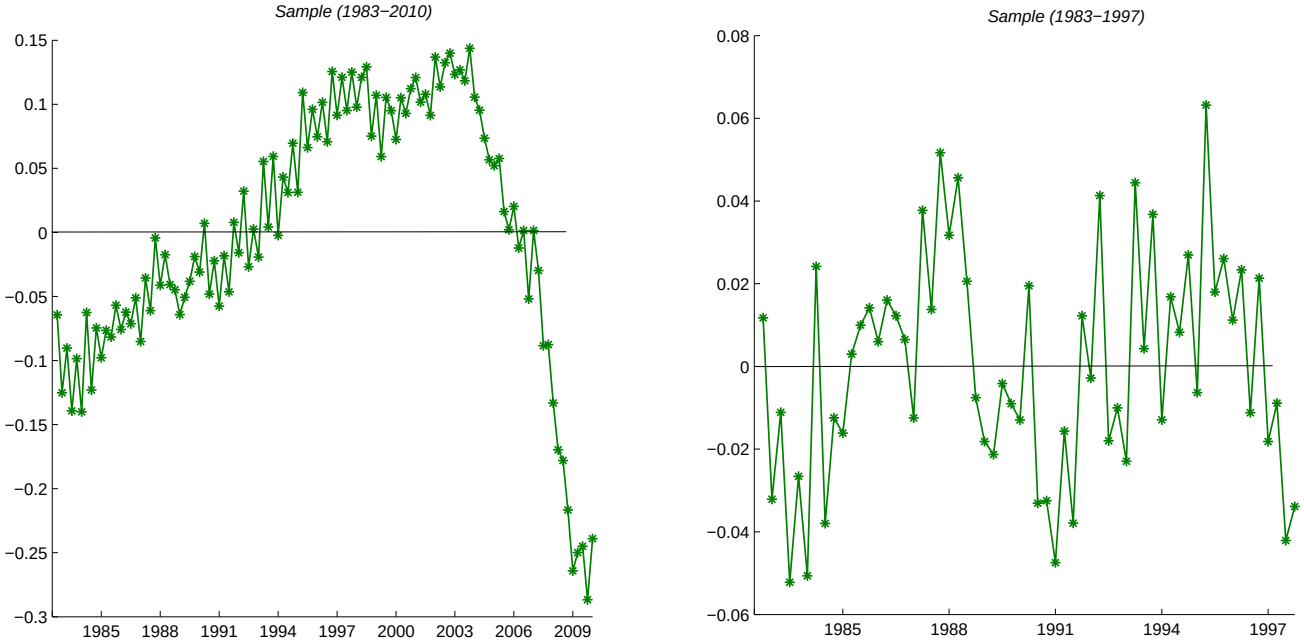

Figure 8

Actual and Counterfactual Credit Levels

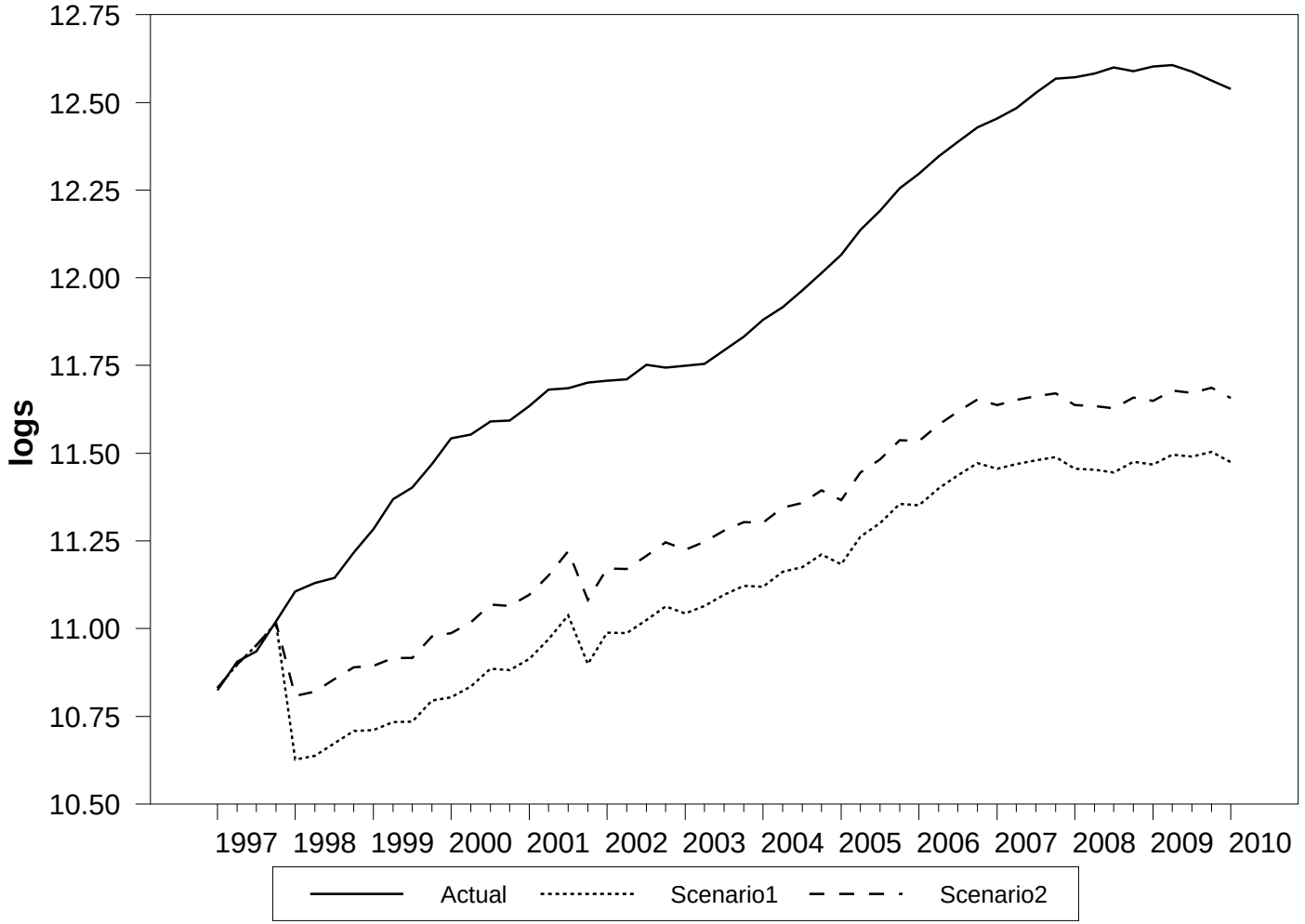

Figure 9

Scenario Results for Counterfactual Private Sector Credit