Financial Structure and the Impact of Monetary Policy on Property Prices

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Abstract

We study the monetary transmission mechanism using VARs in which we distinguish between groups of countries depending on the structure of their financial systems. The data set includes residential property prices, consumer prices, real GDP, short-term interest rates and credit and covers 18 countries in the period 1986-2008. We use eight different criteria proposed in the literature to distinguish between countries with different housing finance markets and find that monetary policy shocks elicit stronger macroeconomic responses in economies with more "flexible" financial structure.

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1. Introduction

The housing sector plays an important role in the business cycle. This has become particularly apparent in the recent global financial crisis in which a significant overvaluation of housing markets in the US and elsewhere played a central role. But also other countries – including Ireland, the UK and Spain – experienced residential investment booms that made them vulnerable to declines in property prices. Besides its role in economic fluctuations, housing is also an important variable in the monetary transmission mechanism (Mishkin 2007). As housing can be thought of as a durable consumption good, its value corresponds to the discounted sum of future returns, making it particularly sensitive to interest rate changes. Moreover, the use of housing as collateral provides a direct link between house prices and aggregate demand.

It is generally believed that the impact of monetary policy on macro economic conditions depends on the structure of the financial system. Particular attention has been focussed on the structure of housing finance, since housing is typically the most important asset of households and mortgages their most important liability. Thus, in economies in which mortgage finance is "flexible", monetary policy is thought to have relatively large and rapid effects on aggregate demand and, through it, on real economic activity and inflation. What precisely is meant by "flexibility" is perhaps less clear, but the literature suggests that relevant considerations include the speed and extent to which interest rates charged on new and outstanding loans respond to monetary stimuli, the typical duration of mortgage contracts, whether mortgage equity withdrawal is possible, whether loans are securitised, the level of loan-to-value ratios and the share of owner-occupied housing.[1]

Understanding whether and, if so, to which extent the strength of the transmission mechanism of monetary policy differs across countries and financial systems is important for at least three reasons.

First, it may help explain observed differences in the interest rate setting behaviour of central banks. For instance, the Federal Reserve cut interest rates more rapidly and to a greater

[1] See the discussion in Calza et al. (2007) and IMF (2008).

extent than the European Central Bank (ECB) following the onset of financial tensions in August 2007 and their transformation to a full-blown financial crisis after the collapse of Lehman Brothers in September 2008. One interpretation of this difference is that the ECB is slow to take action, perhaps because of its consensual decision-making procedures. Another hypothesis is that the transmission mechanism of monetary policy in the euro area is slower, for instance because of the dominance of fixed-rate lending and the central role of banks, than in the US where the financial system which is more market based.[2] If this hypothesis is correct, it would seem natural for the ECB to focus more on the medium term than on short-term exigencies in setting interest rates. While our estimates are too crude to address this issue directly, they do suggest that the impact of monetary policy on economic activity is indeed more gradual in economies with the type of financial structure that is dominant in the major euro-area economies.

Second, if the strength of the transmission mechanism depends on the financial structure, then this information is important when regulating the financial system. For instance, if some aspect of the latter, say the degree of securitisation of mortgage loans or the loan-to-value ratio, plays an important role in conditioning the effects of monetary policy on the economy, then this fact should presumably be considered in the regulatory process. In particular, systemic risk may spread more widely if monetary policy measures work only gradually and larger capital buffers might be required.

Third, it is a long-debated issue whether one type of financial system is "preferable" to another, see e.g. Levine (2005). This debate presumes that the structure of the financial system is important for the functioning of the economy. It is therefore of interest to explore whether this is true.

In this paper we seek to shed light on the relationship between financial structure and the monetary transmission mechanism. To do so, we estimate vector autoregressive models (VARs) on a panel data set including consumer prices, real GDP, residential property prices, short-term interest rates and credit for a sample of 18 OECD economies for the period 1986 to

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[2] Tillmann (2009) shows that in a New Keynesian model it is optimal for central banks to cut interest-rates more aggressively than otherwise if financial markets are flexible. Moreover, it seems plausible that financial market shocks have greater macroeconomic effects if the financial system is more flexible.

2008. The IMF (2008) recently proposed a mortgage-market index (MMI) that is intended to capture the flexibility of housing-finance markets. We use this index to form two groups of countries and compare the average impulse responses to monetary policy shocks in the two groups. However and as we discuss below, for any observed differences in impulse responses to be attributable to the dissimilarities in economic structure, the interest rate path in the two groups must be identical. Calza et al. (2009) present closely related empirical work but do not constrain the reactions in the two groups of countries to be the same.

We first investigate whether macroeconomic responses to monetary policy shocks differ between countries depending on how they score on the IMF index. We find that real GDP and residential property prices decline more in response to a monetary policy shock in economies with flexible mortgage markets, confirming the role of the structure of housing finance markets in the monetary transmission mechanism.[3]

In order to shed light on the question which feature of mortgage markets is most important, we use four of the subcomponents of the MMI and three additional indicators to assess specific features of mortgage markets. The criteria we use include whether mortgage equity withdrawal is possible; the duration of mortgages; whether mortgages are securitised; the loan-to-value ratio for new mortgages; the mortgage-debt-to-GDP ratio in the economy; the share of owner occupied dwellings; and the importance of floating rate lending. We then rank the countries according to the different criteria, and compare the impulse responses across groups.

We find that the duration of mortgages is most important, though the differences after conditioning on the same interest rate response tend to be reduced. Furthermore, we find that the differences between the two sets of countries are greatest when the MMI is used, which suggests that the different underlying characteristics reinforce each other.

The paper is organised as follows. The next section contains a discussion of the data. In Section 3 we first briefly discuss our estimation methodology before presenting results for the full panel of countries. Section 4 focuses on the importance of financial structure and

[3] See also Maclennan et al. (1998) and Carstensen et al. (2009).

provides the impulse responses to monetary policy shocks when the countries are divided into two groups on the basis of financial structure. Finally, Section 5 concludes.

2. Data

The econometric analysis below is conducted on quarterly data on residential property prices, consumer price indices (CPIs), real gross domestic product (GDP), credit and interest rates.[4] Much of the interest in the behaviour and determination of property prices stems from their role in episodes of financial instability. Since our views on monetary policy and financial imbalances risk being excessively influenced by a few specific events, such as the experiences of Japan in the last two decades, there is a risk of sample selection bias, which can be mitigated by using data from a broad cross-section of countries. We therefore study 18 countries for which we could obtain both credit and residential property price data: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the UK and the US.

The sample starts in 1986 in order to avoid the more turbulent, higher inflation period that ended in the first half of the 1980. Moreover, and as noted by Ahearne et al. (2005) and Girouard and Blöndal (2001), many countries deregulated their mortgage markets during the early to mid-1980s, suggesting that estimates relying on older data are unlikely to be representative for modern economies.[5] The data set ends in the last quarter of 2008, which covers the first quarters of the global financial crisis triggered by the developments in the US subprime mortgage market.

Residential property prices are from the data base of the Bank for International Settlements (BIS). Figure 1 shows the resulting residential property price series.[6] Interestingly, many

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[4] All results are obtained with the software RATS 7.2.

[5] Goodhart and Hofmann (2008) in their panel VAR analysis also study, as a part of their robustness analysis, a sub-sample spanning 1986 to 2006 and find that this later period indeed differs from the earlier part of their sample. However, their data are somewhat different from those we use.

[6] Quarterly data for the full sample period are available for Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Netherlands, Sweden, Switzerland, the UK and the US. For Australia and Austria, missing values for the first two quarters of 1986 were constructed using the growth of residential construction cost. For Ireland and Norway we interpolate annual data with the Chow-Lin (1971) procedure, using a rent index and an index of residential construction cost as reference series, and link the resulting series to the BIS quarterly data that start in 1988 and 1991, respectively. Annual data for Norway are from Eitrheim and Erlandsen (2004). The same

economies experienced a sharp rise in residential property prices in the second half of the 1980s, in many cases associated with liberalisation and deregulation of the housing finance sector. Residential property prices were subsequently weak or fell in the 1990s, following the US recession in 1990-1991 and the episode of high interest rates in many European countries after the turmoil in the European exchange rate mechanism (ERM) in 1992-93, which was triggered by the adoption of tight monetary policy in Germany to offset the aggregate demand effects of German Reunification. In the early 2000s, several countries – in particular Belgium, Denmark, Spain, the UK and the US – again experienced large increases in residential property prices. The figure also indicates that Japan and Germany did not follow this general pattern. After the collapse of the "bubble economy" in Japan around 1990, residential property prices fell continuously until the end of the sample. In Germany, residential property prices started falling in 1994 and declined until 2006, vividly indicating the weakness of the German economy in this period.

Before proceeding, it should be emphasised that data on residential property prices are not necessarily comparable across countries. The main differences concern the type of housing that is included (single family houses, flats or all types), whether existing dwellings or new dwellings are considered, whether prices are per dwelling or per square meter, and the region (urban, non-urban or both) where the data is collected. While price developments vary between types of housing reflecting supply and demand conditions in different market segments, the most noticeable differences arise with respect to the area where the data come from. Property-price booms generally occur in metropolitan areas and are often less pronounced if data for the whole country are considered. The impact of this, however, is difficult to assess since only few countries have series covering these different categories. As an example, Figure 2 shows the annual increase in nominal UK residential property prices for the whole country and the greater London area. While the prices in the latter area seem more volatile, the two series evolve in much the same way over time (their correlation is

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interpolation procedure is applied to annual property price data for Germany. For Italy and Japan the semi-annual series is interpolated, with annual property price data for Italy before 1990 taken from Cannari et al. (2006). For Japan we use residential land prices, as houses are normally torn down after a few decades and a market for old homes practically does not exist. As a consequence, land prices determine the value of housing, see the Economist (2008). We note that despite the difference in data sources, the patterns are comparable to those reported in Tsatsaronis and Zhu (2004) and Ahearne et al. (2005).

0.76). The right-hand panel shows the annual increase in prices for single-family houses and flats in Switzerland. Again, the year-to-year changes differ somewhat but generally convey the same information (the correlation is 0.87). For our study we use whenever possible the broadest residential property price index available in order not to capture regional booms. Nevertheless, great care needs to be exercised when comparing property-price developments across countries.

The credit data we use is from the IMF's International Financial Statistics (IFS) and measures claims of the financial sector on the domestic non-financial private sector.[7] Credit can be defined in a number of different ways depending on the type of financial assets involved and on who the borrowers and the lenders are. Since different credit aggregates potentially evolve over time in conflicting ways, it is not obvious which precise aggregate to use in the empirical work below. While it might be interesting to consider only mortgage credit, which arguably is more closely tied than overall credit to developments in the residential real estate sector, only few countries provide the relevant data. Moreover, it is not clear that it would be the most appropriate measure to use. Some movements in mortgage credit – such as secondary mortgages used to finance purchases of durable goods – are unrelated to the housing market and will reduce the information content of mortgage lending.

With respect to lenders, the statistics compiled by the IMF distinguishes between the central bank, deposit-taking banks and other financial institutions. For most countries we use lending to the domestic private sector from deposit-taking banks. Nevertheless, for Canada, Sweden and the US, where non-bank financial institutions that are often not included in the banking (credit) statistics provide a significant share of financing, we use credit from banks and non-bank financial institutions from the IMF statistics as our preferred measure. For the euro-area countries we use credit aggregates based on national (as opposed to euro-area-wide) residency.

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[7] Credit data are also available from the Bank for International Settlements (BIS). We prefer the IMF credit series to the BIS data because the IMF data is based on a harmonized system of sectoral accounts and thus more comparable across countries, whereas the BIS data rely on the national definitions. Nevertheless, the IMF aggregates frequently exhibit breaks. In the case of a recognised break, as marked by a specific flag in the IMF statistics, we link the series using the growth rate from credit series taken from the BIS data base, which often does not show a break at the same time.

Turning to the sources of the other data, the CPI (all items) is from the OECD Main Economic Indicators (MEI) data base. Real GDP data were taken from the BIS data base and supplemented with data from the IFS data base. For Ireland annual GDP data before 1997 were interpolated with the Chow-Lin (1971) procedure using industrial production as the reference series. We use a three-month interbank rate for Denmark, Switzerland, Spain, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway and the UK; a three-month Treasury bill rate for Belgium, Sweden and the US; and a three-month commercial paper rate for Australia, Canada and Japan.[8] All interest rates are from the OECD's MEI.[9] For the euro-area countries we use the three-month EURIBOR rate after 1998. We deflate both credit and residential property prices by the CPI. Except for interest rates all data are in logarithms and seasonally adjusted.

Before we proceed to the econometric analysis it is useful to investigate the time-series characteristics of the data. Table 1 reports results for the individual countries. Interest rates are all nonstationary in levels but stationary in first differences. The CPI, real GDP, real property prices and real credit typically turn out to be nonstationary in levels. The results for the first differences of these variables, however, are less clear cut as in many cases we do not reject nonstationarity. The reason is that unit root tests have low power and for each country we work with a relatively short sample period. Since we take a panel approach below, we also perform panel unit root tests that provide a summary assessment of whether a variable can be regarded as stationary or not. We use the panel unit root test proposed by Im et al. (2003) that allows for heterogeneity in the dynamics of the time series. We interpret the results from the panel unit root tests as suggesting that all variables as integrated of order one, $I(1)$.

Next we test for cointegration between the CPI, real GDP, the three-month interest rate, real residential property prices and real credit. When using a common lag length of four (which is sufficient to eliminate any seasonal pattern in the residuals for quarterly data) for all

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[8] To eliminate a large spike during the ERM crisis we regressed the three-month interest rate for Ireland on a dummy, which is unity in 1992Q4 and zero elsewhere, and used the fitted value in the analysis.

[9] For Finland and Denmark missing data for 1986 were replaced with data from the IFS (call money rate).

countries, the existence of at least one cointegrating vector was not be rejected.[10] We therefore specify the VAR models in the levels of the variables. Nevertheless, we neither impose the number of cointegrating relations on the systems nor do we attempt to impose overidentifying restrictions on the cointegrating vector.

3. VAR Analysis

In our empirical analysis we are interested in quantifying the average response to typical monetary policy shocks of the CPI, real GDP and real residential-property prices in the 18 countries in our data set. A panel approach provides a natural way of summarising the data. Moreover, the use of panel-econometric methods allows us to obtain more precise estimates by exploiting the cross-sectional information in the data than by analysing them on a country-by-country basis.

When dealing with panel data sets in which both the number of observations and the number of groups are large, different approaches to estimating the average effect can be taken (see Pesaran and Smith 1995). These include averaging the data, either over cross sections or over time, pooling the data and imposing common slopes, or averaging coefficients obtained by estimating separate regressions for each group. While in static models all these procedures are consistent, in dynamic models aggregation over time and pooled estimation lead to biases. The reason for this inconsistency is that restricting the coefficients on the lagged endogenous variables to be the same across countries, though they actually differ, induces serial correlation in the residuals when the regressors are autocorrelated. This serial correlation does not vanish when instrumental variable estimation is applied (Pesaran and Smith 1995), so that the fixed effects estimator remains biased even when applying instrumental variables or generalized method of moments.[11]

In our case, there is little reason to believe that coefficients are the same across countries since many authors have argued that differences in financial structure have important effects on the strength of the monetary transmission mechanism. Since our sample period is rather long, we opt for estimating separate VAR models for each country. We then average the

[10] Iacoviello (2002) argues that a long-run relation between GDP and real residential property prices should exist.

[11] Goodhart and Hofmann (2008) employ the fixed-effect estimator.

impulse-response functions from these individual-country VARs to obtain the mean effect of a monetary policy shock across countries.[12]

More formally, the model can be written as

$$A_0^n Y_t^n = \mu^n + A^n(L) Y_{t-1}^n + \varepsilon_t^n,$$

where $Y_t^n = (p_t^n, y_t^n, pp_t^n, i_t^n, cr_t^n)$ is a $N \times 1$ vector containing observations on the CPI (*p*), real GDP (*y*), the three-month interest rate (*i*), real residential property prices (*pp*) and real credit (*cr*) for the *N* countries, $n = 1, \ldots N$; μ^n is a country-specific intercept and $A^n(L)$ is a lag polynomial with the VAR coefficients. The disturbances, ε_t^n, have zero mean and a country-specific variance, σ_n^2. For each country we determine the optimal lag length using the Akaike information criterion, considering a maximum of eight lags.

To identify the structural shocks, we impose a triangular structure on A_0^n for each country, i.e., we use a Choleski decomposition to identify the shocks, with the variables ordered as above, which is standard in the monetary transmission literature (see Christiano et al. 1999). This triangular identification structure allows output, property prices and the CPI to react only with a lag to monetary policy shocks, whereas credit may respond immediately. We thus assume that central banks can react to current output growth and inflation when setting interest rates, but not to current developments in credit.[13]

While few observers would doubt that central banks react to changes in credit growth since it influences aggregate demand and inflation pressures, barring exceptional circumstances one would not expect any reactions to be instantaneous but rather to occur if credit rises or falls for an extended period. By contrast, we allow credit to react immediately to changes in

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[12] This approach seems preferable to averaging coefficients across countries and then to compute the impulse responses at the mean-group estimate because our main interest is in the average response to macro economic shocks. Because of the triangle inequality, calculating the impulse responses at the average coefficients will lead to smaller responses than averaging over the impulse responses. Nevertheless, the actual difference between the two approaches depends on the dispersion of the coefficients across countries. In our case it turns out that both ways of averaging leads to almost the same results.

[13] To identify the monetary policy shock it is sufficient to determine the position in the triangular ordering of the policy instrument; the ordering of the variables in the groups before and after the interest rate does not matter. It has to be remembered, however, that the other shocks do not have an economic interpretation.

monetary policy. We have explored whether the results are sensitive to this assumption and found that they are not.

The confidence bands for the impulse responses are obtained by bootstrapping from the residuals of the individual-country VARs, taking into account both the correlation structure across variables and across countries.[14] We then compute the average impulse responses across countries and present the median impulse-response together with the one- or two-standard-error bounds obtained from 1000 bootstrap replications. For the impulse responses across all countries we report two-standard errors (i.e. 95 percent) confidence bounds. When analysing the difference in the response across country groupings, we show the less stringent one-standard-error (i.e. 68 percent) bounds.

Figure 3 shows the average impulse responses to monetary policy shocks across all countries in our sample. We consider the responses to a 25 basis point increase in the interest rate. Not surprisingly, the large increase in information that comes from using panel data generates impulse responses that typically are significantly different from zero at the 95% level. After a monetary policy shock it takes four quarters before the price level starts to fall, with the effect becoming significant only after more than three years. While our results indicate the presence of a "price puzzle", it seems plausible that the estimates underpredict the impact of monetary policy on the level of prices since we do not include indicators or predictors of future inflation in our VAR system. Furthermore, the results indicate that output falls for about six quarters in response to the monetary policy shock before recovering slowly. Residential property prices and credit reach their trough somewhat later after ten to twelve quarters and take even longer to recover.

These findings warrant several comments. First, the reactions of prices and output to the shocks are similar to those found in the literature based on single-country studies (see, e.g. Christiano et al. (1999) for the US and the VAR studies in Angeloni et al. (2003) for the euro area). Second, the responses of real GDP leads those of residential property prices, which in

[14] More precisely, we first orthogonalize the residuals from each country by multiplying them with the inverse Choleski factor of the respective country. We then draw a joint set of residuals across all countries and reimpose the original correlation structure across variables for each country by multiplication with the Choleski factor. By orthogonalizing the residuals before drawing from them, the bootstrap procedure is more efficient and fewer draws should be needed to obtain reliable confidence bounds.

turn lead those of real credit. This suggests that the transmission of a monetary shock affects property prices primarily via its effects on real GDP which then reduce credit demand. Third, the width of the confidence bands indicates that the responses of residential property prices are, statistically, somewhat less well defined than the impact on real economic activity. This suggests that different financial structures may have an impact on the monetary transmission mechanism. Fourth and most importantly, the point estimate shows that after about one year residential property prices have fallen about two to three times as much as the level of real GDP, that is, by 0.24% rather than by 0.10%.

Of course, these estimates reflect the policy choices made by central banks in the sample period during which central banks did not seek to stabilize property prices. Thus, it is possible, as suggested by the Lucas critique, that the estimates would change if central banks started to do so. As they stand, the results suggest that while monetary policy could in principle be used to offset swings in residential property prices that are seen as causing a threat to financial stability, it risks inducing potentially large swings in real economic activity. For instance, to offset a 10% rise in residential property prices, which is not an unusually large increase by the standards of many recent property price booms, the central bank must be willing to depress real GDP by 4%, a substantial amount.[15]

4. How important is financial structure?

The estimates above mask any potential heterogeneity across the 18 countries in our sample. This is unfortunate since many authors have argued that the impact of monetary policy on the economy varies across countries depending on the financial structure of the economy (Cecchetti 1999, Ehrmann et al. 2003, Giuliodori 2005). Moreover, it is well documented that the financial structure differs significantly between the countries we consider (Maclennan et al. 1998; CGFS 2006). In the literature, however, little quantitative evidence on the importance of these characteristics for the transmission of monetary policy has been

[15] See also Assenmacher-Wesche and Gerlach (2008, 2010). Proponents of using monetary policy to mitigate swings in asset prices, such as Borio and Lowe (2002), do not seem concerned by the impact of such a policy on economic activity. By contrast, opponents, such as Kohn (2006), emphasise the effects on output and inflation. Interestingly, experimental evidence also shows that interest rate policy is not effective in dealing with asset price bubbles, see Becker et al. (2007).

presented.[16] Of course, there is no lack of cross-country studies that find differences in monetary transmission and attribute these to differences in financial structure (e.g., Carstensen et al. 2009). Nevertheless, the estimated impulse responses may differ for many other reasons, including the conduct of monetary policy and wage-setting arrangements, that are not taken into account. Here we seek to investigate the effect of financial structure more directly. We concentrate on the structure of mortgage finance because it can be expected to determine in the role of property prices in the transmission of monetary policy shocks.[17]

While there are several characteristics that might influence the effects of monetary policy on the economy, there is no agreement on which characteristics are most important and how best to measure these. We therefore use the mortgage market index (MMI) computed by the IMF (2008), which combines several features of mortgage finance into a single measure. The index is intended to capture the degree of mortgage market flexibility and is constructed in such a way that high values indicate more developed mortgage markets, which we expect to strengthen the transmission mechanism of monetary policy. The first column in Table 2 shows the values of the MMI for the countries in our sample.[18]

One problem, however, is the nature of the available data. Institutional characteristics change little over time, so that time-series analysis with such data is precluded. We therefore divide the countries in two groups on the basis of their financial structure and compare the average impulse responses in these two groups in order to assess the differences in the monetary transmission. We classify countries with a MMI value above the median as having "flexible," and the others as having "inflexible," housing-finance systems (see Table 3). In that way we are able to focus on the differences across countries that are related to features of financial markets, hoping that other country-specific idiosyncrasies of importance for the transmission mechanism average out.

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[16] An exception is Calza et al. (2007, 2009).

[17] Of course, monetary policy will also influence financing conditions for firms differently depending on financial structure. However, there is little information available about the financial structure faced by firms differs between countries and we therefore do not consider this aspect here.

[18] Since Switzerland is missing from the IMF study, we construct the index for Switzerland following the description in IMF (2008), footnote 3. The resulting index value of 0.26 implies that Switzerland is in the country group with less flexible mortgage markets.

Next we turn to the estimates. In the first two columns, Figure 4 contains the average impulse responses of the variables in the system to a monetary policy shock for the countries with flexible and inflexible mortgage markets, together with bootstrapped plus/minus one–standard-error-wide confidence bounds. The last panel in the figure shows the difference in the impulse responses between the two groups. If the confidence bounds in the last panel exclude the zero line, we consider there to be a significant difference in the transmission mechanism between the flexible and the inflexible countries. As conjectured, we find that in the flexible group real GDP falls quicker and more strongly after a monetary policy shock. Moreover, this difference seems to be due to a stronger response in property prices in the more flexible countries.

Nevertheless, at a closer look it turns out that the responses are not directly comparable since, as can be seen in Figure 5, the typical path of the interest rate after an initial 25 basis-points increase differs widely across countries. One would expect a stronger reaction of the variables if the interest rate returns to its initial level slowly or even overshoots, as is the case for the US than when the reactions of the interest rate are short-lived, as in Spain or Italy.[19] Differences in the impulse responses could therefore also be due to the fact that the interest rates themselves evolve in different ways following a monetary policy shock.[20]

To deal with this problem, we therefore condition the interest rate path in each country to match the average interest rate response for the first twelve quarters after the shock.[21] More precisely, we use the identified monetary policy shock to force the interest rate in each countries to follow the average response, i.e., the solid line in Figure 5.

The resulting estimates, which are shown Figure 6, confirm the previous results. In particular, the responses of residential property prices to monetary policy shocks are larger in countries with a high value of the index, though the difference in the responses is now smaller. The reason is that monetary policy is restrictive for a longer period in the less flexible countries when the interest rate path is forced to be the same in the two groups of

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[19] Standard New-Keynesian models imply that the persistence in the reaction of output and inflation is higher when monetary policy reacts more strongly to deviations of output from baseline.

[20] Calza et al. (2009) do not report results for the interest rate in their analysis.

[21] After twelve quarters, no further shocks are added to the interest rate in order to let it converge to the model-endogenous path.

countries, leading to a greater effect on GDP and property prices. Nevertheless, real GDP and property prices still react more strongly in the first four quarters after a monetary policy shock. By contrast, the response in credit does not differ significantly between the flexible and the inflexible countries in Figure 6 in contrast to in Figure 4.

Furthermore, the figure shows a clear price puzzle – a tendency for the CPI to rise after a monetary policy shock – in the economies with more flexible mortgage finance systems. This suggests that what we have identified as monetary policy shocks at least partly are responses to expected increases in inflation. Interestingly, as central banks in these economies respond aggressively to such shocks, they depress real GDP and property prices. This is compatible with the notion that property markets play an important role in the monetary transmission mechanism, particularly in economies with a high value on MMI.

While the MMI provides an overall assessment of the flexibility of mortgage markets, it is of interest to investigate in more detail which precise features of mortgage markets are important. Furthermore, it may be that the characteristics of the mortgage finance system amplify or mitigate each other.[22] We therefore go beyond the overall MMI and group the countries on the basis of a number of indicators that capture a single aspect of financial structure. We look at several indicators that have been identified in the literature as affecting the strength of the transmission mechanism. To avoid influencing the results, we do not compile these indicators ourselves but rely on some that have been published in the literature.

When using information on financial structure from different sources one has to keep in mind that these are not always comparable. One example is the loan-to-valuation (LTV) ratio, where some studies quote the maximum, while others refer to the average, LTV ratio. In addition, judgement is required when grouping countries according to these criteria. Consider, for instance, the classification of countries as having fixed or flexible mortgage interest rates. While a majority of mortgages with an interest-rate adjustment at three months' notice certainly classifies as flexible, it is much more difficult to decide whether interest rates that are fixed between one and five years (e.g., Italy; see Calza et al. 2007)

[22] For instance, it may be that the ability to obtain a second mortgage dampens the responses of households in economies in which floating rate lending is prevalent.

should be regarded as fixed or flexible. Any grouping of countries is therefore subjective and consequently disputable.

To address these problems, we compare estimates of the average transmission mechanism in the countries grouped according to the various criteria considered. In these exercises, we do not consider the full set of countries but focus on the more extreme cases. For instance, in the case of mortgage equity withdrawal, we leave out those countries in which mortgage equity withdrawal is possible, but limited. In the case of the other criteria, we consider the at least five countries that score highest and lowest according the respective criterion. Since in the case of the typical duration and the LTV ratio many countries share the same values, the size of the groups may vary.

Leaving out some countries when forming the country groups has several advantages. Goodhart and Hofmann (2008) argue that the *relative* position of countries, when ranked according to some measure of financial structure, is likely to remains broadly constant. If so, our approach of distinguishing between countries with the highest and lowest values of the different criteria may be robust to changes in financial structure that occurred in our sample. This problem is also mitigated by choosing a relatively short sample period that excludes data from the seventies and early eighties when many countries deregulated mortgage finance markets.

We now turn to a discussion of the components included in the MMI and their presumed importance for the monetary transmission mechanism.[23] In addition to four sub-components of the MMI, we consider three other characteristics of mortgage markets that are commonly are felt to be important: mortgage-debt-to-GDP ratio, the owner occupation share and the type of interest rate adjustment. The values of these indicators are listed in Table 2, while Table 3 indicates the allocation of the countries to the different groups. To ensure that the use of the different criteria actually provides new information, we verify that they do not lead to the same allocation of countries to the two groups. By only looking at a smaller number of countries rather than the full sample of 18 countries, the correlation across the groupings is greatly reduced.

[23] We do not consider fee-free prepayment of mortgages, because it will introduce nonlinearites into the impulse responses that our approach is unable to deal with since people chose to refinance only in the case of falling interest rates.

Mortgage equity withdrawal

We first consider the importance of mortgage equity withdrawal. If households are able to withdraw equity, one would expect them to do so in response to rising residential property prices. This would boost consumption spending and aggregate demand, and might further increase residential property prices. Figure 7 shows that the ability to withdraw mortgage equity leads to a stronger reaction of real GDP in the more flexible countries in the first two quarters after the shock. Property prices decrease more strongly in the group with equity withdrawal.

Duration of mortgages

Next we study the average duration of mortgages. It seems likely that the longer the average typical term of a mortgage, the smaller is the impact of changes in short-term interest rates on consumption and thus GDP. Indeed, Figure 8 supports the notion that the effects of monetary policy shocks are felt significantly faster and more strongly in countries where mortgages have a shorter average duration. Though property prices fall more in countries with a shorter average duration, they lag behind the effect on GDP, indicating that it is not a wealth channel that is responsible for this result.

Securitisation of mortgages

Does it matter if mortgage loans are securitised? Tsatsaronis and Zhu (2004) conjecture that the prevalence of securitisation reduces the sensitivity of residential property prices to monetary policy shocks since it allows banks to transfer the credit risk associated with mortgages to the capital market. Without securitisation the risk of credit crunches would therefore be commensurately larger, implying that the effects of monetary policy may be more pronounced in economies in which mortgage loans are not securitised. On the other hand, it has been argued that the increased reliance on capital markets for mortgage funding associated with securitisation implies stronger effects of monetary policy on the economy and on residential property prices (CGFS 2006). Furthermore, the subprime crisis demonstrated that the risk transfer associated with securitisation did not function well at the economy-wide level.

While the Anglo-Saxon countries mainly rely on securitisation, Denmark, Switzerland, Spain and Sweden have liquid markets for covered bonds that allow banks to refinance mortgages

on the capital market. Since for our purposes these two features are broadly similar, we use the sum of mortgage backed securities and covered bond issues, relative to the amount of residential loans outstanding, to indicate the prevalence of securitisation. Figure 9 shows that the fall in real GDP is significantly larger and faster in economies where securitisation is not common and thus provides some support for the first hypothesis. By constrast, the difference in the reaction of property prices is not significant though they tend to fall more in economies without securitisation.

Loan-to-value ratio

A further important characteristic of the financial system is the LTV ratio. A high LTV ratio means that households can relatively easily obtain financing to purchase property, suggesting that the effects of changes in interest rates are likely to be marked. Furthermore, interest rate increases may be more contractionary since households have less equity and thus may be more prone to default in conditions of economic hardship. While we obtain a marginally significant difference in GDP with the unconstrained interest rate response, Figure 10 shows that the reaction of GDP does not differ significantly across groups when the interest rate is assumed to follow the average path. Nevertheless, the more pronounced fall in property prices indicates that in the high-LTV group monetary policy affects property prices more strongly.

Mortgage-debt-to-GDP

Since data on the average LTV ratio are difficult to obtain and banks presumably apply different criteria to different borrowers, one possible reason why we do not find differences in the response with the LTV ratio is poor data. We therefore reproduce our analysis using the mortgage-debt-to-GDP ratio that provides an alternative measure of the responsiveness of the housing market to interest rate changes. Surprisingly, Figure 11 shows that property prices fall more strongly in countries with a low mortgage-debt-to-GDP ratio, whereas both groups show approximately the same reaction of real GDP.

Owner-occupied housing

Next we consider whether the share of owner-occupied housing matters. With high owner-occupancy rates, the wealth effect of monetary policy should be important and one would expect a larger impact of monetary policy shocks on GDP (see Maclennan et al. 1998). On the

other hand, landlords or institutional investors owning rental housing also will experience a wealth effect and the argument rests on their wealth effect being smaller than that for the owner occupiers. Figure 12 shows that neither real GDP nor credit respond differently to monetary policy in the two groups. By contrast, property prices react less in economies with high owner occupancy, which probably reflects the fact that home owners view housing more as a consumption good than as investment and are therefore less price sensitive compared to institutional investors.

Fixed vs. flexible interest rates

Finally, we consider the importance of floating rate financing. It is commonly believed that in economies in which mortgage rates are tied to short-term interest rates, changes in monetary policy have relatively large effects on residential property prices and therefore on the economy since the interest rates on all loans are reset at the same time. By contrast, in the case of fixed-rate lending, only new borrowers are affected by changes in interest rates.[24] It is therefore sometimes argued that fixed-rate mortgages are less risky than floating-rate mortgages. However, an unexpected fall in the steady-state inflation rate exposes fixed-rate borrowers to an increase in the real interest rate. This effect may have been a factor contributing to the fall in residential property prices and the generally weak economic performance in the 1990s in Germany and Japan, both of which rely predominantly on fixed-rate financing.

Figure 13 presents the results obtained when we distinguish between countries depending on the prevalence of fixed- versus variable-rate mortgages. As one would expect, the effects of monetary policy on GDP are faster when variable-rate mortgages are prevalent, since changes in interest rates then immediately influence interest rates of the outstanding stock of mortgages. The difference in the reaction, however, is significant only in the first quarter after the shock. One reason for the small difference between the two groups may be that, depending on the slope of the term structure, the share of mortgages with fixed and floating rates in a country can change quickly and our classification thus may not remain stable over the full sample period. The reaction of property prices confirms that housing plays an

[24] See Maclennan et al. (1998). Calza et al. (2007) present a model which implies that the sensitivity of consumption to monetary policy shocks is higher with variable-rate mortgages.

important role in the transmission mechanism. While property prices only show a significant reaction after ten quarters in economies with fixed-rate mortgages, they fall immediately and significantly in countries where floating-rate mortgages are common.

Summing up, we generally find a larger reaction of GDP and property prices to monetary policy shocks in those countries that have more market-based financial systems, as also found by Carstensen et al. (2009) using another econometric framework. Regarding the features that are most important for our results, the estimates indicate that the average maturity of the mortgage has a strong and persistent effect on the response of GDP to monetary policy shocks. While the possibility of mortgage equity withdrawal and the type of interest rate adjustment also tend to increase the response of real GDP to monetary policy shocks, their effect is significant only in the first quarters after the shock. By contrast, we do not find any significant differences in the response when we group the countries according to their LTV, or mortgage-debt-to-GDP ratio, or the share of owner-occupied housing, whereas a higher degree of securitisation tends to lower the reaction to monetary policy shocks.

5. Conclusions

In this paper we have estimated VARs including residential property prices, consumer prices, real GDP, short-term interest rates and credit for a panel of 18 OECD economies for the period 1986-2009 in order to explore the importance of the structure of housing finance for the monetary transmission mechanism. In the existing literature a number of aspects of this financial structure have been identified and associated indicators proposed. We use eight of these to rank the countries, and estimate VARs for the countries that score highest and lowest on each criterion. We then compute the average impulse responses to monetary policy shocks in the two groups of countries and compare the responses. The criteria we use include a mortgage market index recently proposed by the IMF (2008) to capture the joint impact of financial market characteristics on the monetary transmission mechanism; whether mortgage equity withdrawal is possible; the duration of mortgages; whether mortgages are securitised; the loan-to-value ratio for new mortgages; the mortgage-debt-to-GDP ratio in the economy; the share of owner occupied dwellings; and the importance of floating rate lending.

The results of this analysis show that the structure of housing finance markets, which is likely to reflect the structure of financial markets more broadly, plays an important role in conditioning the economy's responses to monetary policy shocks. Thus, economies with more "flexible" financial markets respond relatively strongly to monetary stimuli, which would corroborate the hypothesis that the more gradual response of the ECB to the financial crisis is warranted because of the less flexible financial markets in the euro-area countries.

Moreover, our results indicate that the regulatory measures that are discussed today may impact on the monetary transmission process. Attempts to limit, for instance, the possibility of mortgage equity withdrawal is likely to reduce the transmission of monetary policy shocks to GDP and property prices.

While we consistently find a relationship between one measure of the financial system and the transmission mechanism, we recognise that it is possible that these reflect third factors that we have not controlled for in the analysis. For instance, it may be that the countries with relatively market-oriented financial systems, where monetary policy shocks have relatively pronounced effects, may also have labour markets characterised by relatively low degrees of wage stickiness and employment protection and that these labour market features tend to strengthen the transmission mechanism. Thus, further work on financial structure and the transmission mechanism, controlling for such factors, is warranted.

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Table 1. Unit-root test results

Levels	CPI	GDP	Prop. price	Interest rate	Real credit
Australia	-2.95	-1.69	-1.67	-2.13	-0.54
Austria	-2.38	**-3.51**	-2.40	-1.93	-1.98
Belgium	-2.24	-2.91	-1.35	-1.20	-2.66
Canada	-2.86	-2.05	-2.14	-1.51	0.56
Denmark	**-4.00**	-1.79	-2.71	-1.51	2.26
Finland	**-3.68**	-2.63	-2.02	-1.56	-2.15
France	-2.48	-2.27	-2.37	-1.36	2.12
Germany	-1.92	-2.38	-1.54	-1.99	-3.32
Ireland	-1.73	-0.88	-1.80	-2.35	**-3.80**
Italy	-1.87	-1.20	-2.69	-1.01	-0.66
Japan	-2.27	**-3.62**	-2.98	-1.33	-2.76
Netherlands	-2.30	-1.52	-1.80	-2.00	0.33
Norway	**-4.55**	-1.76	**-4.12**	-2.24	1.69
Spain	-2.12	-2.02	-2.98	-2.43	-2.85
Sweden	-3.40	-2.03	-1.75	-0.92	0.01
Switzerland	-1.99	-2.02	-1.24	-1.74	-2.85
UK	-2.71	-2.41	-1.77	-1.43	1.68
US	-2.50	-1.33	-2.06	-2.35	1.67
IPS	**-2.13**	-0.46	-0.32	-0.87	-1.45
1st diff.	CPI	GDP	Prop. price	Interest rate	Real credit
Australia	**-3.25**	**-7.34**	**-4.57**	**-4.31**	-2.26
Austria	**-3.33**	**-3.35**	-2.01	**-3.20**	**-3.15**
Belgium	**-4.38**	**-4.72**	**-3.28**	**-8.13**	-2.34
Canada	-2.76	-2.81	**-3.04**	**-4.38**	**-3.01**
Denmark	**-2.94**	**-3.52**	-1.65	**-5.58**	**-3.76**
Finland	-1.77	-2.36	**-2.91**	**-3.85**	-1.65
France	-2.63	-2.55	-1.99	**-4.48**	-2.14
Germany	-2.39	-2.52	**-3.65**	**-3.27**	-1.07
Ireland	**-3.40**	-2.55	-1.81	**-4.58**	-2.50
Italy	-1.23	-2.44	-2.48	**-5.33**	-2.04
Japan	-2.17	-2.10	-2.31	**-3.53**	-2.23
Netherlands	**-3.34**	-2.26	**-2.96**	**-3.50**	-2.13
Norway	**-3.58**	**-4.56**	-2.21	**-4.65**	**-3.30**
Spain	-1.88	-2.29	-2.17	**-9.02**	-1.94
Sweden	-2.05	-2.17	-2.64	**-4.79**	-2.54
Switzerland	-2.32	**-4.30**	-1.76	**-3.67**	**-2.93**
UK	-2.03	-1.43	-1.61	**-4.03**	-2.00
US	-2.87	-2.31	-2.32	**-3.22**	-2.19
IPS	**-5.17**	**-5.92**	**-4.96**	**-13.56**	**-5.75**

Note: IPS is the Im, Pesaran and Shin (2003) test. Except for the interest rate, where we include a constant only, the tests for the levels include a constant and a trend and four lags, whereas the test for the differences include a constant and three lags. Critical values for the ADF tests are -3.44 for the test with trend and -2.89 for the tests including only a constant. The IPS test statistics are distributed as N(0,1). Bold face denotes significance at the 5 percent level.

Table 2. Characteristics of mortgage markets

Country	IMF mortgage market index	Mortgage equity withdrawal	Typical average duration	Mortgage-backed securitisation	Typical loan-to-value ratio (%)	Mortgage–debt-to-GDP ratio (%)	Owner occupation share (%)	Share of fixed-rate mortgages (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Australia	0.69	Yes	25	7.9	80	51	70	16
Austria	0.31	No	25	2.2	60	20	56	75
Belgium	0.34	No	20	1.9	83	30	68	75
Canada	0.57	Yes	25	3.6	75	43	65	71
Denmark	0.82	Yes	30	58.6	80	88	52	70
Finland	0.49	Yes	17	2.6	75	39	64	7
France	0.23	No	15	2.6	75	26	55	68
Germany	0.28	No	25	3.8	70	52	44	84
Ireland	0.39	Limited	17	10.6	70	52	77	15
Italy	0.26	No	20	4.7	50	15	74	22
Japan	0.39	No	15	4.7	70-80	37	60	78
Netherlands	0.71	Yes	25	5.3	90	89	53	64
Norway	0.59	Yes	30	-	70	50	78	10
Spain	0.40	Limited	17	16.8	70	46	82	7
Sweden	0.66	Yes	20	11.0	80	52	46	50
Switzerland	0.26	No	25	11.2	66	102	35	72
UK	0.58	Yes	25	7.3	80-90	75	69	28
US	0.98	Yes	30	20.1	80	58	67	65

Note: For column (1) to (5) see IMF (2008), with own calculations for Switzerland based on information in Calza et al. (2009). Columns (6), (7) and (8) are from Igan et al. (2009).

Table 3. Classification of countries

Country	IMF mortgage market index (1)	Mortgage equity withdrawal (2)	Typical average duration (3)	Mortgage-backed securitisation (4)	Typical loan-to-value ratio (%) (5)	Mortgage–debt-to-GDP ratio (%) (6)	Owner occupation share (%) (7)	Interest rate adjustment (8)
Australia	Flexible	Flexible			Flexible		Flexible	Flexible
Austria	Inflexible	Inflexible		Inflexible	Inflexible	Flexible		Inflexible
Belgium	Inflexible	Inflexible	Flexible	Inflexible	Flexible	Flexible		Inflexible
Canada	Flexible	Flexible						Inflexible
Denmark	Flexible	Flexible	Inflexible		Flexible	Inflexible	Inflexible	
Finland	Flexible	Flexible	Flexible	Flexible				Flexible
France	Inflexible	Inflexible	Flexible	Inflexible		Flexible		
Germany	Inflexible	Inflexible		Inflexible	Inflexible		Inflexible	Inflexible
Ireland	Inflexible		Flexible		Inflexible		Flexible	Flexible
Italy	Inflexible	Inflexible	Flexible		Inflexible	Flexible	Flexible	
Japan	Inflexible	Inflexible	Flexible			Flexible		Inflexible
Netherlands	Flexible	Flexible			Flexible	Inflexible	Inflexible	
Norway	Flexible	Flexible	Inflexible	Inflexible	Inflexible		Flexible	Flexible
Spain	Inflexible		Flexible	Flexible	Inflexible		Flexible	Flexible
Sweden	Flexible	Flexible	Flexible	Flexible	Flexible		Inflexible	
Switzerland	Inflexible	Inflexible		Flexible	Inflexible	Inflexible	Inflexible	Inflexible
UK	Flexible	Flexible			Flexible	Inflexible		
US	Flexible	Flexible	Inflexible	Flexible	Flexible	Inflexible		

Note: Classification of countries in the regression, based on Table 2.

Figure 1. Log residential property prices in levels and changes relative to the same quarter of the previous year

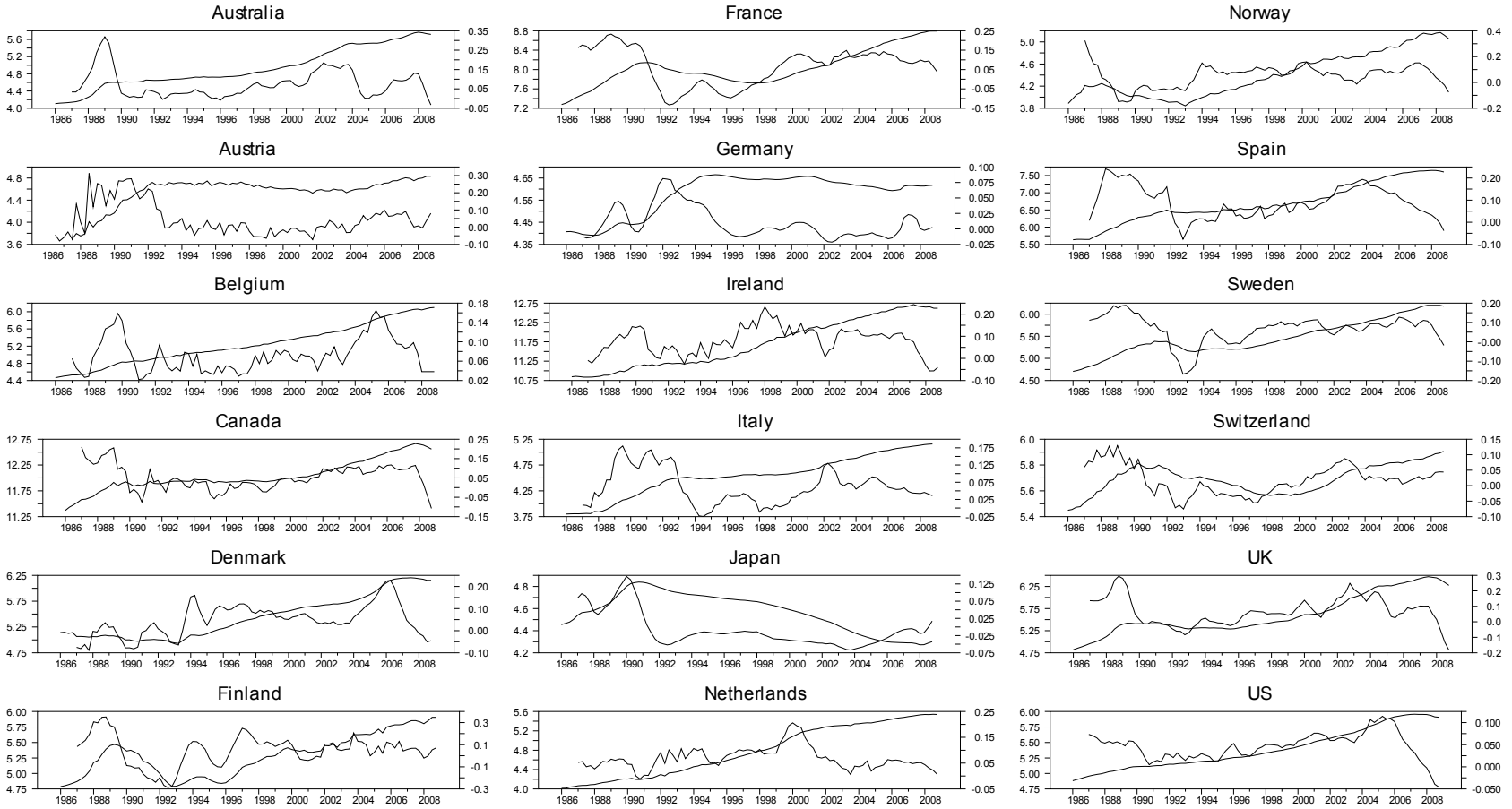


Figure 2. Annual property-price growth rates for subcategories

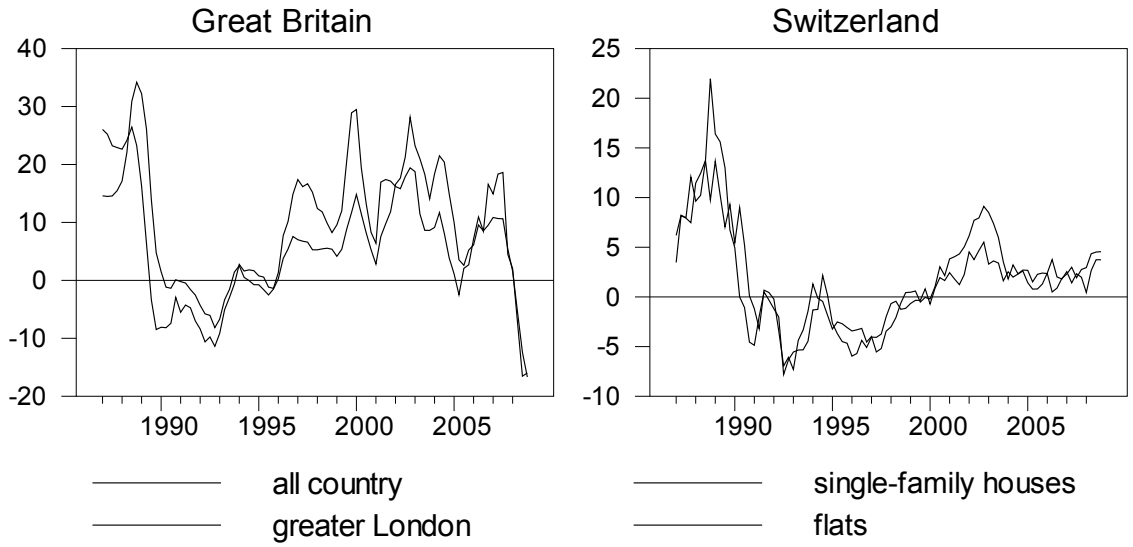
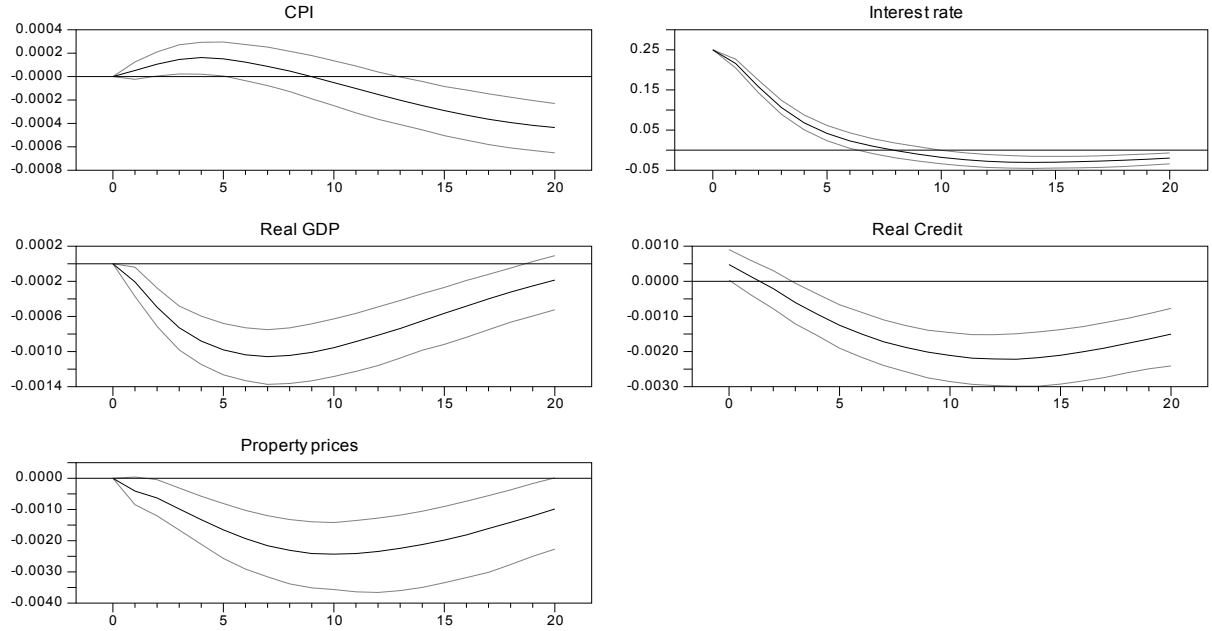
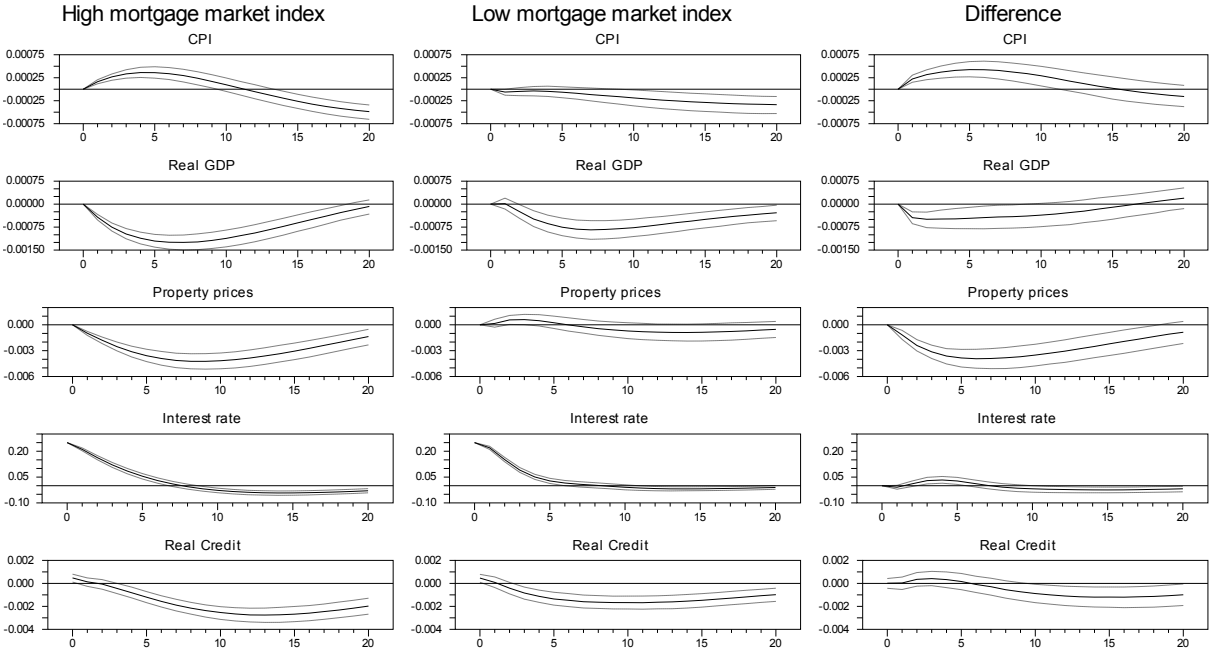


Figure 3. Mean-group impulse responses to a 25 basis point monetary policy shock



Note: The solid line is the bootstrapped median impulse response, the dashed lines indicate two-standard-error confidence bands. Results are based on 1000 bootstrap replications.

Figure 4. Mean-group impulse responses to a 25 basis point monetary policy shock for countries with high and low mortgage market index



Note: The solid line is the bootstrapped median impulse response, the dashed lines indicate one-standard-error confidence bands. Results are based on 1000 bootstrap replications.

Figure 5. Interest rate responses across countries

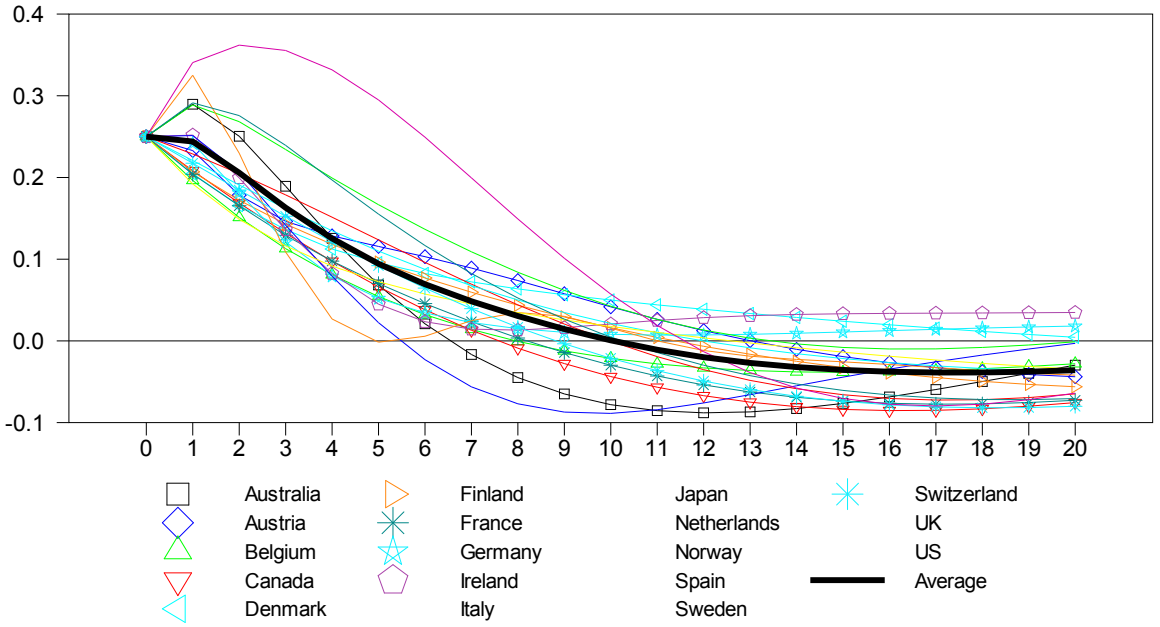
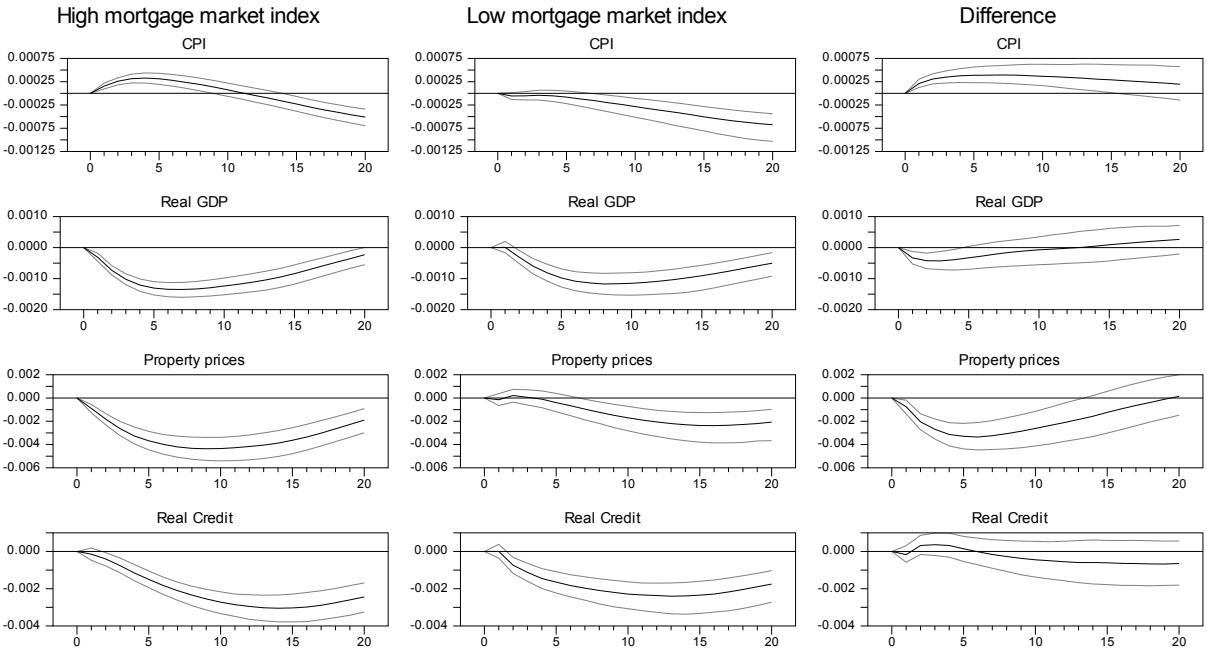
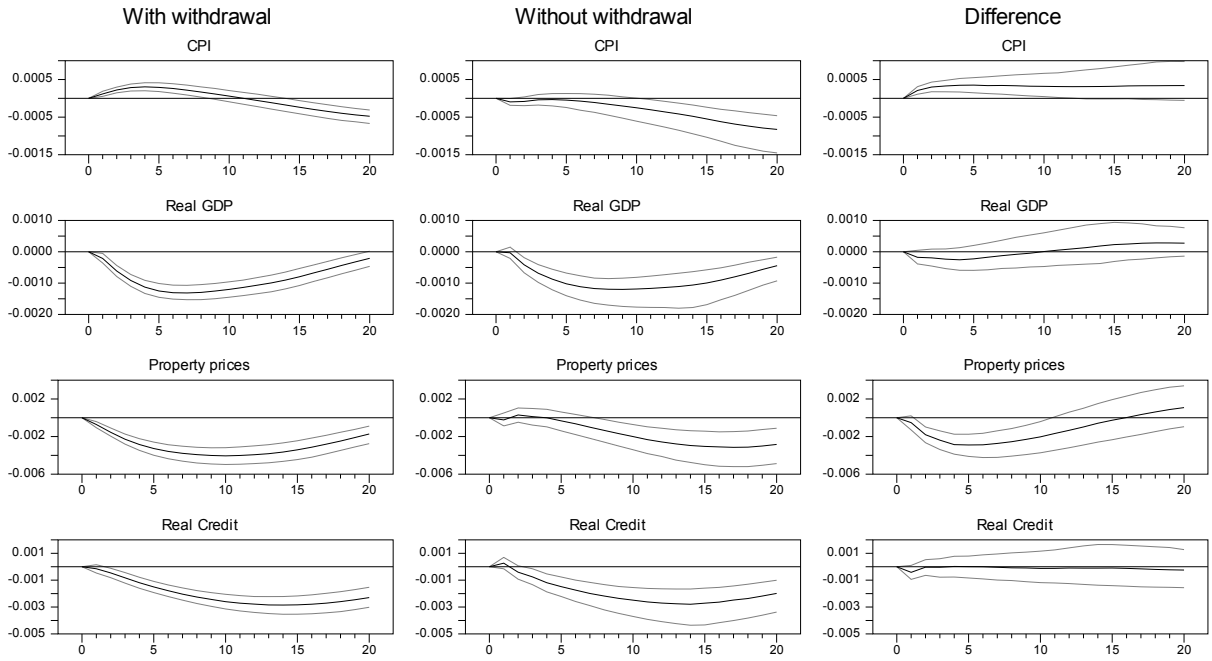


Figure 6. Mean-group impulse responses to a 25 basis point monetary policy shock for countries with high and low mortgage market index



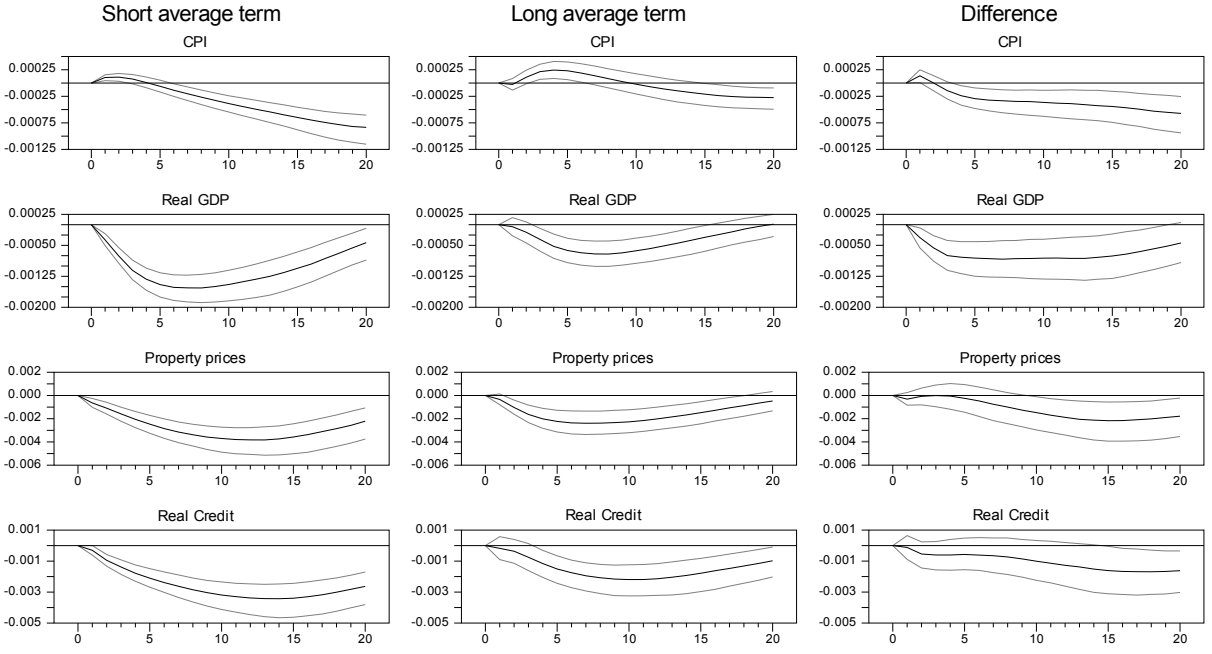
Note: The solid line is the bootstrapped median impulse response, the dashed lines the one-standard-error confidence bands. Results are based on 1000 bootstrap replications. The country grouping is indicated in Table 3.

Figure 7. Mean-group impulse responses to a 25 basis point monetary policy shock for countries with and without mortgage equity withdrawal



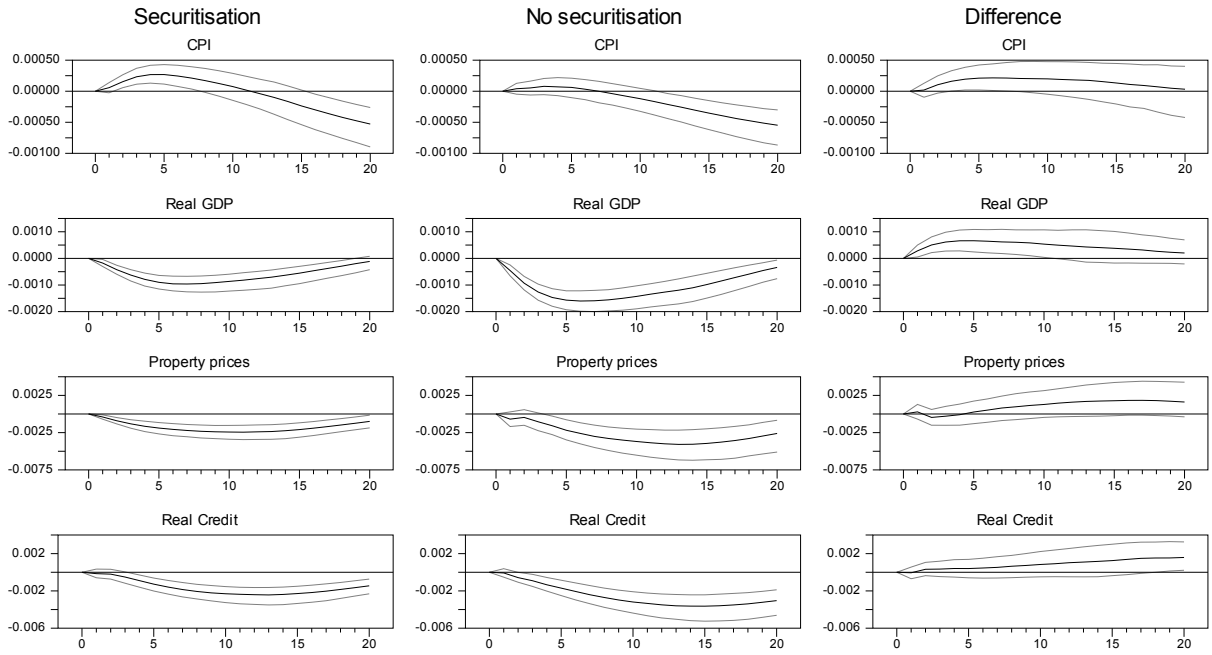
Note: The solid line is the bootstrapped median impulse response, the dashed lines the one-standard-error confidence bands. Results are based on 1000 bootstrap replications. The country grouping is indicated in Table 3.

Figure 8. Mean-group impulse responses to a 25 basis point monetary policy shock for countries short and long average term



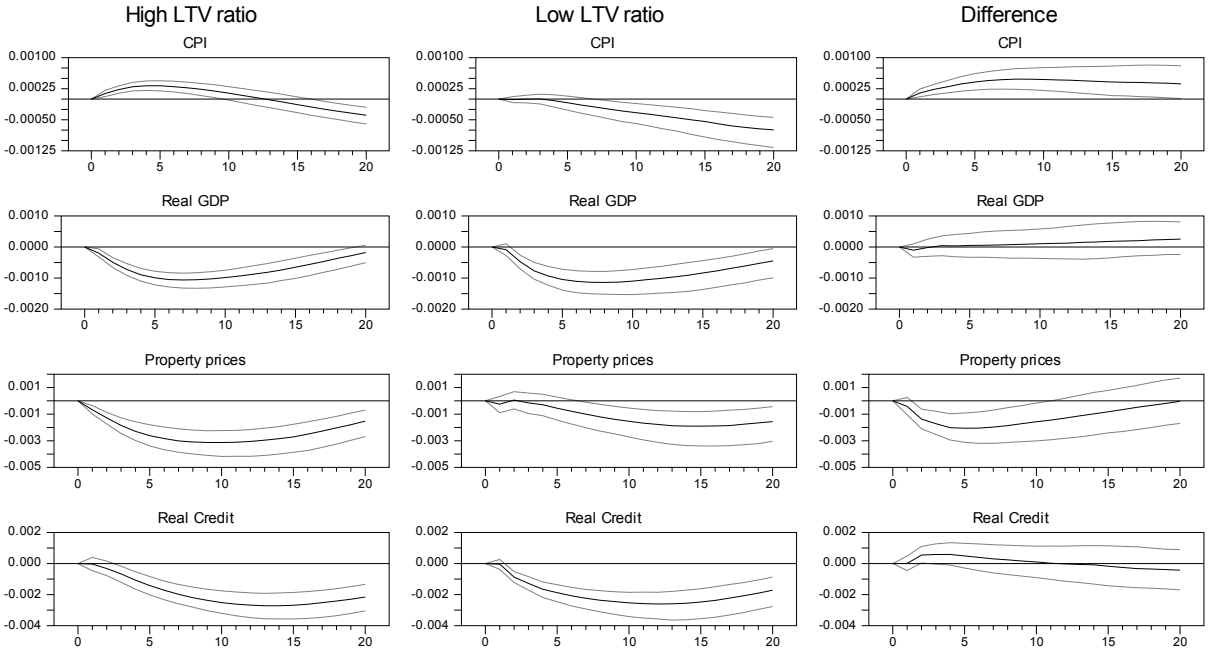
Note: The solid line is the bootstrapped median impulse response, the dashed lines the one-standard-error confidence bands. Results are based on 1000 bootstrap replications. The country grouping is indicated in Table 3.

Figure 9. Mean-group impulse responses to a 25 basis point monetary policy shock for countries with and without securitisation



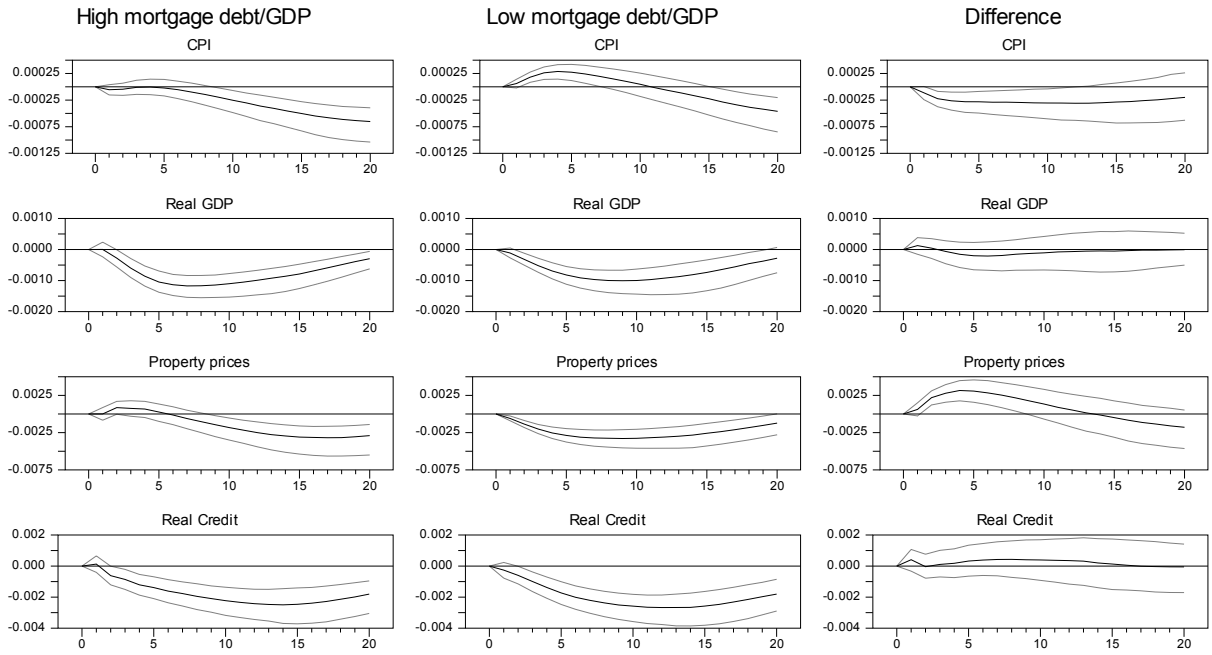
Note: The solid line is the bootstrapped median impulse response, the dashed lines the one-standard-error confidence bands. Results are based on 1000 bootstrap replications. The country grouping is indicated in Table 3.

Figure 10. Mean-group impulse responses to a 25 basis point monetary policy shock for countries with high and low loan-to-value ratios



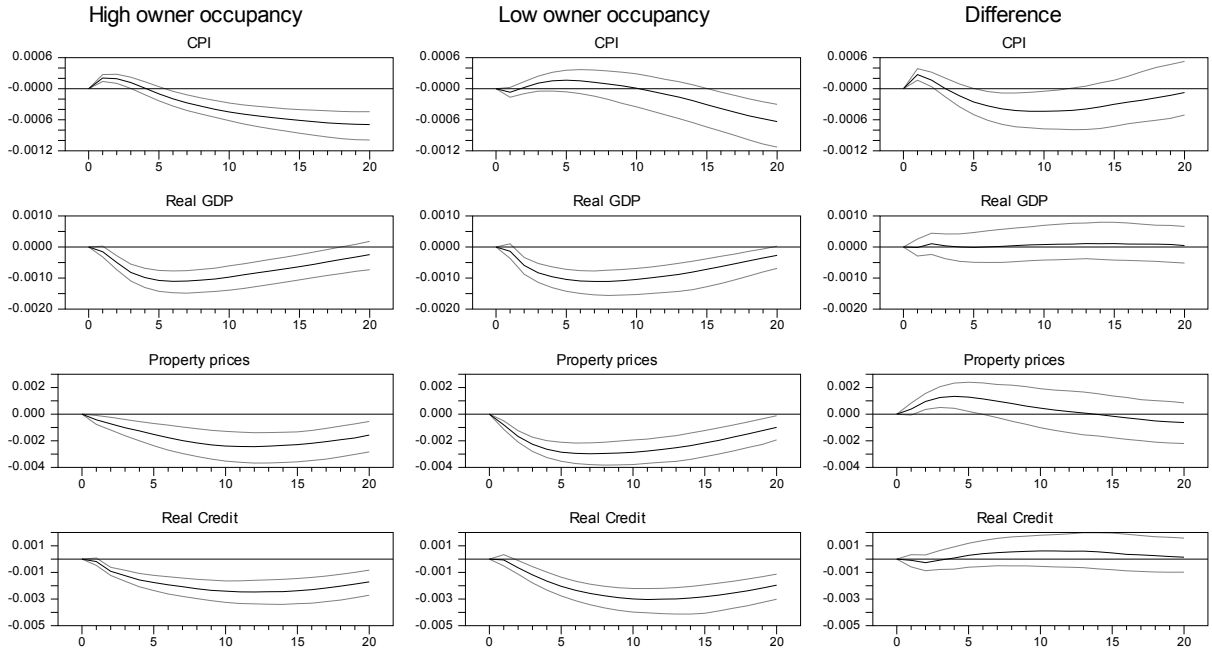
Note: The solid line is the bootstrapped median impulse response, the dashed lines the one-standard-error confidence bands. Results are based on 1000 bootstrap replications. The country grouping is indicated in Table 3.

Figure 11. Mean-group impulse responses to a 25 basis point monetary policy shock for countries with high and low mortgage-debt-to-GDP ratios



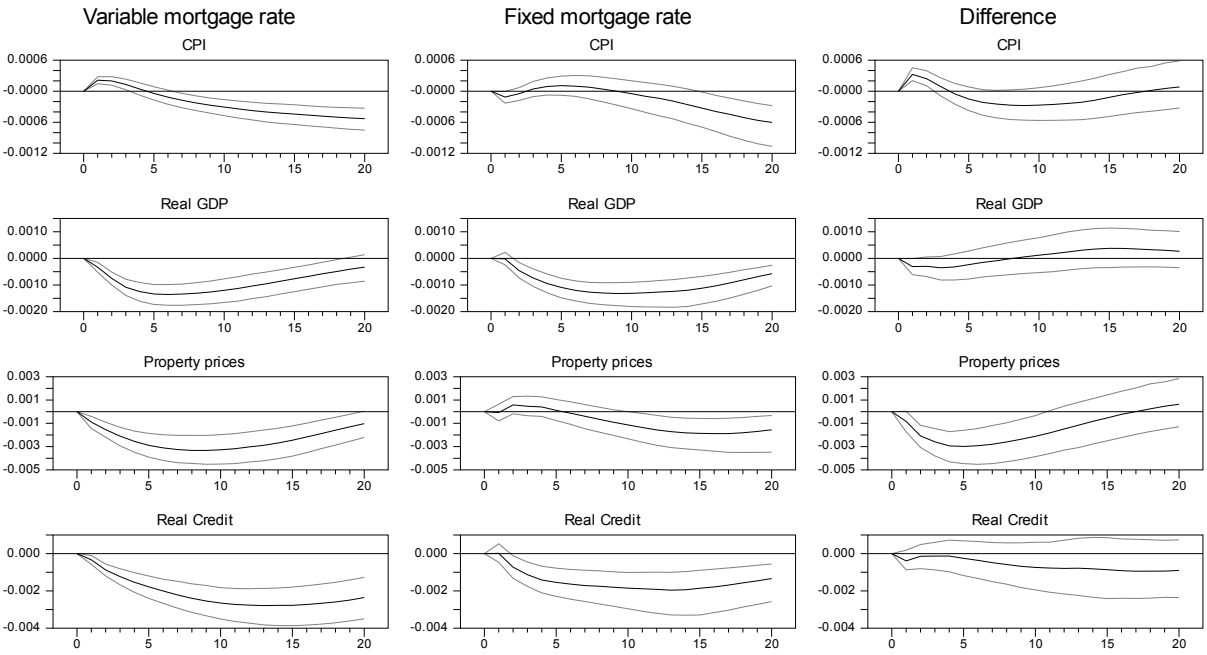
Note: The solid line is the bootstrapped median impulse response, the dashed lines the one-standard-error confidence bands. Results are based on 1000 bootstrap replications. The country grouping is indicated in Table 3.

Figure 12. Mean-group impulse responses to a 25 basis point monetary policy shock for countries with high and low owner occupancy



Note: The solid line is the bootstrapped median impulse response, the dashed lines the one-standard-error confidence bands. Results are based on 1000 bootstrap replications. The country grouping is indicated in Table 3.

Figure 13. Mean-group impulse responses to a 25 basis point monetary policy shock for countries with fixed and variable mortgage rates



Note: The solid line is the bootstrapped median impulse response, the dashed lines the one-standard-error confidence bands. Results are based on 1000 bootstrap replications. The country grouping is indicated in Table 3.