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Effectiveness and Channels of Macroprudential Instruments

Lessons from the Euro Area

By Thierry Tressel and Yuanyan Sophia Zhang

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Effectiveness and Channels of Macroprudential Policies: Lessons from the Euro Area

Prepared by Thierry Tressel and Yuanyan Sophia Zhang[1]

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Abstract

The crisis has highlighted the importance of setting up macro-prudential oversight frameworks, having effective macro-prudential instruments in place to be called upon to mitigate growing financial imbalances as needed. We develop a new approach using the euro area Bank Lending Survey to assess the effectiveness of macro-prudential policies in containing credit growth and house price appreciation in mortgage markets. We find instruments targeting the cost of bank capital most effective in slowing down mortgage credit growth, and that the impact is transmitted mainly through price margins, the same banking channel as monetary policy. Limits on loan-to-value ratios are also effective, especially when monetary policy is excessively loose.

JEL Classification Numbers: E32, E4, E5, G01, G21

Keywords: macroprudential policy, LTV ratios, capital requirement, mortage, bank lending

Author's E-Mail Address: ttressel@worldbank.org; yzhang@imf.org

[1] Thierry Tressel is a Lead Economist at the World Bank and Yuanyan Sophia Zhang is an Economist at the International Monetary Fund. The authors are grateful to IMF colleagues for useful comments at internal seminars, and to Luc Everaert and Helge Berger for discussions at the initial stage of this project.

I. INTRODUCTION

The design of a macro-prudential framework and its interaction with monetary policy has been at the forefront of the policy agenda since the global financial crisis (IMF, 2011, 2013; ESRB, 2013; Borio, 2011). However, most advanced economies (AEs) have little experience using macro-prudential policies, while there is, by contrast, more evidence about macro-prudential instruments aimed at moderating the volatility of capital flows in emerging markets (Cerutti, Claessens and Laeven, 2015). As a result, relatively little is known empirically about macro-prudential instruments' effectiveness in mitigating systemic risks in these countries, about their channels of transmission, and about how these instruments would interact with monetary policy. Many countries publish bank lending surveys that provide very useful information on how banks modify the price and non-price terms of loans to the private sector, and on the drivers of these lending conditions. Some of the terms of loans (such as actual loan-to-value ratios (LTVs)) or some of the drivers of the lending standards (such as the cost of bank capital or the liquidity position of a bank) are directly related to macro-prudential instruments considered to be key in the policy toolkit of many jurisdictions (BCBS, 2011; ESRB, 2013). In this paper, we make use of the European Central Bank Lending Survey to develop a methodology and estimate empirically the likely effectiveness of some of these macro-prudential policies, their channel of transmissions and their interactions with monetary policy.

There is thus far little knowledge about how (policy driven) changes in the cost of bank capital (which could be the result of the implementation of a countercyclical capital buffer, of time contingent or sectoral risk weights, or more generally of bank specific changes in the capital adequacy ratio) or in the bank liquidity position would be transmitted to credit supply. Specifically, would such policy actions be transmitted through non-price factors (such as LTVs, collateral requirements, or maturity) or through price factors (such as price margins or fees)? There is also relatively little knowledge about whether limits on LTVs could significantly slow down house price appreciation and/or mortgage loan growth. Should measures affecting capitalization be complemented by non-price measures constraining lending standards? Can some of these macro-prudential policies be effective during housing booms when traditional monetary policy is typically too loose? Assessing such interactions and the transmission channel of macro-prudential instruments, with a specific focus on the real estate market, is important, as shocks to the real estate market have been a key source of systemic risk during the recent financial crisis.

The Euro-system Bank Lending Survey (BLS) contains information on overall changes in lending standards, or net tightening of lending standards and changes in lending standards related to non-price factors (LTVs, collateral requirements, maturity), price factors (such as margins) and factors contributing to the changes in lending standards, including balance sheet characteristics (such as capital and liquidity ratios) which can be mapped to specific macroprudential targets set by national regulators. However, identification of the impact of macro-prudential policies requires addressing specific challenges. The BLS does not require banks to specify the exact nature of the shocks that cause a change in lending standards or in the cost of capital, even though it provides information on perceptions of risks, economic activity, and competition pressures, and their contribution to the change. Hence, our approach is potentially subject to omitted variable bias, reverse causality and measurement bias (as expectations about house

prices and credit growth may be mis-measured). Moreover, our observable variables (lending standard, and the contribution of balance sheet factors to lending standard) are not policy variables, which in our case are unobserved shocks affecting our observables. To address these issues, we develop methodologies relying upon instrumental variables and GMM estimators; our study also includes various control variables such as growth prospects, financial conditions, perception of risks and monetary policy cycle. Still, a potential advantage of our approach is that we would be able to capture the impact of the *announcement* of macro-prudential measures on lending standards, even before the actual implementation of the policy.

Our main findings are the following. First, our estimates suggest that measures that increase the cost of bank capital are effective in slowing down credit growth and house price appreciation. Second, changes in LTV also impact credit growth and house price appreciation but their impact tends to be more moderate. Third, macro-prudential policies affecting the cost of capital are transmitted mainly through price margins, with very little impact on LTV ratios or other non-price characteristics of mortgage loans. The evidence also suggests that tightening of LTVs is more effective in slowing down credit growth and house price appreciation when monetary policy is too loose.

These findings have the following policy implications. First, monetary policy and macro-prudential policies related to bank capital are likely to be transmitted through the same channels in the banking system as they both affect the cost of loans. So, they should be expected to reinforce each other. Second, capital buffers or liquidity ratios targeting specific sectoral exposures are likely to be effective in slowing down credit growth in the mortgage market. Third, macro-prudential instruments affecting the cost of capital or the liquidity position could usefully be complemented by instruments related to non-price dimensions of mortgage loans such as limits on LTVs.

II. LITERATURE

Since the global financial crisis, a fast growing literature has studied theoretically and empirically the role of macroprudential policies in mitigating volatility in financial markets. Indeed, the macroprudential approach has come to play a visible role in policy discussions only very recently as policy-makers have aimed at pinning down the definition of financial stability and the design and goals of macroprudential policies. However, we lack a thorough understanding and established models of the interaction between the financial system and the macroeconomy (Galati and Moessner, 2011).

Our paper is related to several strands of the literature. First, our paper is related to several papers that explore how monetary policy affect bank lending standards. Notably, using the same lending survey, Maddaloni and Peydro (2013) study the impact on lending standards of monetary policy rates and macro-prudential policy in euro area countries. In contrast to their paper, we identify how shocks affecting the balance sheet of banks affect price and non-price dimensions of lending standards while they focus on the specific impact of shocks to a Taylor rule. This allows us to a priori identify the transmission channels of any policies that affect bank capital or the liquidity position. Moreover, in contrast to their paper, we study how lending

standards and shocks to bank balance sheets affect mortgage loans growth and house price appreciation. Second, our paper is related to papers that estimate the impact of changes in capital requirements or limits on LTVs on credit growth. For example, using bank-specific and time varying capital requirements imposed by the regulator, Aiyar, Calomiris, and Wieladek (2012) show that capital measures have a significant impact on credit growth in the UK. Third, our paper is also related to the theoretical literature that quantifies the optimality and effectiveness of macro-prudential instruments (see for instance, in the case of the euro area, Quint and Rabanal (2013)). Last, our paper is relevant to the emerging literature that identifies the risk taking channels of monetary policy (Dell'Ariccia et al., 2013).

Recently, an increasing number of theoretical papers have attempted to capture the macro-financial linkages by incorporating financial intermediaries and housing sector in DSGE models. This approach allows testing the effectiveness of macro-prudential policies and their interaction with monetary policy. The link between financial sector and the macroeconomy is typically modeled by the spread between bank lending rate over the deposit rate which is a function of borrowers' net worth, following Bernanke et al. (1998) and Aoki et al. (2004) which allows to study the impact of macro-prudential policies (Angelini, Neri and Panetta, 2011; Lambertini, Mendicino, Punzi, 2011; Beau, Clerc and Mojon, 2012; Quint and Rabanal, 2013; and Scott, Rabanal and Kannan, 2009). For example, Angelini, Neri and Panetta (2011) model two macro-prudential instruments: a countercyclical capital requirement, and a LTV ratio. The former has an immediate impact only on the lending rate. The later affects the stringency of the borrowing constraint – as the collateral constraint tightens, borrower's ability to finance consumption and housing investment is reduced, so both these types of spending fall. Within a simple static macroeconomic model including banks, Cecchetti (2009) finds that coordination between monetary policy and capital adequacy policy is essential, since they can act as substitutes: the more monetary policy is used for stabilization purposes, the less capital adequacy policy needs to be used, and vice versa. Bean et al. (2010) study how the use of macroprudential policy tools might affect the conduct of monetary policy within a New-Keynesian DSGE model adapted from Gertler and Karadi (2009).

There is a growing consensus that strong monetary reactions coordinated with macroprudential instruments that specifically dampen credit market cycles are useful to maintain macroeconomic stability. Yet the identification of the source of shocks remains to be a challenge (Scott, Rabanal and Kannan, 2009). Lambertini, Mendicino, Punzi (2011) suggests that an interest rate rules that endogenously responds to financial variables mitigates macroeconomic and financial cycles and is welfare improving relative to more traditional rules that do not include financial variables. Agur and Demertzis (2009) examine the interaction between optimal monetary policy and endogenous bank risk and find that leaning-against-the-wind will on average lead to tighter monetary policy. Borio and Drehmann (2009a) not only support the use of monetary policy to address financial imbalances, but also stress that relying only on macroprudential policy to address (the time-dimension of) financial instability would burden it too much. According to Angelini, Neri and Panetta (2011) such interaction is asymmetric during different stages of the business cycle. In "normal" times, macroprudential policy generates only modest benefits for macroeconomic stability over a "monetary-policy-only" world. Yet the benefits of introducing macroprudential

policy tend to be sizeable when financial or housing market shocks are important drivers of economic dynamics. However, contrary to the above findings, Aiyar and others (2014) finds very little evidence of interactions between monetary and macro-prudential policies, providing a counter-example to the consensus in the literature on the interaction effects.

The empirical results however are mixed, and are largely limited to the emerging market economies. Lim, Columba, Costa, Kongsamut, Otani, Saiyid, Wezel, and Wu (2011) show that many of the most frequently used instruments are effective in reducing pro-cyclicality and the effectiveness is sensitive to the type of shock facing the financial sector. Due to the lack of data on advanced economies, their results mostly apply to emerging market economies. Crowe, Dell' Ariccia, Igan, and Rabanal (2011) use case studies and find positive correlations between LTV limits and house price appreciation between 2000 and 2007; measures of dynamic provisioning are effective in strengthening a banking system against the effects of a bust, but do little to stop the boom itself; some experience (Bulgaria, Croatia, Estonia, and Ukraine) failed to use capital requirement to stop the boom in the real estate sector while some does achieve partial success (Poland). Igan and Kang (2011) find that in Korea, loan-to-value and debt-to-income limits are associated with a decline in house price appreciation and transaction activity. The econometric analysis from Wong et al. (2011) suggests that LTV policy is effective in reducing systemic risk associated with boom and- bust cycles in property markets in Hong Kong. Cerutti, Claessens and Laeven (2015) find that macroprudential instruments can be effective in managing financial cycles, but less during busts. Vandenbussche et al. (2015) find that, in Central, Eastern, and Southeastern Europe, minimum capital adequacy ratios and non-standard liquidity measures had an impact on housing price inflation. Koen, van der Veer, and Hoeberichtsy (2013) use the micro-level survey information from the Netherland to test if the tightening of bank lending standards permanently reduces bank lending. Maddaloni and Peydro (2014) finds some suggestive evidence of excessive risk-taking due to low interest rates for mortgage loans, but the impact is reduced by more stringent prudential policy on either bank capital or loan-to-value ratio.

III. METHODOLOGY AND DATA

A. Data

The main dataset that we use in this paper is the Euro-system Bank Lending Survey (BLS). The lending survey is conducted on a quarterly basis by national central banks of the euro area and results are published at the country level and for the euro area as a whole.[2] The survey is addressed to senior loan officers of a representative sample of euro area banks. The sample group participating in the survey comprises around 140 banks from all euro area countries and takes into account the characteristics of their respective national banking structures. The lending survey monitors corporate lending, loans for house purchases, and other consumer lending.[3]

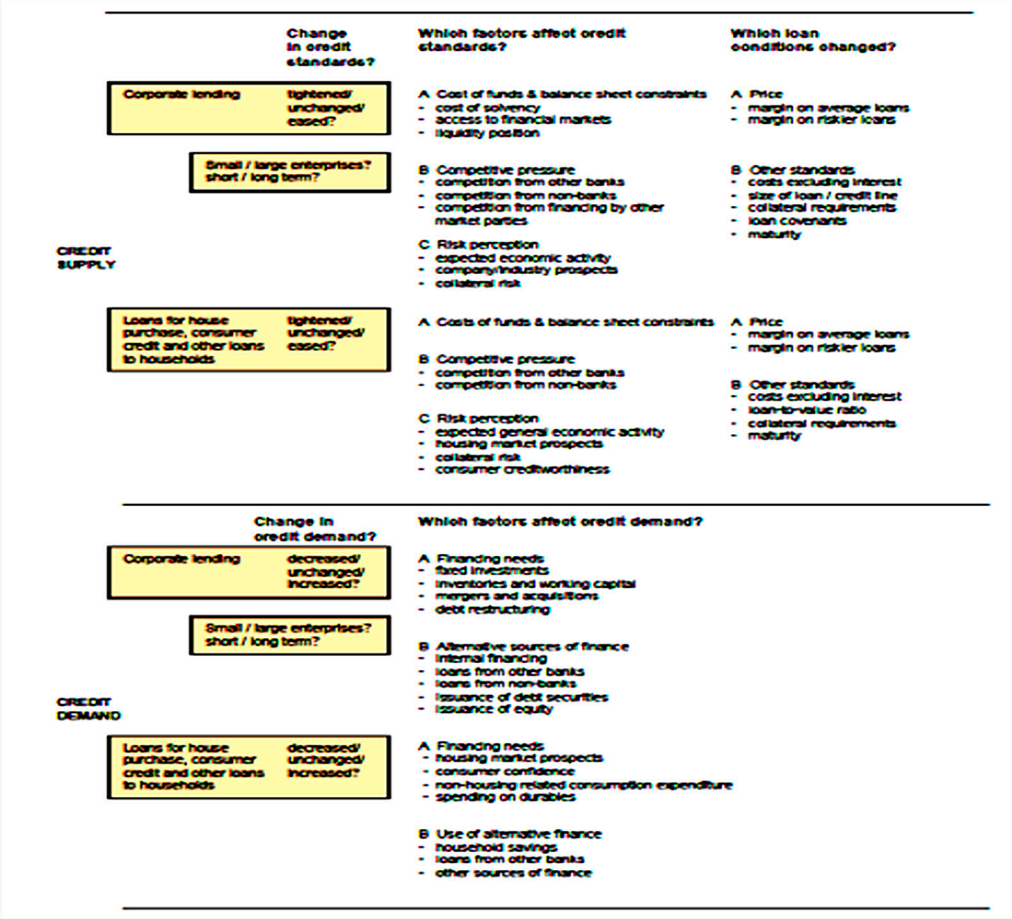
[2] https://www.ecb.europa.eu/stats/money/surveys/lend/html/index.en.html.

[3] The BLS is described in Berg, J., Van Rixtel, A., Ferrando, A., de Bondt, G., and Scopel, S. (2005): "The Bank lending Survey for the Euro Area", ECB occasional paper, no. 23.

The survey does not report level of lending conditions directly. It contains information on changes in lending conditions, which are presented as net changes, defined as the difference between the proportion of banks responding that they tightened lending conditions and the proportion of banks responding that they relaxed lending conditions during the quarter considered. In addition, the survey contains information about the net tightening for specific terms applied to customers. These terms are related to price factors (such as margins on average loans, margins on risky loans) and to non-price factors (such as, for mortgage loans: non-interest costs, loan-to-value ratios, collateral requirements, and maturity). The survey also asks questions on the contribution to the change in lending standards of several factors such as: (i) the costs of funds and balance sheet constraints, (ii) competitive constraints, and (iii) risks perceptions. The lending survey also asks banks to assess changes in the demand for credit by enterprises or households, and the contribution of various factors to these changes. Figure 1 describes the structure of the Bank Lending Survey. We focus on a panel between 2003q1 and 2010q4 covering 13 euro area countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovenia, and Spain.[4] Hence our sample stop before the crisis became systemic in the euro area in 2011.

[4] The data for Slovenia start in 2007q2.

Figure 1. The Eurosystem Bank Lending Survey

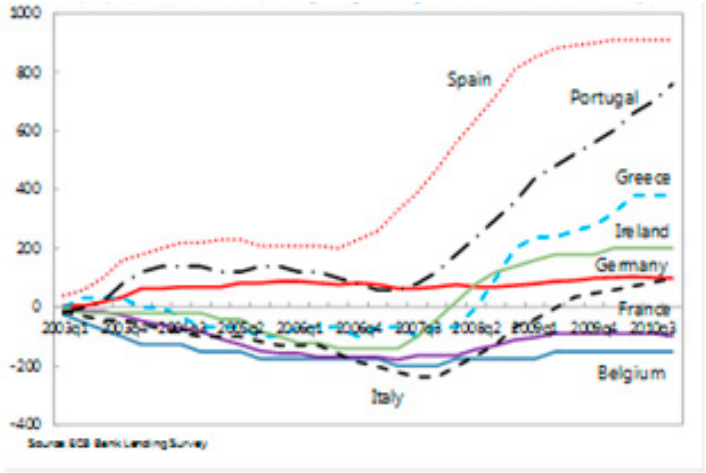


Source: Berg et all. (2005)

To give a sense of the time evolution and country dimension of some information contained in the survey, consider the evolution of lending standards for mortgages with respect to the loan-to-value ratios set by the banks. Figure 2 shows the *cumulative* net tightening of LTVs since 2003 by country. A flat line shows that there is no net change in loan to value ratios on average relative to the previous quarter, an upward sloping line implies that there is an increasing proportion of banks reporting a tightening than of banks reporting a loosening during the quarter, and a downward sloping line that there is a decreasing proportion of banks reporting a tightening than of banks reporting a loosening. As appears on the figure, there is substantial heterogeneity in the timing of net tightening (or loosening) of LTVs across euro area countries, and in their trends across countries. Countries such as Italy, Greece, Ireland or France had a loosening bias after 2005 and in the run-up to the crisis. In Spain, banks also somewhat loosened their LTV standards, but they had tightened them in the first years of existence of the euro. Once the crisis started, Spain, Portugal, Greece, Ireland and Italy all tightening their LTV standard considerably. In France and Belgium, LTV standards at the end of the sample on net remained on a loosening bias relative to the first year of the survey. In Germany, there was barely no net changes, or a moderate tightening in LTV standards between 2004 and 2010.

Figure 2. Cumulative Net Tightening of LTVs since 2003[1/]

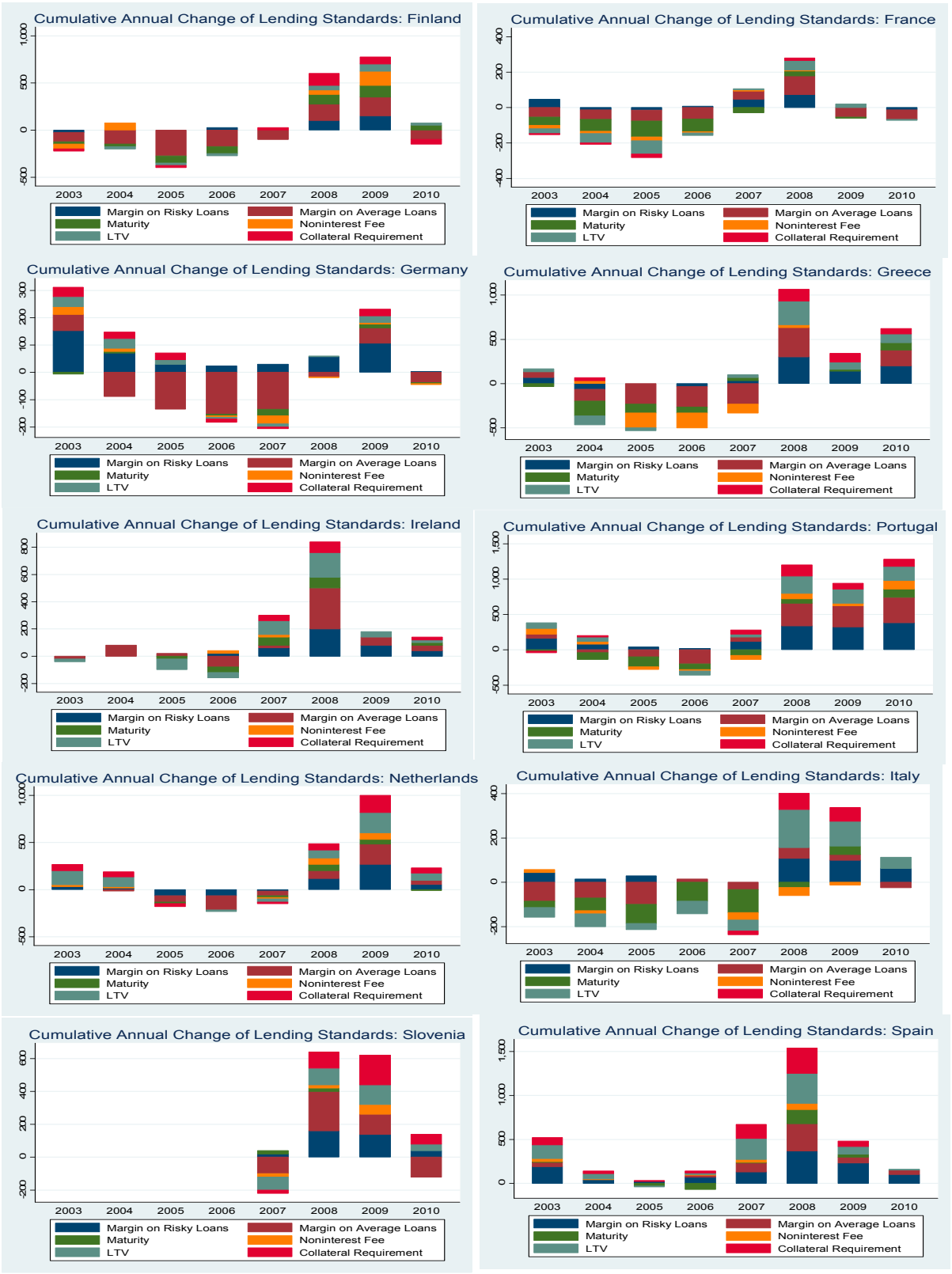
Net proportion of banks reporting a tightening (somewhat or considerably)



[1/]Cumulative net proportion of banks reporting that they "somewhat" or "considerably" tightened loan-to-value ratios.
Source: ECB lending survey.

Figure 3 reports the net changes of lending standards for mortgages for each of the six categories (margins on risky loans, margins on average loans, maturity, loan-to-value ratios, non-interest fee, and collateral requirements). It shows that, before the start of the global financial crisis, lending standards overall were on a loosening bias, in the sense that many if not most dimensions of lending standards were being relaxed. However, different lending standards were being loosened in different countries and at different times. For instance, in Germany, margins on average loans were compressed substantially between 2004 and 2007, while LTVs were moderately tightened. In Greece, LTVs, margins on average loans, non-interest fees and maturities were all loosened. Once the crisis started, a sharp tightening of lending standards, combining changes in many of these dimensions, took place in many countries of the sample.

Figure 3. Evolution of Price and non-Price Lending Standard, By Country



Source: ECB lending survey.

Table 1 reports pairwise correlations among the main variables used in our empirical analysis. These includes factors affecting mortgage loans lending standards, the components of lending standards, the perception of credit demand and of risks in housing market, and macroeconomic variables. We find that overall changes in lending standards for mortgage loans are correlated with each components of these net tightening in lending standards (price and non-price components). Non interest charges and maturity requirements are the least correlated with the overall lending standards. Lending standards are strongly correlated with risk perceptions related to housing market prospects (correlation of 0.8), but they are also correlated with the contribution of the cost of funds and balance sheet conditions and the contributions from bank competition. The perception of improvements in the demand for mortgage loans is associated with a loosening of lending standards. Net tightening of lending standards is negatively associated with quarterly mortgage loan growth and with house price appreciation.

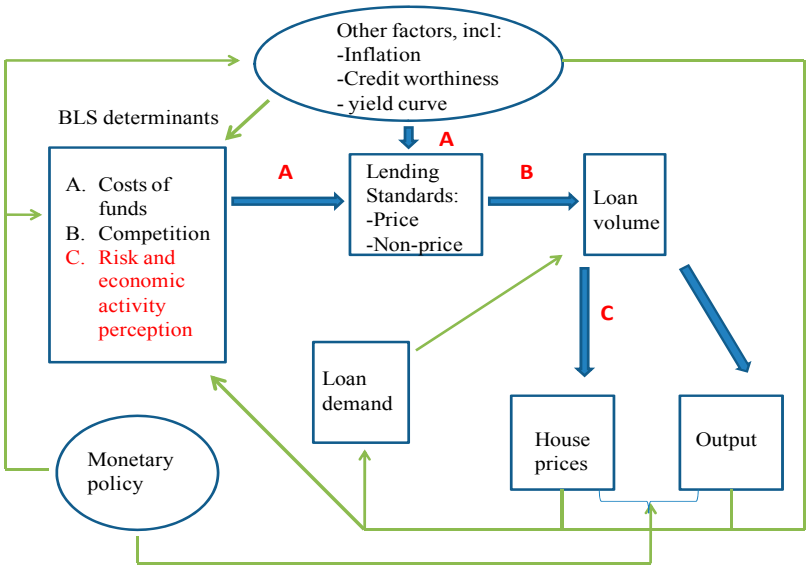
Table 1. Pairwise Correlation Among Components of Lending Standards and Credit Demand

		Overall Change in Lending Standard	Cost of funds and balance sheet condition	Competition from bank	Change in Lending Standards (Non price lending standards)				Price lending Standards		Change in demand for mortgage loans	Housing market prospects	Mortgage loans growth (qoq)	Growth of house price (qoQ)	Real GDP growth (qoq)	EONIA
					Non-interest charges	Loan-to-value	maturity requirement	Collateral requirements	Margins on Risky Loans	Average Margins						
Overall change in lending standards for mortgage loa		1														
Cost of funds and balance sheet condition		0.6454	1													
Competition from bank		0.57	0.39	1												
Change in Lending Standards (Non price lending standards)	Non-interest charges	0.40	0.38	0.40	1											
	Loan-to-value	0.80	0.51	0.43	0.32	1										
	maturity requirement	0.50	0.33	0.46	0.35	0.53	1									
	Collateral requirements	0.70	0.49	0.39	0.38	0.74	0.48	1								
Change in Lending Standards (price lending standards)	Margins on Risky Loans	0.70	0.63	0.46	0.41	0.69	0.44	0.65	1							
	Average Margins	0.69	0.60	0.56	0.45	0.62	0.46	0.59	0.80	1						
Change in demand for mortgage loans		-0.54	-0.43	-0.35	-0.26	-0.55	-0.42	-0.49	-0.53	-0.54	1					
Change in lending standards due to housing market prospects		0.80	0.58	0.39	0.39	0.76	0.42	0.69	0.70	0.68	-0.54	1				
Mortgage loans growth (qoq)		-0.24	-0.23	-0.22	-0.19	-0.21	-0.15	-0.12	-0.28	-0.24	0.37	-0.18	1			
Growth of house price (qoQ)		-0.32	-0.24	-0.31	-0.16	-0.35	-0.29	-0.33	-0.35	-0.34	0.43	-0.29	0.37	1		
Real GDP growth (qoq)		-0.26	-0.33	-0.24	-0.16	-0.31	-0.27	-0.28	-0.35	-0.36	0.25	-0.26	0.22	0.32	1	
EONIA		NS	0.10	NS	NS	NS	-0.11	NS	NS	NS	-0.33	0.12	NS	0.17	NS	1

Source: OECD, Haver, and ECB lending Survey, and Staff Calculation.

B. Framework

In our empirical analysis, we perform a decomposition of the channels through which various factors affect lending standards, and of how these lending standards affect mortgage loan growth and house price appreciation. The various channels through which policies, the macroeconomic environment and conditions in financial markets affect the equilibrium on the credit market and the housing market are depicted in the text Figure. According to the *balance sheet channel*, changes in short-term interest rates will affect the balance sheets of various economic agents, thereby affecting the equilibrium on various financial and non-financial asset markets. According to the *interest rate channel*, changes in policy rates affect the cost of borrowing on financial markets, and therefore tends to dampen economic activity. According to the *lending channel*, changes in refinancing rates affect banks' deposits and net worth, and therefore tend to affect the supply of credit. Finally, the *risk taking channel* posits that reductions in short-term interest rates may cause *excessive* risk taking by financial intermediaries (see for instance Dell'Ariccia, De Nicolò, Laeven, and Valencia, 2011).



In this paper, we are interested in the structural equations denoted by the letters A, B and C. Equation A is the structural relationship that determines the changes in lending standards of banks. Denote $\Lambda(\mathrm{B},\Phi,\mathrm{E})$ a vector of the six lending standards comprising price components and non-price components of changes in lending standards, $\mathrm{B}(i)$ a vector of bank balance sheet characteristics (capitalization, liquidity, access to wholesale funding markets), $\Phi(i)$ a vector of conditions on financial markets (the yield curve, liquidity, demand for credit), $\mathrm{E}(i)$ a vector of expectations and of indicators of economic activity (household debt/GDP, quarterly growth of house price index, quarterly real GDP growth, and BLS survey response to expectations regarding general economic conditions or of housing market prospects), and i the overnight interbank rate (EONIA). A set of country fixed effects f_i capture all slow moving unobserved characteristics affecting lending standards (it could be financial market regulations, culture, etc.). We also include time (quarterly) dummies d_t in our analysis. Hence, shocks common to all euro area countries are filtered out. Such effects could for instance be macroeconomic factors that impact the monetary policy stance of the euro area (oil prices, the global financial crisis, etc.). This means that our empirical strategy exploits the cross-country heterogeneity to identify the association between the evolution of lending standards, of their determinants and of the growth of credit or

the appreciation of house prices. The inclusion of country fixed effects allows to control for time invariant unobserved country factors (which could be related to the country specific institutional environment).
Equation A is given by:

$$\Lambda_{it} = \alpha + \sum_{L} \beta_L \cdot \mathrm{B}_{i,t-L} + \sum_{L} \delta_L \cdot \Phi_{i,t-L} + \sum_{L} \varphi_L \cdot \mathrm{E}_{i,t-L} + f_i + d_t + \varepsilon_{it} \qquad (1)$$

The second relationship B on Figure 1 is given by equilibrium on the market for mortgage credit growth $C(r)$ and the interest rate r which is determined by supply S and demand D. The supply of mortgage credit $S = S(\Lambda(r, np))$ is determined by lending standards, price factors (r) such as margins and fees, and non-price factors (np) such as the loan-to-value ratio, collateral requirement, and maturity. The demand for credit is given by: $D = D(r, E, \Phi)$. Combining the two relationships for supply and demand, the equation (B) can be written as follows:

$$C_{it} = \alpha + \sum_{L} \eta_L \cdot \Lambda_{i,t-L} + \sum_{L} \delta_L \cdot \Phi_{i,t-L} + \sum_{L} \varphi_L \cdot \mathrm{E}_{i,t-L} + g_i + d_t + \nu_{it} \qquad (2)$$

Where: g_i, d_t and ν_i are respectively a set of country fixed effects, common time dummies and error terms. By combining the structural relationships (1) and (2), one obtains a reduced form relationship linking determinants of lending standards to mortgage loan volume growth:

$$C_{it} = \alpha + \sum_{L} \theta_L \cdot B_{i,t-L} + \sum_{L} \lambda_L \cdot \Phi_{i,t-L} + \sum_{L} \sigma_L \cdot \mathrm{E}_{i,t-L} + g'_i + d'_t + \nu'_{it} \qquad (3)$$

Since credit supply factors affect the volume of mortgage loans, they are also going to affect the equilibrium house price level. Accordingly, one can write several relationships determining house prices depending on whether the credit equilibrium is described by the combination of the "structural" relationships (2) of the more reduced-form relationship (3) that combines equation (2) and (1).

The structural relationship is given by:

$$House_{it} = \alpha + \sum_{L} \omega_L \cdot \Lambda_{i,t-L} + \sum_{L} \xi_L \cdot \Phi_{i,t-L} + \sum_{L} \psi_L \cdot E'_{i,t-L} + l_i + m_t + \omega_{it} \qquad (4)$$

And the reduced form relationship by:

$$House_{it} = \alpha + \sum_{L} \omega'_L \cdot B_{i,t-L} + \sum_{L} \xi'_L \cdot \Phi_{i,t-L} + \sum_{L} \psi'_L \cdot E'_{i,t-L} + l'_i + m'_t + \omega'_{it} \qquad (5)$$

Where E′ excludes house price changes from E, and l_i, l'_i are country fixed effects and m_t and m'_t are time dummies.

In practice, in all of the equations, we will directly include the lending survey measure of demand for mortgage credit growth to filter out demand effects (see Basset et al., 2012, for a similar approach to filter out demand factors).

C. Methodology

Mapping macro-prudential instruments to banks' lending policies:
We map various macro-prudential policy instruments to factors that affect changes in bank lending standards. For example, instruments that constrain borrowers such as caps on loan-to-value ratios are mapped to change in LTV lending standards. Liquidity measures such as reserve requirements or the Basel III net stable funding ratio are mapped to changes in lending standards due to banks' liquidity position. Contingent capital buffers such as the Basel III countercyclical capital buffer, sectoral and time varying risk weights (such as for exposures to the housing market), dynamic provisioning, restrictions on profit distribution are mapped to changes in lending standards related to banks' capital position. Instruments that affect banks' costs of wholesale funding such as levies on wholesale funding or bail-in tools are mapped to change in lending standards due to bank's ability to access market financing.

We make use of these variables provided by the BLS to assess what could be the impact of macro-prudential policies on the mortgage loan market and the housing market of euro area countries. However, the BLS does not require banks to specify the nature of the shocks to the balance sheet that cause a change in lending standards. For example, we do not know whether changes in lending standards such as LTVs are caused by shocks to the balance sheet of banks (which may result from the monetary policy or from exogenous factors), by their endogenous assessment of economic prospects, or by changes in macro-prudential policies. Similarly, balance sheet conditions (the cost of capital, the liquidity position, access to wholesale markets) are endogenous variables, which can be influenced, not only by policies, but also by expectations regarding future conditions on the credit market and economic activity, and by conditions on financial markets (which can depend on monetary policy, or on general market expectations or other shocks). Because some of these factors also affect credit demand and supply directly, the estimated coefficient is likely to be biased and therefore does not provide a "correct" estimate of the impact of a policy decision on lending standards.[5] Using the notations introduced in section III, there is an endogeneity bias because $E\left(B_{it-L}\cdot\varepsilon_{it}\neq 0\right)$,

$E\left(B_{it-L}\cdot\nu'_{it}\neq 0\right)$, $E\left(B_{it-L}\cdot\omega'_{it}\neq 0\right)$, $E\left(\Lambda_{it-L}\cdot\nu_{it}\neq 0\right)$ and $E\left(\Lambda_{it-L}\cdot\nu'_{it}\neq 0\right)$

Endogeneity concerns are muted by the introduction of control variables. We are controlling for banks' expectations of conditions on the housing market.[6] We are also controlling for various macroeconomic variables (real GDP growth, house price appreciation, inflation), and market prices (the yield curve, the overnight euro interest rate), and banks' perceptions of mortgage credit demand. Importantly, to filter out the effects of changes in borrowers' characteristics and

[5] Of course, policy decisions are themselves endogenous to the economic environment. For example, the Basel III countercyclical capital buffer will rise when there is a credit boom. Because of this reverse causality, estimating the impact of macro-prudential policies on the credit market equilibrium is also not straightforward.

[6] This variable is highly correlated with banks' expectations regarding economic activity. Controlling for the latter variable instead of the former one does not modify our findings significantly.

macroeconomic conditions on the demand for credit, we are also controlling for the demand for mortgage loans. Time dummies and country fixed effects filter out the influence of common shocks and of slow moving country factors affecting the equilibrium on the credit market and the housing market. While these controls will allay some concerns, we cannot rule out that unobserved factors affect both our dependent variables directly and our explanatory variables.

We attempt to address endogeneity concerns further by developing two different strategies to estimate equations (2), (3), (4) and (5). The first approach is to estimate our model using the dynamic panel GMM estimator developed by Arellano and Bond (1991).[7] To check the validity of the instruments, we report a test of over-identifying restrictions (Sargan test), and tests of serial correlations for the error terms of the differenced equation. The instruments for the equations estimated in first difference are lags of these variables in levels (with lags ranging from t-2 to t-4). Lending standards and the contributions of balance sheet factors are considered endogenous and are instrumented by their lags. The identifying assumption is that $E\left[X_{t-k} \cdot \Delta \nu_{it}\right]=0$, where $k \geq 2$ and X_{it} is an endogenous variable $B_{i,t-k}$ or $\Lambda_{i,t-k}$ and ν_{it} is a residual: factors contributing to lending standards and lending standards themselves are uncorrelated with future innovations of the unexplained portion of mortgage loan growth, house price appreciation or lending standards. We assume that EONIA and risk perception on the housing market are exogenous while other variables are predetermined.

The second approach to correct the endogeneity bias is to develop an instrumental variable strategy (two stage least squares, 2SLS). The difficulty is to find instruments that are correlated with the endogenous variable (the various contributions of bank balance sheet factors to the change in lending standards) but that are not with mortgage loan volume or house prices, *after controlling for other factors*. Specifically, to be valid, a vector of instruments Z_{it} must verify: $E\left(Z_{it} \cdot \nu_{it} \middle| X_{it}\right)=0$ where X_{it} is a vector of right-hand side variables and ν_{it} is a residual. As instrumental variables, we will use the growth rate of claims of US banks and UK banks on banks of each euro area country, and their lags, up to 6 quarters. These data are from the BIS Consolidated Banking Statistics. The identification strategy is that US and UK banks do not finance mortgage loans directly in euro area countries, but provide wholesale interbank funds to local euro area banks.[8] The first stage of the 2SLS requires that these cross-border interbank flows are good explanatory variables for the shocks to balance sheet factors in the reduced form equations (3) and (5), and potentially in the more structural equation (1). Validity of the instruments second stage requires that the over-identifying restriction of the second stage above characterized is met.

[7] The panel data dynamic GMM estimator also corrects the general bias of dynamic panels with fixed effects when the right hand side variables include lags of the dependent variables (Nickell, 1981). Our GMM estimates include one lag of the dependent variable.

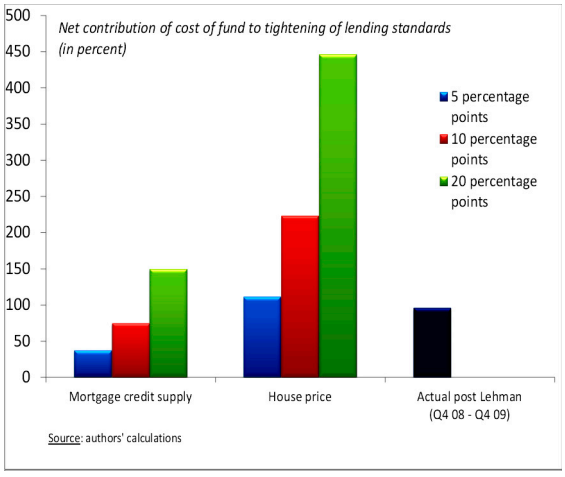
[8] Laeven and Tressel (2014) show that there is very little foreign presence of banks at the retail level in euro area countries while domestic banks relied significantly on cross-border wholesale funding to finance their activities.

IV. EMPIRICAL RESULTS

A. The Impact of Shocks to Banks' Balance Sheets on Credit and House Prices

As shown in section II, the questionnaire pertaining to mortgage loans does not include a breakdown of the "costs of funds and balance sheet conditions" into various components. In contrast, the questionnaire pertaining to loans to enterprises provides the following breakdown: the cost of capital, the access to financial markets and the liquidity position. Given our objective to map macro-prudential instruments to categories of the lending standard questionnaires, we have an interest in exploiting this detailed information.[9] It turns out that the broad category of lending standards due to costs of funds and balance sheet conditions for mortgage loans and for loans to enterprises are strongly correlated with each other. So we hypothesize that using the answers to the enterprise questionnaires for the subcategories could be a reasonable approximation for mortgage loans' lending standards. However, using these variables is likely to introduce measurement error in our estimations. This measurement error introduced in our estimations requires the use of GMM estimators and IV techniques.

In Table 2, we report the findings of the GMM and IV estimations for the reduced form relationship (3) between the balance sheet determinants of lending standards and credit growth, and the relationship (5) with house price appreciation. Panel A shows the results of the credit growth GMM and IV regressions.[10] It turns out that, after controlling for various determinants of credit demand and supply, mortgage loan growth is higher where banks report a loosening of lending standards due to lower cost of capital, better liquidity position or easier access to market finance. The effect seems the strongest for the capital position, and impact credit growth up to 3 quarters later. The effect of changes in liquidity position or access to financial market is also generally statistically significant, but with a smaller impact. We also uncover an impact of higher cost of capital on house price appreciation, but there is only weak evidence that the liquidity position or access to financial market have an impact on house prices (panel B). Turning to specification tests, it appears that the difference GMM estimator performs well: the AR1 and AR2 tests of the differenced equation support the hypothesis of non-autocorrelation of the residual term in the level equation. Moreover, the Sargan test of over-identifying restrictions does not reject the null of validity of the instruments. In the IV regression, the Hansen J test similarly does not reject the null of validity of the instruments in most cases



[9] These three subcategories are also correlated with each other. Indeed, the pairwise correlation coefficients are between 0.6 and 0.7 and are significant at the 5 percent level.

[10] OLS and GLS regression results are also available upon request.

(the one exception being the IV2 estimation for the lending standards due to the liquidity position). The Anderson-Rubin Wald test does not reject the null that the instruments are not weak in most regressions.

Table 2. Impact of Balance Sheet Contributions of Lending on Mortgage Loan Growth and on House Price Appreciation

Dependent variable:	**Mortgage loan growth**									**House price appreciation**								
Determinant of LS:	**Cost of funds**			**Liquidity position**			**Access to financial markets**			**Cost of funds**			**Liquidity position**			**Access to financial markets**		
	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)
Contemporaneous	**-0.0490***	0.00238	0.0865	-0.0203	-0.111	-0.0765	-0.0348	0.08	0.124*	**-0.0226***	0.0297	0.045	-0.00447	-0.0116	-0.0488	**-0.0313****	-0.0145	-0.0312
	(-1.85)	(0.05)	(1.29)	(-0.50)	(-1.64)	(-1.01)	(-1.09)	(1.20)	(1.81)	**(-1.95)**	(0.56)	(0.86)	(-0.31)	(-0.31)	(-1.05)	**(-1.98)**	(-0.53)	(-1.13)
(t-1)	**-0.0454***	-0.0605	**-0.121***	**-0.0736****	0.0686	0.0647	**-0.0460***	-0.0254	-0.049	0.00613	**-0.0670***	**-0.0696***	0.0159	-0.0193	-0.00244	0.0140	-0.0268	-0.0204
	(-1.54)	(-1.08)	**(-1.69)**	**(-2.18)**	-1.1	-1.02	**(-1.80)**	(-0.55)	(-0.96)	(0.45)	**(-1.78)**	**(-1.84)**	(1.13)	(-0.34)	(-0.04)	(1.55)	(-0.67)	(-0.50)
(t-2)	**-0.0392***	0.0249	-0.0327	-0.00164	0.0128	-0.0116	-0.00945	0.0712	0.0629	-0.00458	-0.0246	-0.0319	-0.0147	-0.0328	-0.0232	-0.0123	0.0101	0.00544
	(-1.89)	(0.48)	(-0.45)	(-0.05)	-0.28	(-0.25)	(-0.32)	(1.30)	(1.31)	(-0.70)	(-0.55)	(-0.68)	(-1.26)	(-0.70)	(-0.52)	(-0.92)	(0.37)	(0.20)
(t-3)	-0.0234	**-0.0945***	-0.0742	-0.0431	0.0173	0.00828	-0.0265	**-0.0759***	**-0.0983****	0.00635	-0.0116	-0.00511	0.00482	0.0275	0.0318	-0.00118	-0.0248	-0.0226
	(-0.72)	**(-1.79)**	(-1.49)	(-1.38)	-0.48	-0.24	(-0.83)	**(-1.72)**	**(-2.18)**	(0.53)	(-0.38)	(-0.16)	(0.38)	(0.92)	(1.06)	(-0.11)	(-0.74)	(-0.61)
(t-4)	0.0100	0.0491	0.0175	-0.0185	-0.0516	-0.0436	-0.0188	0.0432	0.045	-0.000970	-0.0343	-0.0421	0.000726	-0.0217	-0.031	0.0215	0.00139	-0.0076
	(0.47)	(1.08)	(0.34)	(-0.66)	(-1.29)	(-1.00)	(-1.07)	(1.27)	(1.35)	(-0.08)	(-1.33)	(-1.63)	(0.04)	(-0.78)	(-1.14)	(1.61)	-0.07	(-0.38)
Country FE	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	266	276	276	266	276	276	266	276	276	266	276	276	266	276	276	266	276	276
R2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Specification tests																		
Arellano-Bond test for AR(1) (p val.)	0.067	.	.	0.075	.	.	0.046	.	.	0.020	.	.	0.037	.	.	0.033	.	.
Arellano-Bond test for AR(2) (p val.)	0.466	.	.	0.992	.	.	0.592	.	.	0.282	.	.	0.848	.	.	0.762	.	.
Sargan test (p value)	0.145	.	.	0.873	.	.	0.279	.	.	0.122	.	.	0.489	.	.	0.716	.	.
Hansen test (v value)	.	0.167	0.167	.	0.167	0.044	.	0.167	0.044	.	0.8566	0.8983	.	0.2251	0.2155	.	0.1533	0.1205
Anderson-Rubin Wald test (p val)	.	0.6535	0.4112	.	0.6758	0.7526	.	0.4112	0.6901	.	0.1882	0.0262	.	0.1882	0.0262	.	0.1882	0.0262

T statistics in parentheses; * p<0.10, **, p<0.05, *** p<0.01

Note: Control Variables include housing market prospects (from the BLS), demand for mortgage loans from (BLS), household debt to GDP, house price appreciation (in mortgage loan growth regressions only), real GDP growth, a measure of the yield curve, the inflation rate and the EONIA GMM regression include a lagged dependent variable. Difference GMM includes as instruments.

Source: OECD, Haver, and ECB lending Survey, and Staff Calculation.

Are the effects of the contribution of the cost of capital to lending standards on credit growth or on the growth of mortgage prices economically large? We answer this question by performing the following thought experiment. Consider the objective of reducing credit growth or house price appreciation by 5/10/20 percentage points respectively. Assuming all other macroeconomic indicators, including those of credit demand and risk to housing market, are unchanged, we ask what would be according to our estimated, the required contribution to the change in lending standards due to the cost of capital required to reach this objective. To compute this estimate, we sum the significant coefficients on the variable, from the contemporaneous effect to lag four. To gauge the size of the contribution of the cost of capital, we compare it with the actual size of tightening in the year following the start of the global financial crisis (2008Q4 to 2009 Q4). We find that, holding all macroeconomic conditions constant, a 10 percentage points reduction in credit growth would require an increase in the cost of capital with a 70 percent contribution to lending standards. This tightening of lending standards due to the cost of capital would be about the same order of magnitude as the actual average tightening of euro area lending standards due to the cost of capital that took place during the year that followed the start of the global financial crisis. These findings suggest that macro-prudential instruments related to the cost of capital may have a quite large impact on mortgage credit growth. Repeating the same exercise for house prices we find that a similar tightening of lending standards due to an increase in the cost of capital would result in a 5 percentage points reduction in house price appreciation.

B. The Impact of Balance Sheet Factors on Price and Non-Price Lending Standard

In Table 3, we report OLS and GLS estimates of the equation (1) linking the various dimensions of lending standards for mortgages to factors related to balance sheet conditions, the cost of capital, the liquidity position and access to market financing. We find that all of these balance sheet conditions seem to affect price and non-price dimensions of mortgage lending standards. Hence, banks adjust to shocks affecting their liabilities by modifying various dimensions of their lending standards –including interest margins on risky and average loans, LTV ratios, fees, collateral requirements and loan maturity. However, the econometric analysis suggests that the transmission of the shocks affecting the balance sheet of banks is transmitted principally to price margins, and has a relatively weak impact on other dimensions of lending standards. Indeed, both point estimates and significance levels are much higher in the regressions of interest margins than in the regressions of non-interest components of mortgage loans. GMM and instrumental variable regressions reported in Table 4 tend to confirm these conclusions.

Table 3. Impact of Balance Sheet Factors on Price and non-Price Components of Lending Standards for Mortgage Loans

Dependent variable: (lending standard component)	Loan-to-value ratio						Non-interest costs						Collateral requirements					
explanatory variable:	cost of funds		liquidity position		market financing		cost of funds		liquidity position		market financing		cost of funds		liquidity position		market financing	
	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE
Contemporaneous	**0.141****	0.0669	**0.128***	0.0300	0.0331	-0.0539	**0.197*****	**0.167****	0.0672	0.0524	**0.138*****	0.0714	**0.0806***	0.0143	0.0315	-0.0234	**0.111*****	**0.0940****
	(2.16)	(0.93)	**(1.89)**	(0.41)	(0.53)	(-0.85)	**(3.47)**	**(2.54)**	(1.15)	(0.76)	**(2.65)**	(1.20)	**(1.92)**	(0.28)	(0.72)	(-0.44)	**(2.88)**	**(2.07)**
(t-1)	-0.0682	-0.0698	-0.0244	-0.0132	**-0.110***	-0.0533	0.0395	0.0821	**0.106***	0.140*	0.0397	0.0478	0.0220	0.0357	0.0493	0.0807	-0.0206	-0.0156
	(-1.08)	(-0.94)	(-0.36)	(-0.16)	**(-1.66)**	(-0.72)	(0.73)	(1.21)	**(1.85)**	(1.87)	(0.74)	(0.69)	(0.52)	(0.67)	(1.09)	(1.40)	(-0.49)	(-0.29)
(t-2)	0.0194	0.0663	-0.0617	-0.0248	-0.0182	-0.0176	0.0476	0.0692	-0.00597	0.0385	0.0928*	0.0600	-0.0657	**-0.115****	**-0.0988****	**-0.118***	-0.0434	-0.0658
	(0.30)	(0.88)	(-0.83)	(-0.29)	(-0.26)	(-0.23)	(0.86)	(1.00)	(-0.10)	(0.48)	(1.68)	(0.82)	(-1.51)	**(-2.11)**	**(-1.98)**	**(-1.91)**	(-0.98)	(-1.17)
(t-3)	-0.0254	-0.0554	-0.00657	-0.00969	0.00881	-0.0468	0.00412	0.0433	-0.0367	-0.0301	-0.0316	0.0162	-0.0151	0.0189	-0.00492	0.0187	0.0300	0.0579
	(-0.39)	(-0.72)	(-0.09)	(-0.11)	(0.13)	(-0.61)	(0.07)	(0.61)	(-0.60)	(-0.38)	(-0.58)	(0.23)	(-0.35)	(0.34)	(-0.10)	(0.30)	(0.69)	(1.05)
(t-4)	-0.0370	0.000608	0.0390	0.0496	-0.0320	-0.00185	-0.0422	-0.125**	-0.0257	0.0148	0.0305	-0.0207	-0.0346	-0.0279	0.0174	0.0138	0.0101	-0.0418
	(-0.63)	(0.01)	(0.57)	(0.65)	(-0.54)	(-0.03)	(-0.84)	(-2.03)	(-0.44)	(0.21)	(0.64)	(-0.35)	(-0.91)	(-0.58)	(0.39)	(0.25)	(0.27)	(-0.93)
N	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
R2																		

Dependent variable: (lending standard component)	Maturity						Margin on average loan						Margin on risky loans					
explanatory variable:	cost of funds		liquidity position		market financing		cost of funds		liquidity position		market financing		cost of funds		liquidity position		market financing	
	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE	GLS	FE
Contemporaneous	**0.113***	0.102	0.0652	0.0534	**0.106***	0.0867	**0.428*****	**0.419*****	**0.382*****	**0.301****	**0.407*****	**0.393*****	**0.277*****	**0.306*****	**0.318*****	**0.286*****	**0.342*****	**0.303*****
	(1.88)	(1.54)	(1.03)	(0.77)	**(1.88)**	(1.45)	**(3.91)**	**(3.55)**	**(3.44)**	**(2.44)**	**(4.19)**	**(3.80)**	**(3.78)**	**(3.99)**	**(4.18)**	**(3.55)**	**(5.39)**	**(4.44)**
(t-1)	-0.0769	-0.102	-0.0507	-0.0750	0.0113	-0.0137	**0.273****	0.180	0.160	0.111	0.139	0.0350	**0.204*****	0.0962	0.0439	-0.00672	-0.0300	-0.0826
	(-1.30)	(-1.49)	(-0.80)	(-1.00)	(0.19)	(-0.20)	**(2.57)**	(1.48)	(1.44)	(0.83)	(1.36)	(0.29)	**(2.89)**	(1.22)	(0.59)	(-0.08)	(-0.45)	(-1.04)
(t-2)	-0.0298	-0.0425	-0.0349	-0.0530	-0.0234	-0.0158	-0.00582	-0.0255	0.120	0.0867	0.157	0.131	0.0131	0.0385	0.0781	0.0914	**0.173****	0.137
	(-0.49)	(-0.61)	(-0.50)	(-0.66)	(-0.37)	(-0.21)	(-0.05)	(-0.21)	(0.99)	(0.61)	(1.46)	(1.02)	(0.18)	(0.48)	(0.96)	(0.98)	**(2.48)**	(1.62)
(t-3)	**-0.116***	**-0.131***	-0.0789	-0.0469	0.0115	0.0153	0.0599	0.0154	-0.117	-0.141	0.0373	0.0396	-0.120	-0.137*	-0.0837	-0.0789	**-0.138****	**-0.139***
	(-1.91)	**(-1.84)**	(-1.15)	(-0.58)	(0.19)	(0.21)	(0.55)	(0.12)	(-0.96)	(-0.98)	(0.35)	(0.32)	(-1.64)	(-1.66)	(-1.04)	(-0.84)	**(-2.01)**	**(-1.69)**
(t-4)	-0.0141	0.00584	-0.0425	-0.0493	-0.0150	0.0211	-0.0399	-0.103	0.0658	-0.0200	0.0404	-0.0232	0.0408	0.0646	0.0325	0.0314	**0.125****	**0.113***
	(-0.25)	(0.09)	(-0.65)	(-0.69)	(-0.27)	(0.36)	(-0.38)	(-0.93)	(0.57)	(-0.16)	(0.42)	(-0.23)	(0.61)	(0.90)	(0.43)	(0.38)	**(2.04)**	**(1.68)**
N	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
R2																		

T statistics in parentheses; * p<0.10, **, p<0.05, *** p<0.01

Note: control variables include housing market prospects (from BLS), demand for mortgage loans (from BLS), real GDP growth, and house price appreciation, and a measure of the yield curve, the inflation rate, and the EONIA. All specifications include country and year fixed effects.

Source: OECD, Haver, and ECB lending Survey, and Staff Calculation.

Table 4. Impact of Balance Sheet Factors on Price and non-Price Components of Lending Standards for Mortgage Loans

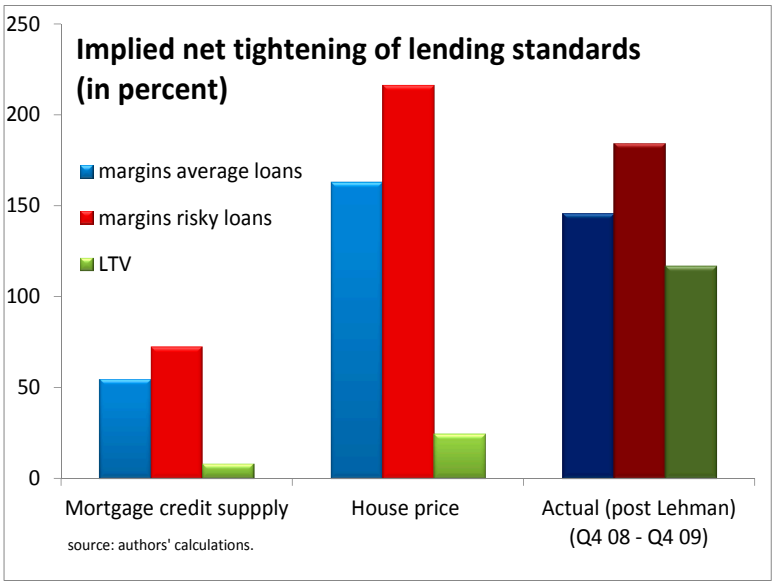
	Loan-to-value ratio									Non-interest costs									Collateral requirements								
	Cost of funds			Liquidity position			Market financing			Cost of funds			Liquidity position			Market financing			Cost of funds			Liquidity position			Market financing		
	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)
Contemporaneous	**0.330****	0.0531	0.235	**0.459****	-0.338	0.0542	0.0350	-0.079	0.176	**0.479*****	0.1	-0.0843	-0.0770	0.253	0.127	**-0.249***	-0.418	**-0.694***	-0.0588	-0.0961	0.0504	0.207	-0.18	-0.25	**0.417****	0.0666	0.147
	(2.33)	(0.23)	(0.92)	**(2.52)**	(-1.24)	(0.18)	(0.24)	(-0.35)	(0.65)	**(3.76)**	(0.39)	(-0.30)	(-0.37)	(1.04)	(0.44)	**(-1.70)**	(-1.46)	**(-1.84)**	(-0.57)	(-0.68)	(0.32)	(1.03)	(-1.04)	(-1.23)	**(2.30)**	(0.58)	(0.91)
(t-1)	0.109	0.394	0.248	0.126	0.328	0.133	0.0135	0.25	0.201	**-0.241***	-0.0468	-0.295	-0.0288	0.0707	0.0803	0.158	-0.0737	-0.0762	**0.328***	-0.129	-0.176	-0.122	0.031	0.0635	-0.106	0.0607	0.0607
	(0.51)	(1.31)	(0.91)	(1.59)	(0.90)	(0.40)	(0.26)	(0.98)	(0.79)	**(-1.85)**	(-0.19)	(-1.07)	(-0.11)	(0.21)	(0.24)	(0.77)	(-0.35)	(-0.31)	**(1.93)**	(-0.83)	(-1.36)	(-0.76)	(0.16)	(0.33)	(-0.43)	(0.41)	(0.40)
(t-2)	-0.00548	-0.11	-0.312	-0.153	-0.367	-0.443	-0.222	-0.163	-0.195	0.167	**0.440****	0.389	**0.341*****	0.212	0.357	0.126	0.251	0.308	**-0.221***	-0.0975	-0.222	-0.231	-0.176	-0.233	-0.216	-0.169	-0.156
	(-0.03)	(-0.46)	(-1.30)	(-0.64)	(-1.07)	(-1.25)	(-1.41)	(-0.77)	(-0.89)	(0.66)	(2.15)	(1.37)	**(3.06)**	(0.88)	(1.22)	(0.75)	(1.25)	(1.35)	**(-1.81)**	(-0.79)	(-1.60)	(-1.44)	(-1.10)	(-1.34)	(-1.57)	(-1.54)	(-1.40)
(t-3)	-0.136	-0.247	-0.330*	0.0456	-0.0353	-0.0516	0.0470	-0.23	-0.246	0.0792	**0.563****	0.436	0.118	0.0784	0.0627	0.139*	**0.448***	**0.460****	-0.0376	0.0933	0.0165	0.331	0.139	0.106	0.435	0.145	0.157
	(-0.56)	(-1.33)	(-1.65)	(0.29)	(-0.18)	(-0.25)	(0.31)	(-1.27)	(-1.44)	(0.55)	**-2.05**	-1.59	(1.05)	(0.30)	(0.24)	(1.65)	(1.96)	**(2.08)**	(-0.31)	(0.61)	(0.09)	(0.80)	(0.77)	(0.53)	(1.58)	(1.00)	(0.97)
(t-4)	0.0831	0.161	0.187	**0.200****	0.175	0.245	0.0242	0.0715	0.125	-0.137	-0.28	-0.366*	-0.0344	0.0387	0.00111	0.0731	0.0209	-0.0402	0.172	0.117	0.0692	-0.0656	-0.0904	-0.0951	-0.128	-0.0368	0.0132
	(0.40)	(0.97)	(1.03)	**(2.50)**	(0.89)	(1.10)	(0.21)	(0.56)	(0.87)	(-0.86)	(-1.40)	(-1.77)	(-0.30)	(0.17)	0.00	(1.43)	(0.13)	(-0.24)	(1.08)	(0.99)	(0.56)	(-0.29)	(-0.70)	(-0.66)	(-0.65)	(-0.40)	(0.12)
Country FE	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276
Specification tests																											
Arellano-Bond test for AR(1) (p v	0.060			0.068			0.097			0.025			0.080			0.058			0.008			0.05			0.085		
Arellano-Bond test for AR(2) (p v	0.131			0.098			0.025			0.827			0.980			0.4			0.053			0.736			0.276		
Sargan test (p value)	0.596			0.256			0.52			0.463			0.879			0.837			0.178			0.833			0.441		
Hansen test (v value)		0.5522	0.7587		0.4719	0.5621		0.4412	0.6217		0.6535	0.3647		0.4112	0.2958		0.8875	0.8904		0.1971	0.146		0.3259	0.3598		0.2559	0.4107
Anderson-Rubin Wald test (p val)		0	0		0	0		0	0		0.0167	0		0.0167	0		0	0		0	0		0	0		0	0

	Maturity									Margin on average loans									Margin on risky loans								
	Cost of funds			Liquidity position			Market financing			Cost of funds			Liquidity position			Market financing			Cost of funds			Liquidity position			Market financing		
	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)	diff. GMM	IV (1)	IV (2)
Contemporaneous	**0.192***	-0.1	-0.204	**0.132****	0.0101	**-0.489***	0.0109	0.0104	-0.284	**0.728*****	-0.108	-0.255	0.324	-0.316	-0.0573	**0.487*****	-0.273	-0.001	**0.638****	0.103	0.234	**0.552****	-0.183	0.18	0.177	-0.0665	0.275
	(1.74)	(-0.52)	(-0.99)	**(2.00)**	(0.05)	**(-1.66)**	(0.06)	(0.06)	(-1.18)	**(4.10)**	(-0.31)	(-0.72)	(1.18)	(-0.86)	(-0.14)	**(4.99)**	(-0.90)	(-0.00)	**(2.48)**	(-0.56	-1.31	**(2.09)**	(-0.65)	-0.58	(0.59)	(-0.36)	(1.29)
(t-1)	**0.306***	0.00633	-0.0806	-0.0742	-0.014	0.197	-0.153	0.00932	0.0353	**0.585***	**0.680***	0.418	0.128	0.263	0.195	0.276	0.0927	-0.0061	**0.276***	**0.450****	0.295	0.189	0.216	0.0467	-0.0233	-0.0115	-0.0803
	(1.78)	(0.03)	(-0.33)	(-0.79)	(-0.06)	(0.89)	(-1.16)	(0.05)	(0.20)	**(1.76)**	**-1.92**	(1.04)	(0.54)	(0.71)	(0.48)	(1.46)	(0.33)	(-0.02)	**(1.76)**	**(2.18)**	(1.45)	(0.99)	-0.68	-0.14	(-0.14)	(-0.07)	(-0.44)
(t-2)	0.0283	-0.0665	-0.108	-0.0555	-0.0679	0.00426	0.0284	0.2	0.243	0.370	0.359	0.288	**0.892***	**0.859****	**1.016****	0.314	0.313	0.283	**0.308***	-0.0231	-0.226	**0.211***	0.178	0.162	-0.0978	0.201	0.127
	(0.22)	(-0.31)	(-0.44)	(-0.31)	(-0.41)	(0.02)	(0.11)	(1.30)	(1.31)	(1.30)	(1.19)	(0.81)	**(1.81)**	**(2.33)**	**(2.43)**	(1.35)	(0.83)	(0.82)	**(1.73)**	(-0.12)	(-1.24)	**(1.62)**	-0.52	-0.49	(-0.58)	(0.84)	(0.53)
(t-3)	-0.0294	**-0.669*****	**-0.735*****	0.209	-0.318	-0.374	0.219	-0.34	-0.362	0.236	0.325	0.191	**0.805****	-0.55	-0.473	0.0649	0.341	0.21	0.0568	-0.0861	-0.186	0.222	-0.175	-0.146	-0.0703	-0.202	-0.236
	(-0.12)	**(-2.99)**	**(-3.15)**	(1.23)	(-1.21)	(-1.28)	(1.05)	(-1.51)	(-1.38)	(0.74)	(0.77)	(0.44)	**(2.20)**	(-1.64)	(-1.27)	(0.34)	(0.85)	(0.53)	(0.31)	(-0.44)	(-0.94)	(1.11)	(-0.73)	(-0.60)	(-0.32)	(-0.95)	(-1.15)
(t-4)	0.00996	0.155	0.125	-0.0128	0.103	0.0562	-0.0215	0.214*	0.164	**0.221***	0.237	0.194	-0.166	0.339	0.438	0.201	0.147	0.163	**0.314*****	**0.469*****	**0.461*****	**0.297*****	**0.404****	**0.469****	**0.301****	**0.404*****	**0.438*****
	(0.07)	(1.00)	(0.77)	(-0.11)	(0.44)	(0.22)	(-0.22)	(1.72)	(1.16)	**(1.74)**	(0.77)	(0.60)	(-0.68)	(0.92)	(1.14)	(1.07)	(0.49)	(0.55)	**(7.65)**	**(3.06)**	**(2.83)**	**(2.63)**	**(2.10)**	**(2.09)**	**(2.30)**	**(2.71)**	**(2.77)**
Country FE	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276	270	276	276
Specification tests																											
Arellano-Bond test for AR(1) (p v	0.041			0.024			0.014			0.045			0.019			0.064			0.024			0.045			0.049		
Arellano-Bond test for AR(2) (p v	0.875			0.725			0.961			0.308			0.584			0.771			0.537			0.896			0.376		
Sargan test (p value)	0.119			0.429			0.794			0.216			0.352			0.367			0.632			0.952			0.685		
Hansen test (v value)		0.1356	0.5474		0.0444	0.5491		0.014	0.1327		0.1263	0.092		0.0748	0.4399		0.2344	0.1764		0.1503	0.1741		0.1067	0.1417		0.2976	0.1952
Anderson-Rubin Wald test (p val)		0	0		0	0		0	0		0	0		0	0		0	0		0	0		0	0		0	0

T statistics in parentheses; * p<0.10, **, p<0.05, *** p<0.01

Note: control variables include housing market prospects (from BLS), demand for mortgage loans (from BLS), real GDP growth, and house price appreciation, and a measure of the yield curve, the inflation rate, and the EONIA. In the GMM regressions, instruments include in the 2SLS regression, instruments include lags 1 to 6 of the growth rates of US and UK banks' claims on the banks of the euro area country considered.

Source: OECD, Haver, and ECB lending Survey, and Staff Calculation.



To quantify the size of these effects of balance sheet factors on each dimension of lending standards, we compute the net tightening of lending standards implied by increase in costs of funds to reduce mortgage credit or house price appreciation by 10 percentage points. Here we do not attempt to address potential asymmetry of such tightening effect depending on the level of lending conditions as our approaches focuses on the impact of changes in lending standards on credit growth and house price appreciation. In other words, tightening effect on mortgage loan growth in an already tight lending environment may differ from a loose lending environment. We focus on margins on average loans, margins on risky loans and LTVs, using the GLS estimates of table 3. The text figures shows the quantification of these effects. The implications are very clear. While margins on average loans and on risky loans respond very strongly to changes in the cost of capital, there is very little pass-through to LTVs imposed by the banks. These findings, joint with those of the previous section, imply that changes in the cost of capital seem to affect mortgage loan growth mainly through changes in banks' price margins. Looking at the actual net tightening that took place in the year following the start of the global financial crisis, we see that lending standards related to price margins were tightened much more than required to reduced credit growth by 10 percent. But it is also striking to notice that the tightening of LTVs was also very large. This suggests that other factors than shocks to bank liabilities impacted LTVs offered by banks during the crisis. If banks endogenously adjust mostly through margins while other dimensions of lending standards are somewhat less affected by shocks to bank liabilities, there remains scope for additional policies (such as limits on LTV) to complement any policies targeted at the liabilities of banks. Lending standards and mortgage credit growth.

We now turn to assessing which dimensions of lending standards are more likely to be associated with credit volumes (equation (2) and house prices (equation (4)).

Table 5 reports the credit growth regressions in which each component of lending standards is entered as an explanatory variable one at a time. A net tightening of margins on average loans and on risky loans are significantly and negatively associated with mortgage credit growth after two to four quarters. The estimated coefficient suggests that tightening margins has economically significant impacts on credit growth, because it implies that a 100 percent net tightening of margins on risky loans would result in a decline of credit growth of about to 7 percentage points after four quarters. And an increase in the net proportion of banks reporting a tightening of the loan-to-value ratio or a tightening of mortgage fees is also negatively associated with mortgage loan growth after four quarter. This is a particularly interesting finding

because it tends to suggest that policies targeted at setting a maximum LTV would be effective at limiting the supply of mortgage credit. Moreover, since most of the effects of balance sheet constraints seem to be transmitted through interest rate margins on risky and average loans, as uncovered in the previous section, it seems that policies focused on the cost of capital, market financing or liquidity position of banks could be complemented by policies focused on non-price dimensions of mortgage loans such as LTVs. Also, changes in lending standards also seem to be transmitted to house price appreciation as suggested by the findings reported in Table 6.

Table 5. Lending Standards and Mortgage Loan Growth

Dependent variable :	**Mortgage loan Growth**								
Determinant of LS:	**Loan-to-value ratio**			**Non-interest costs**			**Collateral requirements**		
	GLS	FE	diff GMM	GLS	FE	diff GMM	GLS	FE	diff GMM
Contemporaneous	0.00279	0.0167	0.0110	**-0.0162***	**-0.0189***	**-0.0181**	0.0130	0.0300*	0.0242
	(0.34)	(1.38)	(1.31)	**(-1.72)**	**(-1.60)**	**(-1.59)**	(1.16)	(1.73)	(1.51)
(t-1)	-0.00737	-0.00973	-0.00572	0.00691	0.0102	-0.0138	-0.00783	0.00188	0.000248
	(-0.94)	(-0.86)	(-0.40)	(0.78)	(0.83)	(-0.91)	(-0.76)	(0.11)	(0.01)
(t-2)	-0.00479	0.00144	**-0.0226***	0.00744	0.0108	0.0259	-0.00865	-0.0158	-0.0238
	(-0.61)	(0.13)	**(-1.90)**	(0.84)	(0.87)	(1.11)	(-0.79)	(-0.92)	(-1.29)
(t-3)	0.00291	0.00566	-0.00425	-0.00259	-0.00123	-0.00394	-0.00397	-0.00735	-0.0395
	(0.38)	(0.51)	(-0.35)	(-0.30)	(-0.10)	(-0.26)	(-0.40)	(-0.46)	(-1.47)
(t-4)	**-0.0132***	**-0.0163***	0.00211	**-0.0188****	**-0.0301*****	-0.00793	-0.0139	-0.00249	-0.00873
	(-1.84)	(-1.62)	(0.09)	**(-2.26)**	**(-2.63)**	(-0.51)	(-1.49)	(-0.16)	(-0.37)
	Maturity			**Margin on Average Loans**			**Margin on Risky Loans**		
	GLS	FE	diff GMM	GLS	FE	diff GMM	GLS	FE	diff GMM
Contemporaneous	**0.0147***	**0.0311****	**0.0317***	0.00519	0.00124	-0.00222	0.00199	0.00326	0.00480
	(1.65)	**(2.46)**	**(1.66)**	(1.04)	(0.17)	(-0.20)	(0.26)	(0.30)	(0.34)
(t-1)	-0.00959	-0.0160	-0.0208	0.00286	0.00528	0.0151	-0.00334	-0.00808	**-0.0358****
	(-1.12)	(-1.27)	(-1.56)	(0.54)	(0.67)	(0.76)	(-0.45)	(-0.71)	**(-2.02)**
(t-2)	0.00549	0.0125	**-0.0199****	-0.00691	**-0.0162****	**-0.0315*****	**-0.0176****	**-0.0228***	**-0.0407****
	(0.63)	(0.97)	**(-2.08)**	(-1.33)	**(-2.06)**	**(-3.98)**	**(-2.23)**	**(-1.95)**	**(-2.01)**
(t-3)	-0.00115	0.00737	-0.0114	0.00578	0.00786	-0.0143	0.000404	0.00435	0.00407
	(-0.13)	(0.57)	(-1.10)	(1.14)	(0.99)	(-1.48)	(0.06)	(0.39)	(0.22)
(t-4)	-0.000670	0.0144	0.00590	**-0.00706**	**-0.0119***	**-0.0110**	**-0.0133****	**-0.0195***	**-0.0292***
	(-0.08)	(1.16)	(0.20)	**(-1.58)**	**(-1.76)**	**(-1.59)**	**(-2.01)**	**(-1.89)**	**(-1.84)**

T statistics in parentheses; * p<0.10, **, p<0.05, *** p<0.01

Note: control variables include housing market prospects (from BLS), demand for mortgage loans (from BLS), real GDP growth, household debt/GDP, and house price appreciation, a measure of the yield curve, the inflation rate, and the EONIA. In the GMM regressions, instruments include in the 2SLS regressions, instruments include lags 1 to 6 of the growth rates of US and UK banks' claims on the banks of the euro area country considered.

Source: OECD, Haver, and ECB lending Survey, and Staff Calculation.

Table 6. Lending Standards and House Price Appreciation

Dependent variable :	House Price Appreciation								
Determinant of LS:	**Loan-to-value ratio**			**Non-interest costs**			**Collateral requirements**		
	GLS	FE	diff GMM	GLS	FE	diff GMM	GLS	FE	diff GMM
Contemporaneous	0.00279	0.0167	-0.00796	0.000652	-0.0000528	-0.00522	-0.00894	**-0.0278*** **	**-0.0259***
	(0.34)	(1.38)	(-0.78)	(0.12)	(-0.01)	(-0.37)	(-1.18)	**(-2.77)**	**(-1.86)**
(t-1)	-0.00737	-0.00973	0.00603	-0.00121	0.00216	-0.00565	-0.0103	-0.00285	**-0.0304** **
	(-0.94)	(-0.86)	(0.44)	(-0.24)	(0.29)	(-0.64)	(-1.43)	(-0.30)	**(-2.32)**
(t-2)	-0.00479	0.00144	0.000635	-0.00108	0.00268	-0.00253	**0.0130***	**0.0333*** **	0.0110
	(-0.61)	(0.13)	(0.09)	(-0.21)	(0.35)	(-0.24)	**(1.71)**	**(3.39)**	(0.75)
(t-3)	0.00291	0.00566	0.00180	0.00358	0.00591	-0.00667	-0.00617	-0.000288	-0.0105
	(0.38)	(0.51)	(0.28)	(0.73)	(0.79)	(-0.71)	(-0.86)	(-0.03)	(-1.25)
(t-4)	**-0.0132***	**-0.0163***	**-0.0231** **	-0.00291	-0.000917	-0.00914	-0.000116	0.000774	-0.0103
	(-1.84)	**(-1.62)**	**(-2.11)**	(-0.60)	(-0.13)	(-0.98)	(-0.02)	(0.09)	(-0.56)
	Maturity			**Margin on Average Loans**			**Margin on Risky Loans**		
	GLS	FE	diff GMM	GLS	FE	diff GMM	GLS	FE	diff GMM
Contemporaneous	-0.00414	0.00427	-0.0140	0.00324	0.00596	0.00105	0.00132	0.000594	-0.00572
	(-0.82)	(0.55)	(-0.90)	(1.15)	(1.39)	(0.17)	(0.30)	(0.09)	(-0.52)
(t-1)	0.00392	0.00706	-0.0193	-0.00351	-0.00489	**-0.0178** **	-0.00422	-0.000208	-0.0182
	(0.81)	(0.91)	(-1.40)	(-1.18)	(-1.04)	**(-2.25)**	(-1.02)	(-0.03)	(-1.45)
(t-2)	0.00278		-0.0160	0.00407	0.0109**	-0.000314	0.00169	**0.0148** **	-0.0000636
	(0.58)	(1.04)	(-1.34)	(1.40)	(2.35)	(-0.05)	(0.40)	**(2.08)**	(-0.01)
(t-3)	-0.00685	-0.00120	-0.0117	-0.00143	0.00404	-0.00150	-0.00200	0.000414	-0.00441
	(-1.47)	(-0.15)	(-1.05)	(-0.50)	(0.86)	(-0.35)	(-0.51)	(0.06)	(-0.57)
(t-4)	0.000719	0.00582	-0.00547	-0.00131	-0.00153	**-0.00918***	-0.00334	**-0.00378**	-0.0112
	(0.15)	(0.77)	(-0.41)	(-0.48)	(-0.38)	**(-1.70)**	(-0.88)	**(-0.60)**	(-1.03)

T statistics in parentheses; * p<0.10, **, p<0.05, *** p<0.01

Note: control variables include housing market prospects (from BLS), demand for mortgage loans (from BLS), real GDP growth, household debt/GDP, and house price appreciation, a measure of the yield curve, the inflation rate, and the EONIA. In the GMM regressions, instruments include in the 2SLS regressions, instruments include lags 1 to 6 of the growth rates of US and UK banks' claims on the banks of the euro area country considered.

Source: OECD, Haver, and ECB lending Survey, and Staff Calculation.

C. Interactions Between Monetary Policy and LTV Set by the Banking System

In table 7, we explore potential interactions between the monetary stance and lending standard with respect to LTVs. The monetary policy stance is measured by the difference between a fictitious country specific interest rate implied by a Taylor rule and the EONIA rate. Monetary policy shocks are transmitted through banks by changes in the costs of liabilities. As we have shown, the latter seem to impact lending standards mainly through price margins. This suggests that we can now empirically assess how the monetary policy channels of transmission interact with LTVs and affect credit growth or house prices. We interact the "gap" in the monetary policy

stance and the change of bank's lending standards through loan-to-value ratio. Our results imply that LTV limits tend to be more effective in containing credit growth and housing price appreciation when monetary policy is loose. Conversely, a monetary policy stance that is loose will have a greater impact on credit growth and house prices if LTVs are also being relaxed, as happened in euro area periphery countries before the crisis.

Table 7. Interaction Between Monetary Policy and Lending Standards

Dependent variable:	Mortgage loan growth			House price appreciation		
Determinant of LS:	GLS	FE	diff GMM	GLS	FE	diff GMM
Loan-to-Value Ratio						
Contemporaneous	-0.000886 (-0.09)	-0.00702 (-0.49)	-0.0115 (-0.69)	0.00368 (0.49)	0.00643 (0.56)	0.0113 (1.50)
(t-1)	0.00839 (0.85)	0.00914 (0.57)	-0.00282 (-0.14)	**-0.0124*** **(-1.60)**	**-0.0215*** **(-1.70)**	-0.0225 (-1.21)
(t-2)	**0.0203**** **(2.04)**	0.0193 (1.17)	-0.00329 (-0.18)	0.00534 (0.64)	0.0202 -1.54	0.00611 -0.23
(t-3)	0.00480 (0.46)	-0.0223 (-1.33)	-0.0103 (-0.72)	0.00238 (0.28)	0.00127 -0.09	**-0.0144*** **(-1.90)**
(t-4)	0.00630 (0.64)	**0.0304*** **(1.96)**	0.0454 (1.41)	-0.00748 (-0.88)	-0.0104 (-0.84)	-0.0187 (-1.07)
Implied Policy Rate minus EONIA Gap						
Contemporaneous	**0.335**** **(2.48)**	0.195 (0.90)	-0.0587 (-0.22)	-0.0111 (-0.09)	-0.119 (-0.67)	0.101 (0.41)
(t-1)	-0.0119 (-0.07)	0.0660 (0.24)	-0.201 (-0.60)	-0.0168 (-0.11)	-0.129 (-0.57)	-0.0316 (-0.20)
(t-2)	-0.0679 (-0.46)	**-0.421*** **(-1.83)**	0.0441 (0.18)	0.139 (1.08)	0.208 (1.14)	**0.310*** **(1.86)**
(t-3)	**0.275*** **(1.71)**	**0.391*** **(1.62)**	0.321 (1.46)	-0.00434 (-0.03)	-0.0879 (-0.46)	0.0240 (0.08)
(t-4)	**-0.252*** **(-1.68)**	-0.234 (0.66)	0.116 (0.33)	0.0988 (0.74)	0.263 (1.56)	**0.537*** **(1.67)**
Interaction: Monetary Policy and LTV						
Contemporaneous	0.000178 (0.06)	0.00265 (0.66)	0.000203 (0.05)	-0.00158 (-0.71)	-0.00345 (-1.08)	**-0.00603*** **(-1.57)**
(t-1)	**-0.0101***** **(-2.71)**	**0.0121**** **(-2.15)**	**-0.0104*** **(-1.83)**	0.00357 (1.23)	0.00513 (1.15)	0.000967 (0.21)
(t-2)	-0.00366 (-0.96)	-0.00334 (-0.58)	-0.0107 (-1.20)	-0.00228 (-0.75)	**-0.00696*** **(-1.51)**	-0.00624 (-0.92)
(t-3)	0.00308 (0.73)	**0.0116*** **(1.84)**	0.00669 (1.25)	-0.00222 (-0.64)	-0.00191 (-0.37)	0.00491 (1.29)
(t-4)	-0.00464 (-1.06)	**-0.0154**** **(-2.43)**	-0.00931 (-1.12)	0.000306 (0.08)	0.000924 (0.18)	0.00263 (0.49)

T statistics in parentheses; * p<0.10, **, p<0.05, *** p<0.01

Note: control variables include housing market prospects (from the BLS), demand for mortgage loans (from BLS), household debt to GDP, house price appreciation (in mortgage loan growth regressions only), real GDP growth, a measure of the yield curve, the inflation rate and the EONIA. GMM regressions include a lagged dependent variable. Difference GMM includes as instruments.

Source: OECD, Haver, and ECB lending Survey, and Staff Calculation.

D. Evidence from Panel VARs

We examine the persistence and dynamics of the effect of changes in lending standards by applying a panel vector autoregression model as developed by Love and Zicchino (2006). This methodology combines the traditional VAR approach with the panel-data approach, allowing for both endogeneity and unobserved individual heterogeneity. However, in contrast to the GMM and IV estimators of the previous sections, it does not allow to address endogeneity issues. We specify a first order VAR model as follows:

$$z_{it} = \Gamma_0 + \Gamma_1 z_{it-1} + f_{it} + e_{t-1} \qquad (6)$$

where z_{it} is either a vector of {GHP, GHHMortL, Q2Cost, EONIA}or a vector {GHP, GGDP, Q9HPLTV, EONIA}. GHHMortL is the quarterly percentage change of household mortgage loan; GHP is the quarterly house price appreciation; Q2Cost is change of costs related to bank's capital position; monetary policy stance is proxied by EONIA. The second model tests the effectiveness of LTV measure, where we substitute Q2Cost by Q9HPLTV which is change of loan supply measured changes of LTV ratios – positive numbers represent tightening of LTV standard.

The impulse-response functions show the dynamics of one variable in response to the shock from another variable, which decompose the error terms into orthogonal shocks. The conventional approach is to adopt a particular ordering and allocate any correlation between the residuals of any two elements to the variable that comes first in the ordering. The identifying assumption is that the variables that come earlier in the ordering affect the following variables contemporaneously, as well as with a lag, while the variables that come later affect the previous variables only with a lag. In other words, the variables that appear earlier in the systems are more exogenous and the ones that appear later are more endogenous.

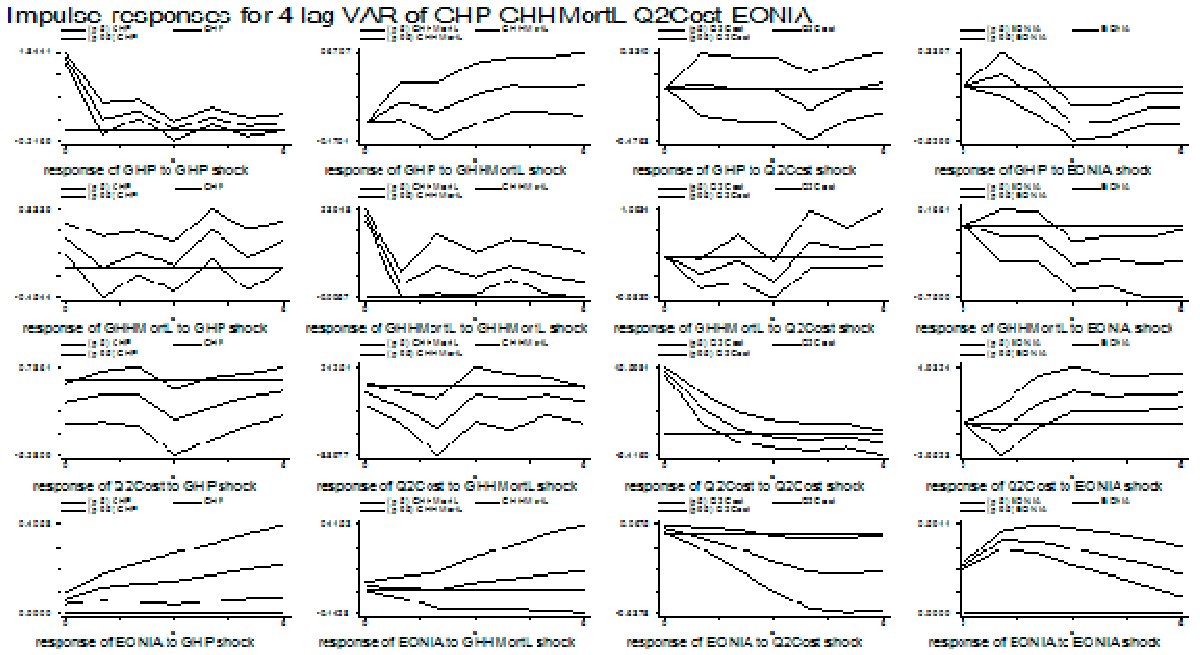
In our specification, we assume the monetary policy to be exogenous with lagged effect on the change in lending standards measured by LTV ratios or costs related to banks' capital position, growth of mortgage loans and house price appreciation. Tighter monetary policy stance increases banks' funding costs which lowers banks' incentive to lend, which is normally reflected as higher lending rates or tighter lending standards. Banks may also tighten lending standards as an independent decision instead of being endogenously affected by higher interest rates. Both lending rates and lending standards could potentially affect house prices and mortgage loan growth.

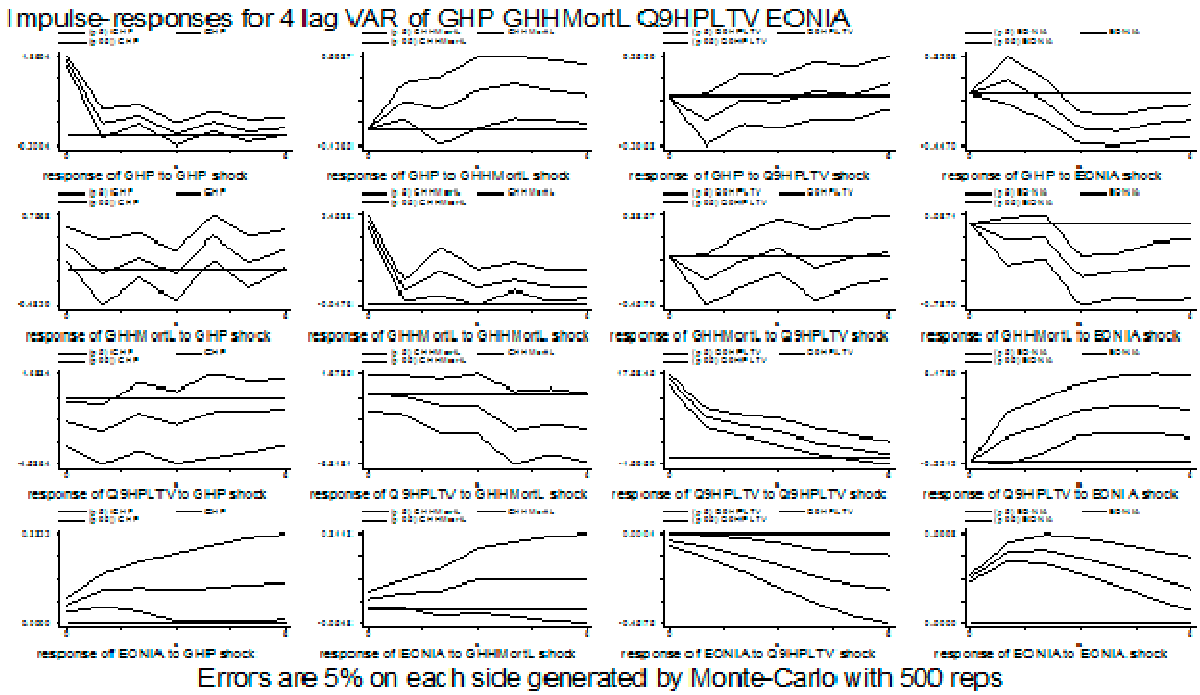
To apply the VAR procedure in the panel data setting, one needs to impose the restriction that the underlying structure is the same for each cross-sectional unit. Yet this constraint is likely to be violated in practice. One could allow for "individual heterogeneity" in the levels of the variables by introducing fixed effects, denoted by f_{it} in the model. Since the fixed effects are correlated with the regressors due to lags of the dependent variables, the mean-differencing procedure commonly used to eliminate fixed effects would create biased coefficients. To avoid this problem, 'Helmert procedure' is used (see Arellano and Bover, 1995). This transformation

preserves the orthogonality between transformed variables and lagged regressors, so we can use lagged regressors as instruments and estimate the coefficients by system GMM.

We present the impulse-response functions in both tables and graphs (Figure 4) with 4 lags (consistent with the regression approach) and 5 percent error bands generated by Monte Carlo simulation. We observe that first of all, responses of monetary policy has large direct impact on house price appreciation and mortgage loan growth, but the effect is delayed to the third quarter. In addition to direct effect, monetary policy also has indirect impact on mortgage credit and house prices through impact on macroprudential policies/or non-price lending standards. This is evident both in the case of LTV limits and costs related to capital position. Direct impact of LTV limits on house price appreciation and mortgage loan growth is significant and complements monetary policy but is relatively short-lived. Yet the direct impact of changes in banks' capital position is significant, immediate and persistent (first and third quarter). Lastly, higher mortgage loan growth drive house prices higher but not vice versa.

Figure 4. Impulse-Responses of the Panel VAR Analysis





Source: OECD, Haver, and ECB lending Survey, and Staff Calculation.

V. CONCLUSIONS

In this paper, we developed an analytical framework using bank lending survey data to investigate the effectiveness of macroprudential measures in containing housing booms, the channels of transmission of such measures and their interaction with monetary policy. We focus on the euro area countries where econometric analysis of macroprudential policies has remained relatively limited. Our findings suggest that macro-prudential instruments targeting the cost of bank capital would be effective in slowing down mortgage credit growth, and given similar channels of transmission, would reinforce the impact of monetary policy tightening. Limits on loan-to-value ratios are also effective in containing housing booms, especially when monetary policy is excessively loose, and can therefore complement macro-prudential instruments affecting the cost of bank capital. Their impact is transmitted mainly through price margins--the same banking channel as monetary policy. For future research, enhancing data on direct measures of macroprudential policies rather than using proxies can help improve identification. Before such data becomes available, our analytical approach can be extended to investigate effectiveness of macroprudential policies in other regions, or more broadly the financial cycle, rather than limited to the housing market.

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