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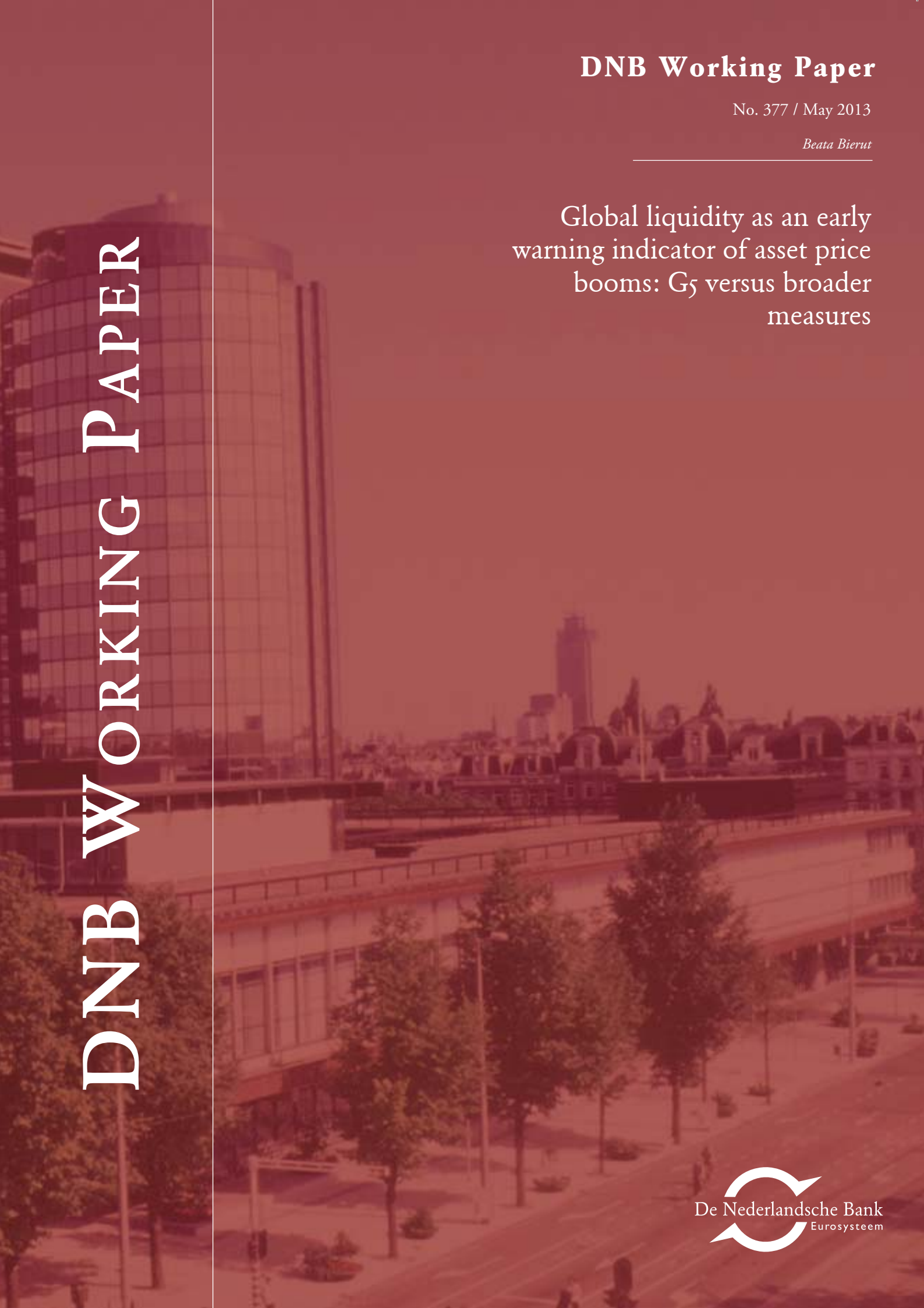

De Nederlandsche Bank
Eurosysteem

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Beata Bierut *

* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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Global liquidity as an early warning indicator of asset price booms: G5 versus broader measures

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Abstract

We test the performance of various measures of global liquidity as early warning indicators of booms in house and equity prices in 20 OECD countries between 1970 and 2010. We use a panel probit approach to test the relative performance of global liquidity measures based on two aggregation schemes: the traditional measures, based on G5 data, and broader measures, based on data for up to 26 countries/currency areas.

Our results show that, in the last decade, global liquidity measures outperformed domestic measures as early warning indicators. Between the two global liquidity measures, G5 aggregates often outperformed broader global liquidity measures. The search for the best early warning indicator showed that the G5 real narrow money gap performed best for booms in house prices, while the global real private credit growth gap performed best for booms in equity prices, either when aggregated over G5 or over a broader sample of countries.

Nevertheless, given the rising importance of the emerging market economies and a declining share of G5 in global liquidity, the current superior performance of G5 measures may not warrant their superior performance in the future. Therefore, given the importance of global liquidity measures in warning about asset price booms, the need for constructing broader global liquidity measures is warranted.

Keywords: Early Warning Indicators, Asset Price Booms, Global Liquidity.

JEL Classification: E44, E51, F65, C53

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1. Introduction

Large fluctuations in asset prices can have potentially damaging effects on the real economy, as we have been aware of at least since the 1930s (the Great Depression). Periods of large swings in asset prices have historically been associated with periods of financial instability, in both industrial and emerging market countries (Borio and Lowe (2002), Detken et al. (2010), Drehmann et al. (2011)). Helbling and Terrones (2003) provide estimates of the likelihood and the costs of house and equity price boom-bust episodes. They find that, historically, on average 40% of house price booms were followed by busts, leading to output losses of the order of 8% of GDP.[3] In case of equity prices, 25% of booms were followed by busts, with losses typically amounting to about 4% of GDP.[4] Bordo and Jeanne (2002) report similar probabilities of asset price booms ending in busts: 17% for equity prices and 55% for house prices. They also report that, in a number of cases, banking crises occurred either at the peak of the boom or after the bust in real house prices.[5] Bordo and Landon-Lane (2010) find that international financial crises are often triggered by asset price booms and busts in key countries and are inevitably associated with recessions. They report that the average cumulative loss in GDP during recessions associated with international banking crises was approximately five times (or: almost 2.5 percentage points) higher than during recessions that occurred without banking crises.[6]

Consequently, economists and policy makers have worked hard on designing and improving methods to detect a build-up of vulnerabilities, potentially leading to large swings in asset prices and/or periods of financial instability, in order to be able to counteract them and thereby to limit their adverse consequences for macroeconomic stability. Early detecting asset price booms rather than periods of financial instability has the advantage that it allows policymakers more time to react and prevent the build-up of perilous imbalances.[7]

Financial liberalization and deregulation have facilitated globalization of investment and financial activities. This has brought about an increase in the magnitude of booms and busts in credit and asset

[3] In the sense that the level of output three years after the bust was on average 8% below the level that would have prevailed with the average growth rate during the three years up to the bust.

[4] Looking at a longer historical time period for the United Kingdom and the United States (starting in 1800), Bordo (2003) finds that about 1/3 of booms in equity prices were followed by busts, and more than half of the busts were associated with recessions.

[5] Reinhart and Rogoff (2008b) reach similar conclusions regarding the coincidence of house price booms and busts around crisis episodes (with a particular emphasis on the Big 5 crises: Spain in 1977, Norway in 1987, Finland and Sweden in 1991 and Japan in 1992).

[6] Measured as the total loss (for all countries, aggregated using relative GDP weighs) due to a recession, as a percentage of the peak level of output.

[7] Which is all the more important in case of house price busts, as Helbling and Terrones (2003) find, that the beginning of the output slowdown after a house price bust usually coincides with the beginning of the bust itself. In case of equity price busts, the onset of the slowdown in output is usually delayed by three quarters.

prices (Borio (2006))[8], and it has also underpinned the necessity to look beyond domestic borders for the drivers of (booms and busts in) asset prices. In recent years, global liquidity has become a key focus of international policy debates, reflecting the recognition of its major importance for international financial stability, in the build-up phase of perilous imbalances as well as when they unwind. In 2011 the Committee on the Global Financial System established an Ad-hoc Group to analyze global liquidity from a financial stability perspective. The Group defined global liquidity, its various concepts, drivers and measurement and concluded, among others, that it should be assessed on the basis of a combination of both price and quantity measures (CGFS (2011)). Following that recommendation we will measure global liquidity both using quantity and price variables.

Traditionally global liquidity has been approximated by aggregating liquidity measures for G5 countries: the United States, the euro area, the United Kingdom, Japan and Canada. However, given the rising importance of the emerging market economies, G5 aggregates could be losing their usefulness. The share of G5 in broader quantity measures of liquidity has been steadily decreasing. Still, G5 aggregates have important advantages, relative to broader measures: they are easy to construct, are based on more reliable data and are available with a much longer history. Additionally, the behavior of G5 and broader liquidity measures has been highly synchronous; hence, broader liquidity measures may have very little added value on top of G5 measures in an econometric analysis.

Existing literature provides evidence on the significance of the traditional measures of global liquidity for asset price developments. In this paper we investigate whether broader measures of global liquidity perform better as early warning indicators of asset price booms, when compared with traditional G5 aggregates. We look both at quantity and price measures: narrow money aggregates, broad money aggregates, credit aggregates and short- and long-term interest rates. The assets we look at are residential property and equity. We carry out our analysis in a number of steps. First, we compare the performance of the broader measures of liquidity and the traditional G5 measures (also relative to domestic liquidity measures). We also use the longer history of data to compare the G5 measures with the domestic ones. Secondly, we perform a number of robustness checks. Finally, we carry out an out-of-sample early warning exercise for the most recent asset price booms.

Our paper is most closely related to the study by Alessi and Detken (2011). The authors compare the performance of a large number of global and domestic variables (real and financial) as early warning indicators of (composite) asset price booms. They find that global liquidity measures (based on the

[8] Kaminsky and Reinhart (1999) present formal evidence on the links between financial liberalization and banking crises. Reinhart and Rogoff (2008a) also find that periods of high international capital mobility repeatedly produced international banking crises.

aggregate for 18 OECD countries), notably a global private credit gap or a global M1 gap (defined as detrended ratios to GDP) are the best early warning indicators.

However, there are important differences. First, we use a different modeling approach, a (panel) probit model, which has important advantages over the signaling approach. It allows for testing the statistical significance of the indicators and for testing whether coefficients are constant over time. Secondly, we investigate house and equity price booms separately. This is justified by the fact that house and equity prices tend to behave differently over business cycles.[9] Our careful review of the literature analyzing the response of asset prices to a (monetary) policy impulse also shows that house and equity prices tend to react with different lags, which justifies different early warning horizons. Finally, we test a smaller set of indicators, focusing purely on financial variables.

Our results show that, in the last decade, global liquidity measures outperformed domestic measures as early warning indicators of asset price booms. Among the global liquidity measures, G5 aggregates often outperformed broader measures. The search for the best early warning indicator shows that the G5 real narrow money gap performed best for booms in house prices, while the global real private credit growth gap performed best for booms in equity prices, either when aggregated over G5 countries or when aggregated over a broader sample of countries (depending on the warning horizon). The superior performance of the G5 real private credit growth gap over a shorter horizon is also corroborated in the out-of-sample early warning exercise. The fact that G5 liquidity measures tend to perform relatively better than broader liquidity measures is most likely due to the short history of broader measures. However, given that the share of G5 in global liquidity has been steadily decreasing over time, the superior performance of G5 measures in the past may not warrant their superior performance in the future. Additionally, the high synchronicity between G5 and broader liquidity measures is not warranted to prevail. Therefore, given the importance of global liquidity measures in detecting booms (and busts) in asset prices, the need for constructing broad global liquidity measures is warranted.

2. Literature review

There exists a large body of literature providing evidence of a significant link between global liquidity and asset price developments. Global liquidity has traditionally been measured by a G4/G5/G7 aggregate, where the G5 aggregate comprises the United States, the United Kingdom, Germany, France and Japan, or – more recently – the United States, the euro area, the United Kingdom, Japan and Canada. Baks and Kramer (1999) is the earliest reference. They measure global liquidity by G7

[9] Borio and Lowe (2002) and Borio and McGuire (2004) report that peaks in equity prices tend to lead those in real estate prices by one to two years. Borio and McGuire (2004) also show that equity price peaks are also a useful early warning indicator of house price peaks.

excess broad or narrow money growth (relative to nominal GDP growth) and find that it has significant effects on real asset returns (stock market returns, long-term interest rates and short-term interest rates) in G7 countries.

All of the studies reviewed below measure global liquidity using monetary aggregates; some studies also use global (short-term) interest rates. Global credit aggregates have so far been less commonly used, see e.g. Alessi and Detken (2011).[10] In general, the studies can be divided into three broad categories: (i) vector autoregression (VAR) models, (ii) early warning indicator (EWI) models and (iii) other methods (OLS regressions, panel regressions, comparative analyses, etc.).

Starting with VAR models, Rüffer and Stracca (2006) estimate a global VAR model including G5 liquidity measures and show that G5 excess broad money (defined as the ratio between broad money and nominal GDP) is a convincing empirical measure of the monetary policy stance at a global level. They also find a significant impact of G5 short-term interest rate on real asset prices (a composite asset price index including equity prices and residential and commercial property prices). However, they find no corresponding significant effect of G5 excess money. Giese and Tuxen (2007) estimate a global VECM including G7 broad money and short-term interest rate. They document a cointegrating relationship between house prices and global broad money and short-term interest rate. Belke et al. (2010) estimate a global VAR model with liquidity measures based on G11 aggregates (comprising G5 countries, South Korea, Australia, Switzerland, Sweden, Norway and Denmark) and also show that global broad money and short-term interest rate have a statistically significant impact on house and commodity prices. However, they find no significant impact of G11 broad money on equity prices. Finally, Darius and Radde (2010) estimate a global VAR model including a measure of global liquidity constructed as the sum of the U.S. monetary base and world international reserves. They also find a significant effect of global liquidity on house prices, but no significant effect on equity prices.

Regarding EWI models, Agnello and Schuknecht (2009) estimate a panel probit model on a sample of house price booms (and busts) in 18 industrialized countries and find that global liquidity (measured as a weighted average of broad money growth for all countries in the sample, minus the corresponding domestic M3 aggregate) is a consistent and significant predictor of house price booms across various specifications. Moreover, they find the marginal effect of global liquidity to be much larger than the marginal effect of the domestic real credit growth. Gerdesmeier et al. (2010) carry out an extensive literature review and conclude that "…the one robust finding across the different studies is that measures of excessive credit creation are very good leading indicators of the building up of financial imbalances in the economy…" (p. 383-384); the results regarding excessive money creation are less

[10] This is most likely to change as the CGFS' Ad-hoc Group concluded that global credit aggregates should serve as the starting point for the assessment of global liquidity (CGFS (2011)).

conclusive. They estimate a panel probit model on the sample of 18 main industrial economies and show that domestic credit aggregates (either in terms of annual changes or as growth gaps, i.e. detrended growth rates) are among the best early warning indicators of asset price busts. Alessi and Detken (2011) show that global liquidity measures, based on aggregates of broad and narrow money and private credit for 18 OECD countries, are among the best early warning indicators of asset price booms that end in busts (based on the composite asset price index), outperforming domestic measures of liquidity. Their results show that the global private credit gap and the global M1 gap (defined as detrended ratios to GDP) are the best early warning indicators of asset price booms.

There exists a large body of literature using EWI models and providing evidence of a significant link between domestic credit aggregates and financial crises. Borio and Lowe (2002) use a noise-to-signal approach and show that a domestic credit gap is a better early warning indicator of financial crises than a domestic asset price gap, a domestic investment gap (all gaps are defined as detrended ratios to GDP) or domestic real credit growth in a sample of 34 countries. Borio and Lowe (2004) use data for 20 countries and again show that a domestic credit gap is a better early warning indicator of banking crises than a domestic asset price gap and a domestic money gap. Finally, Drehmann et al. (2011) use data for 36 countries and show that a domestic credit gap achieves the lowest noise-to-signal ratio for predicting banking crises, relative to 14 other indicators, including measures based on GDP, M2, property prices and equity prices.

Among other types of studies, Detken and Smets (2004) perform a comparative analysis of the behavior of 26 macroeconomic variables in boom, pre-boom and post-boom periods on the basis of 38 asset price booms (based on the composite asset price index) in 18 OECD countries. They find that real growth rates of domestic credit and money tend to be higher in the pre-boom (and the boom) periods than in normal times. They also show that real money and credit growth are useful in distinguishing between high-cost and low-cost booms (in terms of the drop in the real GDP growth in the post-boom period). For the high-cost booms real money growth is significantly higher during the pre-boom period, while both real credit and money growth are significantly higher for high-cost than in low-cost episodes during the boom. Jordá et al. (2010) analyze data for 14 countries over the years 1870-2008 and find that national and global financial crises have tended to be preceded by considerably low natural rates (the difference between nominal short-term rates and real growth), relative to trend, and expansions in domestic money and credit, relative to GDP. The expansions of credit tended to be more pronounced, making it a more useful indicator of financial crises relative to money. Finally, Kokenyne et al. (2010) present a panel model, showing that global liquidity - defined as G4 M2, reserve money or excess liquidity growth (the difference between broad money growth and estimates for money demand in the G4) – has statistically significant effects on equity returns and real interest rates in a sample of 30 countries. This result is robust to controlling for (smaller but

statistically significant effects of) domestic liquidity and (statistically significant effects of) global investors' risk appetite (measured by VIX).

3. Global liquidity and its measurement

Defining liquidity is challenging. The most generic definition of liquidity appears to be the "ease of financing" (CGFS (2011)). According to the CGFS' Ad-hoc Group study, from a global perspective two aspects of liquidity are particularly relevant: official liquidity (created by the public sector) and private liquidity (created by the private financial sector). The Group further concluded that private global liquidity was closely associated with liquidity surges and related build-ups of risk and that this aspect of global liquidity was "… best assessed on the basis of a combination of both price and quantity measures. Price indicators tend to provide information about the conditions at which liquidity is provided, while quantity measures capture how far such conditions translate into the build-up of potential risks…" (CGFS (2011), p. 1).

Regarding the specific variables that could be used to measure global liquidity, the Group concluded that global credit aggregates should serve as the starting point and should be accompanied by a number of complementary price- and quantity-based indicators of monetary, funding and market liquidity (see table 1, p. 20 in CGFS (2011)). In this study we will follow the general recommendation by the Group, but we will limit the analysis to a small subset of the proposed measures, namely to five financial variables and up to six transformations of these variables (in total 30 indicators). The financial variables are: (real) narrow money, (real) broad money, (real) bank credit to the non-financial private sector, (real) short-term interest rates and (real) long-term interest rates (all CPI deflated; quantity measures are seasonally adjusted). The specific indicators are: (i) for quantity measures: annual growth rates, excess growth rates (relative to annual nominal GDP growth rates), deviations of levels from trends, deviations of ratios to GDP from trends, deviations of annual growth rates from trends and deviations of excess growth rates from trends; and (ii) for price measures: levels, excess interest rates (relative to annual nominal GDP growth rates), term spreads, deviations of levels from trends, deviations of excess interest rates from trends and deviations of terms spreads from trends. All trends are calculated recursively (over a moving window of 40 quarters) using very slowly adjusting Hodrick-Prescott filters (with lambda set to 100,000). The recursive approach is more common in the literature (e.g. Borio et al., Alessi and Detken (2011)) and is realistic, using only data available up to each point in time.

The main objective of this study is to assess the performance of broader measures of global liquidity as early warning indicators of asset prices, relative to the traditional G5 aggregates (and domestic measures). G5 measures are based on data for the euro area, the United States, the United Kingdom, Canada and Japan. Broader global liquidity measures are constructed using data for up to 26

countries/currency areas (depending on data availability). These economies are: the euro area, the United States, the United Kingdom, Japan, Canada, Australia, Brazil, Chile, China, the Czech Republic, Denmark, Hungary, India, Iceland, Indonesia, Israel, Mexico, New Zealand, Norway, Poland, the Russian Federation, South Africa, South Korea, Sweden, Switzerland and Turkey. The aggregates are calculated as GDP-weighted averages of national variables, using GDP weights calculated on the basis of purchasing-power-parity (PPP) valuations, as provided in the IMF World Economic Outlook database.[11] The weights are constant, averaged over the period 1995-2010.[12]

G5 measures are usually available for the full sample 1970 Q1 – 2010 Q4.[13] Given data problems, the availability of broader liquidity measures is much more restricted.[14] Charts 1 to 4 illustrate the developments in global liquidity measures over the last decade, i.e. when broader liquidity measures are available. Two observations are worth noting. Firstly, it is clear that G5 and broader liquidity measures display similar behavior over time and this holds both for quantity and price measures (the overall correlation between the two aggregates – for real growth and interest rates - is between 0.47 and 0.86, with a clear upward trend in correlation over time). Secondly, the share of G5 in broader quantity measures has been steadily decreasing, from about 81% in the late 1990s to about 69% at the end of 2010. These observations yield opposite conclusions regarding the need for and the usefulness of broader measures of global liquidity. Given that the behavior of G5 and broader liquidity measures is so highly synchronous, broader measures are likely to have very little added value on top of G5 measures in any econometric estimation. On the other hand, as the share of G5 in global liquidity decreases, this synchronicity could falter, increasing the need and value of constructing broader measures of global liquidity.

11 There are various approaches to combining national data into international aggregates (for an extensive discussion, see Beyer et al. (2001)). The method of using fixed PPP-based GDP weights has been employed earlier in the literature (e.g. Rüffer and Stracca (2006), Alessi and Detken (2011)).

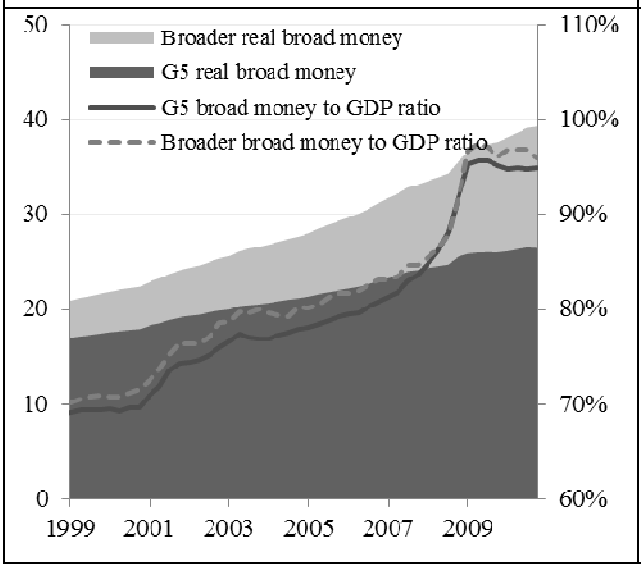
12 Only the level measures (global broad money, narrow money and credit to the private sector presented in charts 1A-3A) are calculated as sums, transformed into the US dollar using an average market exchange rate over 1999-2010.

13 Except for private credit, which is available as of 1992 Q4.

14 Real broad money and real credit to the private sector (level, growth rate, ratio to GDP and excess growth rate) are all available as of 1999 Q1 (with the level and the ratio to GDP of real credit to the private sector available as of 1998 Q1). Real narrow money measures are all available as of 2000 Q1 (with level and ratio to GDP available as of 1999 Q1). Real long-term interest rate is available as of 1995 Q1. Real short-term interest rate (and term spread) is available as of 1997 Q3. Excess interest rates are all available as of 1998 Q1. A detailed description of the data sources is provided in Appendix 1.

Chart 1. Global broad money

A. Levels (in USD trillions) and ratios to GDP



B. Annual growth rates (in %)

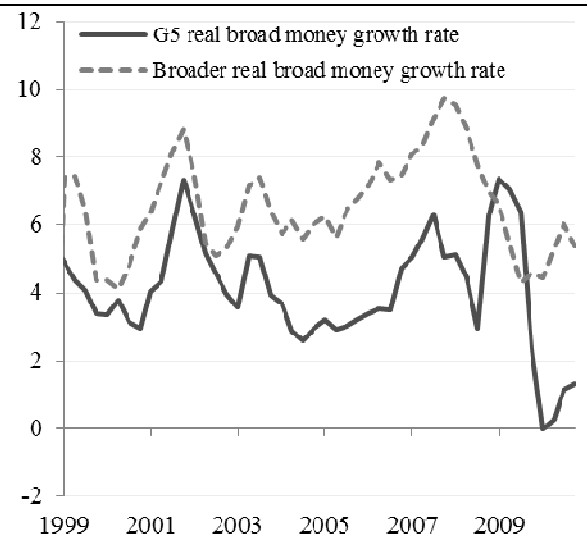
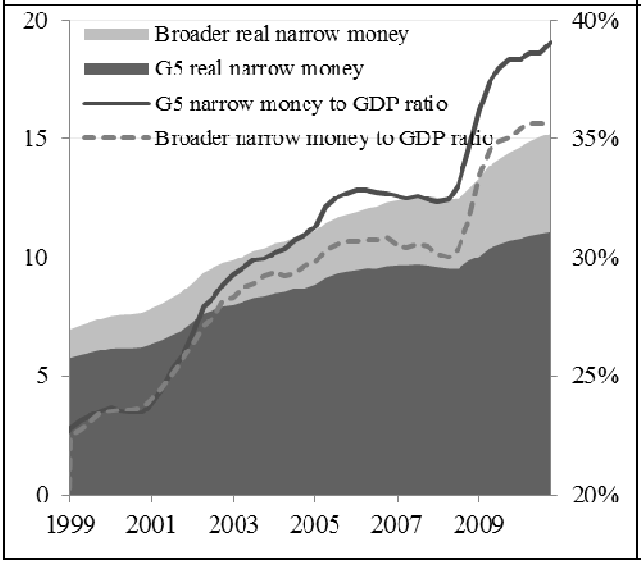


Chart 2. Global narrow money

A. Levels (in USD trillions) and ratios to GDP



B. Annual growth rates (in %)

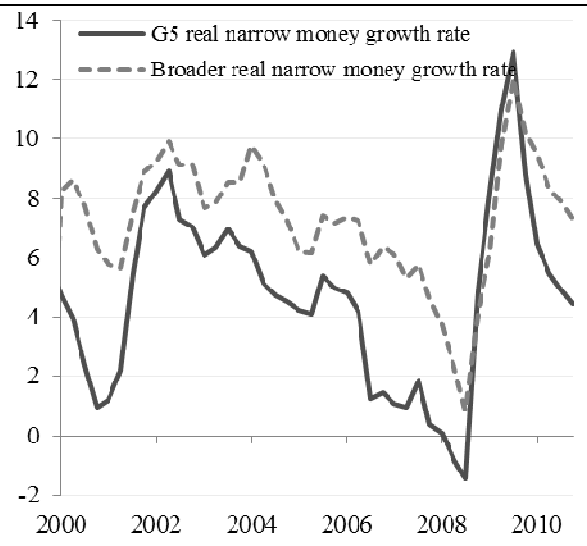
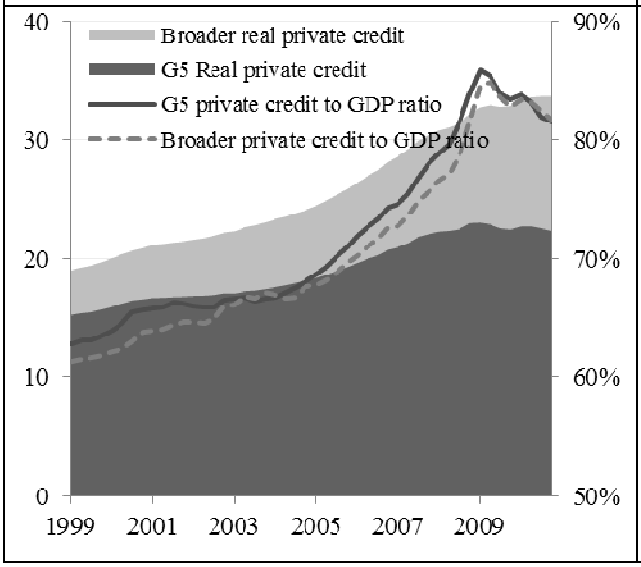


Chart 3. Global bank credit to the non-financial private sector

A. Levels (in USD trillions) and ratios to GDP



B. Annual growth rates (in %)

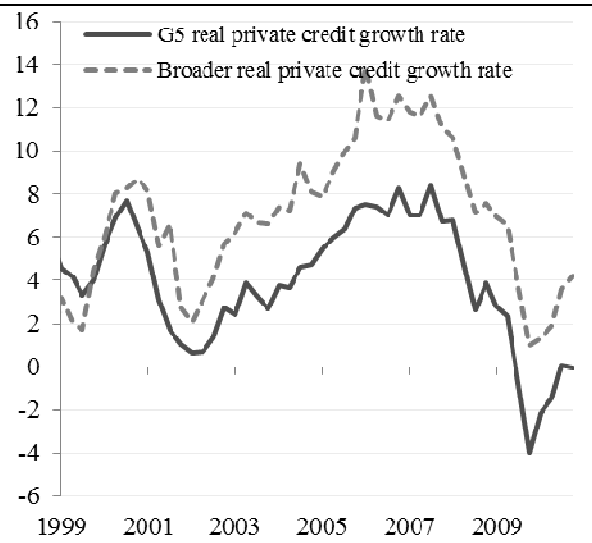
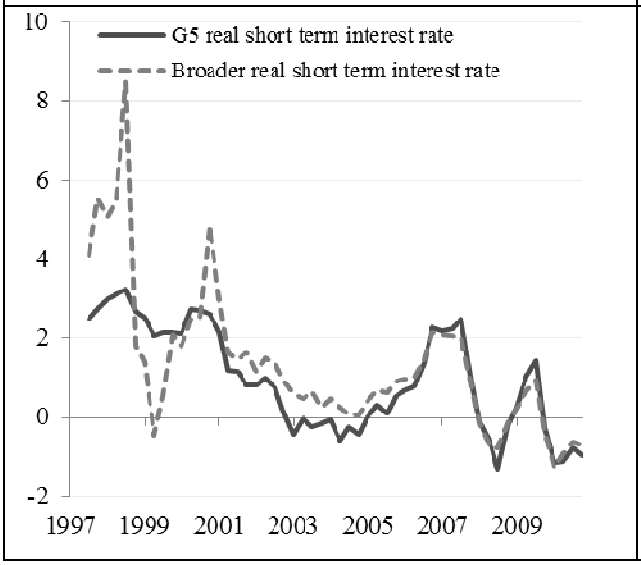
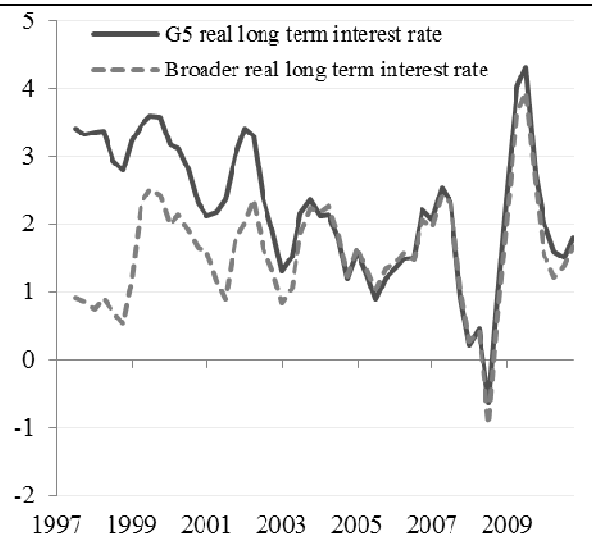


Chart 4. Global interest rates

A. Short-term rates (in %)



B. Long-term rates (in %)



3. Asset price booms and pre-boom episodes

Just as a precise definition of liquidity is elusive, the definition of an asset price boom remains arbitrary, the most generic one being "an unusually swift and persistent asset price increase compared to trend" (Adalid and Detken (2007), Alessi and Detken (2011)). The early warning indicator literature presents a number of approaches with respect to the identification of asset price booms (or busts) and the length of the pre-boom (pre-bust) episodes. Table 1 contains a short overview of the relevant literature, limited to the studies concerned with asset prices (i.e. equity prices and residential and commercial property prices).

Table 1. Definitions of boom and pre-boom episodes in the literature			
	Asset class	Boom definition	Pre-boom period (quarters)
Borio and Lowe (2002) Borio and Drehmann (2009)	Ratio of credit/asset prices to GDP	A period when ratio deviates from its recursive trend more than the threshold (in terms of percentage (points))	4/8/12
Detken and Smets (2004)	Composite real asset price index	A period when index exceeds its recursive HP trend by more than 10%	8
Borio and Lowe (2004)	Ratio of credit/inflation adjusted asset prices to GDP	A period when ratio deviates from its very slowly adjusting recursive HP trend more than the threshold (in terms of percentage (points))	12 to 20
Adalid and Detken (2007)	Composite real asset price index	A period of at least 4 consecutive quarters when index exceeds its very slowly adjusting recursive HP trend by more than 10%	4
Gerdesmeier et al. (2010)	Composite real asset price index	Bust definition: A period when indicator falls below its mean plus 1.5 times the standard deviation	8
Agnello and Schuknecht (2009)	Real house prices	Dating approach	4
Alessi and Detken (2011)	Composite real asset price index	A period of at least 3 consecutive quarters when index exceeds its very slowly adjusting recursive trend plus 1.75 times its recursive standard deviation	6

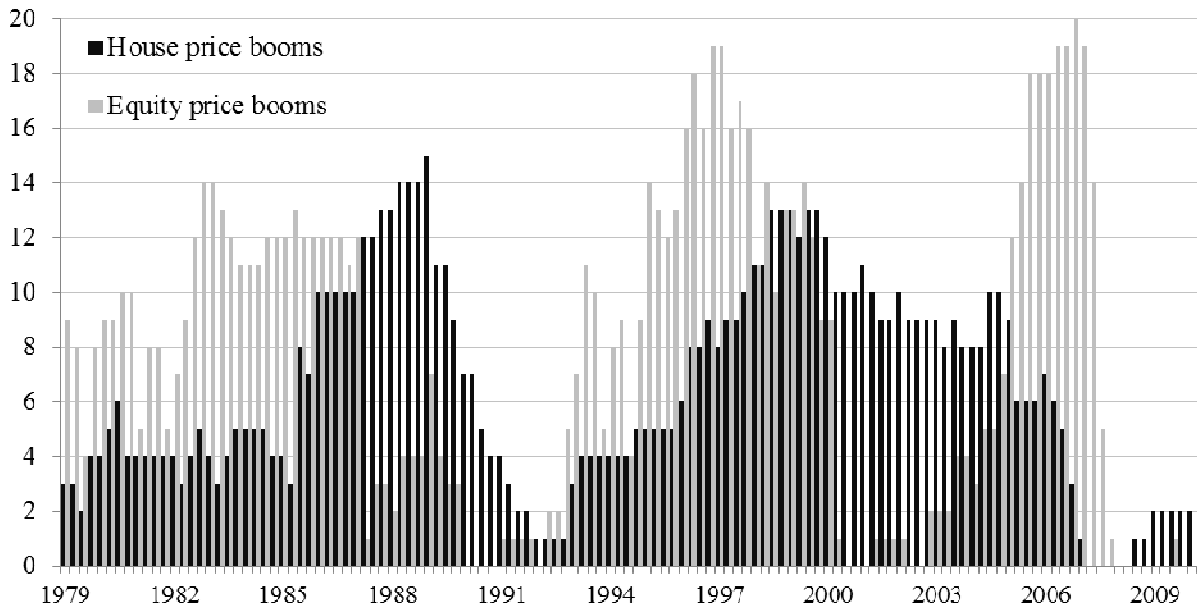
In our analysis we investigate booms for two types of assets (housing and equity, separately) in 20 OECD countries: Australia, Canada, Switzerland, Denmark, the United Kingdom, Japan, Norway, New Zealand, Sweden, Korea, the United States, Germany, France, Italy, Spain, Greece, Ireland, Finland, Belgium and the Netherlands, over the period between 1970 Q1 and 2010 Q4. Real house price indices have been obtained from the OECD. Stock market indices are obtained from Thomson Financials and deflated with national CPIs.

We define an asset price boom as a situation when the asset price index exceeds the recursive trend plus 0.5 times the recursive standard deviation of the series. Trends and standard deviations are calculated over a moving window of 40 quarters, with a very slowly adjusting Hodrick-Prescott filter (lambda set to 100,000). The length of the moving window was chosen to cover (at least) one complete cycle in house and equity prices.[15] Chart 5 presents the number of boom episodes in housing

[15] Girouard et al. (2006) and Bracke (2011) analyze house prices for 18 (19) OECD countries over the period 1970 Q1 – 2010 Q1 and report a mean duration of upturns in the housing market of 23-24 quarters and a mean duration of downturns of 18 quarters, which implies that the 40-quarter window covers roughly one complete average housing market cycle. Claessens et al. (2011) analyze house and equity prices in 21 advanced OECD countries over the period 1960 Q1 to 2007 Q4 and find shorter mean durations (as a result of an imposed shorter minimum duration): 14 quarters for upturns and 8 quarters for downturns in the housing market, which implies that the 40-quarter window covers roughly two complete average cycles. Claessens et al. (2011) also report average durations for the equity market: 22 quarters for upturns and 7 quarters for downturns, which implies that the 40-quarter window also covers roughly two complete average equity price cycles.

and equity markets in our sample. [16] Our sample contains in total 813 house price boom periods and 964 equity price boom periods, i.e. 33% and 39% of the total of 2500 periods. The comparison of the frequency and occurrence of boom episodes in our sample with the findings in the literature reveals a good match.[17] We also compared the occurrence of asset price booms in our sample with the occurrence of banking crises identified in the literature[18] and found the following: for 9 (18) out of 32 banking crises which occurred in the 20 OECD countries between 1979 and 2010, the start year of a crisis coincided with the year with a house (equity) price boom in our sample. This is 28% and 56%, respectively.[19]

Chart 5. Number of countries experiencing asset price booms (out of 20)



16 Given the length of the moving window of 40 quarters, our asset price boom series start in 1979 Q4.

17 For house price booms, the correlation with the booms identified by Helbling and Terrones (2003) is 0.52 and it is as high as 0.74 for the booms identified by Alessi and Detken (2011) and Bracke (2011). For equity price booms the correlation is somewhat lower: 0.31 for Helbling and Terrones (2003) and 0.38 for Alessi and Detken (2011). The occurrence of housing and equity boom episodes also matches well with the statistics reported in Claessens et al. (2011): over the period 1986-2007 housing and equity boom periods account for 40% of the observations (Claessens et al. (2011) report shares of 33% for house price and 40% for equity price upturns). The average duration of asset price booms on our sample is somewhat shorter than in the other studies, with 12 quarters for housing booms and 7 quarters for equity price booms. This is likely related to the fact that, contrary to other studies, we do not impose restrictions on the minimum duration of the boom.

18 Where we combined the dates identified by Bordo et al. (2001), Reinhart and Rogoff (2008a), Reinhart and Rogoff (2008b), Laeven and Valencia (2010) and Bordo and Landon-Lane (2010).

19 For housing booms: the banking crisis in Denmark in 1987, Norway in 1987, the United States in 1988, Australia in 1989, Italy in 1990, Japan in 1991, Sweden in 1991, and Belgium and Denmark in 2007. For equity booms: Canada in 1983, the United Kingdom in 1984, Norway in 1987, the United Kingdom in 1995, Japan in 1997, and Belgium, Denmark, France, Germany, Greece, Ireland, Japan, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States in 2007. The probabilities linking asset price booms and banking crises reported by us here are higher than those linking asset price booms and busts reported in Helbling and Terrones (2003) and Bordo and Jeanne (2002); the probability for equity prices is moreover higher than for house prices. These differences can be explained by the fact that our sample is longer and includes the latest banking crisis (covering 13 countries in our sample), which coincided with equity price booms in all 13 countries and house price booms in 6 countries.

Given our objective to test global liquidity measures as *early* warning indicators, we are interested in detecting the occurrence of boom episodes in advance. Hence, the dependent variable in our panel probit specification is the *lead boom dummy variable*, defined as 1 if an asset price boom occurs within the subsequent couple of quarters. We thereby follow the earlier literature in focusing on detecting a general build-up of vulnerabilities rather than predicting the exact timing of a boom (see also Drehmann et al. (2011) and Bussiere and Fratzscher (2006)).

In our analysis we will consider two pre-boom periods: a two-to-six quarter period and a six-to-ten quarter period for real house prices and a one-to-five and five-to-nine quarter period for real equity prices. The starting points for the first pre-boom episodes were chosen so as to detect the building boom early enough to allow policy makers sufficient time to respond. To this end we reviewed the literature analyzing the response of asset prices to a monetary policy impulse (see table 2). The response of stock prices becomes significant very quickly (after one quarter), while the response of house prices becomes significant somewhat later (between two to seven quarters). The second pre-boom episodes are added to the analysis, following Borio et al., who found that the performance of early warning indicators of financial and banking crises improves considerably as the time horizon is lengthened.

Table 2. Response of asset prices to monetary policy impulse in the literature

	Asset class	Start significant impulse response (quarter)	Maximum impulse response (quarter)
Rüffer and Stracca (2006)	Composite real asset price index	8	12
Goodhart and Hofmann (2001)	House price index	2 to 7	2 to 12
Goodhart and Hofmann (2001)	Equity price index	1	2
Neri (2004)	Equity price index	1	3
Belke and Orth (2007)	House price index	3	12
Assenmacher-Wesche and Gerlach (2008)	House price index	4	10
Assenmacher-Wesche and Gerlach (2008)	Equity price index	1	7
Goodhart and Hofmann (2008)	House prices	1	40[20]

4. Methodology and results

Early warning indicator models have evolved over time (see Detken et al. (2010) for a discussion), although the two often used approaches are the (statistical) signaling approach and the (econometric)

[20] The impulse response levels off towards the end of the response horizon, without achieving a clear maximum.

limited dependent variable approach. In this study we have chosen for the latter approach as it has some important advantages over the signaling approach: it allows for testing the statistical significance of the indicators and for testing whether coefficients are constant over time. If desired, it also allows for a more satisfactory aggregation of individual indicators into one composite indicator, taking into account correlations among different variables (see Berg and Pattillo (1999) and Bussiere and Fratzscher (2006)). Our baseline specification is a *random effects* panel probit model, as we want to make general inference about early warning indicator properties of global liquidity measures, rather than limit ourselves to the effects within the analyzed sample of 20 countries. Jackknife procedure is applied to obtain standard errors in order to enhance the reliability of estimates.

We carry out three sorts of robustness checks. First, we re-estimate the random effects panel probit model for G5 countries only, in order to exclude the possibility that the superior performance of broader liquidity measures is purely the result of a better correspondence between the right- and the left-hand-side variables. Secondly, we estimate a pooled probit model with individual country dummies with a cluster-robust covariance estimator, approximating a fixed effects panel probit model.[21] Although the results from a fixed effects panel model are less generalizable, they are useful for comparison as this approach corrects for the possibility of country-specific factors which could both affect asset prices (the left-hand-side variable) and be correlated with liquidity measures (the right-hand-side variables). An example of such country-specific factors could be the level of financial development or deepening. The final robustness check consists of re-estimating the baseline specification on a rolling window of 40 quarters and is meant to test the stability and significance of the coefficients in our baseline model.

The limited availability of broader measures of global liquidity implies that econometric estimations are carried out on two samples. First, the performance of broader liquidity measures is compared with G5 and domestic measures in shorter data samples, restricted by the availability of broader liquidity measures. Secondly, the performance of G5 aggregates is compared with domestic measures in the longer sample.

Results of estimations discussed below clearly illustrate problems stemming from a short sample of data. Many of the estimated coefficients are insignificant, or have an unexpected sign (i.e. negative for quantity measures, positive for price measures). Hence the specifications that will be discussed and compared have been selected based on (i) their meaningfulness, i.e. all coefficients in the model must be meaningful, and (ii) statistical significance, i.e. p-values should be below 0.05. The best models are

[21] This approach is known for yielding consistent estimates of the coefficients and the asymptotic variance in linear panel models (see Cameron and Trivedi (2005))

then selected based on the information criteria (AIC and BIC) - practical measures for comparing models which are non-nested.

4.1 Results for house prices

Our results indicate that, over the shorter horizon of 2-6 quarters, broader measures of global liquidity outperformed G5 aggregates as early warning indicators of house price booms in two cases (for real credit to the private sector and term spread, see table 3). At the same time, broader liquidity measures also outperformed domestic measures in three cases (for real credit to the private sector, real broad money and real short-term rate). In the longer sample, G5 aggregates outperformed domestic variables in only two cases (for real narrow money and term spread).

Over the longer horizon of 6-10 quarters, broader measures of global liquidity outperformed G5 aggregates again for real credit to the private sector and term spread (see table 4). Broader liquidity measures also outperformed domestic measures in three cases (for real narrow money, real credit to the private sector and term spread). In the longer sample, G5 aggregates outperformed domestic variables in only one case (for real narrow money).

We also carried out estimations looking for the best early warning indicators among domestic variables, G5 aggregates and broader liquidity measures, for both horizons, each time restricting the data to homogeneous samples (i.e. with all variables per aggregation available). In three out of six cases, the best models were the ones with real credit to the private sector, in two cases, models with real narrow money, and in one case – a model with the real long-term interest rate (see Appendix 3.1). We then re-estimated the best six models for domestic, G5 and broader liquidity measures, again restricting data samples. The results of this in-sample horse race exercise show that the G5 real narrow money gap (i.e. deviations of the G5 real narrow money from trend) is the best overall early warning indicator of booms in house prices (for both horizons).

Table 3. Summary results for real house prices, pre-boom horizon of 2-6 quarters

	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Narrow money	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	**Yes**		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		

	G5 outperforms domestic	No		
Short-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Term spread	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		

Table 4. Summary results for real house prices, pre-boom horizon of 6-10 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	**Yes**		
Narrow money	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Short-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Term spread	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		

The results of our first robustness check contradict the thesis that the superior performance of broader liquidity measures is purely the result of a better correspondence between the right- and the left-hand-side variables. Broader measures of global liquidity actually performed slightly better in estimations for G5 countries than for all 20 OECD countries (see Appendix 3.2). The results of fixed effects estimations largely confirmed our baseline results (see Appendix 3.3). The results of rolling estimations explain and corroborate the in-sample horse race results (see Appendix 3.4). Global real narrow money performed well as an early warning indicator of house price booms towards the end of

our sample, with little difference between G5 and broader measures. Since G5 real narrow money also appears to have performed well at the beginning of the sample, its overall performance was better than broader real narrow money. G5 real broad money and credit to the private sector also appear to have been good early warning indicators at the beginning of the sample. On the other hand, towards the very end of the sample, broader real credit to the private sector performed better than the G5 measures. Regarding price measures, G5 interest rates appear to have been good early warning indicators of house price booms at the beginning of the sample. Towards the end of the sample, interest rate gaps (both short- and long-term, G5 and broader) performed well.

4.2 Results for equity prices

Our results indicate that, over the shorter horizon of 1-5 quarters, broader measures of global liquidity outperformed G5 aggregates as early warning indicators of equity price booms in two cases (for real broad money and real short-term interest rate, see table 5). Broader liquidity measures also outperformed domestic measures in two cases (for real credit to the private sector and real long-term interest rate). In the longer sample, G5 aggregates outperformed domestic measures in three cases (for real broad money, real credit to the private sector and term spread).

Over the longer horizon of 5-9 quarters, broader measures of global liquidity outperformed G5 aggregates in two cases (for real broad money and real credit to the private sector, see table 6). Broader liquidity measures outperformed domestic variables in as many as four cases (for real credit to the private sector and all price measures). In the longer sample, G5 aggregates outperformed domestic measures again in two cases (for real broad money and real credit to the private sector).

We again carried out estimations looking for the best early warning indicators among domestic, G5 and broader liquidity measures, for both horizons, on restricted (homogeneous) samples. In five out of six cases, the best models were the ones with real credit to the private sector, and in one case – a model with the term spread (see Appendix 4.1). We then re-estimated the six best models. The results of this in-sample horse race exercise show that the global real private credit growth gap (i.e. deviations of the annual growth rate of real credit to the private sector from trend) is the best overall early warning indicator of booms in equity prices, either when aggregated over G5 countries (for the horizon of 1-5 quarters) or when aggregated over a broader sample of countries (for the horizon of 5-9 quarters).

Table 5. Summary results for real equity prices, pre-boom horizon of 1-5 quarters

	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		

	G5 outperforms domestic	No		
Narrow money	Broader outperforms G5	X[22]	G5 outperforms domestic	No
	Broader outperforms domestic	X		
	G5 outperforms domestic	X		
Private credit	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Short-term rate	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Term spread	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	**Yes**		

Table 6. Summary results for real equity prices, pre-boom horizon of 5-9 quarters

	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Narrow money	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Short-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Term spread	Broader outperforms G5	No	G5 outperforms domestic	X
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		

[22] X denotes a situation when no meaningful model with significant coefficients was available for comparison.

The results of our first robustness check again contradict the thesis that the superior performance of broader liquidity measures is purely the result of a better correspondence between the right- and the left-hand-side variables. Broader measures of global liquidity again performed better than G5 aggregates (see Appendix 4.2). The results of fixed effects estimations largely confirmed our baseline results (see Appendix 4.3). The results of rolling estimations again corroborate the in-sample horse race results (see Appendix 4.4). Global private credit aggregates have been most consistently good early warning indicators of equity price booms, whereby G5 aggregates and broader measures performed similarly well. Global narrow and broad money aggregates appear to have performed well mostly at the beginning of the sample. Regarding price measures, excess interest rate gaps (both short- and long-term, G5 and broader) have been consistently good early warning indicators of equity price booms. Finally, the G5 term spread gap also appears to have been a consistently good indicator, over the shorter horizon.

5. Out-of-sample early warning exercise

Our short out-of-sample early warning exercise is focused on the most recent asset price booms. In order to have a fair comparison for global liquidity measures (which in our panel model can only provide a common early warning for all countries) our exercise will be limited to real equity prices, which have experienced a widely shared boom towards the end of our sample (see chart 5). For the out-of-sample early warnings we use our baseline random effects panel probit model (for the pre-boom period of one-to-five quarters), estimated on the data until 2006 Q4.

The out-of-sample early warning exercise corroborates the superior performance of real credit to the private sector as an early warning indicator of equity price booms. Early warnings issued by domestic real private credit growth gap exhibited the highest correlation with the actual pre-boom episodes over 2007-2010 (0.98), followed by G5 real private credit growth gap (0.90) and domestic real private credit growth (0.86). The best out-of-sample early warning indicator among broader measures of global liquidity was broader real private credit growth gap (with a correlation of 0.70). Charts 6 and 7 present the comparison of the actual post-2006 pre-boom episodes in the equity market with the results of the five best models, and the five best models based on global liquidity measures, respectively. Although in our set-up domestic liquidity measures have an advantage over global measures in that they can provide early warnings for individual countries, chart 6 shows that G5 real private credit growth gap performed very well in issuing early warnings about equity price booms shared by an overwhelming majority of countries in our sample.

Chart 6. Equity price pre-boom episodes and out-of-sample early warnings

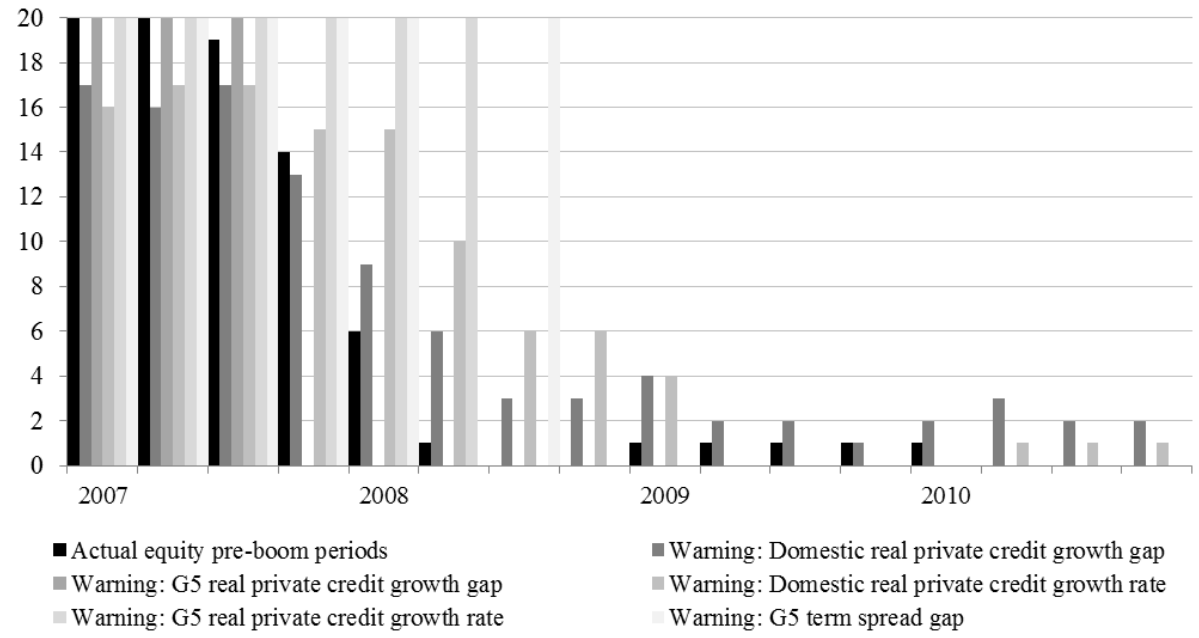
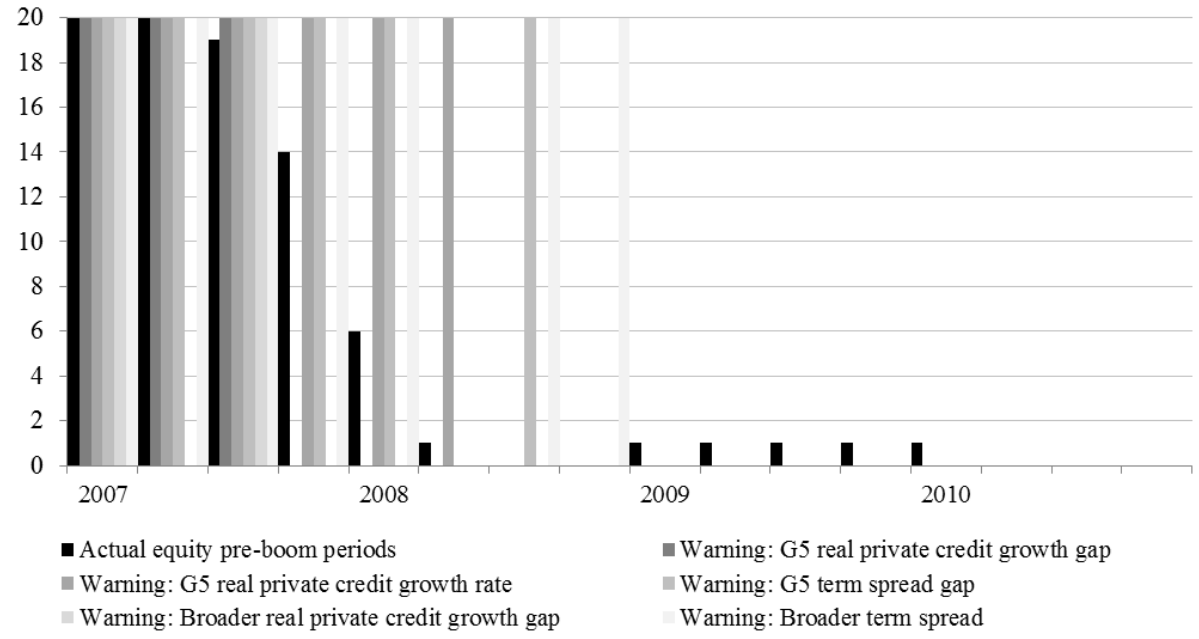


Chart 7. Equity price pre-boom episodes and early warnings based on global liquidity measures



6. Conclusions

Our results show that, in the last decade, global liquidity measures outperformed domestic measures as early warning indicators of asset price booms. Between the two global liquidity measures, G5 aggregates performed better than broader liquidity measures. The search for the best early warning indicator showed that the *G5 real narrow money gap* performed best for booms in house prices (for both warning horizons), while the *global real private credit growth gap* performed best for booms in equity prices, either when aggregated over G5 countries (for the horizon of 1-5 quarters) or over a

broader sample of 26 countries (for the horizon of 5-9 quarters). These findings were subsequently corroborated in a number of robustness checks, including rolling estimations, and in an out-of-sample early warning exercise. The fact that G5 liquidity measures tend to perform relatively better than broader liquidity measures is most likely due to the short period for which broader measures are available. Furthermore, given that the share of G5 in global liquidity has been steadily decreasing over time, the superior performance of G5 measures in the past may not warrant their superior performance in the future. Additionally, the high synchronicity between G5 and broader liquidity measures is not warranted to prevail. Therefore, given the importance of global liquidity measures in detecting booms (and busts) in asset prices, the need for constructing broad global liquidity measures is warranted.

Our results confirm the conclusions by the CGFS' Ad-hoc Group that quantity measures are better suited to capture to what extent global liquidity translates into the build-up of potential risks (CGFS (2011)). Our findings also broadly confirm the results by Alessi and Detken (2011), except that in our study global narrow money performs best as deviations of the level from trend and global credit to the private sector performs best as deviations of the annual growth rate from trend.[23] In the latter detail our study also differs from the findings and recommendations by Drehmann et al. (2011).

Finally, our results clearly illustrate the impact of financial liberalization and globalization, as the performance of global (G5) liquidity measures was worse in the longer sample covering the last four decades, than in the last decade. Given the current regulatory reform agenda (mainly Basel III capital, leverage and liquidity regulations, SIFI regulations, and shadow banking reforms) the question arises whether the superior performance of global liquidity measures will prevail. CGFS (2011) points to the fact that the current reforms are explicitly designed to dampen the pro-cyclicality of the financial system, and hence are likely to reduce the amplitude of global liquidity cycles. Elliott and Mitra (2012) provide a useful overview of the impact of the current reform agenda on the functioning of the financial system. Combining the insights from these two sources, we can infer the following.

First, early evidence suggests that banks are adjusting to the new capital and leverage requirements mainly through de-risking assets, meaning that the growth of the most risky and volatile bank assets (such as the inter-bank liabilities and cross-border lending) is likely to be substantially dampened. At the same time, the growth of credit to the private sector could also be permanently reduced, while the demand for highest-rated sovereign bonds could be permanently increased (reducing yields). Secondly, the new liquidity rules create a strong demand for short-term liquid government securities (the liquidity coverage ratio) and promote the growth of stable deposits and the issuance of long-term liabilities (the Net Stable Funding Ratio). The latter could therefore provide support to the growth of

[23] Moreover, in our study global liquidity measures outperform domestic measures a lot more often.

broad money in the future, provided that banks will prefer to fund themselves with deposits. Thirdly, the liquidity coverage ratio potentially pushes down the overnight money market rate, while increasing longer money market rates (over 30 days).[24] All this implies that the current regulatory reforms could permanently change the behavior of the financial variables used in our study (and their trends). Hence, in future studies one should control for such structural breaks. Finally, there is some evidence that Basel III capital, leverage and liquidity rules are likely to reduce traditional bank-based intermediation, in favor of non-banks. This implies that the scope of quantitative measures of liquidity may in the future need to be extended to include non-banks in order to support their early warning properties.

[24] Bech and Keister (2012)

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Appendix 1. Data sources

- Real house price indices: the OECD (see Girouard et al. (2006) for the description of the dataset).

- Equity price indices (MSCI): Thomson Financials.

- Broad money (M3): OECD Main Economic Indicators, except for the United Kingdom (Bank of England), Japan, Korea (Thomson Financials), Norway (IMF International Financial Statistics), Germany, Italy (IMF International Financial Statistics, augmented with data from the ECB Statistical Data Warehouse), France, Belgium, Spain, Finland, Greece, Ireland and the Netherlands (Eurostat, augmented with data from the ECB Statistical Data Warehouse).

- Broad money growth rates: OECD Main Economic Indicators, except for the United Kingdom, Japan, Norway, New Zealand, (calculated from outstanding amounts and augmented with data from OECD Main Economic Indicators), Korea, Israel, Germany, France, Belgium, Spain, the Netherlands (calculated from outstanding amounts), Italy (calculated from outstanding amounts and augmented with data from Bank of Italy), Finland (Bank of Finland), Greece (calculated from outstanding amounts and augmented with the data from Bank of Greece) and Ireland (calculated from outstanding amounts and augmented with the data from the Central Bank of Ireland).

- Narrow money (M1): OECD Main Economic Indicators, except for the United Kingdom (IMF International Financial Statistics), Norway, New Zealand (IMF International Financial Statistics, augmented with data from OECD Main Economic Indicators), Sweden (Thomson Financials), Germany, France, Belgium, Spain, Finland, Ireland, the Netherlands (Eurostat, augmented with data from the ECB Statistical Data Warehouse), Italy (Bank of Italy, augmented with data from the ECB Statistical Data Warehouse) and Greece (Bank of Greece).

- Narrow money growth rates: OECD Main Economic Indicators, except for the United Kingdom, Norway, New Zealand, Sweden (calculated from outstanding amounts and augmented with data from OECD Main Economic Indicators), Germany, France, Belgium, Spain, the Netherlands (calculated from outstanding amounts), Italy (calculated from outstanding amounts and augmented with data from Bank of Italy), Finland (Bank of Finland), Greece (calculated from outstanding amounts and augmented with the data from Bank of Greece) and Ireland (calculated from outstanding amounts and augmented with the data from the Central Bank of Ireland).

- Credit to the non-financial private sector: IMF International Financial Statistics, except for the euro area (ECB Statistical Data Warehouse), the United States (the Federal Reserve), the United Kingdom, Chile, Hungary, Norway, Turkey, South Africa (Thomson Financials), Canada (Thomson Financials and Bank of Canada), Japan (Bank of Japan, augmented with IMF International Financial Statistics), Denmark (Danmarks Nationalbank, augmented with IMF International Financial Statistics), Sweden (Sveriges Riksbank), the Czech Republic (Czech National Bank), Poland (National Bank of Poland), Germany, France, Italy, Belgium, Spain, Finland, Greece, Ireland and the Netherlands (IMF International Financial Statistics, augmented with data from the ECB Statistical Data Warehouse).

- Credit to the private sector growth rates: calculated from outstanding amounts.

- Short-term interest rates: IMF International Financial Statistics, except for the euro area, India (Thomson Financials), Canada, Norway, New Zealand, Switzerland, Chile, China, Israel, Germany, France, Italy, Belgium, Spain, Finland, Greece, Ireland and the Netherlands (OECD Main Economic Indicators).

- Long-term interest rates: OECD Main Economic Indicators, except for Japan, Australia, Denmark, Korea, Norway, New Zealand, Sweden, Mexico, Italy, Spain, Finland, Greece, Ireland (IMF International Financial Statistics).

- Nominal GDP: OECD Main Economic Indicators, except for the euro area (Eurostat), Japan, Denmark (IMF International Financial Statistics), Norway (OECD Economic Outlook), Sweden, the Russian Federation and China (Thomson Financials).

- Nominal GDP growth rates: calculated from outstanding amounts.

- Consumer price indices: OECD Main Economic Indicators, except for the euro area (IMF International Financial Statistics).

- Exchange rates: IMF International Financial Statistics, except for the euro area (Thomson Financials).

When necessary the data has been seasonally adjusted and corrected for breaks; real series were obtained by deflating with national CPIs.

Appendix 2. Real house and equity price booms

Real house price booms (dates and the total number of quarters)									
Australia	**Belgium**	**Canada**	**Denmark**	**Finland**	**France**	**Germany**	**Greece***	**Ireland**	**Italy**
						1979.04-1981.02		1979.04	
1981.01-1981.04				1981.02-1985.02					1980.04-1981.02
1984.03-1985.04			1984.02-1987.01						
1986.02	1986.04-1991.04	1986.01-1990.01			1986.04-1991.02				
1988.01-1990.02				1988.01-1989.04		1989.03-1994.02		1988.03-1992.01	1988.04-1992.02
			1994.01-1999.02	1996.04-2000.03					
1998.01-2004.02	1999.02-1999.03	1999.02-2007.04			1998.04-2006.02		2000.04	1997.01-2001.02	1999.03-2005.02
	2004.04-2006.02		2005.02-2007.02	2005.03-2005.04			2001.04		
	2006.04-2007.01			2006.03-2006.04			2002.04		
						2009.02-2010.04			
47	32	52	43	45	50	34	3	34	42
Japan	**Korea****	**Netherlands**	**New Zealand**	**Norway**	**Spain**	**Sweden**	**Switzerland**	**UK**	**US**
							1979.04-1982.04	1980.01	
1980.03-1984.01							1983.02-1983.04	1980.03	
			1982.01-1985.04	1984.02-1987.03				1983.03	
	1987.04-1988.03	1986.02-1990.03			1986.02-1990.03	1986.04-1991.01	1987.02-1989.04	1986.02-1989.04	1986.02-1989.04
1989.04-1991.01	1989.01-1989.02								
	1990.02	1992.03							
		1993.04-2000.04	1993.04-1997.03	1994.03-2000.03					1995.03-2002.04
					1998.03-2005.04	1997.03-2002.01	1999.04	1997.01-2003.04	
	2001.03-2007.03		2003.01-2007.02	2006.03-2007.03			2000.02-2005.04	2004.02	2004.03
									2005.02-2005.03
							2009.04-2010.04		
21	32	48	50	44	48	37	56	47	48
Notes: * Available as of 1997.03. ** Available as of 1986.03.									

Real equity price booms (dates and the total number of quarters)									
Australia	**Belgium**	**Canada**	**Denmark**	**Finland***	**France**	**Germany**	**Greece***	**Ireland***	**Italy**
1979.04-1981.03	1979.04-1980.01	1979.04-1981.03			1979.04-1981.02				1979.04-1980.01
			1981.02-1984.03						1980.03-1982.02
1984.01	1982.01-1987-04	1983.03-1983.04			1983.03-1987.04	1983.02-1987.01			1983.01-1983.04
1985.02-1987-04									1985.01-1987.03
	1988.02-1989.04	1987.02-1987.04	1989.01-1990.03		1989.04-1990.01		1989.01		
							1989.04-1990.01		
			1991.04			1990.02	1990.03		
1993.04-1994.02		1994.01-1994.02		1993.01-1996.01		1994.01		1993.03-1994.02	1994.02-1995.01
		1994.04-1998.03			1996.04-2000.04	1995.04-2000.02		1994.04-1995.01	1995.03-1996.01
								1995.03-1999.03	
1997.01	1996.01-2000.01		1997.01-1999.01	1996.04-2001.01			1997.02-2000.03		1996.03-2000.04
1997.03-1997.04									
1998.02		1999.04-2000.04	1999.04-2000.04			2000.04			
2005.01-2008.01	2005.03-2007.04	2005.04-2008.01	2005.03-2008.01	2007.03-2008.02	2006.02-2008.01	2006.02-2008.02	2006.01-2008.01	2006.01-2007.04	2006.02-2007.04
		2008.03							
40	60	47	47	35	52	47	27	31	57
Japan	**Korea***	**Netherlands**	**New Zealand***	**Norway**	**Spain**	**Sweden**	**Switzerland**	**UK**	**US**
		1979.04-1980.01		1979.04-1981.01			1979.04-1980.01	1979.04	
1981.02-1987.04		1980.03-1981.03			1981.03-1988.03	1981.01-1984.04	1980.03-1980.04	1980.03-1981.03	1980.04-1981.03
		1982.01-1982.02						1982.01-1982.02	1983.01-1984.02
		1982.04-1987.04		1983.02-1986.01		1986.01-1987.02	1983.02-1987.04	1982.04-1987.04	1984.04-1987.04
1988.02-1989.01				1987.04		1987.04			
			1989.02	1989.02-1990.03		1989.03-1989.04			
			1989.04						
	1993.03	1993.04-1994.02	1992.01-1992.03			1993.04-1994.02	1993.03-1995.01	1994.01	
	1994.01-1995.04		1993.01-1996.02	1995.01		1994.04-1995.01			
1996.02-1997.01		1995.04-1998.03	1996.04-1997.01	1995.04	1995.04-2000.02	1995.03-1999.01	1995.03-1998.03	1995.04-1998.03	1995.03-2000.02
1997.03-1997.04			1997.03-1997.04	1996.03-1998.03					
1999.03-2000.04	1999.03-2000.03	1999.01				1999.03-2000.04	1999.01	1999.01-1999.03	
	2002.01-2002.04	2000.01			2000.04				
2004.02-	2003.03-		2003.03-	2004.02-	2005.04				

2004.03	2008.01		2006.03	2008.01					
2005.01-2007.04		2006.01-2008.02	2007.01-2007.03		2006.02-2008.02	2005.04-2007.04	2005.04-2008.01	2005.04-2008.01	2006.04-2008.02
								2010.02	
57	37	57	39	52	59	60	54	56	50
Notes: * Available as of 1988.03.									

Appendix 3. Additional results for real house price booms

3.1 In-sample horse race (random effects probit estimations)

In order to assess which liquidity measure performs best as an early warning indicator, we carried out a horse race between three models (for both horizons) involving the best model for broader, G5 and domestic liquidity measures (each time restricting the data to homogeneous samples, with all variables per aggregation available). We then re-estimated the three models (for both horizons) for all three aggregations, again over homogeneous samples. The results are reported in the table below.

In-sample horse race results for real house price booms				
Pre-boom horizon of 2-6 quarters				
Model 1: Best domestic model: trend deviations of real private credit growth rate				
	Marg effect	p-value	AIC	BIC
Domestic	0.0158615	0.015	1094.086	1108.56
G5	0.0327241	0.039	1089.864	1104.337
Broader	0.0520487	0.005	1049.927	1064.4
Model 2: Best G5 model: trend deviations of real narrow money				
	Marg effect	p-value	AIC	BIC
Domestic	0.000000483	0.617	1114.201	1128.674
G5	**0.000000606**	**0.002**	**946.7148**	**961.1879**
Broader	0.000000257	0.005	1096.507	1110.98
Model 3: Best broader model: trend deviations of real private credit growth rate				
	Marg effect	p-value	AIC	BIC
Domestic	0.0158615	0.015	1094.086	1108.56
G5	0.0327241	0.039	1089.864	1104.337
Broader	0.0520487	0.005	1049.927	1064.4
Pre-boom horizon of 6-10 quarters				
Model 1: Best domestic model: trend deviations of excess long-term interest rate				
	Marg effect	p-value	AIC	BIC
Domestic	-0.0210264	0.010	977.4658	991.9128
G5	-0.0195421	0.137	987.5756	1002.022
Broader	-0.0163392	0.167	988.0403	1002.487
Model 2: Best G5 model: trend deviations of real narrow money				
	Marg effect	p-value	AIC	BIC
Domestic	-0.000000173	0.759	993.7067	1008.154
G5	**0.00000053**	**0.010**	**807.1391**	**821.586**
Broader	0.000000241	0.052	972.4219	986.8688
Model 3: Best broader model: trend deviations of real private credit growth rate				

	Marg effect	p-value	AIC	BIC
Domestic	0.0029371	0.552	993.1006	1007.548
G5	0.0193936	0.023	982.4452	996.8921
Broader	0.0395875	0.000	945.4812	959.9281

3.2 Random effects probit estimation results for G5 countries only

Summary results for real house prices, pre-boom horizon of 2-6 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	X	G5 outperforms domestic	No
	Broader outperforms domestic	X		
	G5 outperforms domestic	X		
Narrow money	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	No		
Short-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Term spread	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		

Summary results for real house prices, pre-boom horizon of 6-10 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Narrow money	Broader outperforms G5	X	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	X		
	G5 outperforms domestic	X		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		

	G5 outperforms domestic	X		
Short-term rate	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Term spread	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		

3.3 Fixed effects probit estimation results

Summary results for real house prices, pre-boom horizon of 2-6 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Narrow money	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	**Yes**		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	No		
Short-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Term spread	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		

Summary results for real house prices, pre-boom horizon of 6-10 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	No	G5 outperforms domestic	No

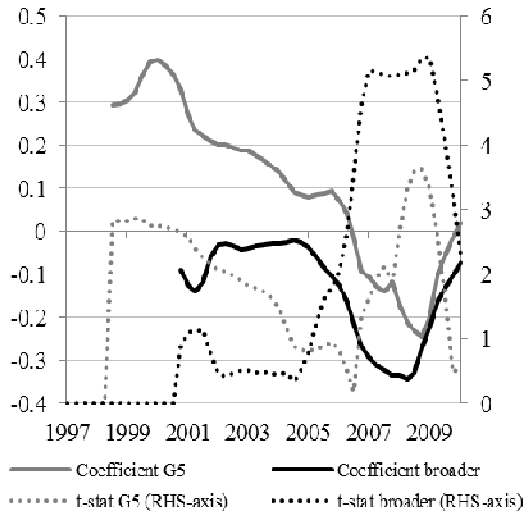
	Broader outperforms domestic	No		
	G5 outperforms domestic	**Yes**		
Narrow money	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Short-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Term spread	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		

3.4 Rolling estimations (random effects probit)

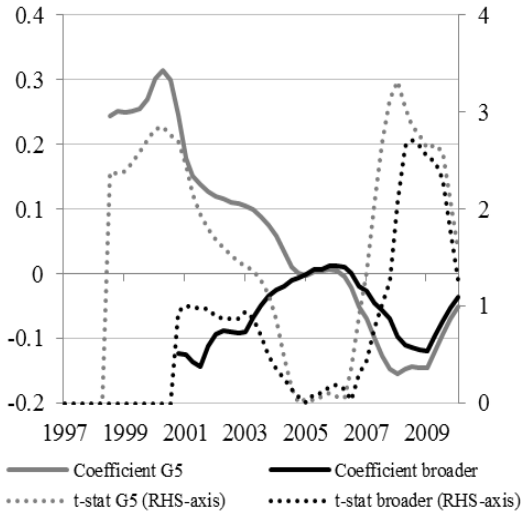
The charts below present coefficient estimates and corresponding t-statistics on the basis of random effects panel probit univariate estimations (i.e. including either the G5 or the broader liquidity measure). The rolling window is set to 40 quarters. Shading highlights the models included in the in-sample horse races.

Broad money - pre-boom horizon of 2-6 quarters

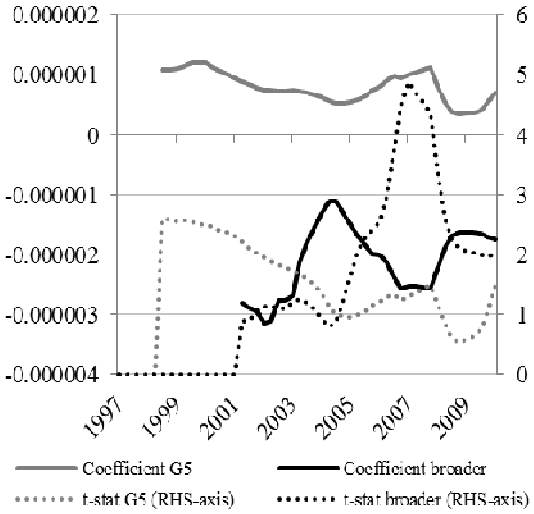
Real growth rate



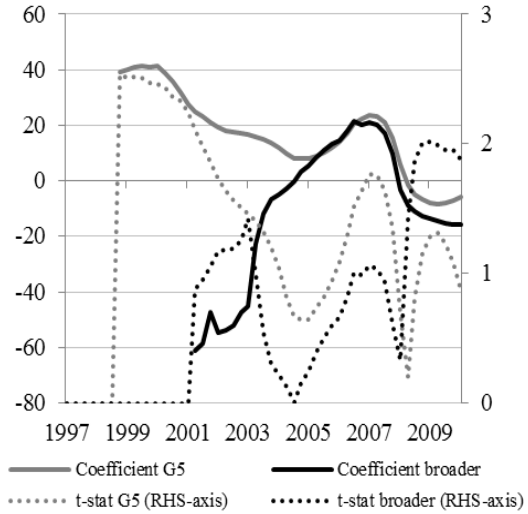
Excess growth rate



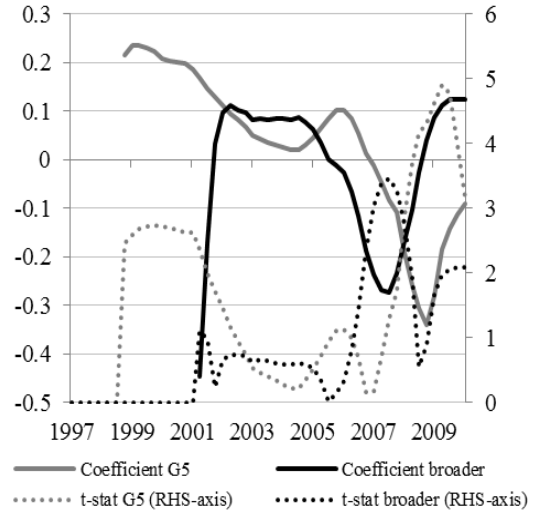
Trend deviation of level



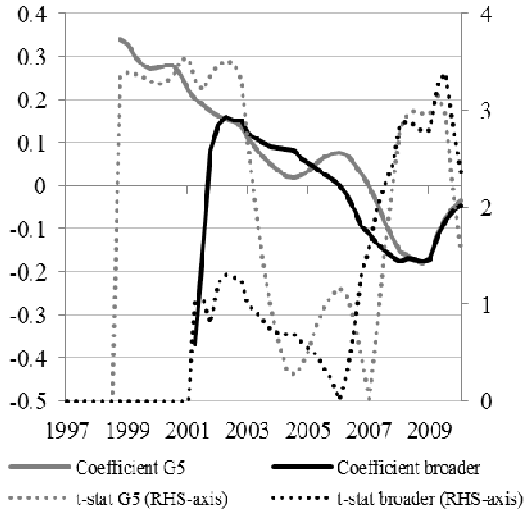
Trend deviation of ratio to GDP



Trend deviation of real growth rate

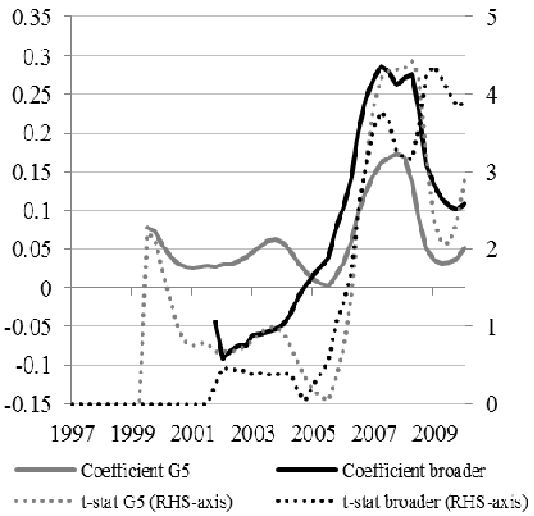


Trend deviation of excess growth rate

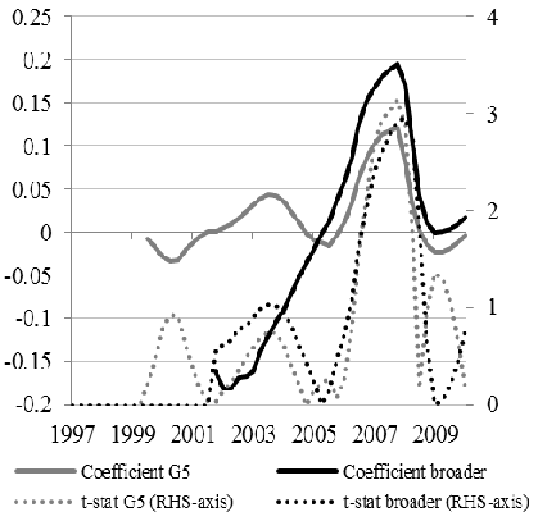


Narrow money - pre-boom horizon of 2-6 quarters

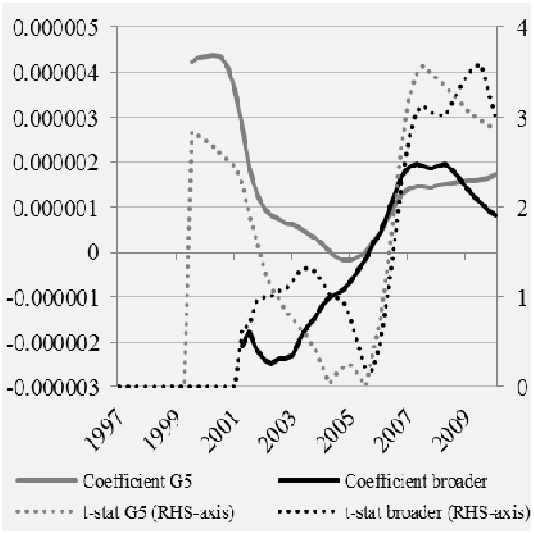
Real growth rate



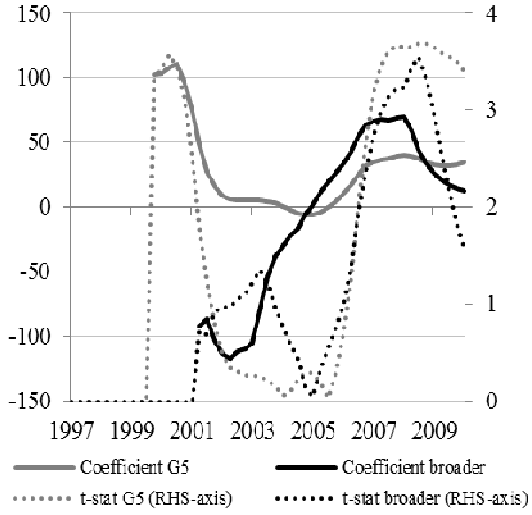
Excess growth rate



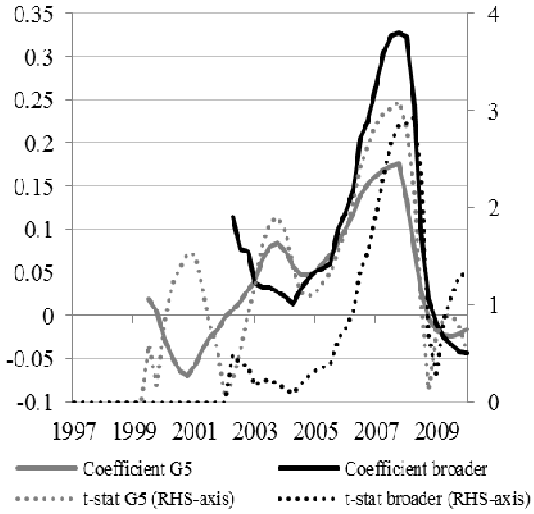
Trend deviation of level



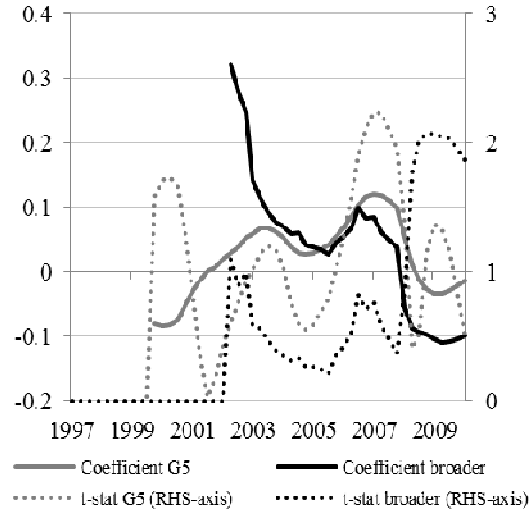
Trend deviation of ratio to GDP



Trend deviation of real growth rate

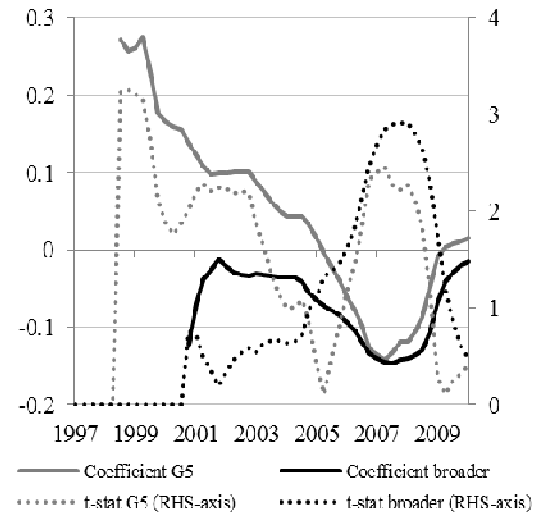


Trend deviation of excess growth rate

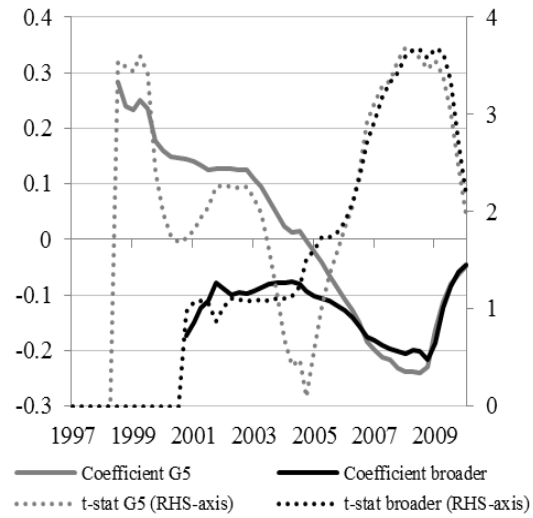


Private credit - pre-boom horizon of 2-6 quarters

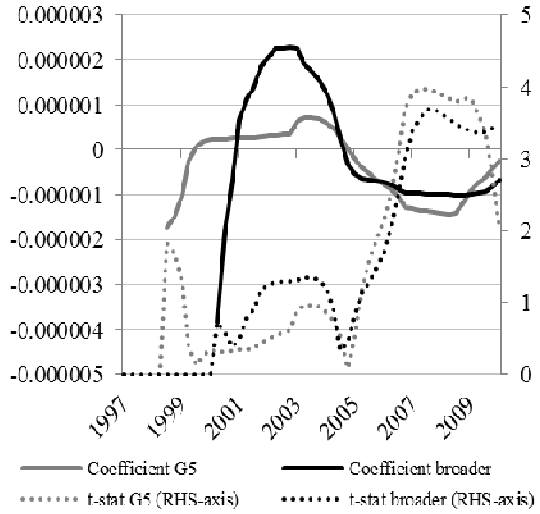
Real growth rate



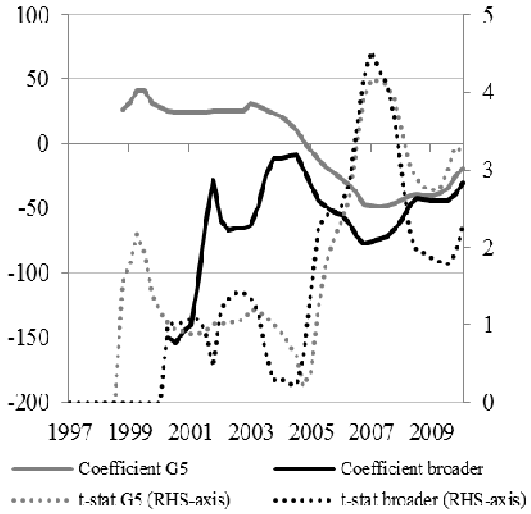
Excess growth rate



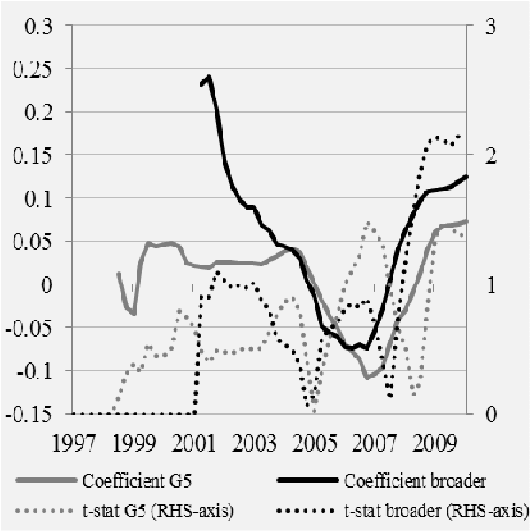
Trend deviation of level



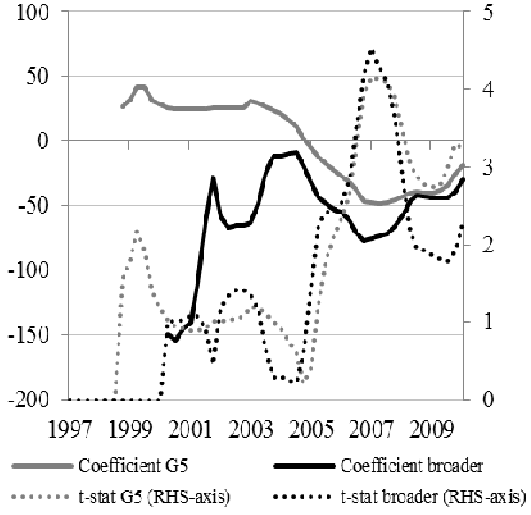
Trend deviation of ratio to GDP



Trend deviation of real growth rate

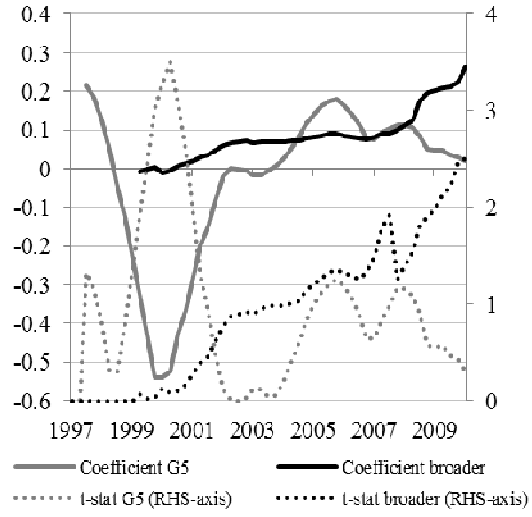


Trend deviation of excess growth rate

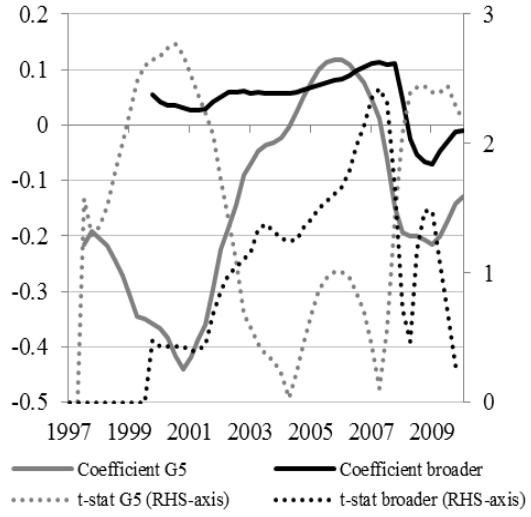


Short-term rate - pre-boom horizon of 2-6 quarters

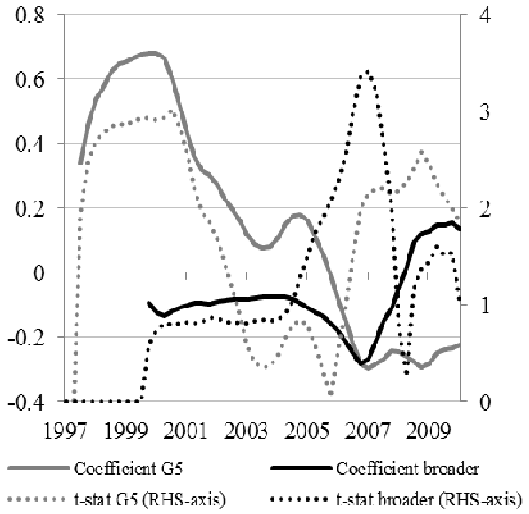
Real rate



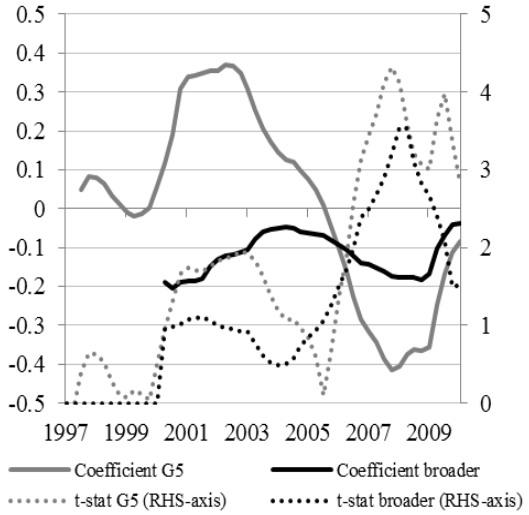
Excess rate



Trend deviation of real rate

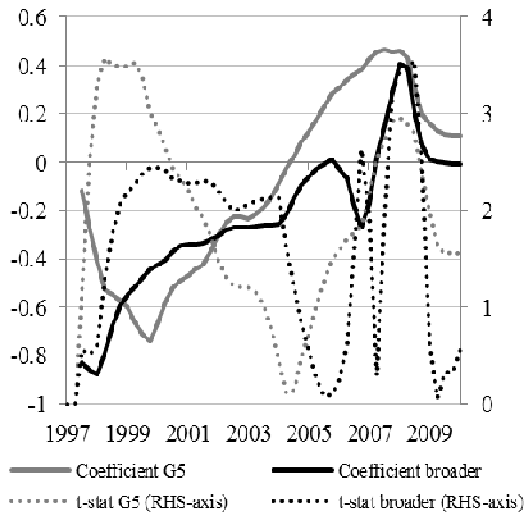


Trend deviation of excess rate

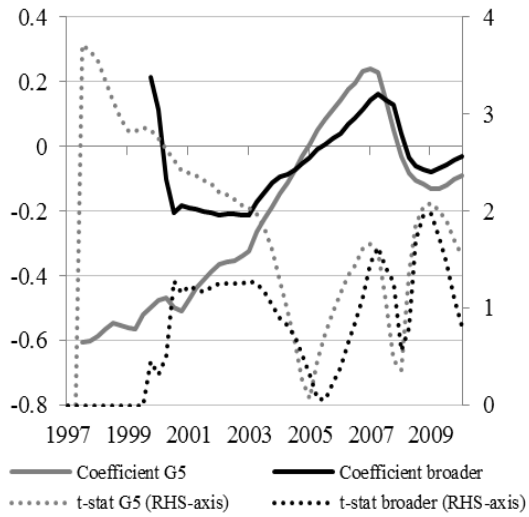


Long-term rate - pre-boom horizon of 2-6 quarters

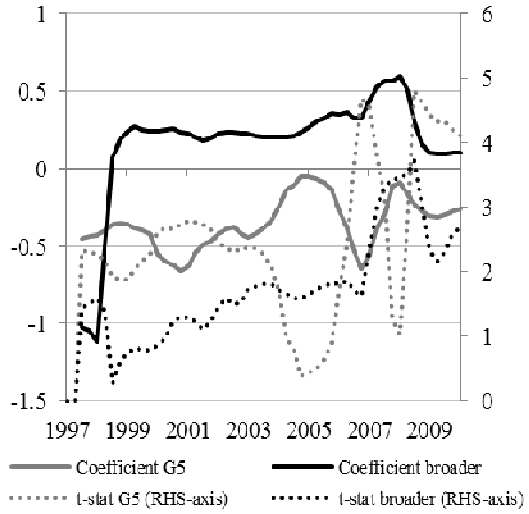
Real rate



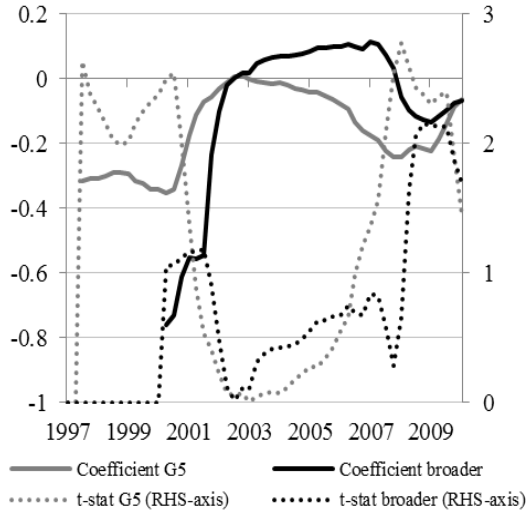
Excess rate



Trend deviation of real rate

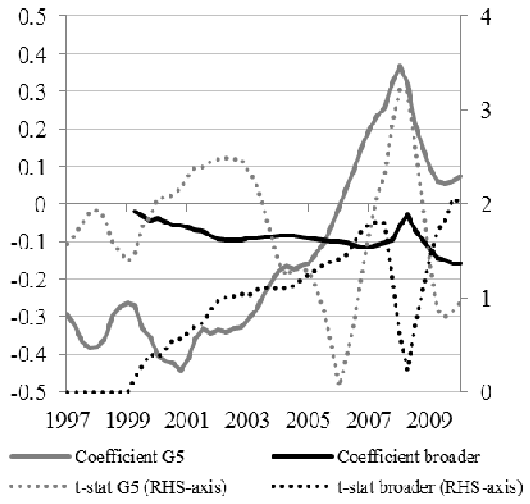


Trend deviation of excess rate

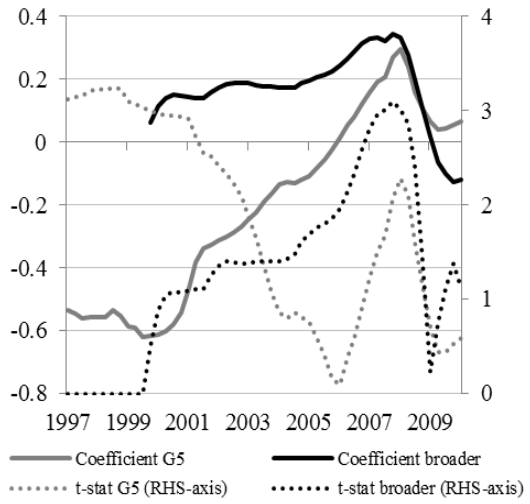


Term spread - pre-boom horizon of 2-6 quarters

Level

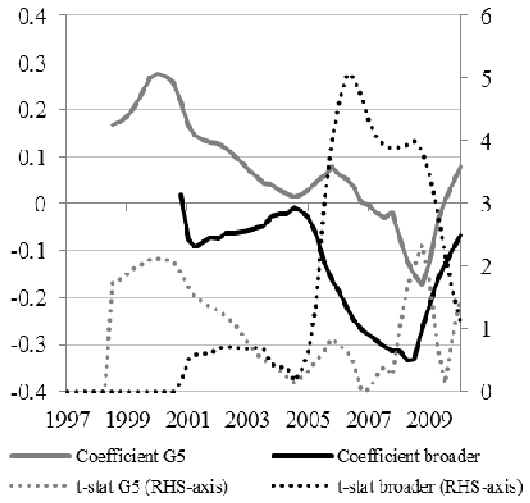


Trend deviation of level

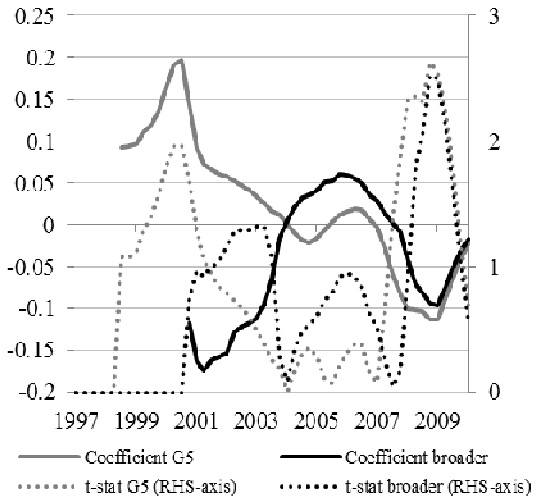


Broad money - pre-boom horizon of 6-10 quarters

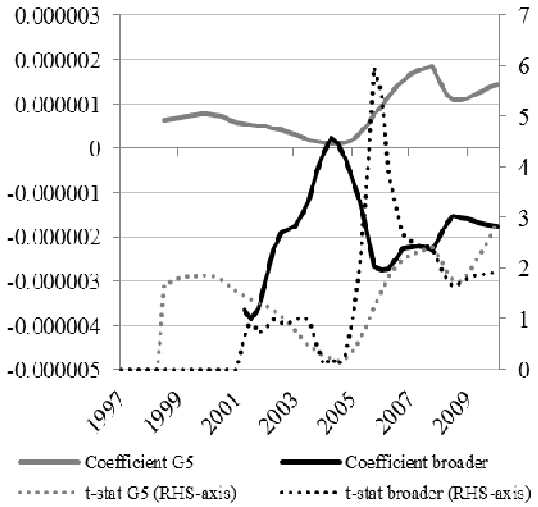
Real growth rate



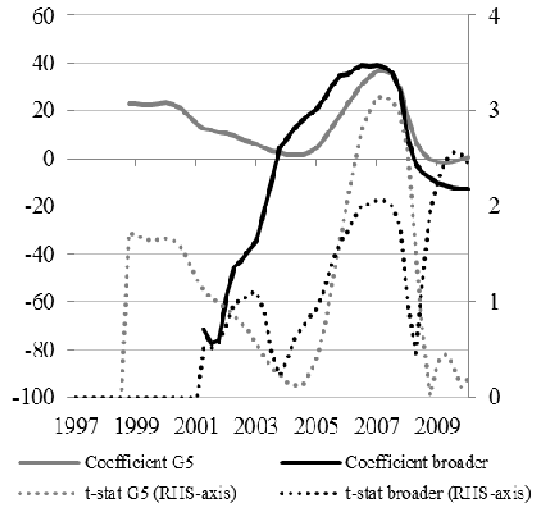
Excess growth rate



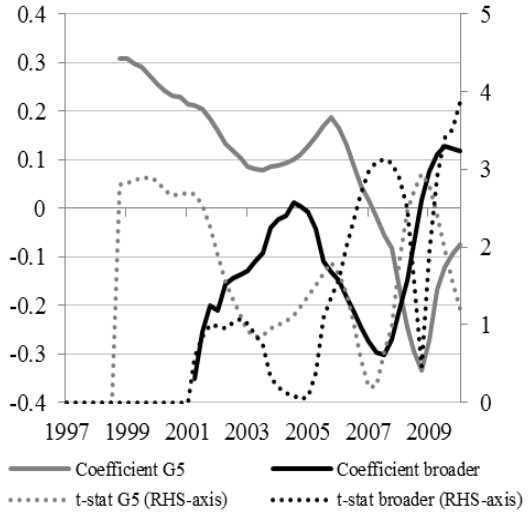
Trend deviation of level



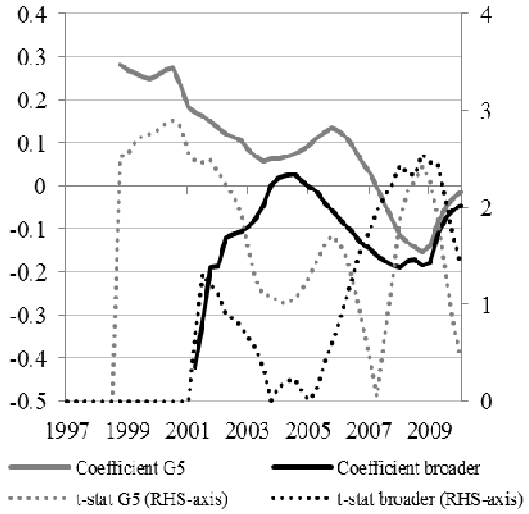
Trend deviation of ratio to GDP



Trend deviation of real growth rate

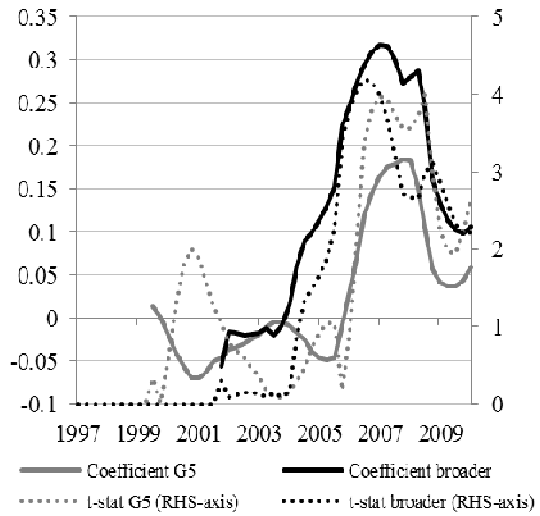


Trend deviation of excess growth rate

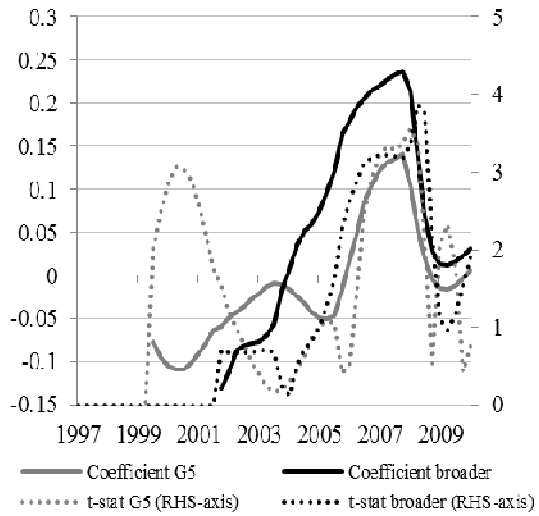


Narrow money - pre-boom horizon of 6-10 quarters

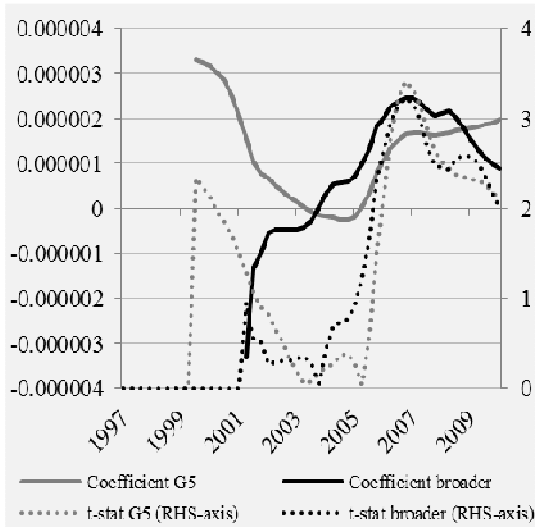
Real growth rate



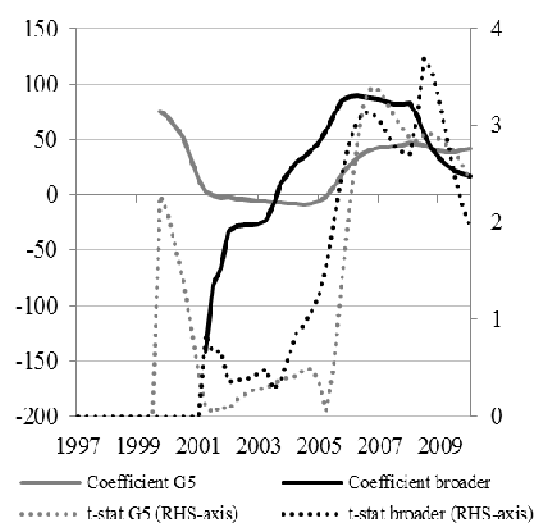
Excess growth rate



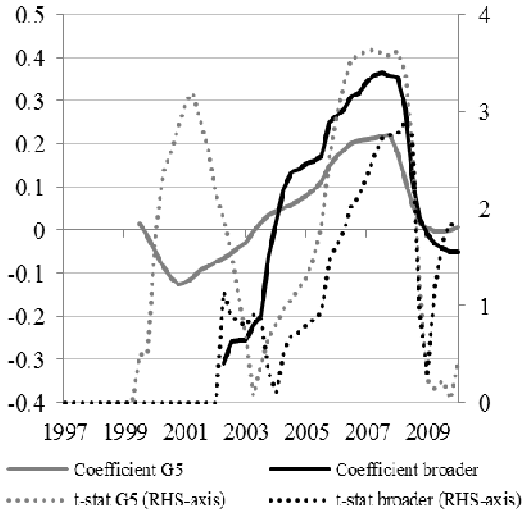
Trend deviation of level



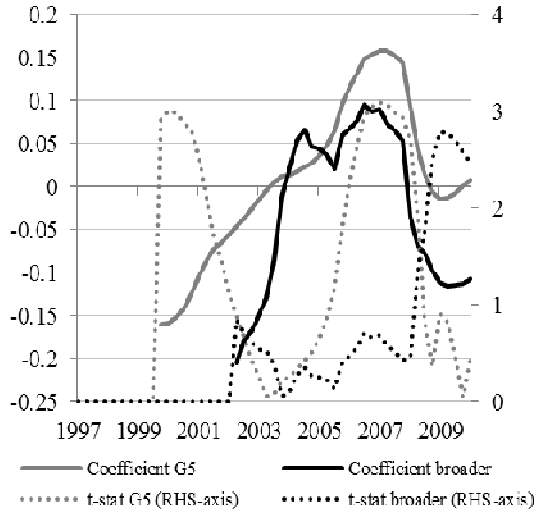
Trend deviation of ratio to GDP



Trend deviation of real growth rate

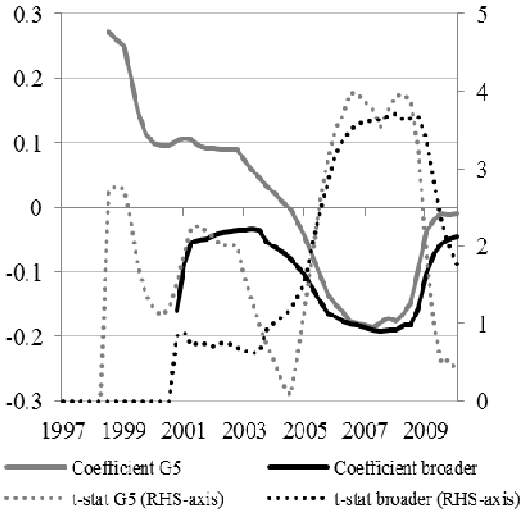


Trend deviation of excess growth rate

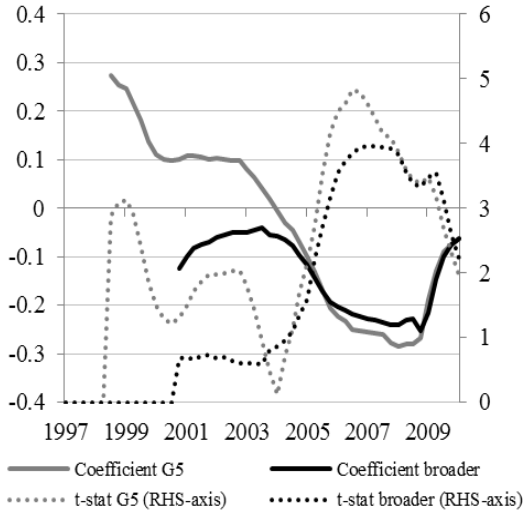


Private credit - pre-boom horizon of 6-10 quarters

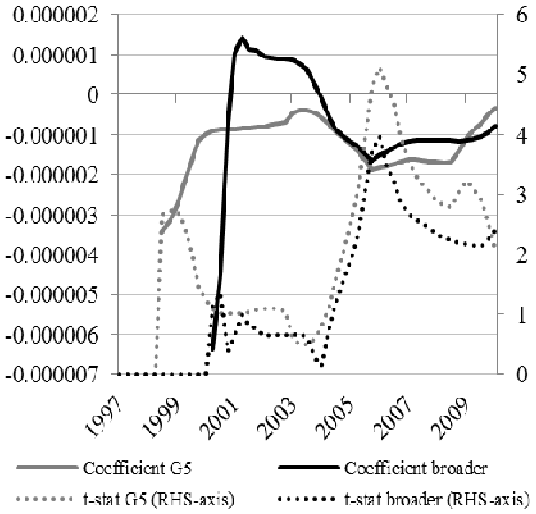
Real growth rate



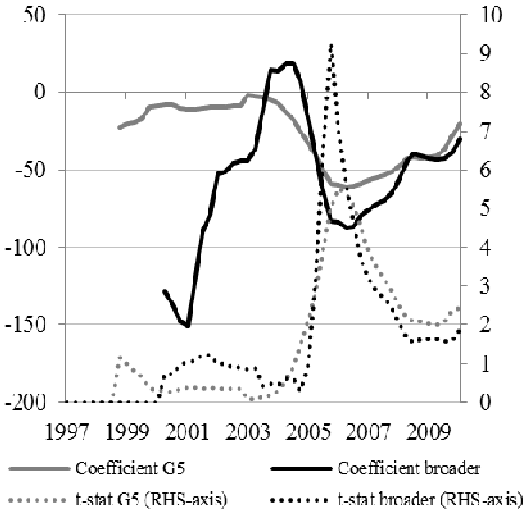
Excess growth rate



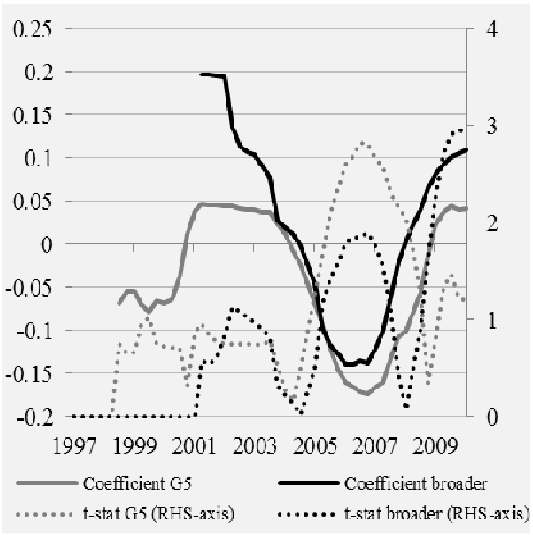
Trend deviation of level



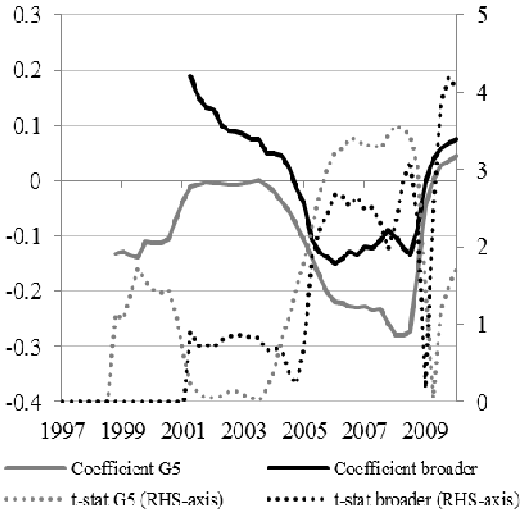
Trend deviation of ratio to GDP



Trend deviation of real growth rate

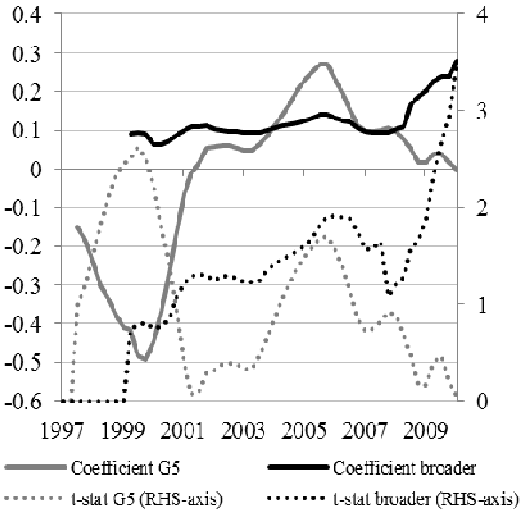


Trend deviation of excess growth rate

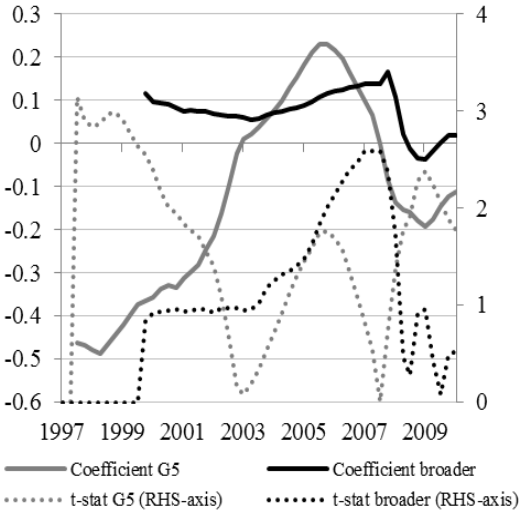


Short-term rate - pre-boom horizon of 6-10 quarters

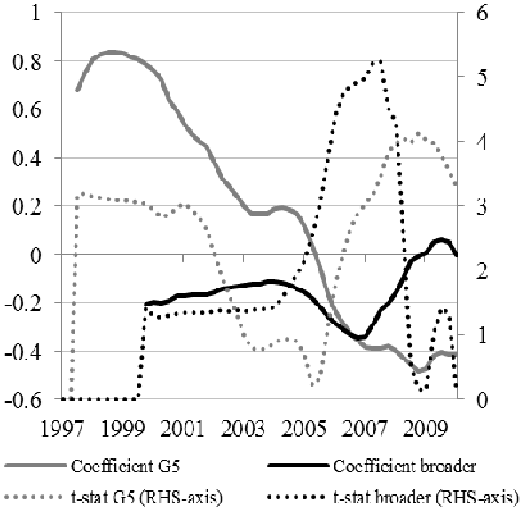
Real rate



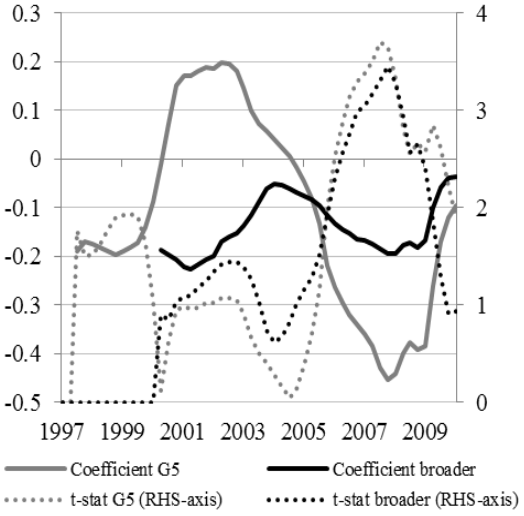
Excess rate



Trend deviation of real rate

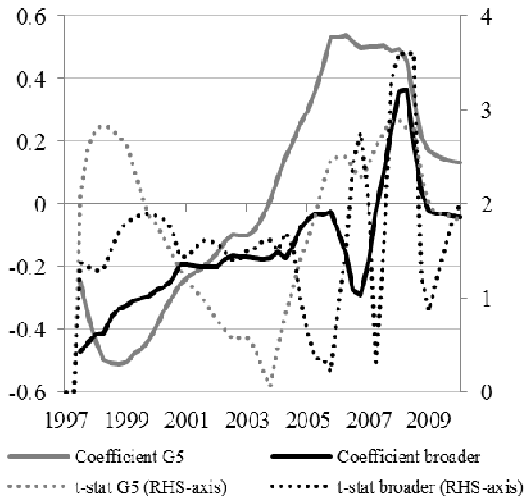


Trend deviation of excess rate

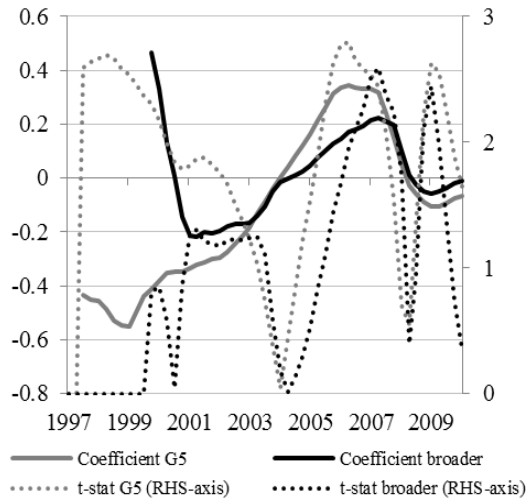


Long-term rate - pre-boom horizon of 6-10 quarters

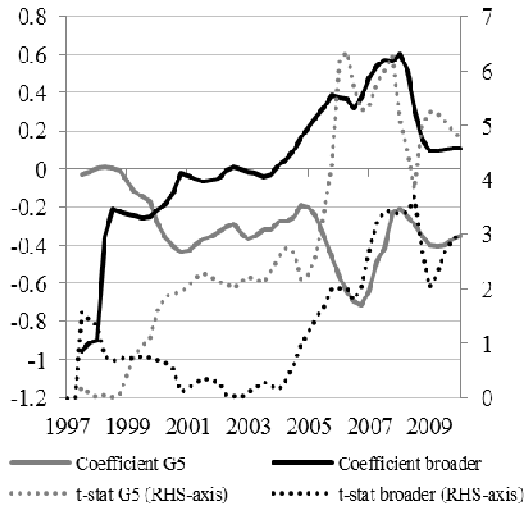
Real rate



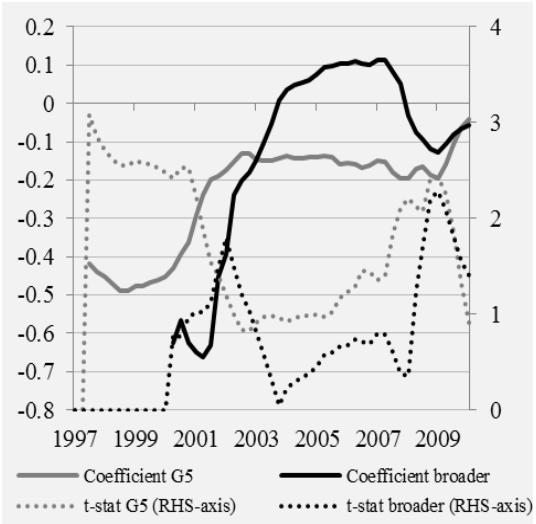
Excess rate



Trend deviation of real rate

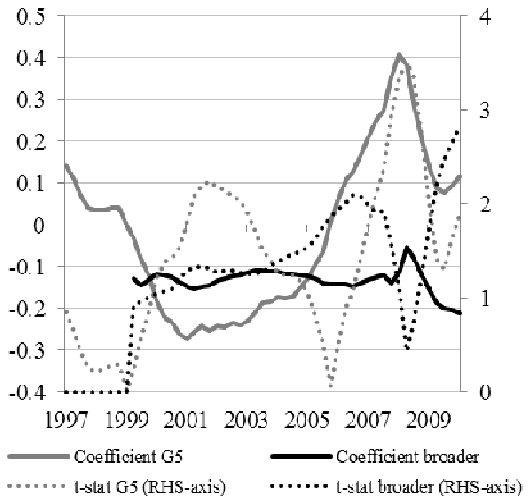


Trend deviation of excess rate

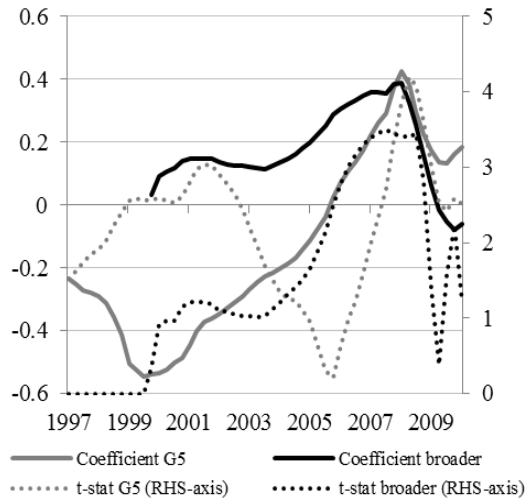


Term spread - pre-boom horizon of 6-10 quarters

Level



Trend deviation of level



Appendix 4. Additional results for real equity price booms

4.1 In-sample horse race (random effects probit estimations)

In-sample horse race results for real equity price booms				
Pre-boom horizon of 1-5 quarters				
Model 1: Best domestic model: trend deviations of real private credit growth rate				
	Marg effect	p-value	AIC	BIC
Domestic	0.0559284	0.001	1001.017	1015.464
G5	**0.1743615**	**0.000**	**748.0041**	**762.451**
Broader	0.1521807	0.001	850.4006	864.8476
Model 2: Best G5 model: trend deviations of term spread				
	Marg effect	p-value	AIC	BIC
Domestic	-0.1474497	0.001	1116.338	1130.785
G5	-0.3811138	0.000	819.4046	833.8515
Broader	-0.1901438	0.000	1072.347	1086.794
Model 3: Best broader model: real private credit growth rate				
	Marg effect	p-value	AIC	BIC
Domestic	0.0434014	0.000	1086.334	1100.781
G5	0.1417141	0.000	809.1096	823.5566
Broader	0.1032848	0.000	906.0396	920.4865
Pre-boom horizon of 5-9 quarters				
Model 1: Best domestic model: trend deviations of real private credit growth rate				
	Marg effect	p-value	AIC	BIC
Domestic	0.0349629	0.001	1075.52	1089.993
G5	0.1262293	0.000	865.0203	879.4934
Broader	0.1412525	0.000	815.4264	829.8995
Model 2: Best G5 model: trend deviations of real private credit growth rate				
	Marg effect	p-value	AIC	BIC
Domestic	0.0349629	0.001	1075.52	1089.993
G5	0.1262293	0.000	865.0203	879.4934
Broader	0.1412525	0.000	815.4264	829.8995
Model 3: Best broader model: trend deviations of real private credit growth rate				
	Marg effect	p-value	AIC	BIC
Domestic	0.0349629	0.001	1075.52	1089.993
G5	0.1262293	0.000	865.0203	879.4934
Broader	**0.1412525**	**0.000**	**815.4264**	**829.8995**

4.2 Random effects probit estimation results for G5 countries only

Summary results for real equity prices, pre-boom horizon of 1-5 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Narrow money	Broader outperforms G5	X	G5 outperforms domestic	No
	Broader outperforms domestic	X		
	G5 outperforms domestic	X		
Private credit	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Short-term rate	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Term spread	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	**Yes**		

Summary results for real equity prices, pre-boom horizon of 5-9 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Narrow money	Broader outperforms G5	X	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Short-term rate	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	No		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No

	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Term spread	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	**Yes**		

4.3 Fixed effects probit estimation results

Summary results for real equity prices, pre-boom horizon of 1-5 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Narrow money	Broader outperforms G5	X	G5 outperforms domestic	No
	Broader outperforms domestic	X		
	G5 outperforms domestic	X		
Private credit	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Short-term rate	Broader outperforms G5	**Yes**	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Term spread	Broader outperforms G5	No	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	**Yes**		

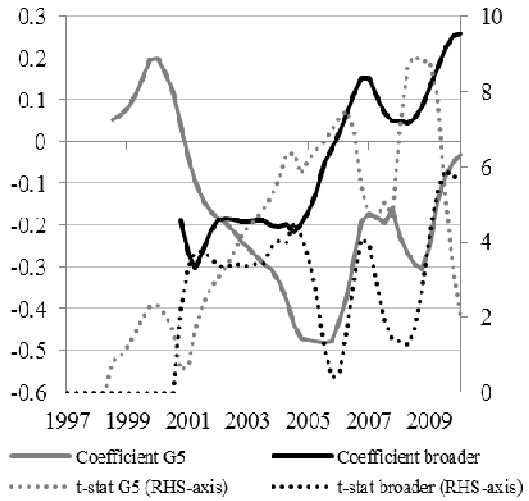
Summary results for real equity prices, pre-boom horizon of 5-9 quarters				
	Short sample		**Longer sample**	
Broad money	Broader outperforms G5	**Yes**	G5 outperforms domestic	**Yes**
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Narrow money	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	No		
	G5 outperforms domestic	No		
Private credit	Broader outperforms G5	**Yes**	G5 outperforms domestic	No

	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Short-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Long-term rate	Broader outperforms G5	No	G5 outperforms domestic	No
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		
Term spread	Broader outperforms G5	No	G5 outperforms domestic	X
	Broader outperforms domestic	**Yes**		
	G5 outperforms domestic	**Yes**		

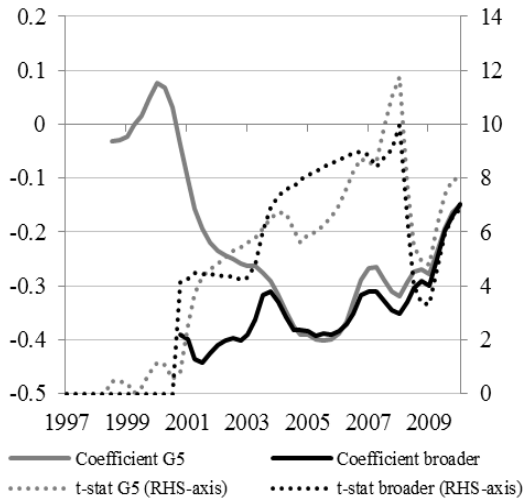
4.4 Rolling estimations (random effects probit)

Broad money - pre-boom horizon of 1-5 quarters

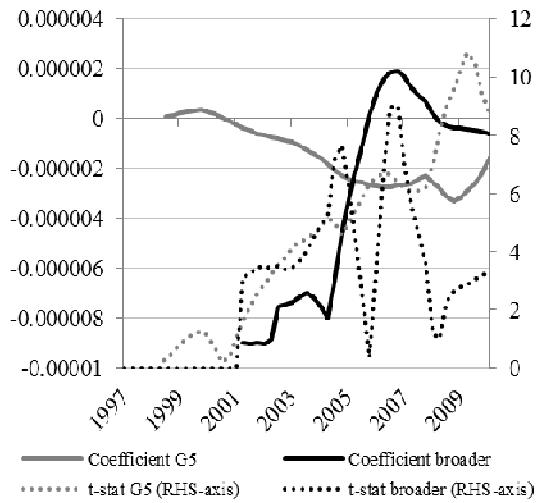
Real growth rate



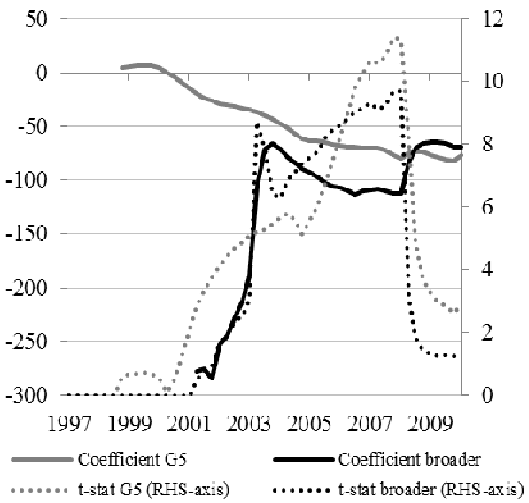
Excess growth rate



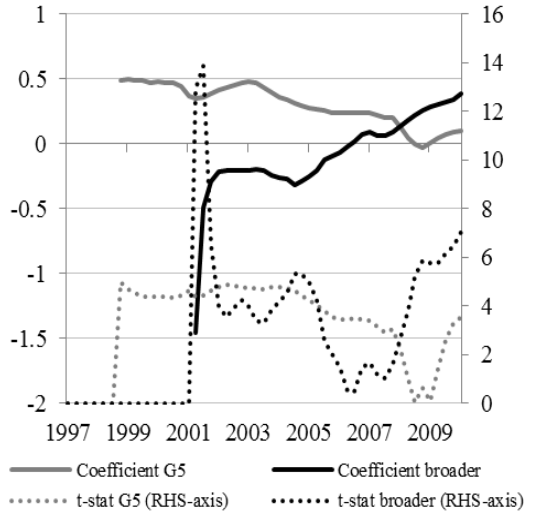
Trend deviation of level



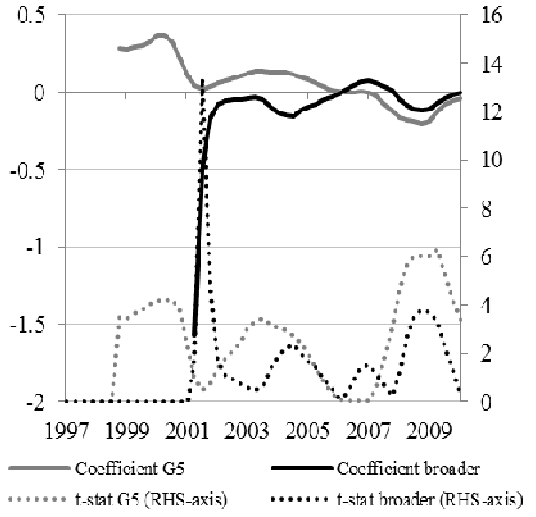
Trend deviation of ratio to GDP



Trend deviation of real growth rate

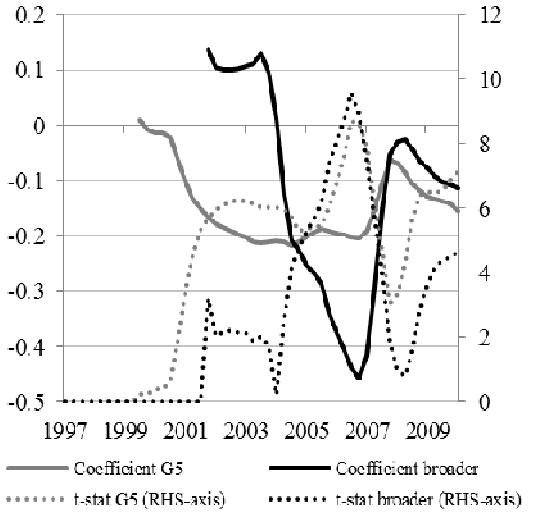


Trend deviation of excess growth rate

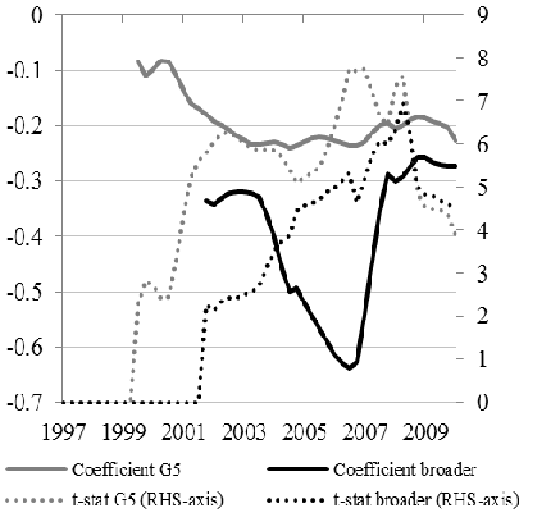


Narrow money - pre-boom horizon of 1-5 quarters

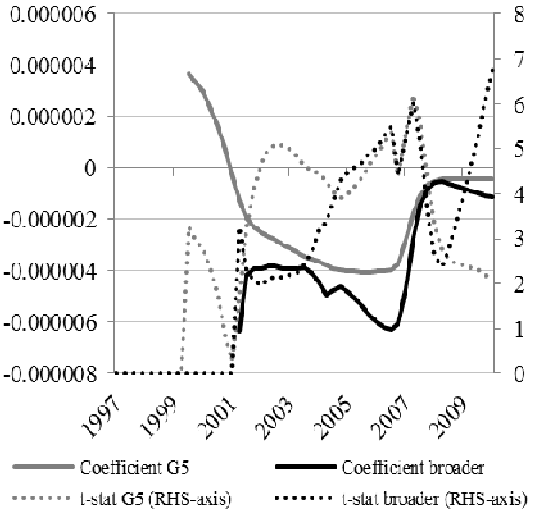
Real growth rate



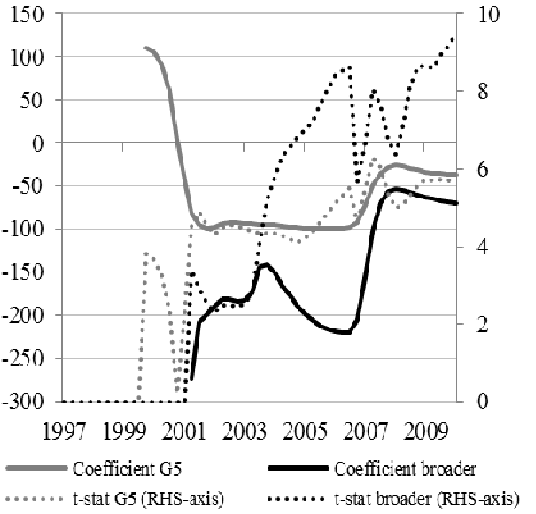
Excess growth rate



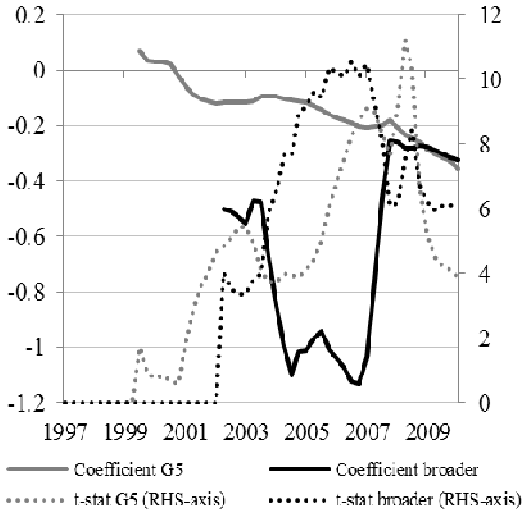
Trend deviation of level



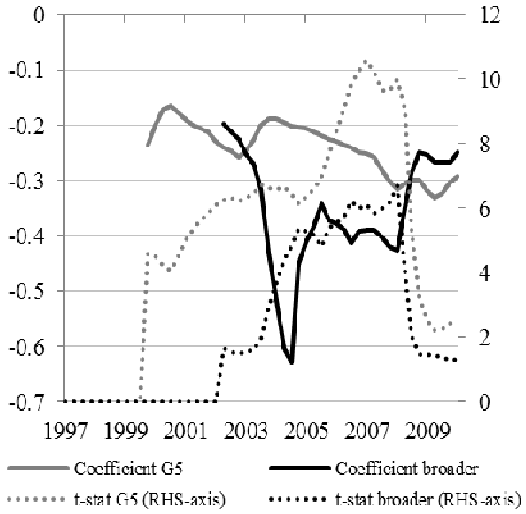
Trend deviation of ratio to GDP



Trend deviation of real growth rate

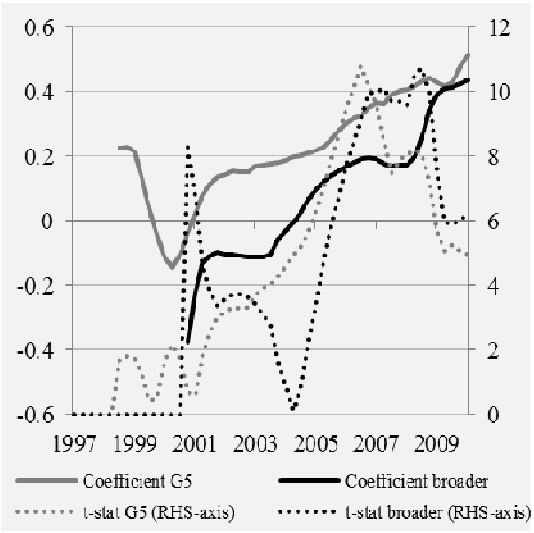


Trend deviation of excess growth rate

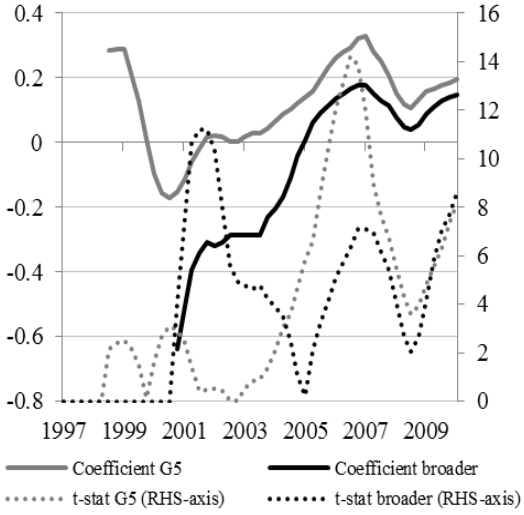


Private credit - pre-boom horizon of 1-5 quarters

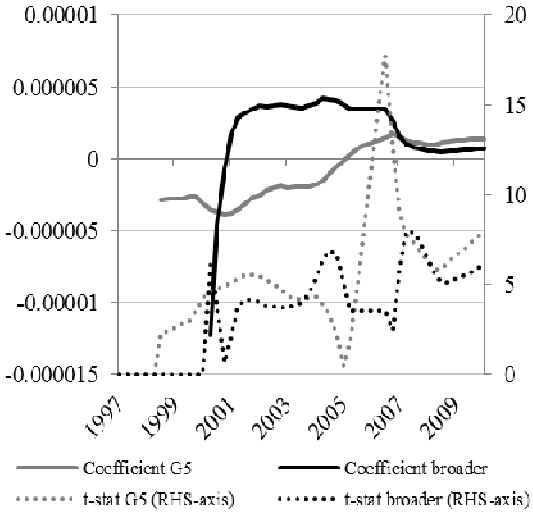
Real growth rate



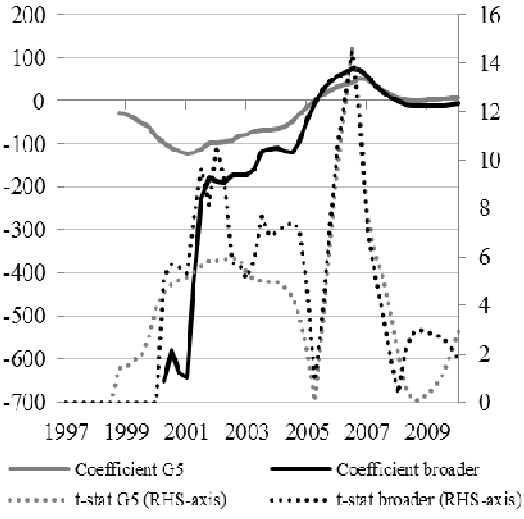
Excess growth rate



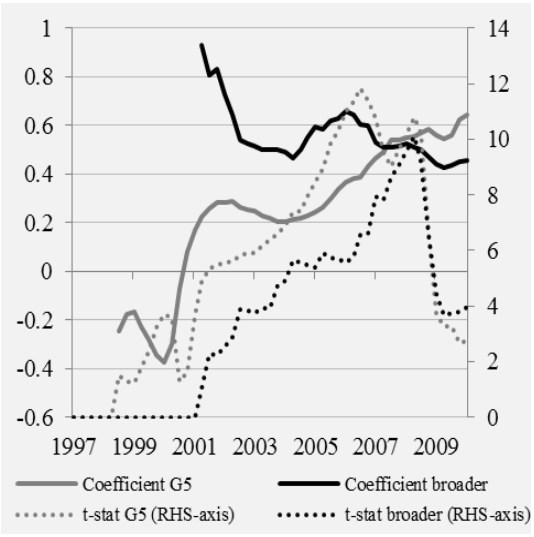
Trend deviation of level



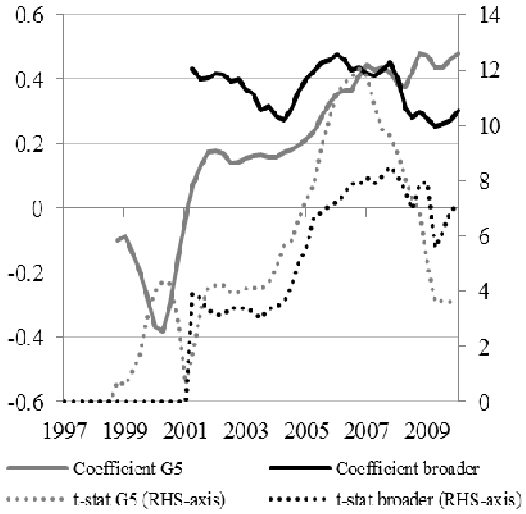
Trend deviation of ratio to GDP



Trend deviation of real growth rate

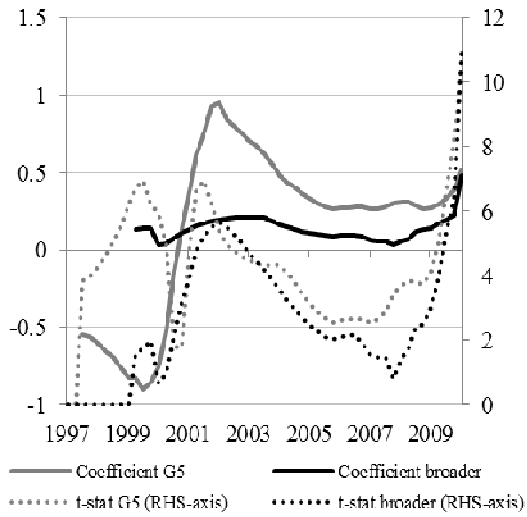


Trend deviation of excess growth rate

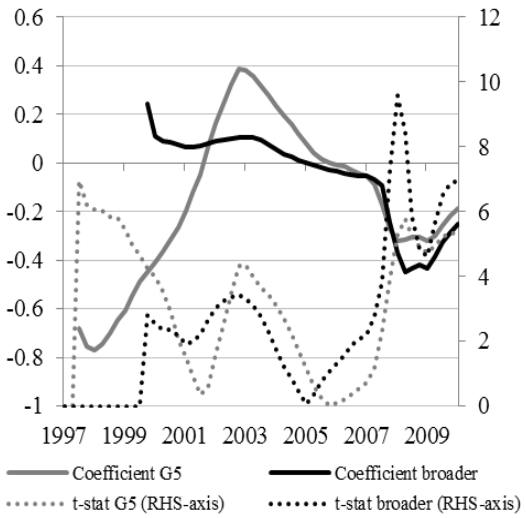


Short-term rate - pre-boom horizon of 1-5 quarters

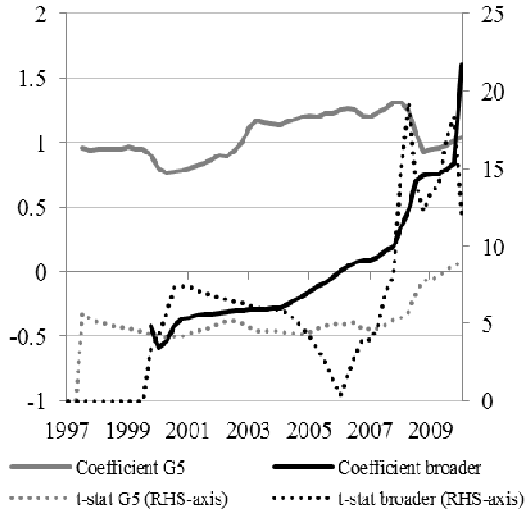
Real rate



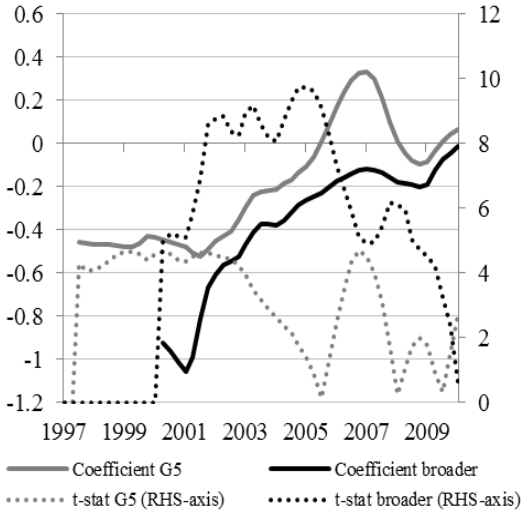
Excess rate



Trend deviation of real rate

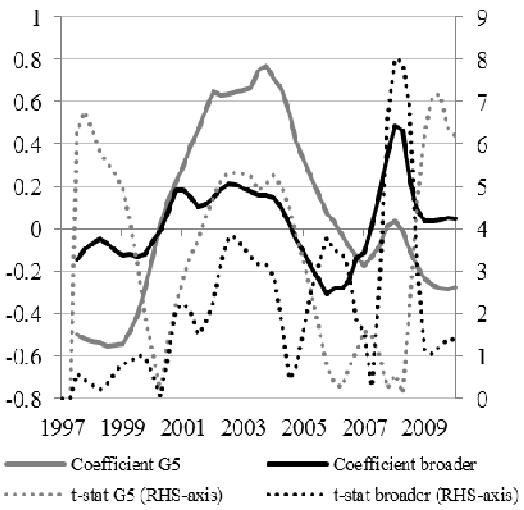


Trend deviation of excess rate

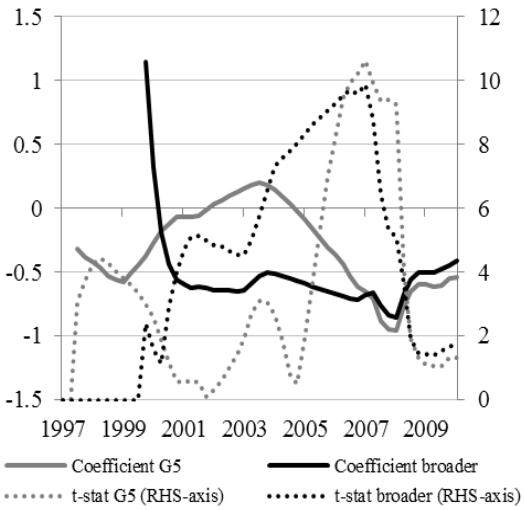


Long-term rate - pre-boom horizon of 1-5 quarters

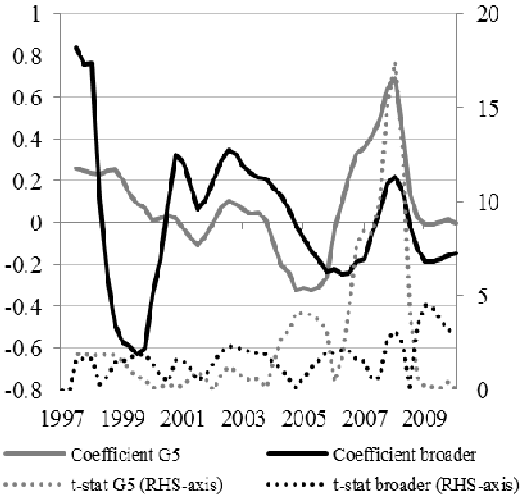
Real rate



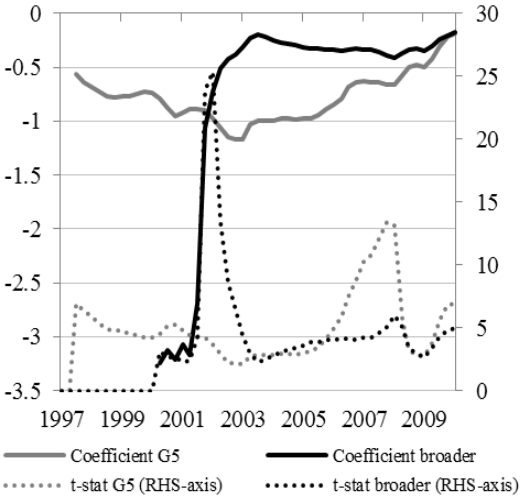
Excess rate



Trend deviation of real rate

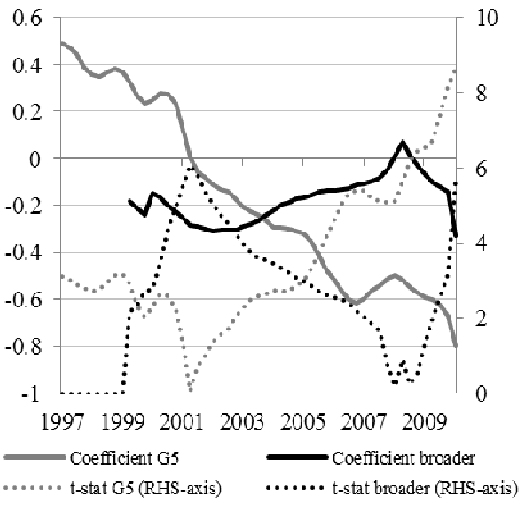


Trend deviation of excess rate

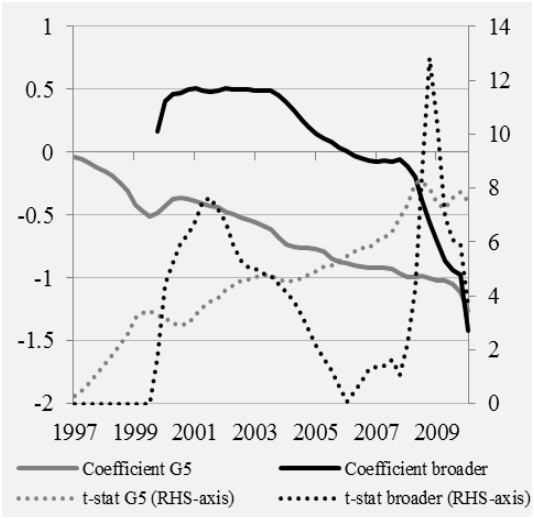


Term spread - pre-boom horizon of 1-5 quarters

Level

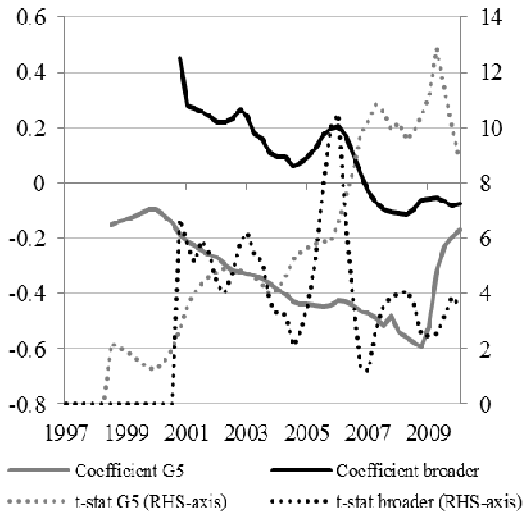


Trend deviation of level

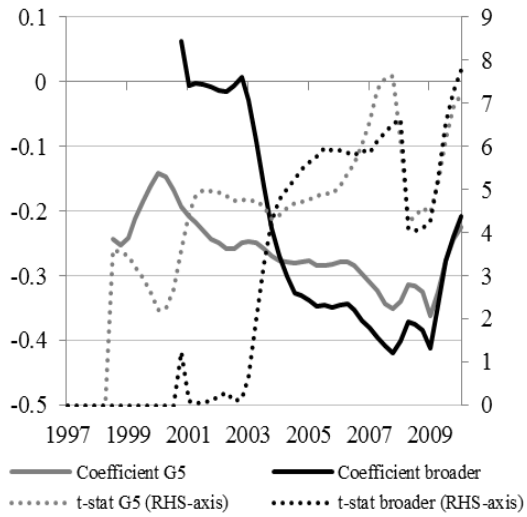


Broad money - pre-boom horizon of 5-9 quarters

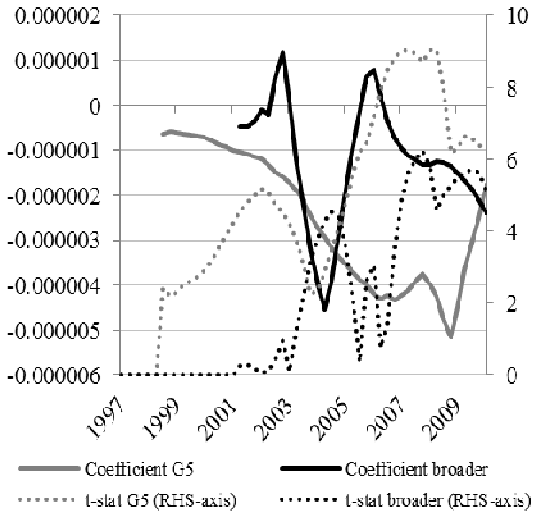
Real growth rate



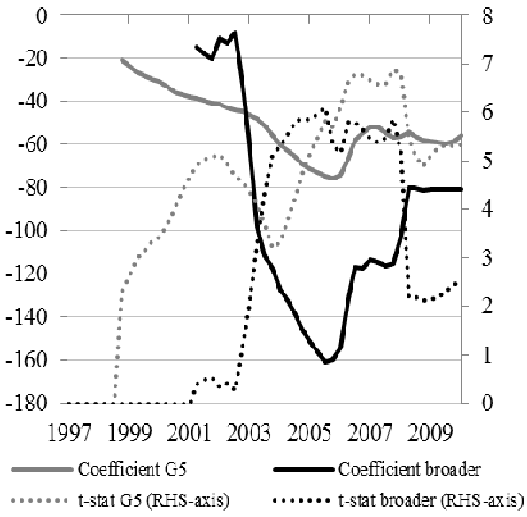
Excess growth rate



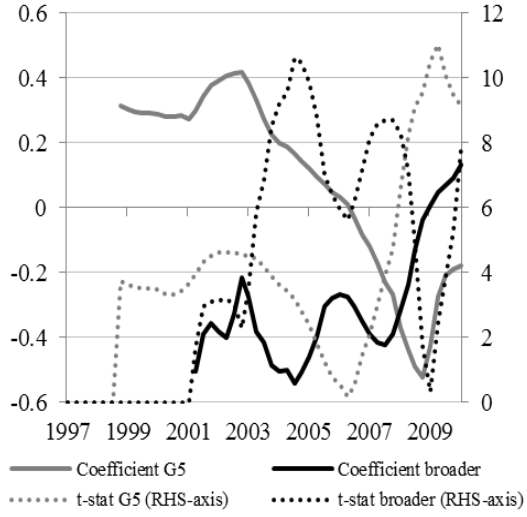
Trend deviation of level



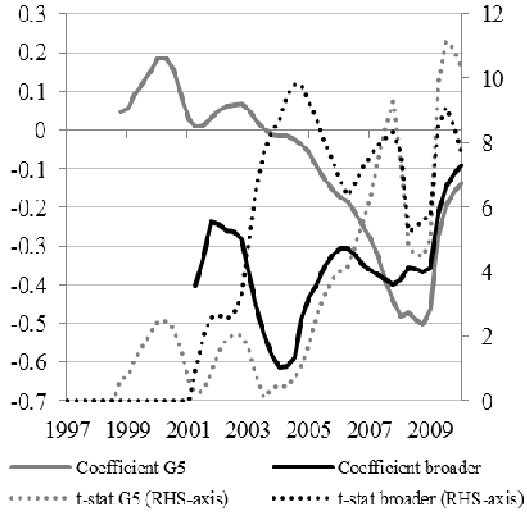
Trend deviation of ratio to GDP



Trend deviation of real growth rate

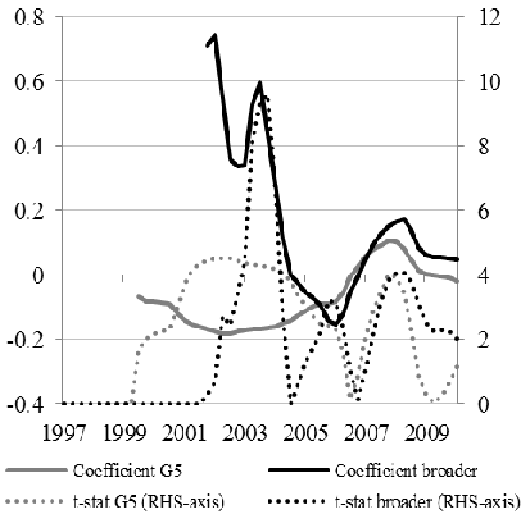


Trend deviation of excess growth rate

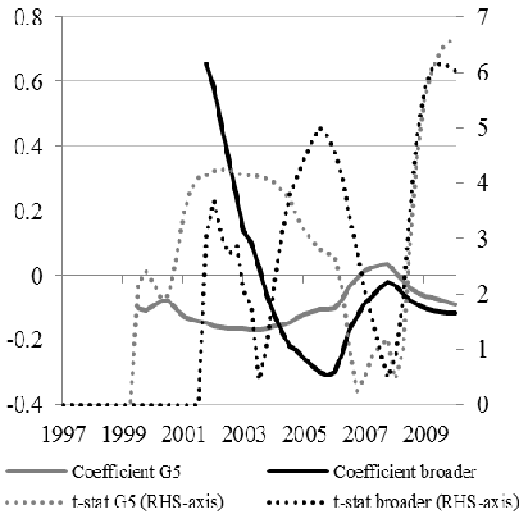


Narrow money - pre-boom horizon of 5-9 quarters

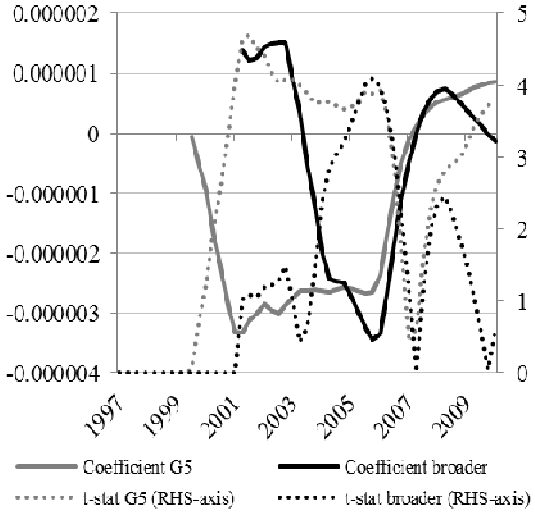
Real growth rate



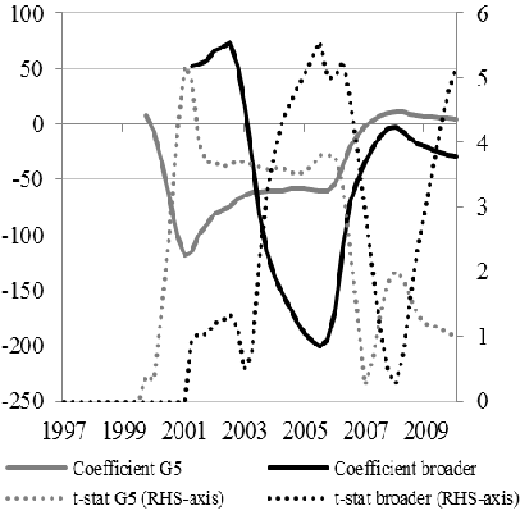
Excess growth rate



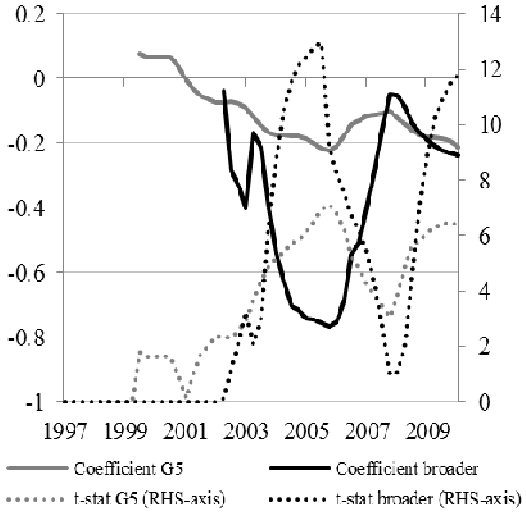
Trend deviation of level



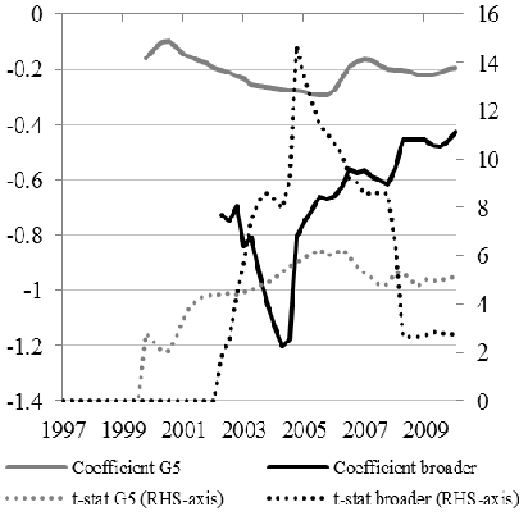
Trend deviation of ratio to GDP



Trend deviation of real growth rate

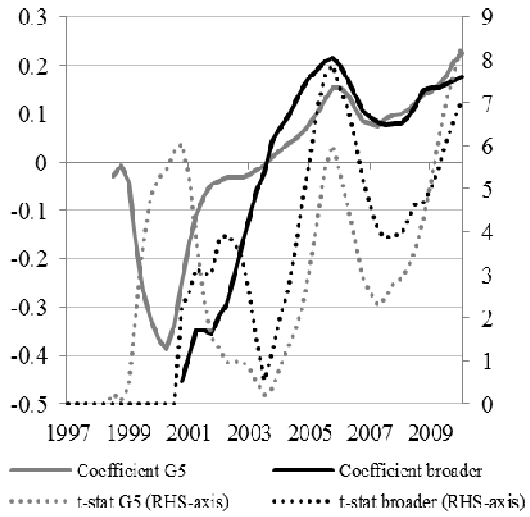


Trend deviation of excess growth rate

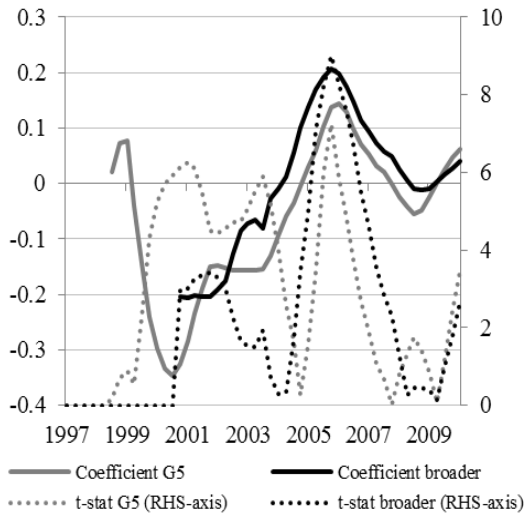


Private credit - pre-boom horizon of 5-9 quarters

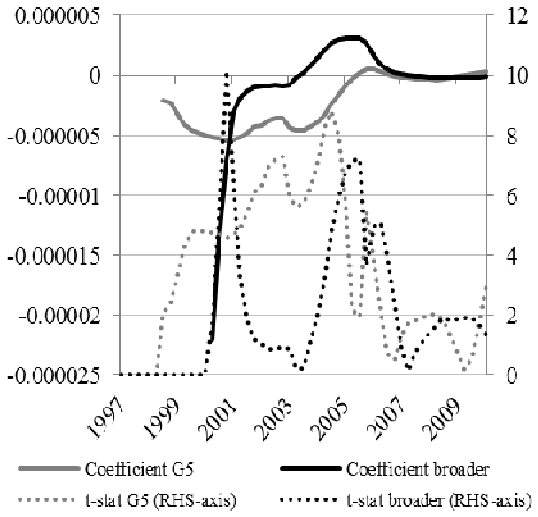
Real growth rate



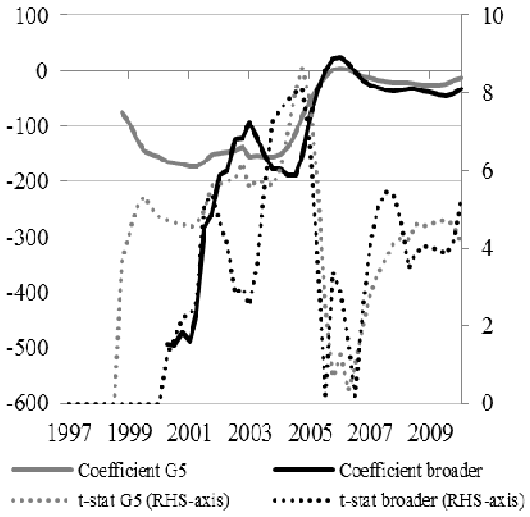
Excess growth rate



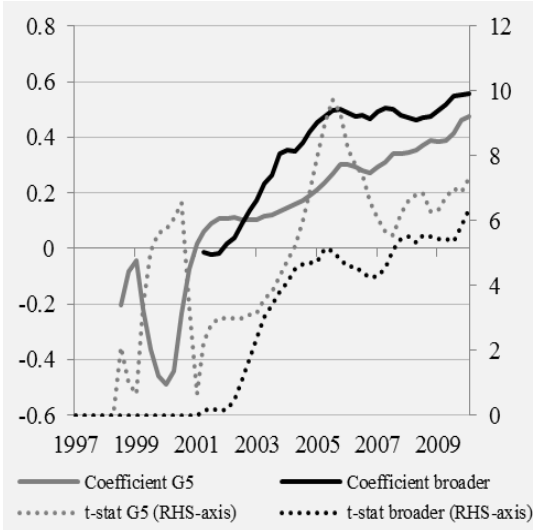
Trend deviation of level



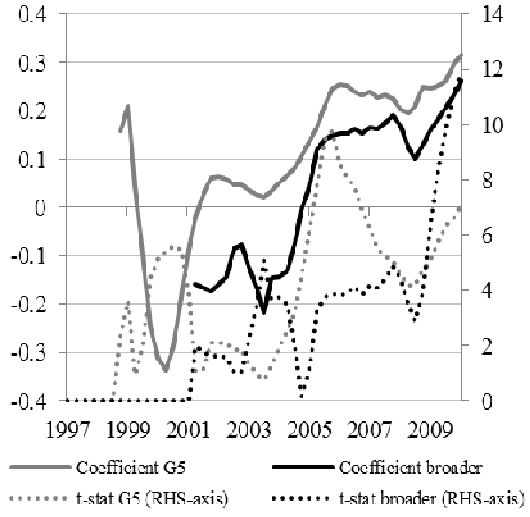
Trend deviation of ratio to GDP



Trend deviation of real growth rate

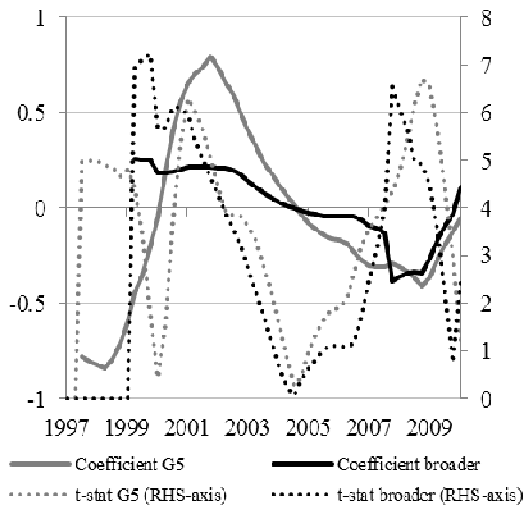


Trend deviation of excess growth rate

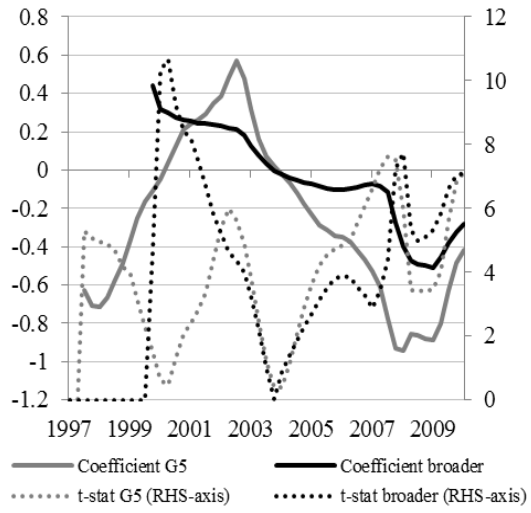


Short-term rate - pre-boom horizon of 5-9 quarters

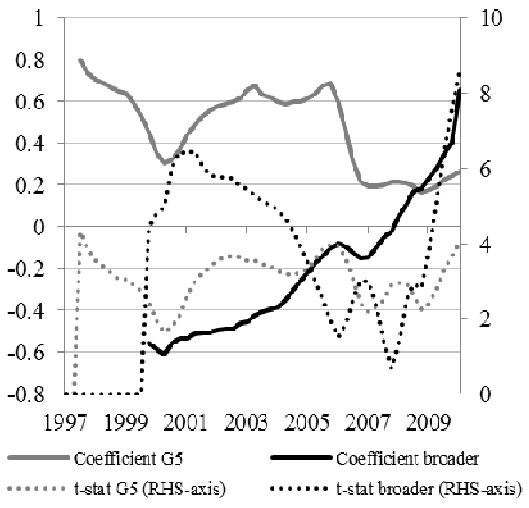
Real rate



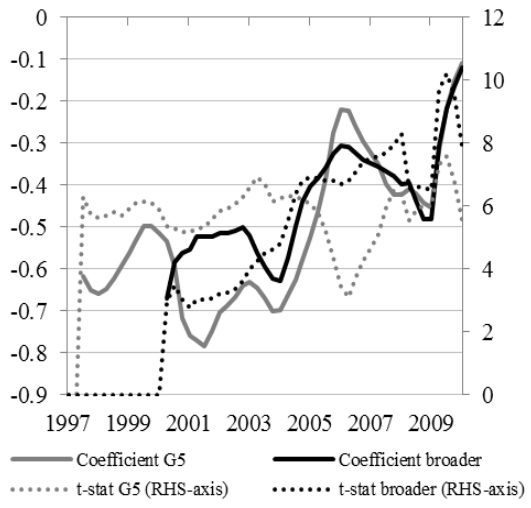
Excess rate



Trend deviation of real rate

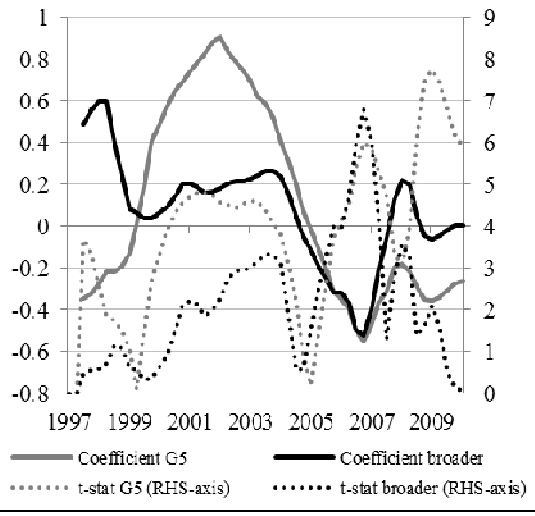


Trend deviation of excess rate

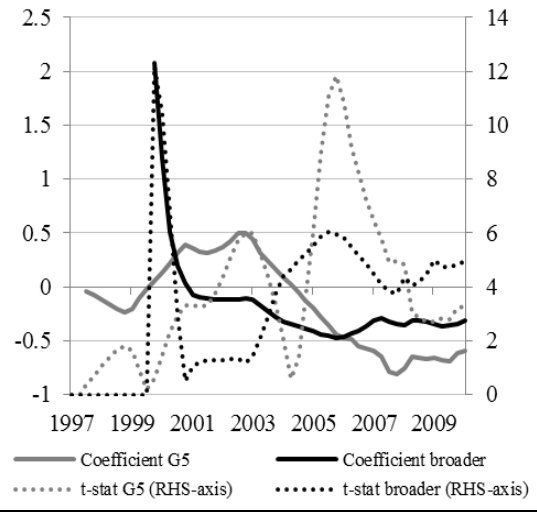


Long-term rate - pre-boom horizon of 5-9 quarters

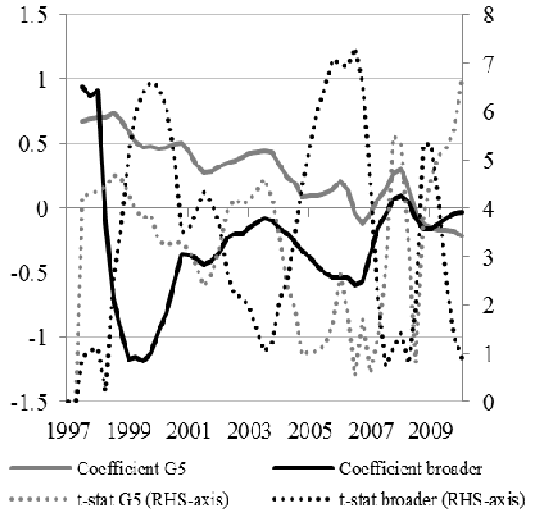
Real rate



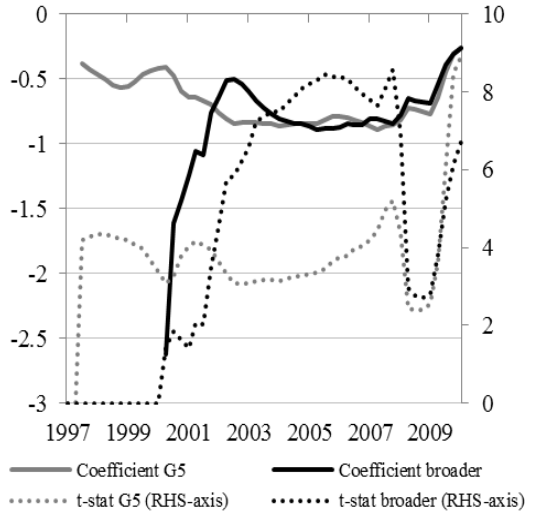
Excess rate



Trend deviation of real rate

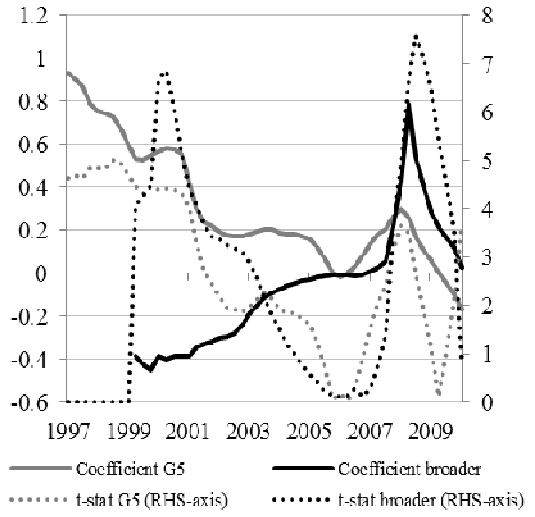


Trend deviation of excess rate

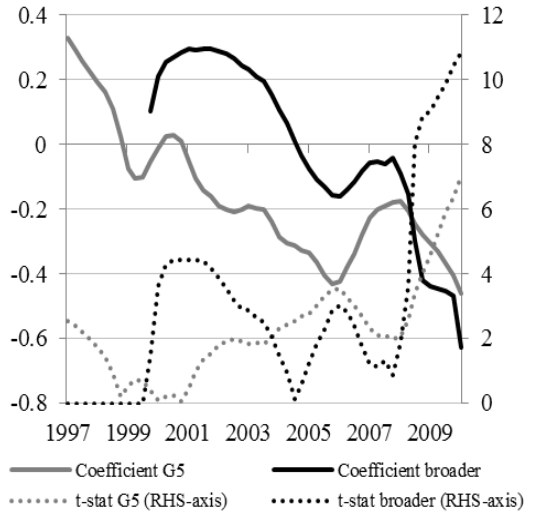


Term spread - pre-boom horizon of 5-9 quarters

Level



Trend deviation of level



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