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Reusens, P.

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Mortgage market flexibility and the transmission of house price shocks: a multi-country study

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Peter Reusens[a]

[a] *Faculty of Economics and Business, KU Leuven, Belgium*

Abstract

This paper assesses how the degree of the mortgage market flexibility alters the effect of a residential house price shock on household credit and GDP. We estimate a panel vector autoregression model for a sample of 16 OECD countries for the period 1985Q1-2012Q4 and we identify a house price shock as an increase in the innovation term of house prices unrelated to the contemporaneous changes in output and inflation. Our results do not support the hypothesis of a stronger household credit and GDP response to a house price shock in countries with a more flexible mortgage market.

Keywords: Household credit, house prices, mortgage market flexibility, panel vector autoregression
JEL: C32, C33, E02, E21, E44, E51, G21, R21, R31

1. Introduction

The recent great financial crisis has illustrated the devastating impact that large negative house price shocks can have on the credit availability and household consumption in many countries. Subsequently, the role of house prices in the macro-economy has been investigated intensively during the last decade (Muellbauer and Murphy, 2008).

Recently, there is increased attention for the question to which extent the impact of residential house price shocks on household credit and GDP is stronger for countries with a more flexible mortgage market, characterized by mortgages with a high loan to value ratio (LTV), low transaction costs of mortgage refinancing, and access to second mortgages and home equity loans. Differences in the macroeconomic effects of house price shocks are expected to arise since an illiberal mortgage market largely turns off several of the transmission channels for both existing home owners and future first time buyers.

Email address: peter.reusens@kuleuven.be (Peter Reusens)

For existing home owners, the financial accelerator mechanism is stronger for countries with a flexible mortgage market because the increased value of housing can be readily used as improved collateral for additional borrowing for housing and non-housing consumption through home equity release products such as home equity loans, second mortgages and refinancing of the existing mortgage with a higher principal (Calza *et al.*, 2013; Cardarelli *et al.*, 2008; Klyuev and Mills, 2007; Muellbauer and Murphy, 2008). First, lower transaction costs of mortgage refinancing and easy accessible second mortgages and home equity loans make it more appealing for households to obtain such additional borrowing (Klyuev and Mills, 2007). Indeed, using a general equilibrium model with borrowing constraints and transaction costs of the home equity release products, Aoki *et al.* (2004) show that the consumption response to higher house prices is larger when these transaction costs of additional borrowing against housing equity are small. Likewise, also Muellbauer (2015) states that the strength of this financial accelerator mechanism greatly depends on the availability of home equity loans. Second, given that the loan to value ratio (LTV) can be interpreted as the fraction of the housing value that can be used as collateral, borrowing constrained consumers in high LTV countries can use a larger fraction of the house price increase as collateral for obtaining new loans, compared to consumers in low LTV countries. Using a general equilibrium model with housing collateral and a borrowing constraint proportional to the product of the expected house price and the loan to value ratio, Calza *et al.* (2013), Cardarelli *et al.* (2008), Iacoviello (2005) and Iacoviello and Neri (2010) show that rising (declining) house prices relax (constrain) the borrowing constraints more when the typical loan to value ratio of mortgages is high.

Also for future first time buyers, the effect of increased house prices on the amount of household credit and consumption is stronger for countries with a flexible mortgage market. First, in an illiberal credit market with a low typical loan to value ratio, higher house prices imply that future first time buyers need to save much more for the purchase of their first home and therefore largely reduce their current consumption expenditures and associated consumption credit. For the same increase in house prices in a more liberal credit market with a higher typical loan to value ratio, less additional saving is required. Second, higher house prices imply that future first time buyers need a larger loan for the financing of the purchase of a house that became more expensive (Anundsen and Jansen, 2013; Davis and Zhu, 2011). Compared to low LTV countries, banks in high LTV countries are more inclined to accommodate a large part of this increased credit demand, because a larger part of the house price increase can be used as collateral.

This paper investigates how the effect of a residential house price shock on both household credit and GDP is influenced by the degree of the mortgage market flexibility. For this end, we split our

sample of 16 OECD countries into a 'flexible mortgage market group' and an 'inflexible mortgage market group'. We then estimate a five variable panel vector autoregression (VAR) model for each group of countries using the mean group estimator proposed by Pesaran and Smith (1995). In contrast to Calza *et al.* (2013), who analyzes the impact of the degree of the mortgage market flexibility on the effects of a monetary policy shock, we analyze its impact on the effects of an exogenous house price shock, which we identify as an increase in the innovation term of house prices unrelated to the contemporaneous changes in output and inflation. Our main result is that we do not find supporting empirical evidence that the household credit or GDP responses to a house price shock are statistically or economically different between countries with respectively a flexible and inflexible mortgage market. This result indicates that the financial accelerator mechanism and the effects on future first time buyers are not substantially stronger in these countries.

Our paper is organized as follows. Section 2 discusses the literature on both the empirical evidence and transmission channels of the effect of a house price shock on credit and GDP. Section 3 presents the panel vector autoregression model. Section 4 discusses the data and the results are presented in Section 5. Finally, Section 6 concludes our findings.

2. Literature review on the macroeconomic effects of a house price shock

This section gives a broad literature overview on both the empirical evidence and transmission channels of the effect of a house price shock on credit and GDP. As elaborated above, our paper contributes to this line of research by investigating how the degree of mortgage market flexibility alters the effect of a residential house price shock on household credit and GDP.

A large number of empirical papers has established a positive credit and GDP response to a house price shock in industrialized countries. Estimating a panel vector autoregression model in growth rates for 16 industrialized countries for the period 1970-2006,Goodhart and Hofmann (2008) find that a house price shock leads to an increase in both credit and GDP. Estimating a panel vector autoregression model in levels for 16 OECD countries for the period 1986-2006, also Assenmacher-Wesche and Gerlach (2008) report a positive and statistically significant credit and GDP response to a house price shock. Next, Hofmann (2003) estimates error correction models for 20 industrialized countries separately and he finds both a short term and a long term causality relationship going from house prices to credit. Estimating VECM models for 16 industrialized countries separately, Hofmann (2004) report a significant, persistent and positive credit response to a property price shock for most countries. Finally, estimating a VECM model for respectively Greece and Hong Kong, both

Brissimis and Vlassopoulos (2009) and Gerlach and Peng (2005) find a long term and short term causality relationship running from house prices to credit.

These empirical findings on the macroeconomic effects of house price shocks can be explained by well known transmission channels. First, a financial accelerator mechanism exists for existing home owners, both for household spending, as in Aoki *et al.* (2004) and Iacoviello (2005), and for firm investment, as in Bernanke *et al.* (1999). In particular, rising house prices improve the collateral of both households and firms and therefore reduce their external finance premium, which makes banks more willing to extend credit to these more creditworthy households and firms for the financing of additional housing and non-housing consumption and investment.

Second, rising house prices also improve the balance sheet of the banks themselves, as both their own properties rise in value and their outstanding loans become more creditworthy through better collateral (Davis and Zhu, 2011; Hofmann, 2003; Goodhart and Hofmann, 2008). This improves the value of the banks' equity and lowers their leverage, which stimulates banks to issue more loans (Adrian and Shin, 2010).

Third, rising house prices imply that first time buyers need to take out a larger loan to finance the purchase of a house that became more expensive, which leads to a higher demand for household credit (Anundsen and Jansen, 2013; Davis and Zhu, 2011). However, higher house prices also imply that borrowing constrained future potential first time buyers need to save a larger fraction of their current income to finance their future house acquisition, restricting their current consumption and the associated demand for consumption credit (Muellbauer, 2007).

Fourth, Goodhart and Hofmann (2008) argue that rising house prices make households feel richer. Consequently, these households desire to consume part of their perceived wealth increase, which leads to an increased demand for household credit to finance this additional consumption. However, Aoki *et al.* (2004), Buiter (2008), Muellbauer (2007) and Price (2008) question this wealth effect and they argue that the aggregate wealth is invariant to increases in the fundamental value of house prices, because these go along with increases in future rents. Subsequently, they state that there is only a redistributive effect from, on the one hand, tenants and owner-occupiers that will increase their future demand for housing services to, on the other hand, landlords and owner-occupiers that will reduce their future demand for housing services.

Finally, because rising house prices increase the Tobin's Q ratio for residential investment, constructing new houses becomes more profitable and property investment increases, which leads construction firms to have an increased demand for credit (Goodhart and Hofmann, 2008).

3. Methodology

We estimate the panel vector autoregression model of Pesaran and Smith (1995), Pesaran (1996) and Rebucci (2010)

$$y_t^i = c^i + \Phi_1^i y_{t-1}^i + ... + \Phi_p^i y_{t-p}^i + \epsilon_t^i \qquad \epsilon_t^i \sim N(0, \Sigma^i) \tag{1}$$

for $t = 1, ..., T$ and $i = 1, ..., G$, where G is the number of countries, y_t^i is an N dimensional vector of country i at time t, p is the lag length, c^i is the N dimensional vector of fixed effects of country i, Φ_k^i is the $N \times N$ coefficient matrix at lag k of country i and ϵ_t^i is a N dimensional vector of country i at time t, which is uncorrelated across countries and over time and has contemporaneous covariance matrix Σ^i. It is further assumed that the coefficients Φ_k^i and Σ^i are independently and identically distributed across countries.

The $N = 5$ endogenous variables are the real gross domestic product (GDP), the consumer price index (CPI), the real (ex post) short term interest rate (IR), the real residential house prices (HP) and the real total credit to the household sector (CHH). In line with Cesa-Bianchi *et al.* (2015), these variables are expressed in logarithm of the levels (except for the interest rate which is expressed in levels), such that the information on the long-run properties of the data, including the possible cointegration relationships, is preserved.[1] Also in line with Cesa-Bianchi *et al.* (2015), we take the lag length p to be the same across countries such that differences between countries are not attributable to differences in the specification of the model. In particular, we choose the lag length 2, which is selected by the BIC criterion for most individual country VAR models.

We identify shocks in house prices and household credit using the Cholesky identification scheme with ordering (GDP, CPI, HP, IR, CHH). Since we only analyze house prices shocks, the only identification assumption that matters is whether each of the other variables is ranked before or after the house prices (Christiano *et al.*, 1999). In particular, if a certain variable is ranked before (after) the house prices, this means that the variable cannot (can) contemporaneously react to a house price shock and that house prices can (cannot) contemporaneously react to a shock in that variable. First, we assume that GDP and CPI do not contemporaneously react to house price shocks, as in Assenmacher-Wesche and Gerlach (2008), Calza *et al.* (2013), Goodhart and Hofmann (2008) and Hofmann (2004). Second, we assume that real house prices are relatively sticky such that there is

[1] Note that a specification in differenced time series would throw away information on these long-run properties of the data (Canova, 2007).

no contemporaneous effect of both interest rate shocks and household credit shocks on house prices, in line with Hofmann (2004).[2] Similar to Goodhart and Hofmann (2008), we interpret our identified house price shock as an orthogonalized reduced form shock, which represents an increase in the error term of house prices unrelated to the contemporaneous changes in output and inflation.

We estimate the panel VAR model using the mean group estimator originally proposed by Pesaran and Smith (1995). As in Cesa-Bianchi *et al.* (2015) and Gambacorta *et al.* (2014), the mean group estimator of the responses to a house price shock is computed as the equally weighted average of the individual country estimates of the responses. Calza *et al.* (2013), Canova (2007) and Pesaran and Smith (1995) show that in the presence of dynamic heterogeneity, which means that the VAR coefficients Φ_k^i differ across countries and which very frequently arises in macroeconomic applications, the mean group estimator is consistent, whereas the commonly used fixed effect pooled estimator is not consistent.[3] A consistent standard error of the mean group estimator is given by the standard deviation of the individual country point estimates divided by $\sqrt{G}$. Finally, following the central limit theorem, the mean group estimator is asymptotically normally distributed.

4. Data

4.1. Variables in the panel vector autoregression model

We use quarterly data between 1985Q1-2012Q4 for 16 industrialized countries: Australia (AU), Belgium (BE), Canada (CA), Switzerland (CH), Denmark (DK), Spain (ES), Finland (FI), France (FR), Germany (GE), Italy (IT), Japan (JP), The Netherlands (NL), Norway (NO), Sweden (SW), United Kingdom (UK) and United States (US).[4]

We use the Bank for International Settlements (BIS) dataset on total credit to the household sector, discussed in Dembiermont *et al.* (2013). To be specific, we use the credit extended by 'all sector lenders', including both national and international and both financial and non-financial organizations,

[2] As Hofmann (2003) and Price (2008) state that the mutual ordering of house prices, interest rate and household credit is debatable, we have performed robustness checks with alternative orderings of these three variables in the identification scheme, yielding comparable results.

[3] Pesaran and Smith (1995) show that in the presence of dynamic heterogeneity, the fixed effect pooled estimator is inconsistent for dynamic panel data models in which lagged endogenous variables are included. They argue that a heterogeneity bias arises because the combination of the ignorance of coefficient heterogeneity and serially correlated regressors leads to serial correlation in the disturbances, which in turn leads to inconsistent estimates of the coefficients.

[4] We have excluded Ireland from our analysis because its estimated impulse response functions have an unrealistic explosive behavior for the larger impulse horizons.

to both households and non-profit institutions serving households. Note that the theoretical linkages between credit and house prices mainly go through the household sector, and are therefore better captured using the credit to the household sector variable, rather than using the credit to the entire private sector variables. Due to missing values at the beginning of the sample, the data for Switzerland (-1999Q3), Denmark (-1994Q3) and The Netherlands (-1990Q3) needed to be linked to the BIS credit series on total credit to the private non-financial sector, which also includes loans to non-financial corporations. Also data on residential house prices is obtained from the BIS (Scatigna *et al.*, 2014). Note that for the construction of their database, the researchers often had to join different comparable house price series over time.

Short term interest rates are averages over the quarter taken from the OECD database. They represent either the three month interbank offer rate or the rate associated with Treasury bills, Certificates of Deposit or comparable instruments, each of three month maturity. For Euro Area countries, the 3-month 'European Interbank Offered Rate' is used after the country joined the euro. For Denmark (-1987Q1), Finland (-1987Q1), Japan (-2002Q1) and The Netherlands (-1986Q1), the data had to be linked to money market rates obtained from IMF IFS. Next, data for Real GDP is obtained from the OECD database. In particular, we use the VPVOBARSA series, where the real GDP of each country is expressed in millions of US dollars using fixed PPPs of 2005. Finally, the OECD MEI database is used for acquiring data on the consumer price index.

Real house prices, real household credit and real (ex post) interest rate are obtained by deflating the nominal series by the consumer price index. All variables, except the interest rate, are seasonally adjusted: the data for real GDP were already seasonally adjusted by the data provider and we performed the X11 adjustment procedure for the other variables using the R interface 'seasonal' to X-13ARIMA-SEATS (Sax, 2015).

4.2. Classification of countries with respect to degree of mortgage market flexibility

We use both the IMF mortgage market index (IMFMMI) of Cardarelli *et al.* (2008), the loan to value ratio (LTV), the usage of mortgage equity withdrawal products (MEW) and the mortgage debt to GDP ratio (debt) as indicators for the degree of mortgage market flexibility. The first is considered to be the best available indicator and it is computed as a combination of the typical loan to value ratio, the standard length of mortgage loans, the ability to make mortgage equity withdrawals, the ability to do mortgage refinancing and the development of secondary markets for mortgage loans (Slacalek, 2009). The data is obtained from Cardarelli *et al.* (2008) and Calza *et al.* (2013) and Figure 1 shows the barplot for each mortgage market flexibility indicator.

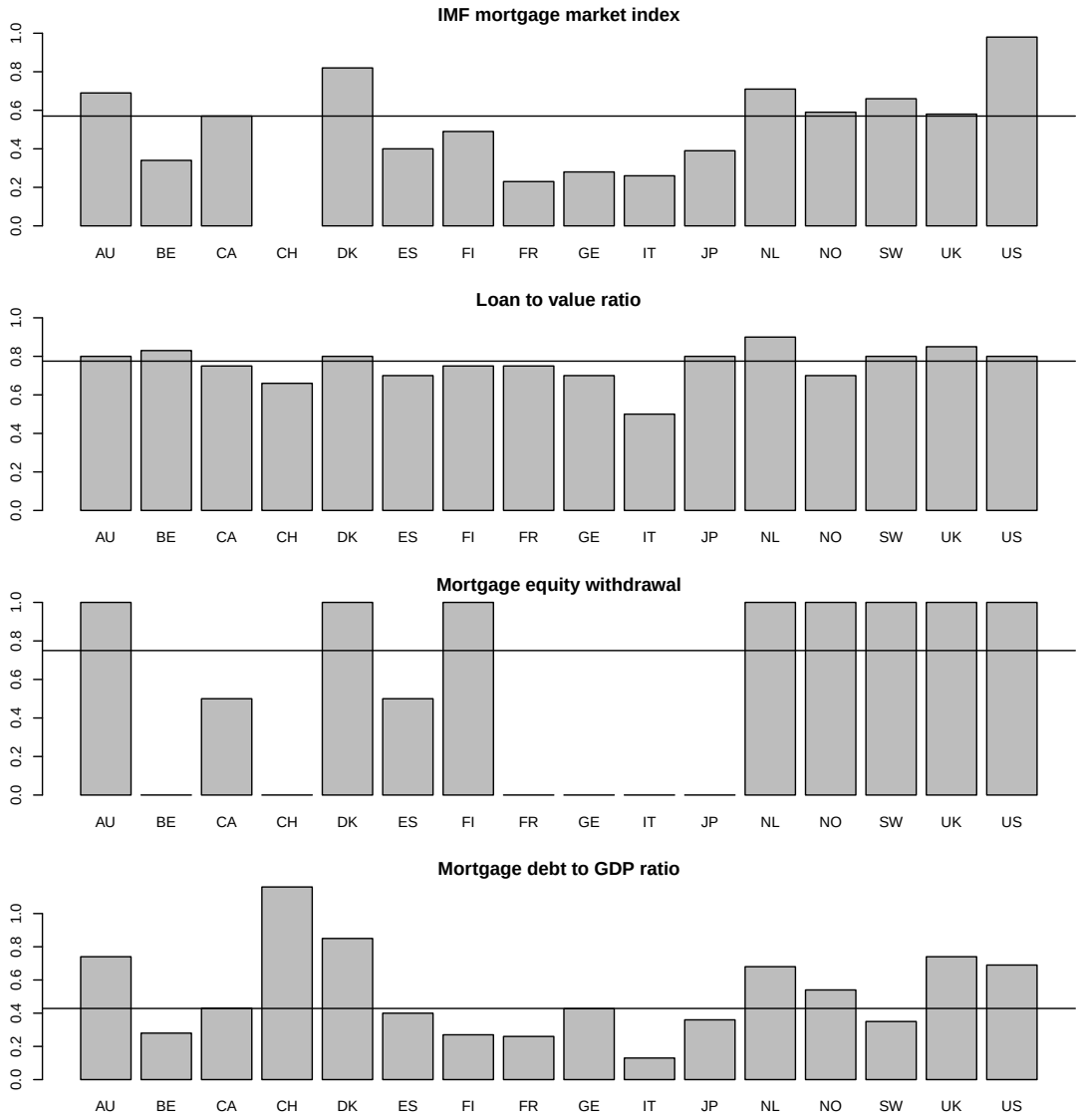

Figure 1: Barplot of the IMF mortgage market index (top graph), the typical loan to value ratio (second graph), the index for the usage of mortgage equity withdrawal products (third graph) and the mortgage debt to GDP ratio (bottom graph). The IMF mortgage market index lies between 0 and 1 and higher values represent a more flexible mortgage market. The index for the usage of mortgage equity withdrawal products can have values 0 (no usage), 0.5 (limited usage) and 1 (usage). The loan to value ratio and the mortgage debt to GDP ratio represent percentages. The median value of each indicator is shown by a horizontal line.

We make the assumption that the degree of mortgage market flexibility is relatively constant over time, which is reasonable because our sample starts in 1985, which is after the introduction of many mortgage market innovations and which is in line with Assenmacher-Wesche and Gerlach (2008), Calza *et al.* (2013), Goodhart and Hofmann (2008) and Slacalek (2009).[5]

For each mortgage market flexibility indicator, we categorize countries with values larger than the median value as 'high mortgage market flexibility countries' and the other countries as 'low mortgage market flexibility' countries, in line with Calza *et al.* (2013).[6] Table 1 summarizes the classification into 'high index countries' and 'low index countries'. While Australia, Denmark, The Netherlands, Norway, Sweden, Switzerland, United Kingdom and United States have a high degree of mortgage market flexibility according to most indicators, the opposite is the case for Belgium, Canada, Finland, France, Germany, Italy, Japan and Spain.

5. Results

5.1. Descriptive statistics of high and low mortgage market flexibility group

For each country, we compute the mean, variance and correlation between the quarterly growth rate of GDP, house prices (HP) and household credit (CHH). For the different mortgage market flexibility indicators, Table 2 shows the average of these means, variances and correlations for respectively the 'high index countries' and the 'low index countries', as well as the p-value of the test of equality of population means.

From Table 2, we see that countries with a flexible mortgage market have a 0.1% higher average quarterly growth rate for both GDP, house prices (HP) and household credit (CHH), according to

[5]Although it would be preferable to use time series data on the degree of mortgage market flexibility, these are only available for a handful of countries. For both United Kingdom and United States, quarterly time series on consumer credit conditions index have been constructed by Duca *et al.* (2013) and Fernandez-Corugedo and Muellbauer (2006), using quarterly micro-level data on loan to value ratios of first time buyers. For United States, quarterly time series for unsecured consumer credit conditions are constructed by Duca and Muellbauer (2013), using data from the Federal Reserve's Senior Loan Officer Opinion survey on the willingness to make consumer installment loans. A quarterly index for the ease of United States mortgage refinancing has also been obtained by Duca *et al.* (2012), using a state space model with a latent variable that explains the percentage of securitized mortgages that are refinanced in a given quarter. Finally, Muellbauer and Williams (2011) obtained estimates for the credit supply conditions in Australia using a system of equilibrium correction models for house prices, consumption mortgage credit and housing equity withdrawal in which the credit conditions indicator is modeled as a latent variable.

[6]For Switzerland, the value of the IMF mortgage market index is not available, but we assume it to be high, in line with Calza *et al.* (2013).

Table 1: Classification of countries into a 'high index group' and 'low index group' according to the different indices: the IMF mortgage market index (IMFMMI), the loan to value ratio (LTV), the mortgage equity withdrawal products index (MEW) and the mortgage debt to GDP ratio (debt).

High index group				Low index group			
IMFMMI	LTV	MEW	debt	IMFMMI	LTV	MEW	debt
AU	AU	AU	AU	BE	CA	BE	BE
CH	BE	DK	CA	CA	CH	CA	ES
DK	DK	FI	CH	ES	ES	CH	FI
NL	JP	NL	DK	FI	FI	ES	FR
NO	NL	NO	NL	FR	FR	FR	GE
SW	SW	SW	NO	GE	GE	GE	IT
UK	UK	UK	UK	IT	IT	IT	JP
US	US	US	US	JP	NO	JP	SW

most indicators for the degree of mortgage market flexibility. However, only for the GDP growth rate, these differences are statistically significant at the 10% significance level. Next, while the point estimates of the average variance of the quarterly growth rates of GDP and household credit are similar between high and low index countries, the average variance of the house price growth rate is about 1 to 2.5 percentage-squared larger for countries with a high IMF mortgage market index, mortgage equity withdrawal products index and mortgage debt to GDP ratio. However, these differences are only statistically significant for the mortgage equity withdrawal products index. Finally, the sample mean is about 0.08, 0.06 and 0.01 larger in 'high index countries' for the correlations between respectively house prices and household credit, house prices and GDP and household credit and GDP, but these differences between the two groups are never statistically significant at the 10% level.

5.2. Mortgage market flexibility and the transmission of house price shocks

This section compares the household credit and GDP responses to a house price shock between the group of countries with a flexible and the group of countries with an inflexible mortgage market. Since the variables in our model (except the interest rate) are expressed in logarithms, a 0.01 increase in the error term of a variable in our VAR model corresponds to a 1% increase in the levels of this variable. Therefore, our impulse responses should be interpreted as the percentage increase of the response variable to a one percent exogenous increase in the impulse variable. For the interest rate, which is not expressed in logarithms, the interpretation is in 0.01 units increases. Next, given the small number of countries in our sample, our reported two-standard-deviation confidence interval of

Table 2: The average of the mean (first block) and the variance (second block) of the growth rates of GDP, house prices (HP) and household credit (CHH) and the correlations between these variables (third block). For each mortgage market flexibility indicator, the average is computed separately for 'high index countries' (High) and 'low index countries' (Low), where the classification of countries into groups is given in Table 1. Finally, 'pval' denotes the p-value of the t-test of equality of the corresponding population averages.

		GDP			HP			CHH		
Mean		High	Low	pval	High	Low	pval	High	Low	pval
	IMFMMI	0.57	0.48	0.16	0.59	0.48	0.60	1.25	1.14	0.60
	LTV	0.55	0.49	0.33	0.53	0.54	0.97	1.19	1.20	0.97
	MEW	0.58	0.47	0.09	0.63	0.44	0.38	1.31	1.07	0.26
	debt	0.58	0.47	0.09	0.59	0.48	0.60	1.29	1.10	0.36
		GDP			HP			CHH		
Variance		High	Low	pval	High	Low	pval	High	Low	pval
	IMFMMI	0.80	0.80	0.98	4.81	3.83	0.42	1.70	1.92	0.61
	LTV	0.79	0.81	0.96	4.03	4.61	0.63	1.74	1.88	0.76
	MEW	0.97	0.63	0.19	5.55	3.09	0.03	2.00	1.62	0.39
	debt	0.74	0.86	0.64	5.12	3.53	0.19	1.54	2.08	0.22
		HP,CHH			HP,GDP			CHH,GDP		
Correlation		High	Low	pval	High	Low	pval	High	Low	pval
	IMFMMI	0.52	0.42	0.38	0.34	0.29	0.47	0.22	0.21	0.86
	LTV	0.52	0.42	0.35	0.37	0.27	0.18	0.22	0.20	0.80
	MEW	0.51	0.42	0.40	0.37	0.26	0.13	0.21	0.21	0.98
	debt	0.48	0.46	0.88	0.31	0.32	0.86	0.21	0.21	0.99

the mean group estimator of the impulse responses are only approximately 95% confidence intervals, since the mean group estimators are only asymptotically normally distributed.

For the full sample of 16 countries, Figure 4 in Appendix shows the mean group estimators and corresponding two-standard-deviation confidence interval of the responses to a house price shock. A house price shock leads to a relatively persistent and statistically significant rise in both real GDP, consumer prices, house prices, household credit and interest rate. In particular, the GDP response to an exogenous 1% increase in house prices peaks at 0.13% after 4 quarters, it then becomes negative after 10 quarters with a peak negative response of -0.20% after 22 quarters and it finally converges to zero. The responses in the consumer price level, the house prices and the interest rate peak

at respectively 0.20%, 1.71%, 0.14 percentage points and 0.40%, after respectively 13, 4, 6 and 8 quarters and gradually go to zero afterwards. These responses are resemblant to those in Goodhart and Hofmann (2008) and Assenmacher-Wesche and Gerlach (2008), who use similar panel VAR models for the sample period 1985Q1-2006Q4 with the variables expressed in growth rates and logarithms, respectively.

The main focus of this paper is to analyze how the household credit and GDP response to a house price shock are influenced on the degree of mortgage market flexibility. Therefore, for each mortgage market flexibility indicator separately, we compute the mean group estimator for both the 'high index group' and the 'low index group' of Table 1. Figures 2 and 3 respectively show the household credit and GDP responses for these two groups. Finally, Table 3 shows the difference of the estimated cumulative responses of the two groups for different horizons.[7]

Table 3: The difference between the cumulative response of the 'high index group' and the 'low index group' for the IMF mortgage market index (IMFMMI), the loan to value ratio (LTV), the mortgage equity withdrawal products index (MEW) and the mortgage debt to GDP ratio (debt).

	Credit response				GDP response			
Horizon	IMFMMI	LTV	MEW	debt	IMFMMI	LTV	MEW	debt
4	-0.4	0.51	-0.14	-0.06	-0.06	0.08	0.25	-0.13
8	-1	1.03	-0.44	0.15	-0.25	-0.11	0.43	-0.24
12	-1.95	1.16	-1.31	0.45	-0.36	-0.54	0.31	-0.06
24	-6.65	-0.17	-8.45	1.88	-0.15	-2.07	-0.88	1.58

Comparing the 'high index group' and the 'low index group' in Table 3, we find that the household credit response to a house price shock is higher for countries with a high loan to value ratio and a high debt to GDP ratio and weaker for countries with a high mortgage market index and a high mortgage equity withdrawal index. In contrast, the point estimate of the GDP response to a house price shock is stronger for countries with a high mortgage equity withdrawal index, but weaker for countries with a high mortgage market index, a high loan to value ratio and a high debt to GDP ratio. However, we find that the two-standard-deviation confidence bounds of the responses in Figures 2 and 3 are very large compared to the differences in estimated responses across groups, which suggests that these

[7]For a given horizon h, the cumulative response is defined as the sum of the responses with horizons from 0 to h.

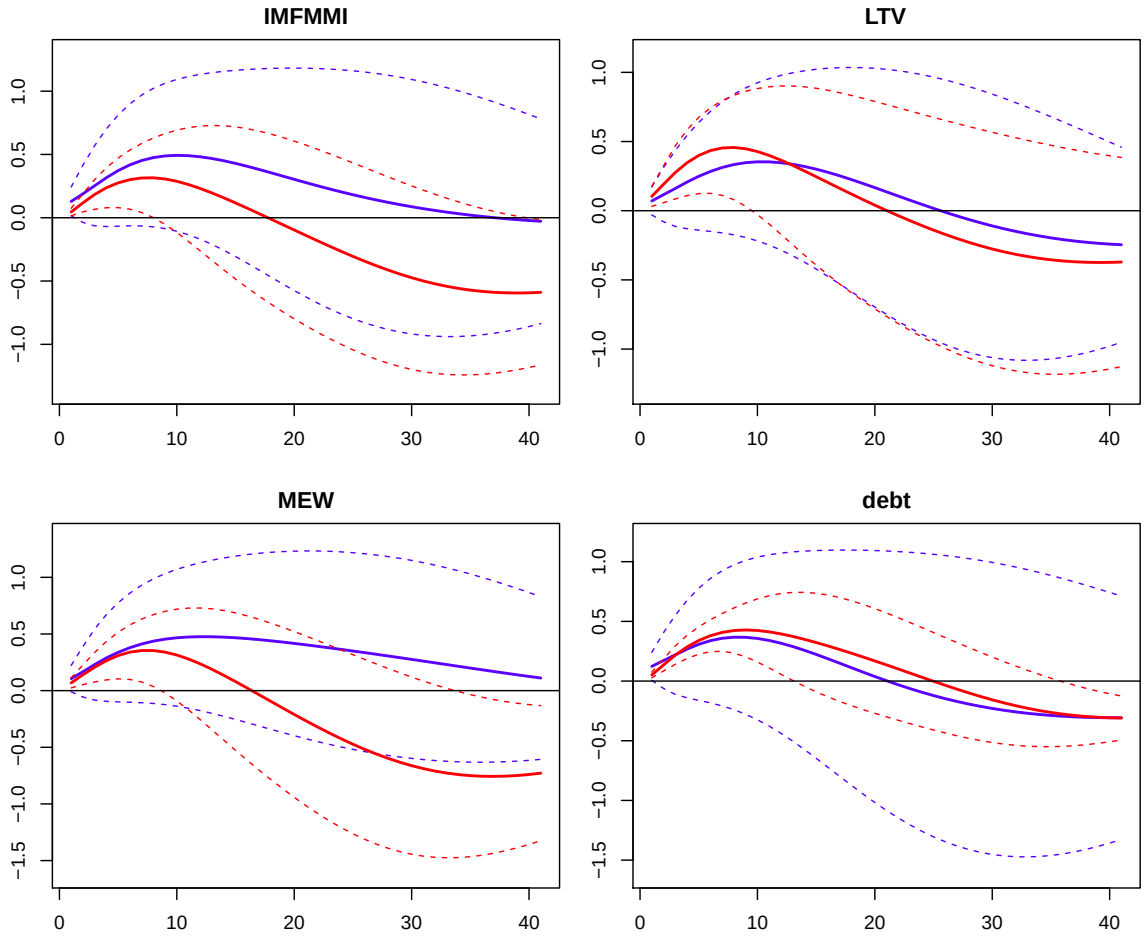

Figure 2: Mean group estimator and two-standard-deviation confidence bounds of the household credit response to a house price shock for the 'high index group' (red lines) and 'low index group' (blue lines), for each of the mortgage market flexibility indices.

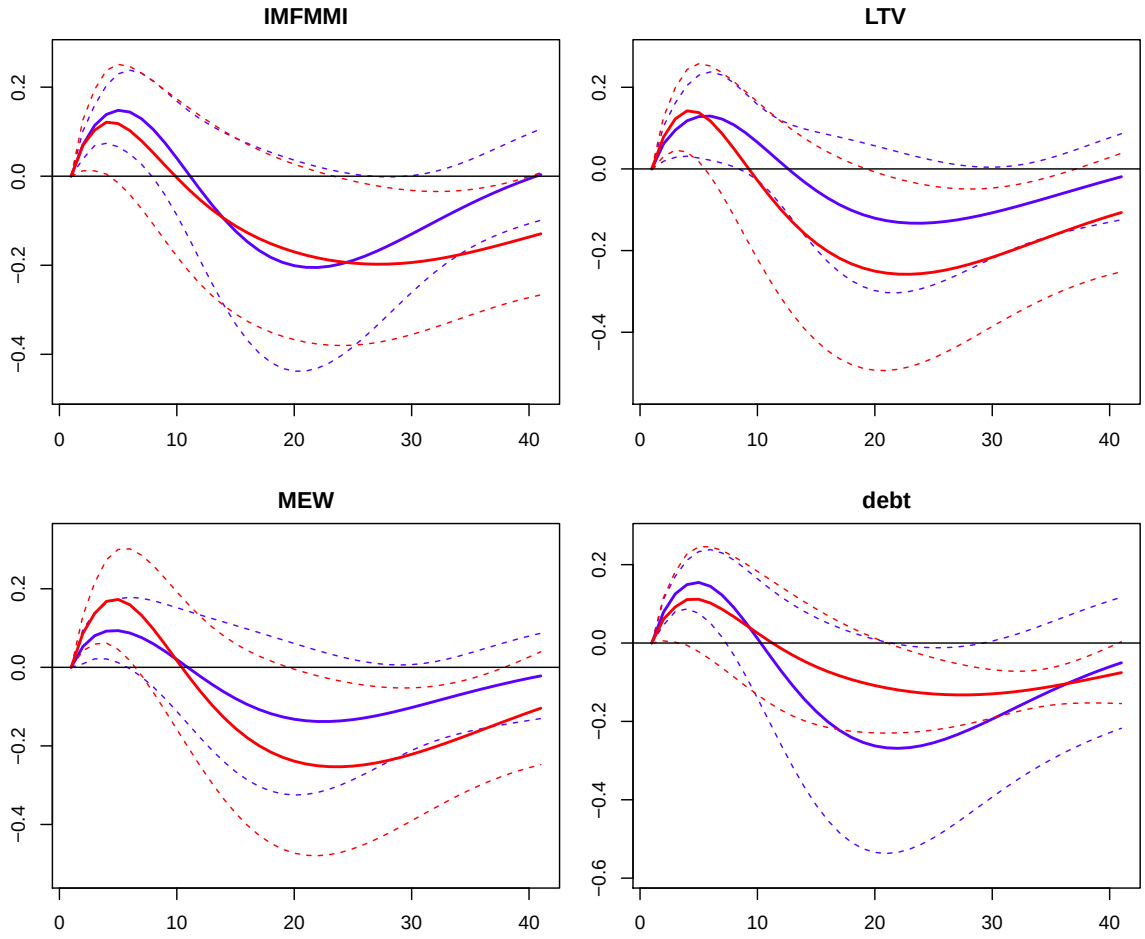

Figure 3: Mean group estimator and two-standard-deviation confidence bounds of the GDP response to a house price shock for the 'high index group' (red lines) and 'low index group' (blue lines), for each of the mortgage market flexibility indices.

differences are not statistically significant.[8] In line with Calza *et al.* (2013), we also performed a test for differences in means of the cumulative responses assuming that the cumulative response are independent across countries. We find that the differences between the averages of the high and low index group are small relative to the intra-group variability and therefore, none of these differences are statistically significant at the 10% confidence level.[9]

Up until now, we divided the countries in a high index and low index group for each indicator of the mortgage market flexibility and we compared the mean of the cumulative response to a house price shock of each group. The value of the index of mortgage market flexibility was therefore not used apart from dividing the countries into groups. As a robustness check, we compute the correlation between the individual country cumulative responses and the indicators for mortgage market flexibility. Table 4 shows this correlation for the cumulative household credit response and GDP response to a house price shock at different horizons.

Table 4: Correlation between each mortgage market flexibility indicator and the cumulative household credit and GDP response to a house price shock at different horizons. '*' denotes that the correlation is statistically significantly different from zero at the 10% level.

	Credit response				GDP response			
Horizon	IMFMMI	LTV	MEW	debt	IMFMMI	LTV	MEW	debt
4	0.02	0.52*	-0.01	0.19	0.35	0.11	0.35	-0.18
8	0.06	0.50*	-0.01	0.20	0.28	-0.01	0.26	-0.14
12	0.06	0.46*	-0.05	0.20	0.22	-0.10	0.15	-0.05
24	-0.02	0.34	-0.21	0.18	0.10	-0.18	-0.04	0.11

Most correlation values are economically small as the estimates range between -0.15 and 0.30. Also, none of the correlation is statistically significantly different from zero at the 10% level, except for the correlation between the loan to value ratio and the household credit response.[10]

[8] The large uncertainty of the estimated response to house price shocks is in line with the results of Goodhart and Hofmann (2008), who uses a fixed pooled estimator for the estimation of a similar panel vector autoregression model.

[9] Note that, given the small number of countries in the sample, the test of equality of means should be interpreted with care.

[10] However, this significant correlation is largely driven by Italy, for which the Cook's distance of the corresponding simple linear regression in which the loan to value ratio is regressed on the cumulative response, is larger than 4. The reason is that Italy has both a very low LTV coefficient and a very low cumulative household credit response.

6. Conclusion

This paper investigates empirically how the impact of a residential house price shock on household credit and GDP is influenced by the degree of the mortgage market flexibility. This is relevant for macroeconomic policymakers because the degree of mortgage market flexibility differs greatly across developed countries. We hypothesized a stronger effects for countries with a more flexible mortgage market because in these countries, the financial accelerator mechanism for existing home owners is stronger and the effect of higher house prices on the required amount of savings of future first time house buyers is smaller.

We use the mean group estimator proposed by Pesaran and Smith (1995) to estimate a five variable panel vector autoregression (VAR) model both for a group of 8 countries with a flexible mortgage market and for a group of 8 countries with an inflexible mortgage market. We analyze the household credit and GDP responses to a house price shock, identified as an increase in the innovation term of house prices unrelated to the contemporaneous changes in output and inflation.

While both household credit and GDP increase after a positive house price shock for both groups of countries, we do not find empirical evidence that these responses are stronger for countries with a highly flexible mortgage market. This result implies that the differences in transmission channels of house price shocks due to a different mortgage market flexibility are not economically important.

However, our result that the mortgage market flexibility does not have an economically important or statistically significant effect on the effects of house price shocks, could also be due to several shortcomings of our empirical exercise. First, our test for equality of the impulse responses between the flexible and inflexible mortgage market has low power because of the small number of countries in our sample. Second, while house price shocks only affect the new loans extended, our total credit to the household sector variable is a more sluggish variable that includes both previously committed loans and new loans.

Finally, we assumed the cross country differences of the degree of mortgage market flexibility to be large compared to the differences over time within each country. This approach is in line with Calza *et al.* (2013), Goodhart and Hofmann (2008) and Slacalek (2009) and is reasonable given that many mortgage market innovations have occurred before 1985, which is the start of our sample period. Still, caution is warranted because, even after 1985, important mortgage market innovations have taken place, such as a decline in the cost of refinancing mortgages in the United States during the 1990s (Bennett *et al.*, 2001) and the securitization of subprime mortgages into private label mortgage

backed securities in United States, which has increased the loan to value ratio for first time buyers in the US in the period 2000-2005 (Duca *et al.*, 2013). As Muellbauer (2007) warns that the omission of time variation in the degree of mortgage market flexibility could lead to an omitted variable bias in which the collateral effect of housing on consumption in overestimated, a promising area for future research is to construct time series data on the mortgage market flexibility, which can then be used for analyzing the impact of the mortgage market flexibility on the relationship between house prices and the economy. Although such time series have been constructed for United States, United Kingdom and Australia, the construction of similar time series indicators for other countries is hampered by data unavailability. Currently, loan to value ratios are only available pointwise for many countries and detailed time series information on the characteristics of mortgage loans are often lacking or incomplete for Euro area countries (Drudi *et al.*, 2009; Goodhart and Hofmann, 2008). Therefore, improving the datasets on these variables would be a useful step forward towards the construction of time series data on the mortgage market flexibility.

This paper provides empirical evidence on the impact of the degree of the mortgage market flexibility on the macroeconomic effects of a house price shock for a sample of 16 OECD countries. Our result that there is neither an economically important nor statistically significant impact, warrants future research to further quantify and analyze the role of mortgage market flexibility for the transmission of house price shocks.

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Appendix

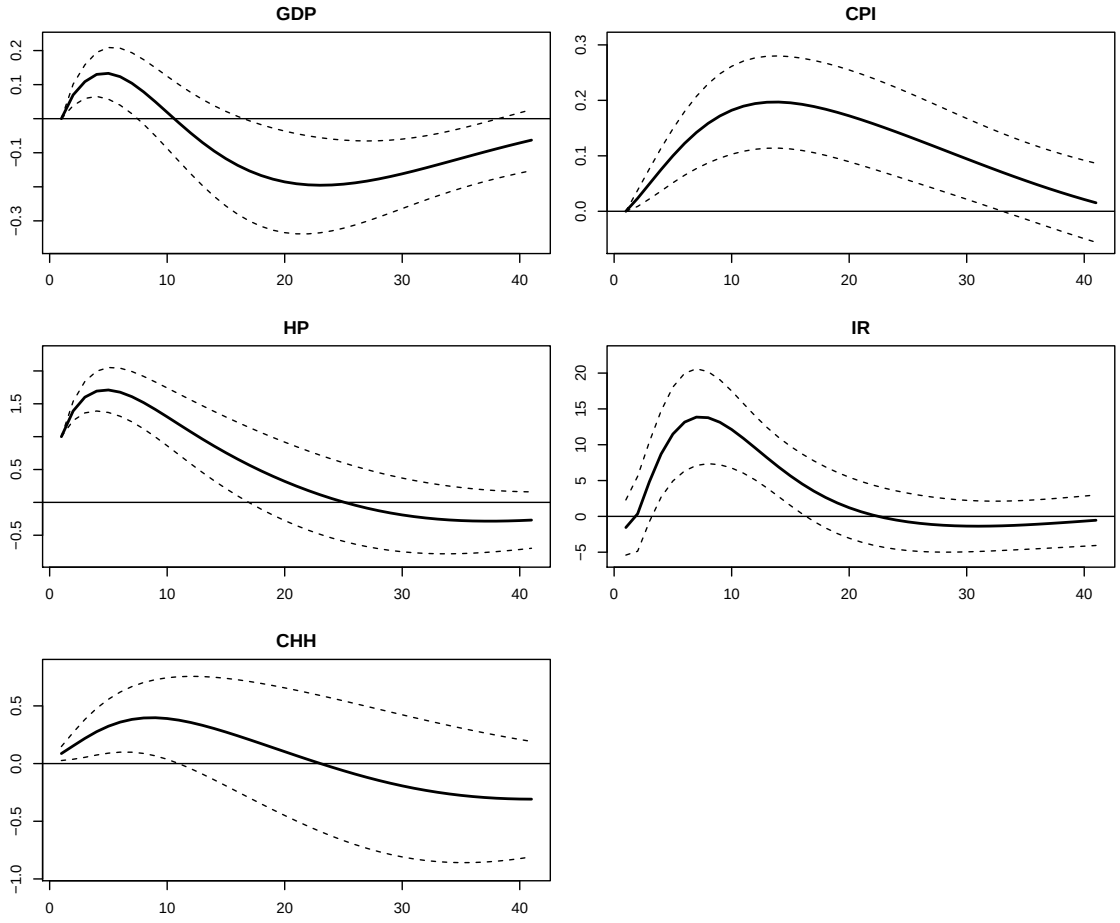

Figure 4: The mean group estimator based on the full sample of 16 countries, and corresponding two standard deviation confidence bounds of the responses to a house price shock. The response variables are the real gross domestic product (GDP), the consumer price index (CPI), the real short term interest rate (IR), the real residential house prices (HP) and the real total credit to the household sector (CHH).

FACULTY OF ECONOMICS AND BUSINESS
Naamsestraat 69 bus 3500
3000 LEUVEN, BELGIË
tel. + 32 16 32 66 12
fax + 32 16 32 67 91
info@econ.kuleuven.be
www.econ.kuleuven.be