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Financial Market Heterogeneity: Implications for the EMU

Johannes Gareis and Eric Mayer*

September 18, 2012

Abstract

This paper evaluates business cycle and welfare effects of cross-country mortgage market heterogeneity for a monetary union. By employing a calibrated two-country New Keynesian DSGE model with collateral constraints tied to housing values, we show that a change in cross-country institutional characteristics of mortgage markets, such as the LTV ratio, is likely to be an important driver of an asymmetric development in housing markets and real economic activity of member states. Our welfare analysis suggests that the welfare of the home country where the reform is implemented increases substantially. In contrast, the rest of the EMU's welfare falls due to spillover effects with magnitude depending on the size of the home country.

Keywords Housing, LTV ratio, monetary union, cross-country heterogeneity.

JEL codes E32, E44, F41.

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1 Introduction

In a monetary union housing markets are crucial. Given the strong impact of housing market fluctuations on the business cycle, cross-country heterogeneity with respect to mortgage market characteristics might be a source of asymmetric business cycle fluctuations. Hence, heterogeneity in mortgage market characteristics across member states fundamentally challenges the very existence of a monetary union.

This paper examines the business cycle and welfare effects of an asymmetric deregulation of mortgage markets within the European Economic and Monetary Union (EMU). Since the launch of the euro on January 1, 1999, housing market developments have been quite heterogeneous across member states. From 1999 to 2007, growth rates of housing loans reached high double-digit rates in countries like Ireland, Greece, Spain and Italy, but were only 3% in Germany for instance (see Drudi et al., 2009). Similar, the amount outstanding of housing loans as percent of GDP varies substantially across member states. While the euro area level increased from 27% in 1999 to 42% in 2007, countries such as Ireland, the Netherlands and Portugal, reached levels far above 60%. House price movements differed significantly across countries in the last decade also. Nominal house prices have risen by a yearly average of above 10% in Ireland and Spain, while they grew moderately in Italy, Portugal and Finland and remained almost constant in Germany.

By applying a calibrated two-country New Keynesian dynamic stochastic general equilibrium (DSGE) model, we argue that a change in cross-country institutional characteristics of mortgage markets, such as the loan-to-value (LTV) ratio, is likely to be an important driver of an asymmetric development in housing markets and real economic activity of member states. In fact, there is ample evidence that European countries exhibit substantial heterogeneity in institutional characteristics of national mortgage markets. A first insight is given by the IMF mortgage market index (see IMF, 2008), which is a composite indicator of the degree of development and completeness of national mortgage markets ranging between 0 and 1.[1] For instance, Germany, France and Italy, which account approximately for 65.1% of the euro area in terms of GDP (see ECB, 2012), have a low index value with 0.28 for Germany, 0.23 for France and 0.26 for Italy. In contrast, smaller member states as Spain, the Netherlands and Ireland, have index values of 0.39, 0.40 and 0.71 respectively. This overall assessment of substantial divergence in national mortgage

[1] A higher value indicates a higher degree of market development and completeness.

markets is also reflected in individual figures. In particular, the degree of heterogeneity with respect to the LTV ratio is immense. The typical LTV ratio in the euro area is about 80%, with substantial variation across member states ranging from 63% to 101% (see Drudi et al., 2009). Additionally, Drudi et al. (2009) find that LTV ratios have risen in the majority of countries over the last years, while they remained fixed for others. Finally, the high degree of cross-country heterogeneity of mortgage markets within the euro area is evident from comparing the share of households holding debt across member states. For instance, Hristov et al. (2010) report that the fraction of indebted households varies from about 25% in Germany and Italy to more than 50% in Spain.

Against this background, we evaluate the effects of a mortgage market reform on the business cycle and welfare in a monetary union, when a single country, which is for the sake of exposition of the size of Spain, implements a deregulation of its mortgage market while the rest of the monetary union keeps its existing legal framework fix. Related literature neglects to analyze the effects of a mortgage market reform itself in terms of transition dynamics and welfare considerations in a monetary union setting. With this paper we take a step in that direction. Studies, such as Hristov et al. (2010) and Rubio (2009), analyze the impact of various shocks in an environment of existing heterogeneous financial market characteristics in the EMU. Hristov et al. (2010) report that empirically plausible degrees of cross-country heterogeneity with respect to the share of indebted households and the LTV ratio can generate cyclical inflation dispersion in the wake of monetary policy and technology shocks. Rubio (2009) highlights the role played by cross-country heterogeneity in mortgage markets within the EMU with respect to the monetary policy regime and various symmetric and asymmetric shocks. She comes to the conclusion that mortgage market homogenization need not per se to be welfare enhancing, except if it is toward lower LTV ratios. Campbell and Hercowitz (2009) study the transition dynamics and welfare consequences of mortgage market deregulation in the US since the early 1980s. By employing a real business cycle model, they find that loosening the collateral constraint worsen the borrowers' welfare due to unfavorable changes in interest rates, whereas the savers' welfare rises substantially. As in Campbell and Hercowitz (2009), our analysis focuses on transition dynamics and welfare effects of the reform itself.

Our analysis employs a standard New Keynesian DSGE model for the EMU, which is a two-country extension of Monacelli (2009). Similar models can be found in Hristov et al. (2010) and Aspachs-Bracons and Rabanal (2010, 2011). Darracq-Pariès and Notarpietro

(2008) provide a two-country model for the United States and the euro area. In our model economy, each country features two sectors producing nondurable consumption goods and housing. In addition, in each economy there are two types of households, namely borrowers and savers. The former are subject to a collateral constraint tied to housing values along the lines of Kiyotaki and Moore (1997) and recent contributions, such as Iacoviello (2005), Monacelli (2009). By determining the level of households' debt, cross-country mortgage market characteristics play an important role in shaping the economy. Given the assumption that the collateral constraint always binds, an asymmetric loosening of the LTV ratio is likely to induce cross-country differences in business cycles and welfare. Eventually, the joint monetary policy is implemented by a common central bank following a simple Taylor-type interest rate rule. Consistent with the mandate of the European Central Bank (ECB), it sets interest rates according to EMU-wide aggregates.

Indeed, our results suggest that an asymmetric mortgage market deregulation in a small economy in a monetary union, as the Spain one, leads to a massive built up of debt in that country since borrowers take advantage of the loosening of the collateral constraint. As a consequence, borrowers' demand shifts toward housing goods which allows them to increase debt holdings further. As the offsetting financial position is held by domestic savers, they benefit from a positive wealth effect, which, in turn, let them to increase consumption and work less. According to our projections, an asymmetric mortgage market deregulation that increases the LTV ratio in Spain from 65% to 75% leads to a massive boost for household debt by 50% over the initial (pre-reform) steady state. Afterwards, debt slowly reverts to the post-reform steady state which is according to our estimate 25% higher than the pre-reform steady state. Alongside the massive expansion of collateralized debt, we find that the Spanish economy is subject to a demand-driven boom. Inflation rates for nondurable consumption goods are 1% above the zero steady state, while inflation rates for house prices are almost 2.5% above. One mechanism that fuels the boom is the asset-pricing channel of the collateral constraint as increasing real house prices lead to further credit availability and therefore allows borrowers to expand demand. Given that the country that implements the reform is relatively small, the externalities for the rest of the EMU are modest. In particular, the inflation rate of nondurable goods in the rest of the EMU is about 0.2% above the zero steady state. This reflects the dilemma faced by the central bank that sets interest rates according to EMU-wide aggregates. Along the transition path monetary conditions are too loose for the country that implements the

reform, while they are too tight for the rest of the union suffering from a mild decrease in GDP. Finally, our welfare analysis suggests that the welfare implications for the home country are positive, while the rest of the union exhibits mild welfare losses. The size of the welfare loss for the rest of the union can be directly linked to the size of the home country that implements the reform. For a country of the size of Spain, the loss for the rest of the union is -0.01%.

The remainder of the paper is as follows. The next section provides the model and calibration. In Section 3, we present the results following the reform in terms of steady state comparison, transition dynamics and welfare effects. Section 4 concludes.

2 The model

The model framework is a two-country, two-sector, two-household general equilibrium model of a monetary union. The home country is of size n and the foreign country (rest of the EMU) is of size $1-n$. In every country there are two sectors producing nondurable consumption goods and housing in a standard setup with monopolistic competition and nominal rigidities. In each country households belong to two different groups, borrowers and savers, which are of measure ω and $1-\omega$ respectively. Both types of households consume nondurable goods as well as housing and work. Only nondurable consumption goods are traded across countries. Borrowers and savers have heterogeneous intertemporal discount factors, with the former being more impatient than the latter. Moreover, borrowers are subject to a collateral constraint as in Iacoviello (2005) and Monacelli (2009).

In the following, we present only the home country block, as the foreign country block is symmetric.[2] We use a tilde to denote variables referring to borrowers. Foreign country variables are indicated with an asterisk.

2.1 Borrower's program

Each borrower b, indicated by $b \in [0, \omega]$, receives utility from the following function

$$\sum_{k=0}^{\infty} \tilde{\beta}^k \left((1-\alpha)\log(\tilde{C}_{t+k}(b)) + (\alpha)\log(\tilde{D}_{t+k}(b)) - \frac{(\tilde{L}_{t+k}(b))^{1+\eta}}{1+\eta} \right), \tag{1}$$

[2]The full set of model equations is available upon request.

where $\tilde{C}_t$ stands for an index of nondurable consumption goods composed of home and foreign produced goods, $\tilde{D}_t$ is the stock of housing, $\tilde{L}_t$ denotes a labor supply index, $\tilde{\beta}$ is the discount factor, α is the share of housing in private consumption and η is the inverse elasticity of labor supply. The index of nondurable consumption goods is defined as

$$\tilde{C}_t(s) = \left[(\tau)^{\frac{1}{\iota}}(\tilde{C}_{H,t}(s))^{\frac{\iota-1}{\iota}} + (1-\tau)^{\frac{1}{\iota}}(\tilde{C}_{F,t}(s))^{\frac{\iota-1}{\iota}}\right]^{\frac{\iota}{\iota-1}}, \tag{2}$$

where $\tilde{C}_{H,t}$ and $\tilde{C}_{F,t}$ stand for goods produced in the home and the foreign country respectively. The parameter ι is the elasticity of substitution between home and foreign produced goods and τ governs the relative weight of home produced goods. The housing stock of a typical borrower evolves as

$$\tilde{D}_t(b) = (1-\delta)\tilde{D}_{t-1}(b) + \tilde{X}_t(b), \tag{3}$$

where $\tilde{X}_t$ denotes housing investment and δ is the depreciation rate of the housing stock. As in Aspachs-Bracons and Rabanal (2010) and Iacoviello and Neri (2010), the labor supply index is defined as

$$\tilde{L}_t(b) = \left[(1-\Delta_D)^{-\iota_L}(\tilde{L}_{C,t}(b))^{1+\iota_L} + \Delta_D^{-\iota_L}(\tilde{L}_{D,t}(b))^{1+\iota_L}\right]^{\frac{1}{1+\iota_L}}, \quad \iota_L \geq 0, \tag{4}$$

where $\tilde{L}_{j,t}$ is sector-specific labor supply ($j = C, D$), Δ_D is the relative size of the housing sector and ι_L governs the cost of reallocating labor across sectors. The period budget constraint of a borrower is given by

$$P_{C,t}\tilde{C}_t(b) + P_{D,t}\tilde{X}_t(b) + R_{t-1}\tilde{S}_{t-1}(b) = W_{C,t}\tilde{L}_{C,t}(b) + W_{D,t}\tilde{L}_{D,t}(b) + \tilde{S}_t(b), \tag{5}$$

where $P_{C,t}$ is the price index of nondurable consumption goods, $P_{D,t}$ denotes the price index of housing and $\tilde{S}_t$ is the nominal amount of end-of-period collateralized debt issued by borrowers.[3] The gross nominal interest rate is R_t and the nominal wage earned in sector $j = C, D$ is given by $W_{j,t}$. Each borrower is subject to a collateral constraint that ties the borrowing limit to the net present value of the future housing stock. It holds that[4]

$$R_t\tilde{S}_t(b) = (1-\chi)(1-\delta)\tilde{D}_t(b)P_{D,t+1}, \tag{6}$$

[3] Throughout we use $P_{C,t}$ as a deflator.

[4] As customary in the housing DSGE literature, we assume that the collateral constraint always binds.

where the parameter χ governs the flexibility of the mortgage market by determining the fraction of the housing stock that cannot be used as collateral. Accordingly, $1-\chi$ provides a measure for the empirically observed LTV ratios outlined in the introduction.

Following Aspachs-Bracons and Rabanal (2010), we assume that households in the home country have to pay a premium above the union-wide riskless nominal interest rate which depends on the aggregate net foreign asset position of domestic households.[5] It holds that

$$R_t = R_t^* exp\left[-\kappa\left(b_t' - b'\right)\right], \quad \kappa \geq 0, \tag{7}$$

where R_t^* is the union-wide gross nominal interest rate controlled by the ECB, b_t' stands for the aggregate net foreign asset position as percent of nominal GDP, b' is the corresponding steady state value and κ denotes the risk premium elasticity.

The first-order conditions to a representative borrower's program are given by

$$\tilde{U}_{C,t} = P_{C,t}\tilde{\lambda}_t \tag{8}$$

$$\text{and} \quad 1 = \tilde{\beta}\frac{R_t}{\Pi_{C,t+1}}\frac{\tilde{U}_{C,t+1}}{\tilde{U}_{C,t}} + R_t\tilde{\psi}_t, \tag{9}$$

where $\tilde{U}_{C,t}$ stands for the marginal utility of nondurable goods consumption, $\tilde{\lambda}_t$ is the multiplier on the budget constraint, $\Pi_{C,t}$ is the gross inflation rate of nondurable consumption goods prices and $\tilde{\psi}_t$ is an auxiliary variable that is proportional to the multiplier on the collateral constraint. The labor supply conditions in both sectors are

$$\frac{W_{C,t}}{P_{C,t}} = \frac{\tilde{L}_t^{(\eta-\iota_L)}(1-\Delta_D)^{-\iota_L}(\tilde{L}_{C,t})^{\iota_L}}{\tilde{U}_{C,t}} \tag{10}$$

$$\text{and} \quad \frac{W_{D,t}}{P_{C,t}} = \frac{\tilde{L}_t^{(\eta-\iota_L)}\Delta_D^{-\iota_L}(\tilde{L}_{D,t})^{\iota_L}}{\tilde{U}_{C,t}}. \tag{11}$$

The first-order condition to a borrower's choice of housing is

$$\frac{\alpha}{\tilde{D}_t}\frac{1}{\tilde{U}_{C,t}} = q_t\left(1-(1-\chi)(1-\delta)\tilde{\psi}_t\Pi_{D,t+1}\right) - \tilde{\beta}(1-\delta)\frac{\tilde{U}_{C,t+1}}{\tilde{U}_{C,t}}q_{t+1}, \tag{12}$$

where $q_t = \frac{P_{D,t}}{P_{C,t}}$ is the real house price and $\Pi_{D,t}$ is the gross inflation rate of house prices.

The allocation of nondurable consumption goods between home and foreign produced

[5] This assumption is needed to ensure a well-defined steady state of the model (see Schmitt-Grohe and Uribe, 2003).

goods is given by

$$\tilde{C}_{H,t} = \tau \left(\frac{P_{H,t}}{P_{C,t}} \right)^{-\iota} \tilde{C}_t \tag{13}$$

$$\text{and} \quad \tilde{C}_{F,t} = (1-\tau) \left(\frac{P_{F,t}}{P_{C,t}} \right)^{-\iota} \tilde{C}_t, \tag{14}$$

where $P_{H,t}$ and $P_{F,t}$ are the price indices of home and foreign produced goods. The nondurable consumption goods price index (consumer price index) is defined as

$$P_{C,t} = \left[\tau \left(P_{H,t} \right)^{1-\iota} + (1-\tau)(P_{F,t})^{1-\iota} \right]^{\frac{1}{1-\iota}}. \tag{15}$$

The terms of trade are given as

$$T_t = \frac{P_{F,t}}{P_{H,t}}. \tag{16}$$

2.2 Saver's program

Each saver s, indicated by $s \in [\omega, 1]$, behaves like a standard rational forward-looking agent with full intertemporal consumption-smoothing. The key feature that describes a typical saver's behavior is the higher intertemporal discount factor ($\tilde{\beta} < \beta$) implying that the saver is more patient than the borrower. Moreover, we assume that savers have access to international asset trading as in Darracq-Pariès and Notarpietro (2008) and Aspachs-Bracons and Rabanal (2010) and that savers are the owners of firms. The utility function of saver s is given by

$$\sum_{k=0}^{\infty} \beta^k \left((1-\alpha) \log(C_{t+k}(s)) + (\alpha) \log(D_{t+k}(s)) - \frac{(L_{t+k}(s))^{1+\eta}}{1+\eta} \right) \tag{17}$$

The saver maximizes its utility function subject to the following period budget constraint

$$\begin{aligned} P_{C,t}C_t(s) + P_{D,t}X_t(s) + S_t(s) + B_t(s) = W_{C,t}L_{C,t}(s) + W_{D,t}L_{D,t}(s) \\ + R_{t-1}S_{t-1}(s) + R_{t-1}B_{t-1}(s) + \frac{Div_t}{1-\omega}, \end{aligned} \tag{18}$$

where B_t are individual holdings of internationally traded assets and Div_t are aggregate profits from firms. Since the saver's optimal choice is standard, we omit further functional forms here.

2.3 Firms

The production structure of the economy is given by two final goods sectors, nondurable consumption and housing. In each sector perfectly competitive final goods producers aggregate a continuum of differentiated intermediate goods purchased from intermediate goods producers. Intermediate goods producers operate under monopolistic competition and have some market power. In addition, they face sectoral price setting frictions as in Calvo (1983). It is assumed that producers are able to re-optimize their nominal price with a probability $1-\theta_j$. Each intermediate goods producer operating in sector $j = C, D$, indexed by $i \in [0, n]$, uses the following production technology

$$Y_{C,t}(i) = L_{C,t}(i), \tag{19}$$

$$\text{and} \quad Y_{D,t}(i) = L_{D,t}(i). \tag{20}$$

The production technologies and the assumptions made above lead to the following standard sectoral Phillips curves

$$\log\left(\Pi_{H,t}\right) = \beta \log\left(\Pi_{H,t+1}\right) + \frac{(1-\theta_C)(1-\beta\theta_C)}{\theta_C} \log\left(\frac{mc_{C,t}}{mc_C}\right) \tag{21}$$

$$\text{and} \quad \log\left(\Pi_{D,t}\right) = \beta \log\left(\Pi_{D,t+1}\right) + \frac{(1-\theta_D)(1-\beta\theta_D)}{\theta_D} \log\left(\frac{mc_{D,t}}{mc_D}\right), \tag{22}$$

where $\Pi_{H,t}$ is the gross inflation rate of home produced nondurable goods prices, $mc_{C,t} = \frac{W_{C,t}}{P_{H,t}}$ are real marginal costs in the nondurable goods sector, $mc_{D,t} = \frac{W_{D,t}}{P_{D,t}}$ are real marginal costs in the housing sector and corresponding variables without a time subscript describe steady state values.

2.4 Market clearing conditions

The market clearing condition for the home country in the nondurable goods market is

$$Y_{C,t} = n\left(\omega \tilde{C}_{H,t} + (1-\omega) C_{H,t}\right) + (1-n)\left(\omega^* \tilde{C}^*_{H,t} + (1-\omega^*) C^*_{H,t}\right). \tag{23}$$

The equilibrium in the housing market is given by

$$Y_{D,t} = n\left(\omega \tilde{X}_t + (1-\omega) X_t\right). \tag{24}$$

The home country's total GDP is then

$$Y_t = Y_{C,t} + Y_{D,t}. \tag{25}$$

The equilibrium condition in each labor market ($j = C, D$) is

$$\omega \tilde{L}_{j,t} + (1-\omega) L_{j,t} = \int_0^n L_{j,t}(i) di. \tag{26}$$

The market clearing in the international assets market is defined as

$$n(1-\omega) B_t + (1-n)(1-\omega^*) B_t^* = 0. \tag{27}$$

and the national debt market equilibrium is given by

$$\omega \tilde{S}_t = (1-\omega) S_t. \tag{28}$$

Finally, the evolution of the aggregate net foreign asset position of the home country is

$$\begin{aligned} n(1-\omega) B_t = {} & n(1-\omega) R_{t-1} B_{t-1} \\ & + (1-n) P_{H,t} \left(\omega^* \tilde{C}_{H,t}^* + (1-\omega) C_{H,t}^* \right) - n P_{F,t} \left(\omega \tilde{C}_{F,t} + (1-\omega) C_{F,t} \right). \end{aligned} \tag{29}$$

2.5 Monetary policy

The model is closed by assuming that the central bank sets the union-wide riskless interest rate according to a simple Taylor-type rule

$$\frac{R_t^*}{R^*} = \left(\frac{\Pi_t}{\Pi} \right)^{\mu_\pi}, \tag{30}$$

where Π_t is the union-wide gross inflation rate with steady state value of $\Pi = 1$. It is defined as

$$\Pi_t = (\Pi_{C,t})^n \left(\Pi_{C,t}^* \right)^{(1-n)}. \tag{31}$$

2.6 Calibration

In the steady state, we assume zero inflation and that the trade balance as well as the net foreign asset position of both countries is zero. We also assume that the degree of monopolistic competition is equal across sectors and countries. The steady state mark-up

of prices over the marginal costs is assumed to be $\frac{1}{\epsilon-1} = 0.2$. In what follows, we use the same parameter values for both countries, if not stated otherwise.

Concerning the size and the degree of openness of the home respectively the foreign country, we set as the home country Spain, and the foreign country the rest of the EMU. Using information drawn from Aspachs-Bracons and Rabanal (2010) this implies $n = 0.1$, $\tau = 0.85$ and $\tau^* = 0.98$. The saver's discount factor is set to $\beta = 0.99$, which implies a steady state real interest rate of 4%. The borrower's discount factor is $\tilde{\beta} = 0.97$. As for the parameters related to mortgage market characteristics, we conservatively choose to set the share of borrowers in both economies at $\omega = 0.2$ and the LTV ratio, $1-\chi$, is set to 0.65 for the baseline specification. We fix the depreciation rate of housing at $\delta = 0.0025$, which is 1% annually. The inverse elasticity of labor supply is set to $\eta = 1$. We calibrate the labor reallocation cost parameter to $\iota_L = 1$ implying less than perfect labor mobility across sectors. The relative weight of nondurable goods in the utility function is numerically determined such that the relative size of the housing sector is $\Delta_D = 0.1$. This gives $1-\alpha = 0.63$.[6] We set the degree of nominal rigidity in the nondurable consumption goods sector to $\theta_C = 0.75$, which implies an average frequency of price adjustment of 4 quarters. Prices in the housing sector are assumed to be more flexible. To facilitate a positive comovement across sectors along the transition path, we set $\theta_D = 0.66$ and therefore an average frequency of price adjustment of about 3 quarters. The elasticity of substitution between home and foreign produced goods is calibrated to 1 such that these goods are not perfect substitutes. The risk premium elasticity is set to $\kappa = 0.02$ as estimated in Aspachs-Bracons and Rabanal (2010). Turning to the parameter governing the Taylor rule followed by the ECB, we set $\mu_\pi = 1.5$.

3 Results

In this section, we present the results of our deterministic experiment in which we model an asymmetric mortgage market deregulation in a member state of the EMU. Concretely, we quantitatively investigate the implications for the growth of collateralized debt and its repercussions on the broader economy, when a reform in the home country is implemented such that the LTV ratio increases instantaneously from 65% to 75%.

In a first step, we analyze the changes in steady state values by comparing pre-reform

[6] When we introduce cross-country heterogeneity in mortgage markets, we take $1-\alpha$ as fixed and allow the size of the housing sector to adjust.

steady state values to post-reform steady state values to which the model economy converges after the reform has been implemented. In a second step, we proceed by illustrating the transition path of all key variables. Finally, we investigate the welfare implications of the mortgage market reform.

3.1 Steady states

Here, we discuss how the asymmetric mortgage market reform influences the long-run equilibrium of the model economy. The analysis employs the calibrated DSGE model as outlined in the previous section in which all parameters (except the home country's LTV ratio) stay at their baseline calibration.

Table 1: Percentage change in steady state values

	Home				Rest of the EMU			
Saver	C	X	L		C^*	X^*	L^*	
	0.54	0.54	-0.54		-0.00	-0.00	-0.00	
Borrower	$\tilde{C}$	$\tilde{X}$	$\tilde{L}$	$\tilde{s}$	$\tilde{C}$	$\tilde{X}$	$\tilde{L}$	$\tilde{s}^*$
	-2.55	8.69	2.51	25.41	-0.00	-0.00	-0.00	-0.00

Note: The table displays for each variable the percentage change in its steady state value. $\tilde{s}$ and $\tilde{s}^*$ denote real debt using the nondurable goods price index as a deflator.

Table 1 indicates that a lower collateral requirement (higher LTV ratio) increases domestic real debt by 25.41% in the long-run. Accordingly, the model provides a clear cut link between credit growth and mortgage market deregulation. Moreover, as a result of the expanding debt holdings, borrowers shift demand toward housing. While housing demand increases by 8.69%, nondurable goods consumption decreases by 2.55%. The experiment also provides evidence that borrowers work more than before the reform which results in an increase in labor supply by 2.51%. Comparing the steady states before and after the reform for savers, it prevails that the increased debt generates a positive wealth effect. As savers hold the offsetting financial position to the increased stock of domestic debt, they are wealthier than before the reform. Consequnetly, given that consumption and leisure are normal goods, savers increase consumption in housing and nondurable goods and decrease the steady state labor supply. The spillover effects of the reform to the rest of the union are negligible as the home country is relatively small compared to the rest of the union. Based on our numerical simulation results we find that all variables that directly impact welfare of the rest of the EMU stay almost unaltered up to two decimals.

3.2 Transition dynamics

While the last section highlights the change in the long-run equilibrium of the model economy, we now investigate the transition dynamics in the first two years following the reform.

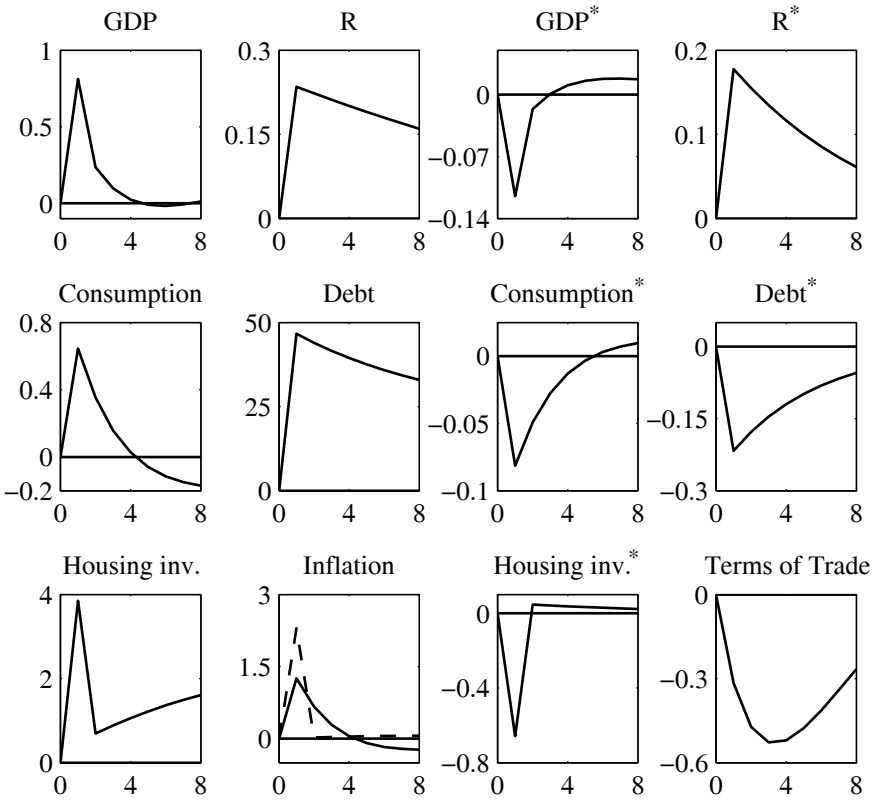

Figure 1: Transition dynamics for macroeconomic aggregates

Note: The figure plots the adjustment path of selected macroeconomic aggregates when the LTV ratio in the home country increases from 65% to 75%. All variables are expressed in percentage deviations from initial steady state values. The solid line in the subplot *Inflation* stands for consumer price inflation and the dashed line represents house price inflation. Interest and inflation rates are given at annual rates.

Figure 1 portrays the adjustment path for selected macroeconomic variables expressed in percentage deviations relative to their pre-reform steady state values. It is apparent from the figure that the reform leads to an immediate rise in households' real debt holdings. The deregulation of the mortgage market acts as a permanent shock to the volume of funds as a larger fraction of the future housing value can be transformed into more credit. Borrowers use the additional funds to purchase additional housing and nondurable goods according to their preferences. As firms in both sectors of the economy have to increase production in response to the boost in demand, real wages and thus marginal costs of production

move pro-cyclically alongside the expansion. Mark-up pricing implies that firms increase prices. Thus, inflation rates in both sectors sharply spike. In the nondurable goods sector in which prices are relatively sticky prices increase by 1% above the ECB's inflation target and in the housing sector in which prices react more instantaneously to changes of the marginal cost of production they increase by almost 2.5%. Put differently, as firms in the housing sector are able to adjust prices more frequently than firms in the nondurable goods sector, the real house price increases. In turn, the increase in the real house price supports the economic boom via the asset-price channel of the collateral constraint. Borrowers raise debt holdings further such that the evolution of real house prices fuels the boom and causes debt to overshoot its long-run equilibrium. The common central bank faces a dilemma as it is committed to achieve price stability for the EMU as a whole. Given that the home country accounts for 10% in terms of total GDP of the monetary union, the boom in the home country mildly increases EMU inflation numbers. Consequently, the ECB increases its nominal rate of interest with the result that real interest rates are temporarily too high in the rest of the EMU and too low in the home country. Higher interest rates in response to the economic boom in the home country create a negative externality for the rest of the monetary union. Savers and borrowers in the rest of the union decrease their demand because of higher real interest rates which leads to a drop in GDP. On the other hand, real exchange rates as reflected by the terms of trade act as a stabilizing propagation mechanism. The rest of the union becomes more competitive as prices in the home economy increase faster than in the rest of the union. This leads to an increase in net exports from the rest of the union to the home country and thus contributes to the rebound in business cycle dynamics.

Figure 2 displays the transition path between the pre-reform and post-reform steady state for selected individual aggregates. As described above, a typical borrower increases consumption of nondurable goods and housing in response to the liberalization of the domestic mortgage market. Via the collateral constraint rising real house prices and a higher housing stock contributes to the rise in debt, which, in turn, increases the borrower's demand for nondurable goods and housing. As for the saver, the increase in wealth given by the rise in borrowers' debt allows them to increase both consumption of nondurable goods and housing. Higher interest rates, however, makes them to smooth consumption of nondurable goods over time such that consumption of nondurable goods initially drops below the pre-reform steady state value. Moreover, as the real house price increases, a

typical saver reduces demand for housing. The same economic mechanisms apply for the foreign country households. A rise in interest rates reduces borrowers and savers demand for consumption of nondurable goods and housing. In addition, foreign borrowers suffer from a decrease in real house prices via the asset-price channel of the collateral constraint. As real house prices fall, a typical saver increases housing demand.

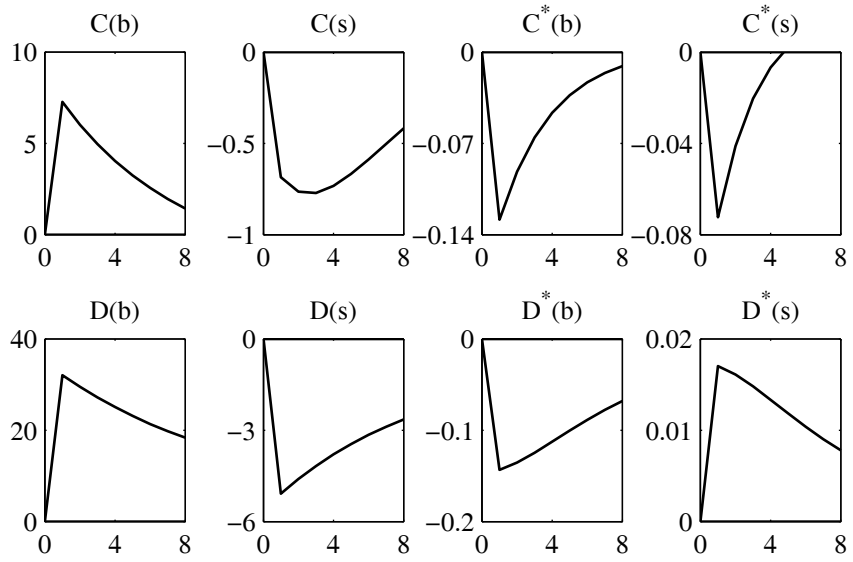

Figure 2: Transition dynamics for individual aggregates

Note: The figure plots the adjustment path of selected individual aggregates when the LTV ratio in the home country increases from 65% to 75%. All variables are expressed in percentage deviations from initial steady state values.

3.3 Welfare implications

We now shed some light on the welfare implications of the deregulation of the home country's mortgage market. Based on the model simulation it is straight forward to compute welfare measures as our deterministic experiment provides us with the level values of all variables of interest. The individual welfare measure for a typical saver, respectively, borrower is given by

$$V_t(s) = \sum_{k=0}^{\infty} \beta^k \left((1-\alpha)\log(C_{t+k}(s)) + (\alpha)\log(D_{t+k}(s)) - \frac{(L_{t+k}(s))^{1+\eta}}{1+\eta} \right) \tag{32}$$

$$\text{and} \quad \tilde{V}_t(b) = \sum_{k=0}^{\infty} \tilde{\beta}^k \left((1-\alpha)\log(\tilde{C}_{t+k}(b)) + (\alpha)\log(\tilde{D}_{t+k}(b)) - \frac{(\tilde{L}_{t+k}(b))^{1+\eta}}{1+\eta} \right). \tag{33}$$

Based on these welfare measures we compute the percentage change in welfare as

$$\Delta V(i) = \frac{V_1(i) - V_0(i)}{|V_0(i)|}, \tag{34}$$

where $V_0(i)$ denotes the welfare level without the reform and $V_1(i)$ denotes the welfare level that reveals after the reform has been implemented. By computing the percentage change, we can evaluate how the reform influences the welfare of households in the home country as well as in the rest of the EMU. The welfare of each country is computed according to

$$W_t = \omega \tilde{V}_t(b) + (1 - \omega) V_t(s). \tag{35}$$

To assess the overall welfare implications for the EMU, we use

$$W_t^{EMU} = nW_t + (1 - n)W_t^*. \tag{36}$$

With this set of equations at hand we evaluate the asymmetric mortgage market deregulation reform in the home country from a welfare perspective. Table 2 displays the results.

Table 2: Welfare implications

	Home	Rest of the EMU
Saver	0.05	0.00
Borrower	11.22	-0.08
Country	2.29	-0.01
Union	0.22	

Note: The table displays percentage changes in per capita welfare for borrowers and savers as well as percentage changes in the aggregated welfare for individual countries and the EMU when the LTV ratio in the home country increases from 65% to 75%.

Due to the permanent loosening of the collateral constraint welfare of borrowers increases by 11.22%. Thus, although borrowers work more and consume less nondurable goods in the long-run equilibrium, the surge in steady state housing consumption dominates the welfare effects. In addition, increasing consumption of nondurable goods and housing during the transition from the pre-reform to the new steady state contribute to the borrowers' welfare gain. The welfare of savers increases only modestly by 0.05%. As the steady state values in the rest of the EMU are unaltered after the reform, the negative welfare externality for the rest of the union is exclusively driven by the temporarily high

real interest rate path in the transition. Due to the relative small size of the home country, however, the welfare loss of the rest of the EMU is negligible.

To assess the importance of the share of indebted households for the overall results we conduct some sensitivity analysis as reported in table 3. When the share of borrowers is set to $\omega = 0.5$ in both economies, the model predicts that the welfare gain of savers is larger relative to the simulation results with a low share of borrowers. This result is intuitive. As the economy is composed by more borrowers, this translates into a larger per capita increase in wealth because a smaller number of savers holds the offsetting financial position. By the same token, per capita welfare of borrowers decreases. Moreover, when borrowers account for a larger fraction of the overall population, the spillover effects for the rest of the EMU are larger. This is due to higher ECB interest rates in the transition to the new steady state. Clearly, given a higher fraction of borrowers, the economic boom in the home country following the increase in the LTV ratio is more pronounced. Likewise, the overall welfare improvement of the home country is higher relative to the baseline simulation results.

Table 3: Welfare implications with high fraction of borrowers

	Home	Rest of the EMU
Saver	0.38	0.02
Borrower	7.63	-0.15
Country	4.01	-0.07
Union	0.34	

Note: The table displays percentage changes in per capita welfare for borrowers and savers as well as percentage changes in the aggregated welfare for individual countries and the EMU when the share of borrowers is 50% in both economies and the LTV ratio in the home country increases from 65% to 75%.

At last, table 4 highlights the welfare consequences of the mortgage market deregulation reform when it is implemented in the rest of the EMU. We find that the results are quite comparable to what we obtain when we implement the reform in the home country. Borrowers gain by about 11%, while the welfare position of savers remains almost unaltered. The main difference is that due to the size of the country where the reform is implemented, the negative spillover effects for the rest of the union are bigger. Therefore, the welfare position of the home country worsens by a larger scale.

Table 4: Welfare implications of mortgage market reform in foreign country

	Home	Rest of the EMU
Saver	0.02	0.07
Borrower	-0.68	10.67
Country	-0.12	2.19
Union	1.96	

Note: The table displays percentage changes in per capita welfare for borrowers and savers as well as percentage changes in the aggregated welfare for individual countries and the EMU when the LTV ratio in the rest of the EMU increases from 65% to 75%.

4 Conclusion

In this paper, we examine the business cycle and welfare consequences of an asymmetric mortgage market deregulation in a monetary union. Related literature (see Rubio, 2009; Hristov et al., 2010) focuses on the role of cross-country heterogeneity of mortgage market characteristics for the transmission of asymmetric and common shocks, but neglected to assess the implications of a mortgage market reform itself in terms of transition dynamics and welfare. With this paper we take a step in this direction. By employing a calibrated two-country New Keynesian DSGE model with collateral constraints tied to housing values, we quantitatively evaluate the effects of an increase in the LTV ratio from 65% to 75% in a small economy in the EMU, which is for the sake of exposition of the size of Spain. Our results suggest that the mortgage market reform leads to a massive build up of household debt in the Spanish economy. According to our quantitative projections, debt holdings increase by about 50% over the pre-reform steady state and gradually revert back to the post-reform steady state, which is about 25% over the initial. The strong expansion of debt leads to a boom in the Spanish economy. One mechanism that fuels the boom is implied by the asset-pricing channel of the collateral constraint. As house prices go up, further debt is available. The central bank faces a dilemma by setting interest rates according to EMU-wide aggregates. As a consequence, the monetary conditions in the Spanish economy are too low, while they are too tight for the rest of the EMU suffering from a mild decrease in GDP. Our welfare analysis reveals that the change in welfare for the country that implements the reform is positive. This effect is dominated by the borrower's additional availability of credit associated with the deregulation of the mortgage market. As the size of the Spanish economy is small compared to the rest of the EMU, the welfare loss of the rest of the union is small.

Our analysis reflects the dilemma of having a common monetary policy in the light of an asymmetric mortgage market deregulation. The common interest rate policy of the ECB is not well suited to design a one size fits all policy. From a business cycle perspective this explains why asymmetric financial reforms pose a challenge to a monetary union as one part of the union will experience a boom along the transition path while the rest of the union faces a recession. As our welfare analysis suggests, welfare gains of the country that implements the reform outweigh welfare losses of the rest of the EMU. However, as the home country wins and the foreign country loses, the mortgage market deregulation is no Pareto-optimal outcome. Thus, our analysis provides some rationale that an asymmetric mortgage market deregulation might be accompanied by national policies to prevent boom-bust cycles in housing and mortgage markets to emerge and/or to setup a compensation scheme to restore welfare for the rest of the union.

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