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The Effects of Housing Prices and Monetary Policy in a Currency Union

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Abstract

Many developed countries have seen housing prices and residential investment soar in the last decade. This fact has refreshed the debate on the drivers of housing cycles as well as the appropriate policy response. We analyze these issues for the case of Spain, who has seen the interest rates at historical lows since it joined the EMU, and increasing housing demand pressures from immigration and the baby boom generation. First, we present evidence based on a VAR model that suggests that both monetary and demand shocks are behind Spain's housing boom. Second, we calibrate a New Keynesian dynamic general equilibrium model of a small open economy in a currency area with durable goods. We study the effects of a housing demand shock, a monetary policy shock and a risk premium shock in the model. This allows us to better understand the factors amplifying a housing boom, the role played by the ECB and the recessionary effects of a housing bust. Our results are as follows. First, the model confirms that a combination of these shocks is indeed behind Spain's housing boom. Second, labor market rigidities provide strong amplification effects to all type of shocks, while financial frictions play a secondary role. Third, monetary policy autonomy is of first order importance to cushion risk premium shocks, while this is not the case for housing demand shocks.

Keywords: Housing, Monetary Policy, Financial Constraints.

JEL Classification: E44, E52, F41.

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1 Introduction

During the last two decades, the economic importance of the housing sector has reached unprecedented levels. In most developed countries, housing wealth is above 100 percent of GDP, as for instance in the US, the UK, or Spain, and it represents the bulk of households' assets. Moreover, residential investment is highly pro-cyclical and more volatile than GDP. As a result, the recent boom in housing prices in many advanced economies has refreshed the debate on the drivers of housing cycles and the role of the housing sector in amplifying economic volatility, as well as the appropriate response of the monetary authorities.[1]

The case of Spain is of special interest since its recent economic expansion has been characterised by sustained growth of residential investment, private consumption, credit and housing prices for more than a decade. Moreover, during this period nominal and real interest rates have fallen to exceptional low levels during the convergence period to enter the European Economic and Monetary Union (EMU). As a result, a growing current account deficit has emerged, reaching almost 10 per cent of GDP by 2007. In addition to growing imbalances, a special source of concern for the Spanish economy is the loss of monetary policy autonomy after entering the EMU. In the UK or the US, the central bank can increase interest rates to slow down the growth rate of housing prices, and also respond to a housing price collapse. However, Spain belongs to the EMU, and the European Central Bank sets rates according to the inflation rate of the Harmonised Index of Consumer Prices (HICP) of the Euro area as a whole.

The recent evolution of the Spanish economy including the housing market is shown in Figures 1 to 5. The large decline of interest rates, with an already booming Spanish economy, discouraged households from saving and increased the demand of mortgage and consumption credit. The demand for housing was further increased by the high levels of inmigration and the baby boom generation, fuelling residential investment in particular and economic growth. The increase in the demand for housing, in turn, caused house prices to rise, augmenting the wealth and borrowing capacity of house owners who could in principle increase their consumption.[2] The

[1] A recent paper by Federal Reserve Governor Mishkin (2007) suggests that in response to a housing price drop in the United States of 20 percent, the Federal Reserve should cut its interest rates between 75 and 175 basis points, depending on the assumptions about the transmission mechanism.

[2] However, we should note that estimates of the marginal propensity to consume out of housing

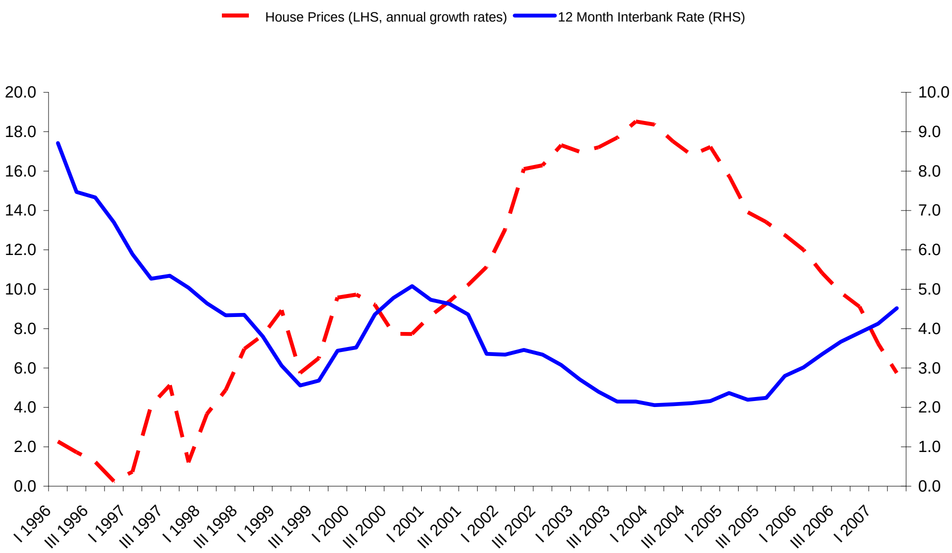

Figure 1: Nominal house prices and interest rates.

growing current account deficit is the other indicator of the magnitude of the consumption and borrowing boom, since the savings-investment imbalance lead Spanish households and firms to obtain financing from abroad.

Hence, in this paper we study the response of an economy such as the Spanish one to fluctuations in housing prices and residential investment, where the main tool of monetary policy, the nominal interest rate, only reacts to domestic conditions as long as they affect aggregate indices of the currency area as a whole. First, we present VAR evidence that shows the response of private consumption, residential investment, and real house prices to an interest rate shock and to a housing demand shock. We show that, as in the US, an increase of interest rates leads to a decline in both final consumption and residential investment, a finding labelled as “comovement” in the literature. On the other hand, we find that these two variables move in opposite directions following a housing demand shock.

Then, we rationalize our findings by building a two-country, two-sector model of a currency union, in the spirit of Benigno (2002) and Rabanal (2007). The model includes durable and non-durable goods. The utility derived from the consumption of the non-durable goods is given by its flow, while the utility derived from the consumption of the durables is given by its stock. As a result, holding durables not

wealth in Spain are lower than in other countries. Bover (2007) obtains estimates of about 0.01-0.02.

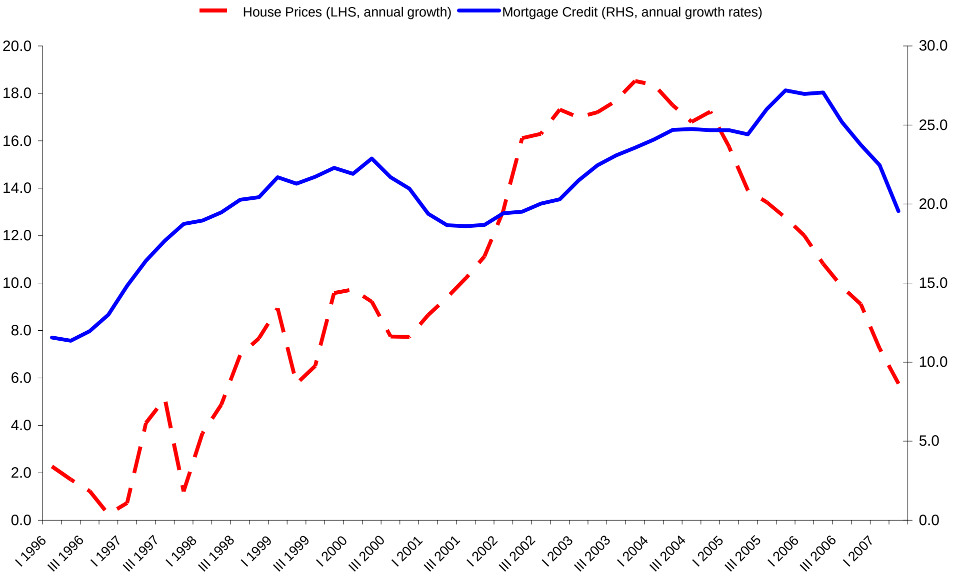

Figure 2: Nominal house prices and mortgage credit

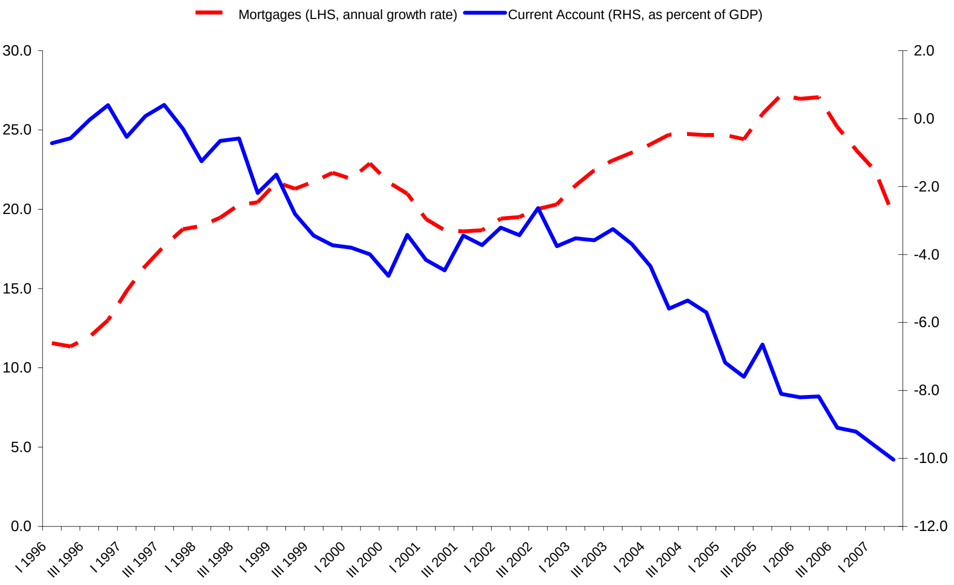

Figure 3: Mortgage credit and the current account.

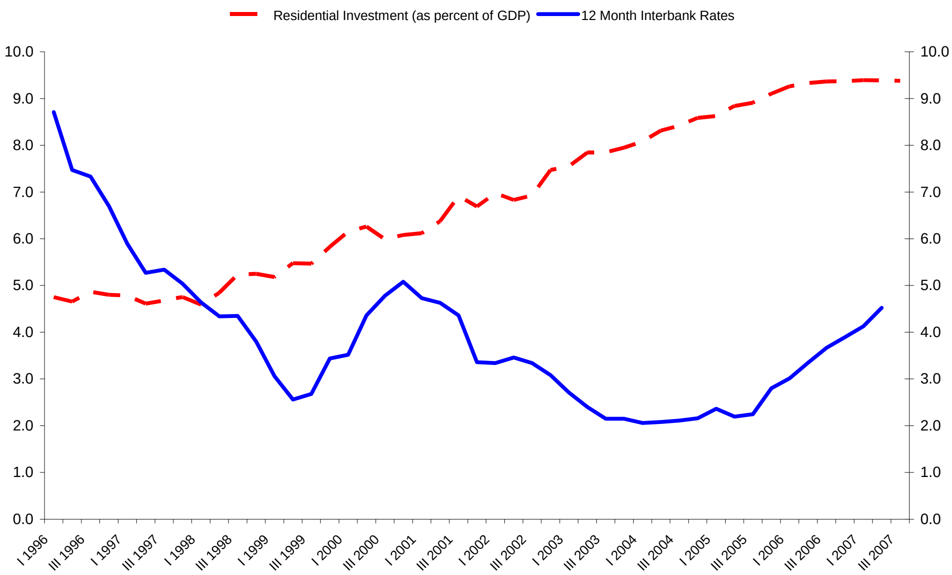

Figure 4: Resident investment and interest rates

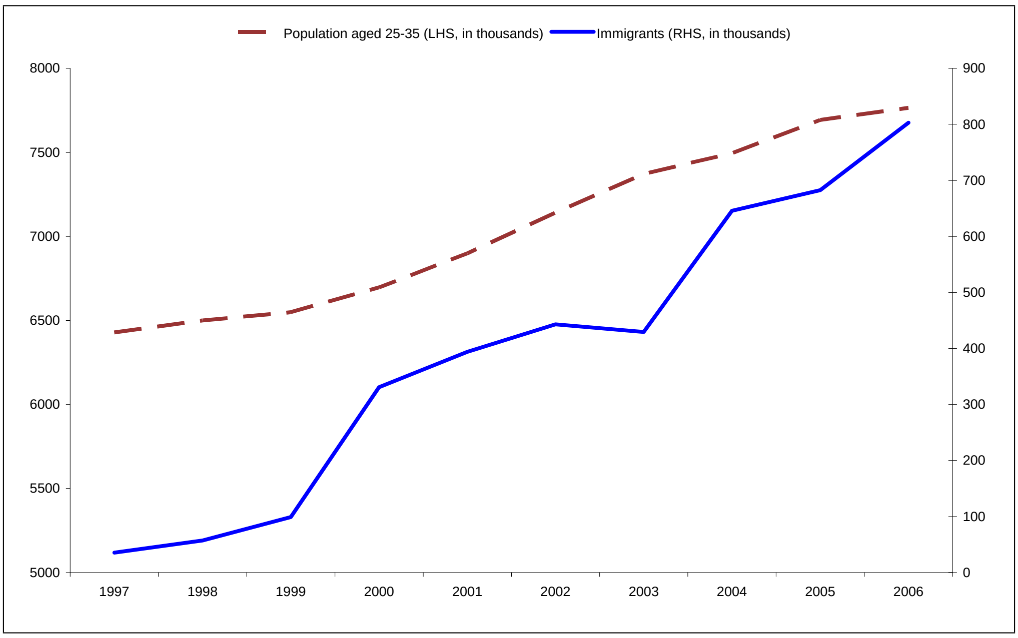

Figure 5: Demographic patterns

only provides utility to the consumer but also provides a wealth effect due to its reselling value. In addition, the international dimension of the model implies that the savings and investment balance need not hold period per period at the country level. This will allow us to explain how increased credit demand in one country of a currency union can be met through funds coming elsewhere in the union without raising the domestic interest rate. We calibrate the model, and examine the reaction of domestic variables and the nominal interest rate to a monetary policy shock, a risk premium shock and a demand/preference shock in the durable sector. We find that shocks that hit Spain and the rest of countries in the currency area symmetrically, such as the monetary policy shock, produce smaller fluctuations than those that are country-specific, such as a risk premium or housing demand shocks. A negative risk premium shock generates larger fluctuations in output than the monetary policy shock, and also leads to a large and persistent deterioration of the net foreign asset position of Spain. The demand shock also ends up generating significant fluctuations on the non-durables sector and in the final output, since the interest rates are set according to Euro Area conditions and do not react importantly to country-specific shocks. Overall, we find that both the demand shock and the risk premium shock produce effects on the main aggregates of the economy similar to the ones observed in the data and in the VAR.

An additional source of concern are the accelerator effects that fluctuations in the housing sector might create. The nominal (and real) growth of the housing sector has increased the amount of collateral available, allowing households to borrow more (or to save less in other instruments) and hence stimulating private consumption. While this amplification effect during the booming side of the cycle may be welcome, the potential effects during a downturn are one of the main worries of many policymakers and households, especially if the effects are asymmetric and stronger during recessions.[3] There is a well established literature that highlights the role of collateral as a key element in the transmission mechanism of shocks and captures how economic cycle swings are amplified through the financial sector (Kiyotaki and Moore (1997) and Bernanke, Gertler and Gilchrist (1999)). More recently, a new strand of the literature has focused on the role that housing in particular plays in the transmission mechanism of shocks, confirming its importance (Aoki et. al. (2004), Iacoviello (2005), and Monacelli (2006)). We therefore proceed with our analysis

[3] See, for instance, the latest conference organized by the Federal Reserve Bank of Kansas City in Jackson Hole, Wyoming.

by studying how the impact of each shock changes when the fraction of credit constrained agents increase, and/or their pledging capacity changes. As expected, the responses of both non-durable and durable output are substantially larger when financial frictions are tighter. But, we find that under financial frictions both consumption and residential investment move in the same direction after a housing demand shock, contradicting our VAR evidence.

However, the most important element that arises from the model in determining the capacity of the economy to absorb those shocks is the flexibility of its labor market. This is key when shocks affect each sector with different intensities, or even with different sign. In our model economy this happens for two reasons. First, following Bils and Klenow (2004) prices are more flexible in the durables sector than in the non-durables sector. Second, the additional value of durables as a saving device makes this sector to be especially dependent on interest rate changes. We compare the impact of the monetary and housing demand shocks for different degrees of labor market frictions and different degrees of financial frictions. Quite surprisingly, and as opposed to the existing literature that stresses the role of financial frictions and borrowing constraints, we find that the effect of introducing these financial frictions is smaller than removing labor market rigidities. However, we find that in order to match our VAR-based evidence, a smaller degree of costly labor reallocation is needed, compared to the estimates for the US economy by Iacoviello and Neri (2008).

In order to analyse the additional volatility that belonging to the EMU might have caused, we compare the impulse response functions of a risk premium and housing demand shocks in the currency union benchmark case with those of running autonomous monetary policy with domestic inflation targeting. Under an inflation targeting regime with a pure floating exchange rate, the monetary policy reaction to a domestic shock is more aggressive than when belonging to a currency union. In addition, we also study the case of running an inflation targeting regime with a managed float. Our conclusion is that running an autonomous monetary policy allows the domestic economy to better cushion adverse shocks. This is specially important in the risk premium shock case since it has first order effects on output and inflation.

Our results are then suggestive of what can work and what cannot work when we estimate our model with Bayesian methods, which is the next step in the agenda. The rest of the paper is organized as follows. In section 2, we present some VAR-based evidence. In section 3, we present the model, and in section 4 we discuss at length the quantitative implications of the model, as well as several robustness checks. We leave section 5 for concluding remarks.

2 The VAR Response to Housing Demand and Interest Rate Shocks

In this section, we present some evidence on the response of main macroeconomic variables to housing demand and interest rate shocks with the help of a Vector Autoregressive (VAR) model. Several papers in the literature have studied the response of durable and non-durable consumption to a monetary policy shock using a VAR and the recursive identification scheme of Christiano, Eichenbaum, and Evans (1999, 2005). This approach consists in identifying the effect of the monetary policy shock by using the Cholesky decomposition of the variance-covariance matrix of the reduced form residuals of the VAR. Papers following this approach include Erceg and Levin (2006) and Monacelli (2006). In addition, we seek to identify a *housing demand* shock from the VAR. We do so by assuming that the housing demand shock affects the relative price of housing within a period, but it does not affect its quantity: in the short run the supply of housing is fixed, and demand shocks must be absorbed via price movements.

We estimate the following VAR using k variables:

$$Y_t = C + \sum_{j=1}^{L} A_j Y_{t-j} + B u_t$$

where Y_t is a $kx1$ vector of observable variables, C is a $kx1$ vector of constants, A_j are kxk matrices that collect the effect of endogenous variables at lag j on current variables, L is the lag length in the VAR, B is a kxk lower triangular matrix with diagonal terms equal to unity, and u_t is a $kx1$ vector of zero-mean, serially uncorrelated shocks with diagonal variance-covariance matrix.

The vector of endogenous variables is divided as follows: $Y_t = \left[\begin{array}{ccc} Y_{1t} & R_t & Y_{2t} \end{array} \right]'$, where Y_{1t} is a group of macroeconomic variables predetermined when monetary policy decisions are taken, R_t is a relevant interest rate, and Y_{2t} contains the variables affected contemporaneously by monetary policy decisions. As is costumary in the literature, to identify the interest rate shock we place the nominal interest rate after the macroeconomic variables. We place it before housing prices since we assume that they respond to changes in monetary policy within a period: as an asset price, housing prices are likely to respond contemporaneously to changes in the nominal interest rate. Hence, our housing demand shock is the shock that affects housing prices within a period, after taking into account the effect that changes in the interest rate have on housing prices.[4]

The vector of observable variables is divided the following way. In Y_{1t} we include: (i) household consumption of final goods in Spain, (ii) residential investment in Spain, and (iii) the harmonised index of consumer prices (HICP) in the Euro Area. We use as a relevant interest rate (R_t) the reference 12-month interbank rate.[5] We include Euro Area inflation in the VAR because nominal interest rates in the euro area should react to inflation in the euro area, given the inflation targeting mandate of the European Central Bank. Finally, we include in Y_{2t} real house prices in Spain. All variables are introduced after taking natural logarithms and first differences, except for the nominal interest rate that we introduce directly in levels.

Private consumption and residential investment come from Spanish national accounts data and are deflated by the Spanish GDP deflator. Spain and Euro Area HICP's come from Eurostat. Nominal housing price series come from the Spanish Ministry of Housing and is deflated by the HICP in Spain. In studies involving US data the Federal Funds rate is typically the variable used as an indicator of the stance of monetary policy, following the study of Bernanke and Blinder (1992). Spain relinquished its monetary policy autonomy when it joined the EMU in January 1st, 1999, and hence a domestic reference rate is no longer available. We choose the 12-month interbank rate because it is the reference interest rate for mortgages. From 1999 we use the 12-month Euribor rate, and before the EMU period we use the 12-month MIBOR rate. Note that because of this reason, we call our shock an interest rate shock rather than a monetary policy shock in the VAR. We must note, however, that the reference rate set by the European Central Bank, the 3-month interbank rate and the 12-month interbank rate move very closely together, such that changes in the 12-month rate reflect mostly policy actions taken by the ECB. We estimate the VAR from 1995:01 to 2007:03 at a quarterly frequency, with 4 lags.

[4] We have also estimated a VAR with the ordering $Y_t = \begin{bmatrix} Y_{1t} & Y_{2t} & R_t \end{bmatrix}'$ and the results are very similar to the ones we present.

[5] Using the 3-month reference rate delivers very similar results.

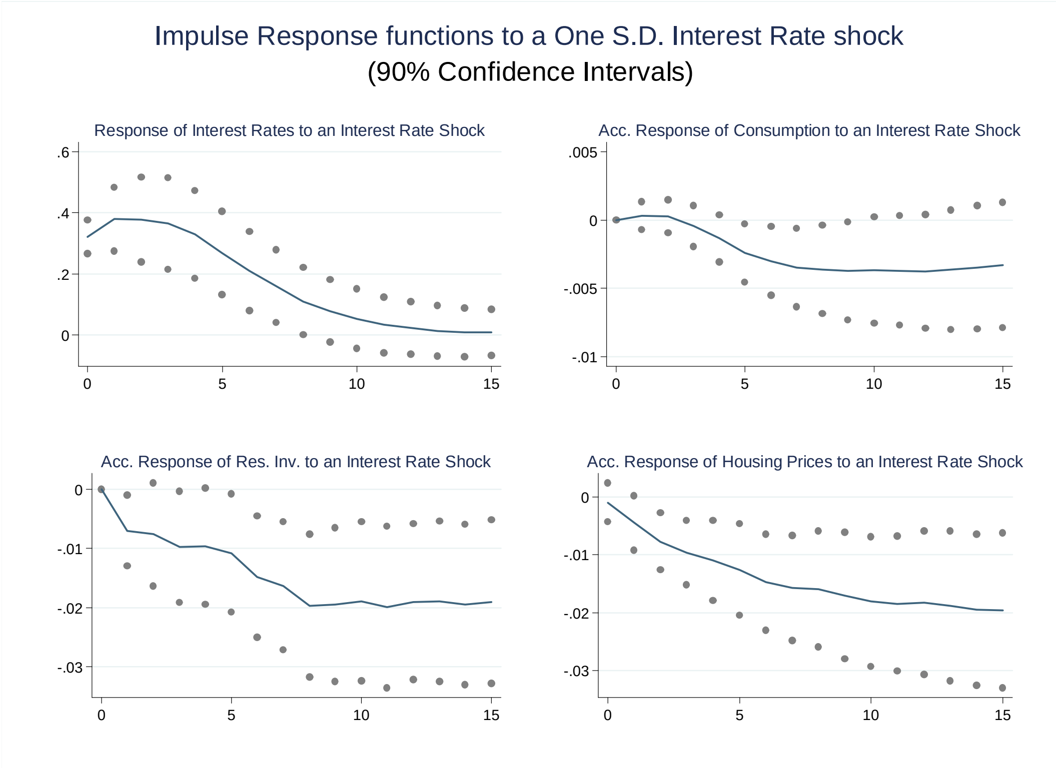

Figure 6: Impulse Response from VAR.

We are constrained by the availability of the housing price series.

In Figures 6 and 7 we present the impulse responses of interest rates and housing prices to an increase of interest rates and a housing demand shock, and the accumulated responses of the other variables with 90 percent confident bands.[6] The impulse responses are qualitatively similar to those shown by Monacelli (2006) for the US economy. The interest rate shock imples an increase of about 25 basis points in the nominal interest rate. The cumulative response of residential investment is about 5 times stronger than that of private consumption, and the effect is also faster. Also note that real house prices decline with an increase in the nominal interest rate. On the other hand, a housing demand shock increases real house prices and residential investment, and it reduces consumption by a small but significant amount during the first period. These are the features that we will ask our model to reproduce.

[6]Given our short sample it is difficult to obtain significance at 95 percent levels.

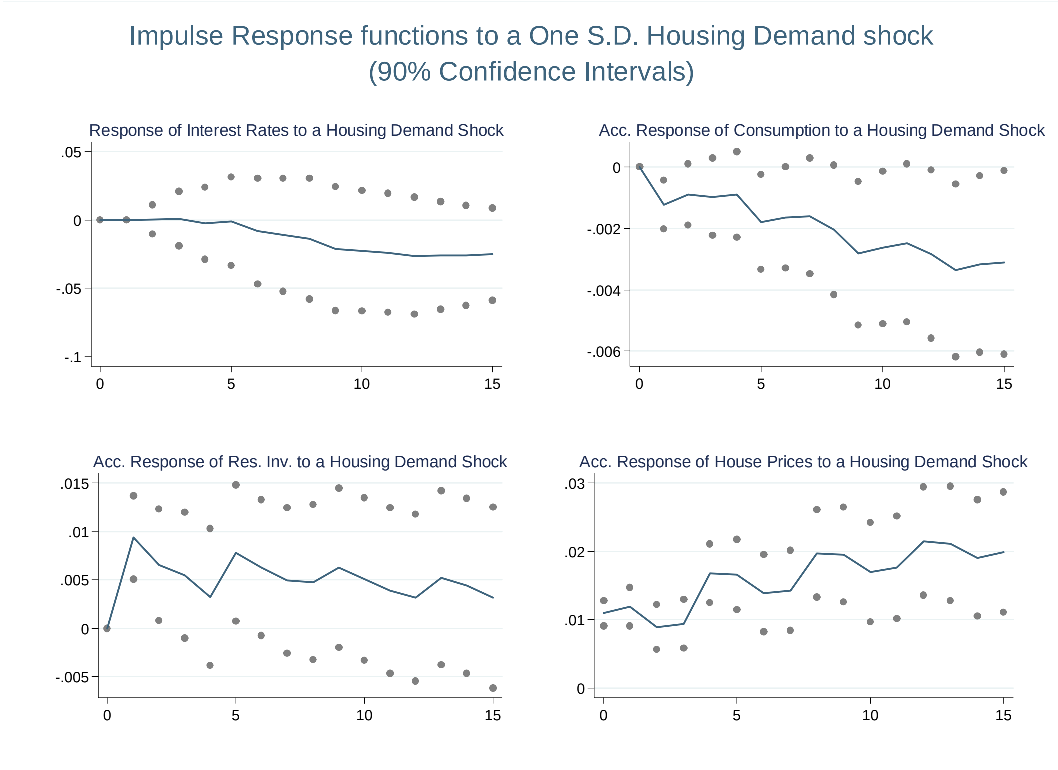

Figure 7: Impulse Response from VAR.

3 The Model

The theoretical framework consists of a general equilibrium two country, two sector model in a single currency area. The countries are of size n and $1-n$, and each of them produces two types of goods, durables and non-durables, under monopolistic competition and nominal rigidities. Only the non-durable goods are tradable. Producers of the final durable good sell its product to domestic households only in each country, which allows them to increase their housing stock. For this reason, we use the terms "durable good production" and "residential investment" interchangeably throughout the paper.

Since our VAR analysis has only focused on the effects of monetary and demand shocks on the housing sector and the spillover effects to the macroeconomy, the model will only include these shocks, so we leave aside technology shocks in the current analysis. Iacoviello and Neri (2008) attribute most of the variation in housing prices to a housing preference shock. In what follows, we present the home country block of the model. The analogous foreign-country variables will be denoted by an asterisk.

3.1 Households

Each household j in the home country maximizes the following utility function:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\gamma \log(C_t^j) + (1-\gamma)\xi_t \log(D_t^j) - \frac{\left(L_t^j\right)^{1+\varphi}}{1+\varphi} \right] \right\} \tag{1}$$

where C_t^j denotes consumption of non-durable goods, and D_t^j denotes consumption of durable goods. In addition, consumption of non-durables is an index composed of home and foreign consumption goods:

$$C_t^j = \frac{1}{\tau^\tau (1-\tau)^{1-\tau}} \left(C_{H,t}^j\right)^\tau \left(C_{F,t}^j\right)^{1-\tau} \tag{2}$$

where $C_{H,t}^j$ and $C_{F,t}^j$ are, respectively, consumption of the home non-durable goods and consumption of foreign non-durable goods by the home agent, and τ is the fraction of domestically produced non-durables at home. ξ_t is a housing preference shock that follows an AR(1) in logs. Finally, following Iacoviello and Neri (2006), we assume that there is imperfect substitutability of labor supply across sectors, such that the labor disutility index can be written as:

$$L_t^j = \left[\alpha^{-\iota} \left(L_t^{C,j} \right)^{1+\iota} + (1-\alpha)^{-\iota} \left(L_t^{D,j} \right)^{1+\iota} \right]^{\frac{1}{1+\iota}}, \text{ where } \iota > 0 \tag{3}$$

where $L_t^{i,j}$ denotes hours worked by household j in each sector $i = C, D$, and α is the economic size of each sector. This imperfect substitutability implies that there is a costly labor reallocation across sectors following a shock. The budget constraint of the home agent, in nominal terms, is given by:

$$P_t^C C_t^j + P_t^D \left[D_t^j - (1-\delta) D_{t-1}^j \right] + B_t^j \leq \tilde{R}_{t-1} B_{t-1}^j + W_t^C L_t^{C,j} + W_t^D L_t^{D,j} + \Pi_t^j \tag{4}$$

where P_t^C and P_t^D are the price indices of durable and non-durable goods, to be defined below, W_t^i is the nominal wage in each sector $i = C, D$, and B_t^j denotes uncontingent nominal assets that are traded among households across the monetary union, and that pays (or costs) a gross nominal interest rate $\tilde{R}_t > 1$. Π_t^j denotes nominal profits, because firms are ultimately owned by households.

We assume that households in the home country have to pay a premium above the union-wide riskless nominal interest rate if the country's debt level as percent of GDP increases. This assumption is useful to obtain a well-defined steady state for the aggregate level of debt as percent of nominal GDP.[7] The relevant interest rate for the home households and the union-wide interest are related as follows:

$$\tilde{R}_t = R_t - \vartheta_t \exp\left[\psi\left(\frac{B_t}{P_t Y_t} - \frac{B}{PY}\right)\right] - 1 \tag{5}$$

where P_t is the aggregate price level, to be defined below, and Y_t is real GDP, also to be defined below. This risk premium depends on aggregate variables, such that each household takes this effect as given when choosing between consuming durables, non-durables, and saving. ϑ_t is a risk premium shock that affects the domestic interest rate but not the union-wide nominal interest rate. Note that the risk premium is declining in the net foreign asset position of the country as percent of GDP, $\frac{B_t}{P_t Y_t}$.

We can separate the household's decision as a two stage process. First, households choose the amount of labor to supply to each sector, and the consumption of durables and non-durables. Second, they allocate how much to spend in home and foreign produced goods, taking into account that $P_t^C C_t = P_{H,t} C_{H,t} + P_{F,t} C_{F,t}$. Note that prices of foreign non-durable consumption goods do not carry an asterisk because they are also set in euros, and there is no price discrimination across countries.

The first order conditions to the household problem are given by:[8]

$$\frac{P_t^D}{P_t^C} = \frac{1-\gamma}{\gamma}\frac{\xi_t C_t}{D_t} + \beta(1-\delta) E_t\left(\frac{C_t}{C_{t+1}}\frac{P_{t+1}^D}{P_{t+1}^C}\right) \tag{6}$$

Note that if the durable good was in fact non-durable (i.e. $\delta = 1$), this condition simply states that the marginal utilities of consumption should equal relative prices. Since the durable good has a residual value the following period, this induces the extra-term of holding an additional unit of the durable good.

A standard Euler equation for the consumption of non-durable goods is:

$$1 = \beta \tilde{R}_t E_t\left(\frac{P_t^C}{P_{t+1}^C}\frac{C_t}{C_{t+1}}\right) \tag{7}$$

[7] See Schmitt-Grohé and Uribe (2003).

[8] Since all households behave the same way, we drop the j subscripts in what follows.

The labor supply conditions to both sectors are given by:

$$L_t^{\varphi-\iota}\alpha^{-\iota}\left(L_t^C\right)^{\iota} = \frac{\gamma}{C_t}\frac{W_t^C}{P_t^C} \tag{8}$$

$$L_t^{\varphi-\iota}(1-\alpha)^{-\iota}\left(L_t^D\right)^{\iota} = \frac{\gamma}{C_t}\frac{W_t^D}{P_t^C} \tag{9}$$

The allocation of expenditures between home and foreign-produced goods is:

$$C_{H,t} = \tau\left(\frac{P_{H,t}}{P_t^C}\right)^{-1} C_t \tag{10}$$

$$C_{F,t} = (1-\tau)\left(\frac{P_{F,t}}{P_t^C}\right)^{-1} C_t. \tag{11}$$

The price index for non-durables is given by

$$P_t^C = P_{H,t}^{\tau} P_{F,t}^{1-\tau} \tag{12}$$

and the CPI is

$$P_t = \left(P_t^C\right)^{\gamma}\left(P_t^D\right)^{1-\gamma} \tag{13}$$

The utility maximization problem of foreign country households is quite similar. We assume that the functional forms for preferences are the same across countries, but allow for different parameter values. That is, γ^* is the weight of non-durables in the utility function, and τ^* the fraction of domestically produced non-durables.

3.2 Producers

There is a continuum of intermediate goods producers, indexed by $h \in [0,n]$ in the home country, and by $f \in [n,1]$ in the foreign country, that are imperfect substitutes of each other, and that supply final goods producers in each sector. There is a continuum of final goods producers in the two sectors that operate under perfect competition and flexible prices. Producers of the final durable good sell its product to domestic households only in each country. Producers of the final non-durable good sell their product to domestic and foreign households. Hence, it is important to distinguish the price level of domestic non-durable consumption goods, $P_{H,t}$, which does not coincide with the price level of non-durables (P_t^C) because of the presence of imported non-durable goods, whose price is $P_{F,t}$.

3.2.1 Final Goods Producers

In the durable sector, final goods producers purchase intermediate goods producers and aggregate them according to the following production function:

$$Y_t^D \equiv \left[\left(\frac{1}{n} \right)^{\frac{1}{\sigma_D}} \int_0^n Y_t^D(h)^{\frac{\sigma_D - 1}{\sigma_D}} dh \right]^{\frac{\sigma_D}{\sigma_D - 1}} \tag{14}$$

Profit maximization delivers the following demand for individual intermediate non-durable goods:

$$Y_t^D(h) = \left(\frac{P_t^D(h)}{P_t^D} \right)^{-\sigma_D} Y_t^D, \tag{15}$$

where the price level is given by imposing the zero-profit condition.

$$P_t^D \equiv \left\{ \frac{1}{n} \int_0^n \left[P_t^D(h) \right]^{1-\sigma_D} dh \right\}^{\frac{1}{1-\sigma_D}}.$$

In the non-durable goods sector, expressions are similar but with an appropiate change of notation since the price level of domestic non-durables and of a basket of durables is not the same. The aggregate production function is:

$$Y_t^C \equiv \left[\left(\frac{1}{n} \right)^{\frac{1}{\sigma_C}} \int_0^n Y_t^C(h)^{\frac{\sigma_C - 1}{\sigma_C}} dh \right]^{\frac{\sigma_C}{\sigma_C - 1}}, \tag{16}$$

individual intermediate non-durable goods demand is:

$$Y_t^C(h) = \left(\frac{P_t^H(h)}{P_t^H} \right)^{-\sigma_C} Y_t^C, \tag{17}$$

where the price level is:

$$P_t^H \equiv \left\{ \frac{1}{n} \int_0^n \left[P_t^H(h) \right]^{1-\sigma_C} dh \right\}^{\frac{1}{1-\sigma_C}}.$$

3.2.2 Intermediate Goods Producers

There is a continuum of intermediate goods producers, indexed by $h \in [0, n]$ in the home country, and by $f \in [n, 1]$ in the foreign country, that are imperfect substitutes of each other, and that supply final goods producers in each sector. Intermediate goods producers face a Calvo-type restriction when setting their price. In each period, a fraction $1 - \theta_j$ in each sector receive a signal to reset their price optimally.

Intermediate goods are produced with labor:

$$Y_t^i(h) = L_t^i(h), \text{ for all } h \in [0, n], \text{ and } i = C, D. \tag{18}$$

In each sector, cost minimization implies that the nominal marginal cost of production equals the nominal wage in each sector:

$$MC_t^i = W_t^i, \ i = C, D.$$

Note that even though labor is the only production input, labor costs may differ across sectors because of imperfect labor substitutability. Hence, this effect induces an additional channel of heterogeneous inflation responses across sectors, even when the parameters governing nominal rigidities are similar across sectors.

Firms in the durable sector face the following maximization problem:

$$Max_{P_t^D(h)} E_t \sum_{k=0}^{\infty} \theta_D^k \Lambda_{t,t+k} \left\{ \left[\frac{P_t^D(h) - MC_{t+k}^D}{P_{t+k}^D} \right] Y_{t+k}^D(h) \right\}$$

subject to future demand

$$Y_{t+k}^D(h) = \left(\frac{P_t^D(h)}{P_{t+k}^D} \right)^{-\sigma_D} Y_{t+k}^D$$

where $\Lambda_{t,t+k} = \beta^k \frac{\lambda_{t+k}}{\lambda_t}$ is the stochastic discount factor, and λ_t is the marginal utility of non-durable consumption.

The optimal choice is given by:

$$\frac{\hat{P}_t^D}{P_t^D} = \frac{\sigma_D}{(\sigma_D - 1)} E_t \left\{ \frac{\sum_{k=0}^{\infty} \beta^k \theta_D^k \lambda_{t+k} \left(\prod_{s=1}^{k} \frac{1}{\Pi_{t+s}^D} \right)^{-\sigma_D} \frac{MC_{t+k}^D Y_{t+k}^D}{P_{t+k}^D}}{\sum_{k=0}^{\infty} \beta^k \theta_D^k \lambda_{t+k} \left(\prod_{s=1}^{k} \frac{1}{\Pi_{t+s}^D} \right)^{1-\sigma_D} Y_{t+k}^D} \right\} \tag{19}$$

Given the assumptions about Calvo pricing, the evolution of the price level is:

$$P_t^D = \left\{ \theta_D \left(P_{t-1}^D \right)^{1-\sigma_D} + (1 - \theta_D) \left(\hat{P}_t^D \right)^{1-\sigma_D} \right\}^{\frac{1}{1-\sigma_D}}. \tag{20}$$

Firms in the non-durable sector face a similar maximization problem, and hence the optimal price and the evolution of the price level have similar expressions, with the appropiate change of notation.

3.3 Closing the Model

3.3.1 Market Clearing Conditions

In each intermediate good, supply equals demand. We write the market clearing conditions in terms of aggregate quantities. Hence, we multiply per-capita quantities by population size of each country. Total production in the non-durable sector is equal to total domestic consumption and exports:

$$Y_t^C = nC_{H,t} + (1-n) C_{H,t}^* \tag{21}$$

while residential investment is used to increase the domestic housing stock:

$$Y_t^D = n \left[D_t - (1-\delta) D_{t-1} \right] \tag{22}$$

For the foreign country, the analogous conditions are:

$$Y_t^{*C} = nC_{F,t} + (1-n) C_{F,t}^* \tag{23}$$

$$Y_t^{*D} = (1-n) \left[D_t^* - (1-\delta) D_{t-1}^* \right] \tag{24}$$

Total hours worked equals labor supply in each sector:

$$\int_0^n L_t^C(h)dh = \int_0^n L_t^{C,j}dj \qquad (25)$$

$$\int_0^n L_t^D(h)dh = \int_0^n L_t^{D,j}dj \qquad (26)$$

Market clearing in the international bonds market is:

$$nB_t + (1-n)B_t^* = 0 \qquad (27)$$

Finally, the evolution of aggregate net foreign assets is:

$$nB_t = n\tilde{R}_{t-1}B_{t-1} + (1-n)\, P_{H,t}C_{H,t}^* - nP_{F,t}C_{F,t} \qquad (28)$$

3.3.2 Monetary Policy Rule

In order to close the model, we need to specify a rule for monetary policy, which is conducted by the European Central Bank with an interest rate rule that targets CPI inflation and also exhibits interest rate inertia:

$$R_t = \left[\bar{R}\left(\frac{P_t^{EMU}/P_{t-1}^{EMU}}{\bar{\Pi}^{EMU}}\right)^{\gamma_\Pi}\right]^{1-\gamma_R} R_{t-1}^{\gamma_R}\exp(\varepsilon_t^m) \qquad (29)$$

where the euro area CPI is given by a geometric average of the home and foreign country CPIs, using the country size as a weight:

$$P_t^{EMU} = P_t^n\left(P_t^*\right)^{1-n}$$

4 Quantitative Implications of the Model

4.1 Calibration

In the steady state, we assume zero inflation, that the trade balance is zero, and that the net international position of both economies is zero. Therefore, we only need to solve for the per-capita values of the home country, which are the same as those in the foreign country. We also assume that the degree of monopolistic competition in both types of goods is the same ($\sigma_C = \sigma_D = \sigma$), and hence the ratio of prices is one. The real interest rate in the currency union is given by the discount factor:

$$R = \frac{1}{\beta} \tag{30}$$

Now, we solve for the levels of consumption of durables, non-durables, debt, total hours, and the economic size of each sector. The optimal steady-state ratio of durable to non-durable consumption is:

$$\frac{C}{D} = \frac{\gamma\left[1-\beta(1-\delta)\right]}{1-\gamma} = \Omega \tag{31}$$

In a standard model with homogeneous agents and non-durable goods ($\delta \to 1$), the optimal steady state ratio of the two types of goods would be equal to the ratio of relative weights in the utility function. Because of durability, the ratio is higher than otherwise. The fraction of spending allocated to non-durable consumption over total spending (α) is equal to:

$$\frac{C}{C+\delta D} = \alpha$$

Note that γ and α cannot be calibrated independently. Given values for α, δ, β, we can solve for the value of γ in the utility function. From the pricing equations and assuming that the level of monopolistic competition is the same in both sectors, we have that:

$$W^C = W^D = \frac{\sigma-1}{\sigma}$$

As a result, from the optimizing conditions for households,

$$(1-\alpha)L^C = \alpha L^D \tag{32}$$

which means that agents spend a fraction α of time working in the non-durable sector, and a fraction $1-\alpha$ in the durable sector. Therefore aggregate production levels are given by

$$\bar{Y}^C = \alpha n L \tag{33}$$

$$\bar{Y}^D = (1-\alpha) n L \tag{34}$$

Table 1 summarises the values of the exogenous and endogenous parameters of the model. We set as the home country Spain, and the foreign country the rest of the euro area. Hence, we set the size of the home economy to $n = 0.1$. We set the size of the construction sector at $1-\alpha = 0.1$, both in Spain and in the EMU, which is roughly the average size for the value added of the construction sector in the last decade. We calibrate the bilateral trade parameter (τ) based on total imports from the EMU to Spain over total spending, and calibrate its analogous parameter in the EMU (τ^*) in a similar way. Finally, we calibrate the debt elasticity parameter to the domestic interest rate to a small value of $\kappa = 0.001$. This value is smaller to the one estimated by Rabanal and Tuesta (2007), but captures the idea that interest rates spreads between Spain and the EMU have been negligible during this period. We calibrate the parameters concerning technology and preferences based on standard values in the literature or on the estimates of Iacoviello and Neri (2008) using US data, except for the degree of substitutability across labor types, that we set to $\iota, \iota^* = 0.5$, which is in between Iacoviello and Neri (2008) and Monacelli (2006) . As we explained previosuly, based on all the other structural parameters of the economy, we solve for the weight of the housing stock in the utility function.

Table 1: Calibrated Parameters of the Model

n	Size of Spain inside the EMU	0.1
α, α^*	Share of the non-durable sector in the GDP	0.9
$1-\tau$	Fraction of EMU imports consumed in Spain	0.15
$1-\tau^*$	Fraction of Spain imports goods consumed in the EMU	0.015
κ	Debt elasticity of the domestic interest rate	0.001
σ_C, σ_D	Elasticity of substitution between intermediate goods	10
β	Discount factor	0.99
δ	Depreciation rate of housing stock	0.025
φ, φ^*	Labor supply elasticity	0.5
ι, ι^*	Substitutability across labour types	0.5
γ, γ^*	Share of non-durable consumption in the CPI	0.82
θ^C	Calvo lottery for the non-durable sector in Spain	0.5
θ^D	Calvo lottery for the durable sector in Spain	0.25
θ^{C*}	Calvo lottery for the non-durable sector in the EMU	0.75
θ^{D*}	Calvo lottery for the durable sector in the EMU	0.25
γ^π	Inflation parameter of the Taylor rule	1.5
γ^R	Interest rate smoothing parameter of the Taylor rule	0.7

Having calibrated the real side of the economy, we now proceed to discuss the calibration of the degree of nominal rigidity in each sector and country, which is not free of controversy. In the literature, there is a long standing debate on the degree of nominal rigidities between housing and the other sectors of the economy, and how this might affect the transmission mechanism of monetary policy. For instance, Carlstrom and Fuerst (2007) use the evidence on frequency of price adjustments in the durable and non-durable sectors of Bils and Klenow (2004) to argue that prices in the housing sector are more flexible than in the consumption goods sector. Using this calibration is problematic because, in the model, a monetary contraction causes an expansion of residential investment. This result arises because the different degree of nominal rigidity across sectors causes a strong movement of relative prices.

Since we do not have similar survey evidence for the Euro Area and Spain, we calibrate the non-durable sector following the estimates of Rabanal (2007) in a model with tradable and non-tradable goods. Hence, we set prices to be more sticky in the non-durable sector in the euro area ($\theta^{C^*} = 0.75$) than in Spain ($\theta^C = 0.5$). To capture the notion that durable goods (housing prices) might be more flexible, we set lower Calvo probabilities in both countries without assuming full flexibility ($\theta^D = \theta^{D^*} = 0.25$). We conduct a thorough robustness exercise in the following section. Finally, we calibrate the parameters of the Taylor rule to estimates obtained in the empirical literature in the Euro Area (see, for instance, Rabanal, 2007).

4.2 Impulse response functions

In this section, we discuss the main features of the model by presenting the impulse response functions of a monetary policy shock, a risk premium shock, and a housing preference shock. We obtain the model's dynamics by taking a log-linear approximation around the steady state. In Appendix A we detail the full set of linear equations of the model.

4.2.1 Monetary policy (ε_t^m) and risk premium (ϑ_t) shocks

In the VAR analysis section, we showed impulse responses to an interest rate shock. Without further information, we could not tell if it was a monetary policy shock or a movement in market interest rates determined by other factors. However, in the context of our model, we can discrimante between monetary policy shocks that affect the whole of the euro area, or just Spain. Figure 7 presents the impulse response functions of the main variables in Spain to an expansionary monetary policy shock in the euro area. We choose the size of the shock ε_t^m in the Taylor rule expression (29) to obtain a decline of 25 basis points on impact in the nominal interest rate. Following the shock, consumption of both good types raises, leading to an increase of production in both sectors, but it is stronger in the durable sector. We obtain a strong comovement between both sectors even though the degrees of nominal rigidity are different across sectors. Why is this the case? After a monetary policy easing, and as a response to the higher demand, durable good producers can increase the price quicker than the non-durable producers and hence, the relative price between durables and non-durables increases. This, in turn, reduces the demand of durables and it further raises the demand for non-durables. However, the additional value that the durable good has as a storage device makes it especially sensible to changes in its relative price due to monetary policy shocks and more than offsets the initial negative effect. Labor market rigidities also limit de degree of reallocation across sectors.

Note also that Spain runs a small trade deficit with the rest of the EMU and hence the net foreign asset position becomes negative, but the effect is quantitatively small. As a result the euro area interest rate and the interest rate in Spain are numerically the same. The small response of the trade balance is due to the fact that the shock is symmetric and affects the two countries similarly, given similar production structures and preferences. The degrees of nominal rigidity are not so different to create quantitatively different responses in Spain and in the rest of the euro area.

Therefore, in Figure 8 we inspect the effects of a risk-premium shock in Spain. This shock can be justified as a shifting in market sentiment that would imply that inverstors are willing to lend to Spain at a lower rate than the euro area. On historical grounds, it can also be justified due to the decline in risk premia (less exchange rate and inflation uncertainty) and convergence of nominal interest rates prior to the introduction of the euro. We assume that the risk premium shock has a persistence coefficient of 0.9.

Since this shock also implies a reduction of the relevant nominal interest rate, it is also followed by higher levels of all consumption goods in the Spanish economy, with a stronger effect on the durable sector. Since Spain's growth and inflation increase, the ECB raises interest rates mildly. Also, since the shock is only expansionary for Spain and not the rest of the EMU, a large trade deficit arises, because the increase of imports in Spain is not matched by an increase of exports to the euro area, as it

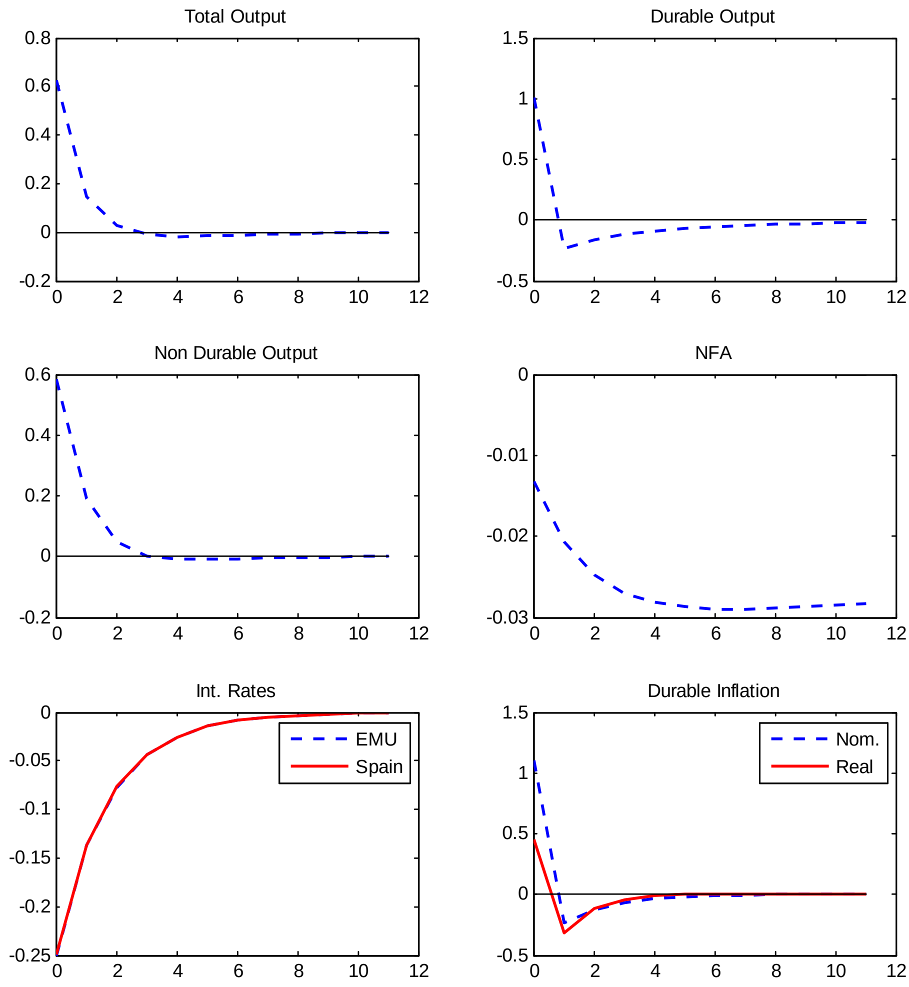

Figure 8: Impulse response to monetary policy shock. X axis: quarters after shock. Y axis: percent deviation from steady-state values.

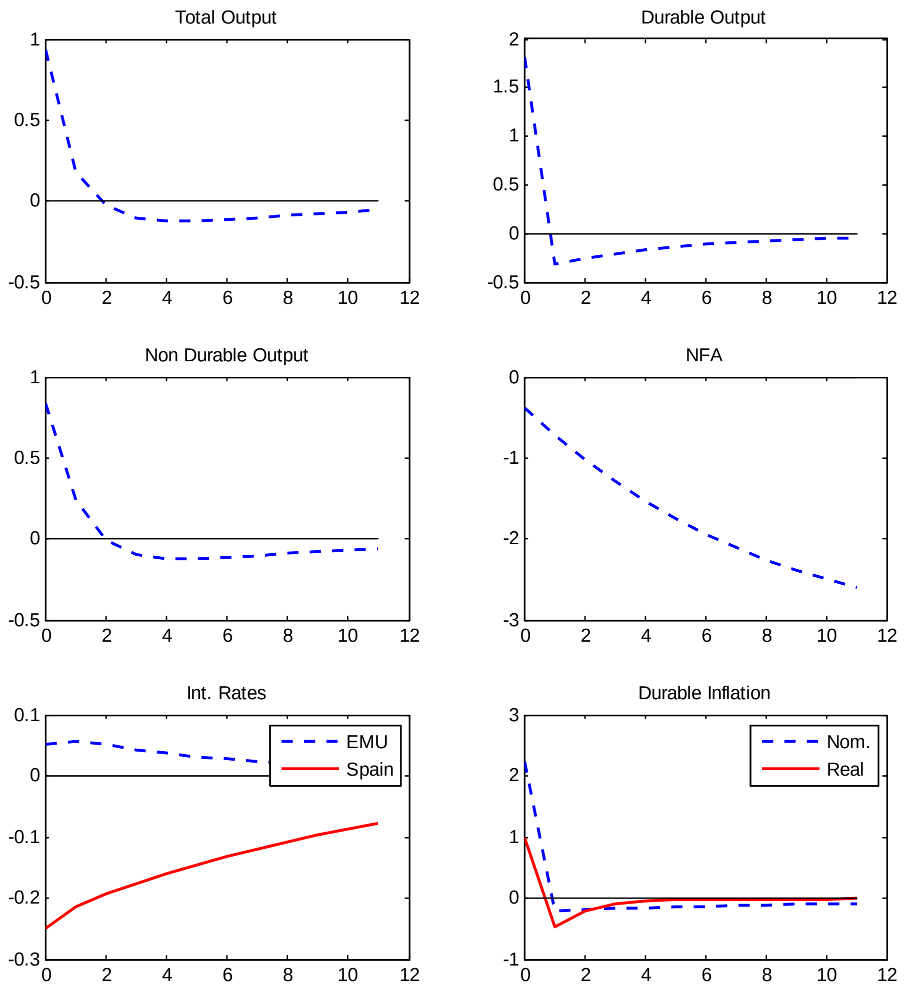

Figure 9: Impulse response to a risk premium shock. X axis: quarters after shock. Y axis: percent deviation from steady-state values.

was the case for the Euro Area-wide monetary policy shock. Therefore, a decline in risk premia does fit the Spanish experience fairly well.

4.2.2 Housing preference shock (ξ_t)

Next, we examine the effects of a housing preference shock. In their study of the US economy, Iacoviello and Neri (2008) conclude that these type of shocks explain a significant fraction of the volatility of house prices and residential investment. In the context of our model, one could see these demand pressures as stemming from population changes: increased immigration, the "baby boom" generation that in Spain peaked in the 1970s, and changes in social attitudes that reduce the number of persons per households.

The housing demand shock is normalized such that residential investment increases about 10 percent above its long-run value, and the shock has a persistence coefficient of 0.9. The preference shock in the durables sector leads to an increase in the relative price of durables. Given the small size of the Spanish economy with respect to the Euro area, interest rates barely react to the greater levels of inflation in the Spanish economy, allowing it to experience a long lived expansion in this sector together with moderate levels of inflation. Note also that non-durable output slightly decreases with the housing demand shock, which coincides with the VAR evidence presented above. We seek to understand this lack of comovement between the two sectors in the following subsection.

4.2.3 The effects of belonging to the EMU

As argued in the introduction, the capacity of the Spanish economy of reacting to idiosyncratic shocks was reduced substantially when joining the EMU due to the loss of monetary policy autonomy. To analyze the consequences of abandoning monetary policy independence, we extend the model of section 3 by assuming that both countries can run an autonomous monetary policy with different national currencies as units of account. We therefore introduce Taylor rules for both countries, an uncovered interest rate parity condition, and we assume producer currency pricing for imports and exports of non-durable goods, as in Lubik and Schorfheide (2005) and Rabanal and Tuesta (2007). The goal is to study how would a small open economy react in a two country model when faced with risk premia and housing demand

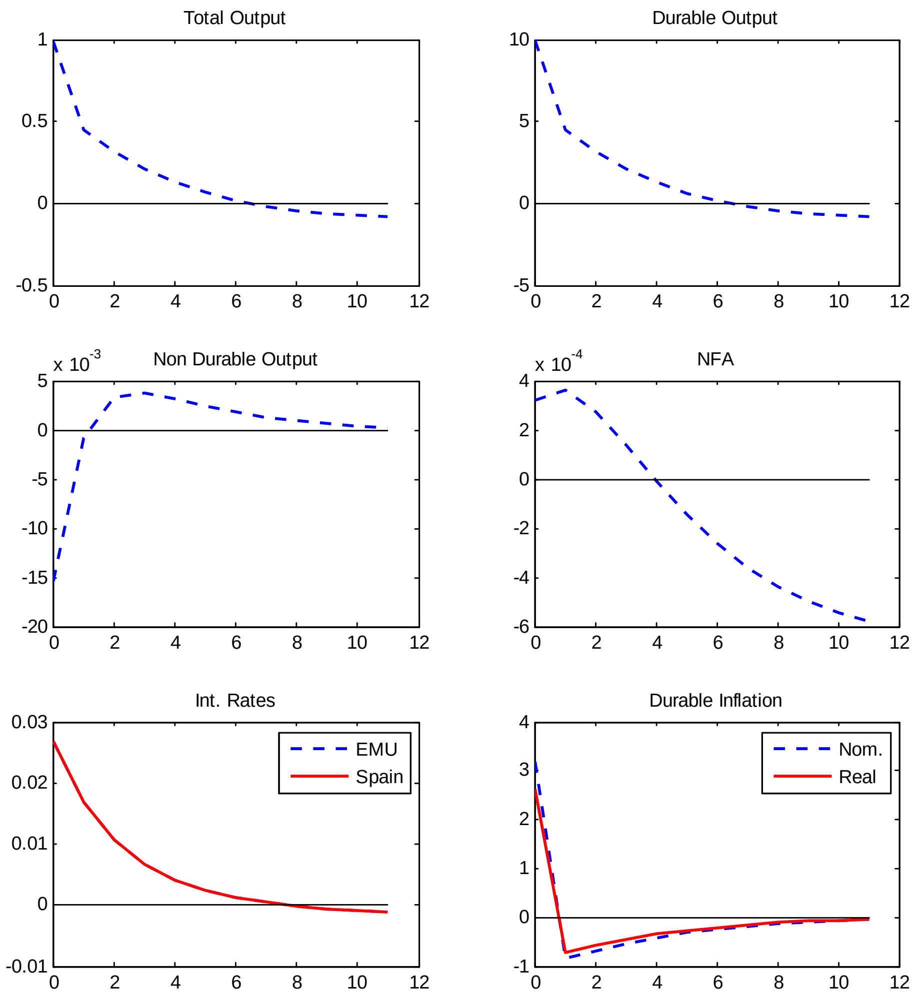

Figure 10: Impulse response to a housing preference shock. X axis: quarters after shock. Y axis: percent deviation from steady-state values.

shocks.

In log linear terms, the uncovered interest rate parity reads as follows:

$$r_t - r_t^* = E_t s_{t+1} - s_t - \kappa b_t - \vartheta_t \tag{35}$$

where s_t is the log of the nominal exchange rate, defined as units of home country currency per unit of foreign country currency. This equation links the interest rate differential to the expected depreciation of the currency, and also includes the endogenous risk premium depending on the net foreign asset position of the economy (b_t).

In this case, the domestic interest rate becomes r_t, while the foreign interest rate is r_t^*, and both follow Taylor rules targeting domestic inflation:

$$r_t = \gamma_R r_{t-1} + (1-\gamma_R)\gamma_\pi \Delta p_t + (1-\gamma_R)\gamma_s \Delta s_t \tag{36}$$
$$r_t^* = \gamma_R^* r_{t-1}^* + (1-\gamma_R^*)\gamma_\pi \Delta p_t^* \tag{37}$$

Note that we assume that the coefficients of the Taylor rule (γ_R and γ_π) are the same across countries. In addition, we consider that the home country can either run a pure float, or put some weight on exchange rate depreciation, which is controlled by the γ_s parameter. That is, the domestic country (Spain) could either run a purely domestic inflation targeting regime ($\gamma_s = 0$), or manage the exchange rate vis-à-vis the currency of the rest of the Euro Area by setting $\gamma_s > 0$. In the limiting case where $\gamma_s \to \infty$, the domestic country pegs the exchange rate with the foreign country, and the model would behave exactly like the one we have presented in section 3.

Finally, since we have assumed that there is producer currency pricing and the law of one price holds, durables inflation in both countries is given by:

$$\Delta p_t^C = \tau \Delta p_{H,t} + (1-\tau)(\Delta p_{F,t} + \Delta s_t) \tag{38}$$
$$\Delta p_t^{C^*} = (1-\tau^*)(\Delta p_{H,t} - \Delta s_t) + \tau^* \Delta p_{F,t} \tag{39}$$

such that movements in the nominal exchange rate affect directly the price of imports and exports.

In Figures 11 and 12 we compare the impulse response functions of the risk premium and housing demand shocks under three different exchange rate regimes: a fixed exchange rate, a pure floating inflation targeting regime and a managed floating regime. We use the same calibrations that we discussed in Table 1. When we refer to the "No EMU Pure float" we set the parameter to $\gamma_s = 0$, while in the "No EMU Man. float" we set the parameter to $\gamma_s = 1$.

The impulse response functions for a risk premium shock are shown in Figure 11. Under a pure float, a favorable (negative) risk premium shock increases the appetite for investment in assets denominated in the home country's currency, thereby pushing interest rates down and causing an appreciation. This worsens the terms of trade, implying that the price of exports increases and the price of imports falls, by a far larger amount than under the EMU or managed float cases. The fall of interest rates causes consumption in both durables and non-durables to expand, while the production of durables increases but the production of non-durables decreases due to the competitiveness loss. This causes aggregate output to fall as well. A large trade deficit emerges under a pure float, which causes the NFA position to worsen much more than under a managed float, or belonging to the EMU. Under a managed float regime output increases because the central bank does not allow such an appreciation to happen, preventing the deterioration of the termos of trade.

Under a housing demand shock of equal magnitude (Figure 12), the response of output is largest in the EMU. The small impact of this shock into the euro area economy produces no reaction of the monetary authority, and the Spanish economy experiences all the consequences of the shock: high growth in the durable sector, almost no effect in the non-durable sector, and moderate levels of inflation. On the contrary, in the "No-EMU pure float" case, since monetary policy is set at the local level, in response to the demand pressures the central bank increases the interest rates, causes an exchange rate appreciation, and output declines in the non-durable sector. However, inflation pressures are not high enough to force the Spanish monetary authoirty to increase the interest rates agressively, and hence the effects on total output do not differ much in either case.

Note that, by the same token, if prices where to collapse due to a negative housing demand shock, running an autonomus monetary would certainly be more helpful to stimulate the economy. However, the differences are quantitatively small. The

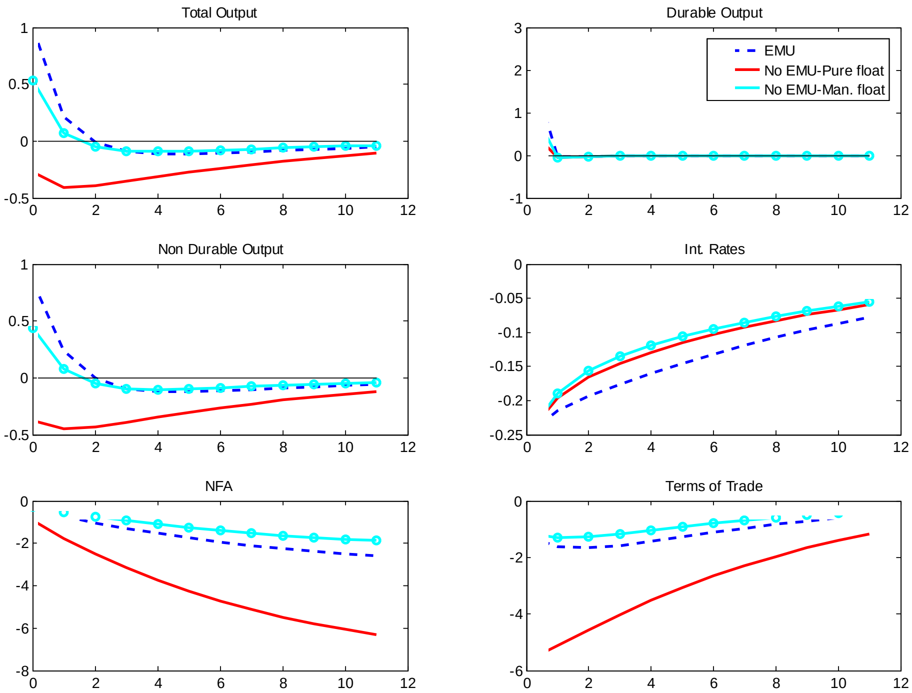

Figure 11: Impulse response to a risk premium shock. The effects of belonging to the EMU. X axis: quarters after shock. Y axis: percent deviation from steady-state values.

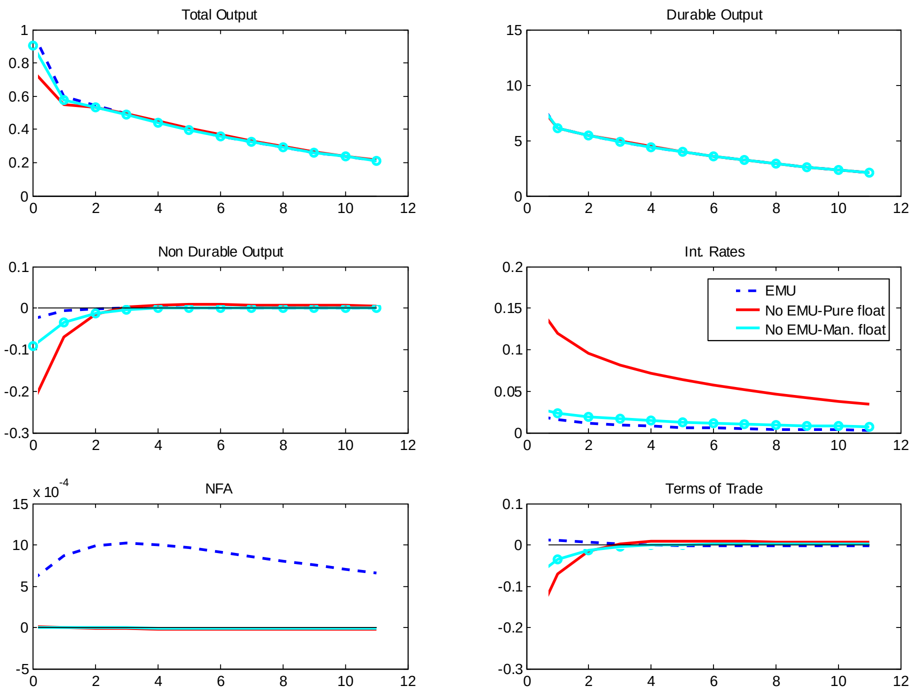

Figure 12: Impulse response to a housing demand shock. The effects of belonging to the EMU. X axis: quarters after shock. Y axis: percent deviation from steady-state values.

managed float is again an in-between of the two extreme case. At any rate, in all cases we are able to explain the lack of comovement, but the intensity is different depending on whether we model the small open economy as belonging to a currency area or running an autonomous monetary policy.

4.3 Robustness checks

4.3.1 The effects of financial frictions

As it has been widely argued in the literature, the presence of financial frictions might amplify the shocks to the economy since the consumption behaviour of credit constrained agents is especially dependent on changes of interest rates and durable good prices. For instance, Iacoviello and Neri (2008), Carlstrom and Fuerst (2006) and Monacelli (2006) have suggested that in order to explain a positive comovement between the two sectors it is crucial to introduce credit constraints into the model. Note, however, that we are able to explain the behavior of Spanish variables with a baseline model without credit constraints. One possible reason could be the low estimated marginal propensity to consume out of housing wealth in Spain (Bover, 2007).

To evaluate the importance of financial frictions we analyse how the impact of a monetary policy and housing preference shocks varies as the fraction of agents with limited borrowing capacity increases, and their pledging capacity changes. We extend the model of section 2 by assuming that a fraction $1 - \lambda$ of agents face credit constraints. In particular, we assume that these agents, which are typically labelled as *borrowers* in the literature (see Monacelli, 2006), are more impatient than the regular agents and have a smaller discount factor than the unconstrained agents of $\tilde{\beta} < \beta$. The maximum amount these households can borrow ($\tilde{S}_t^j$) is linked to their repayment capacity based on their housing collateral as follows:

$$\tilde{S}_t^j \leq (1 - \chi) E_t \left(\tilde{D}_t^j P_t^D \right) \tag{40}$$

where $(1 - \chi)$ is the loan-to-value ratio. We assume that the financially constraint households can borrow from unconstrained households within a country only, and that unconstrained households can borrow and lend at the national and international levels.

We present the impact effect of monetary and housing demand shocks as a function of λ and χ in Figures 13 and 14. All other parameter values are set to those in Table 1. We obtain similar results to those reported in the existing literature, in the sense that the response of both non-durables and durables output are substantially larger when financial frictions are tighter. By financial frictions being tighter we mean that either there is a larger fraction of credit constrained agents (lower λ) in the economy and/or their borrowing capacity is more restricted (higher χ). After a monetary policy shock, non-durable output always increases when financial frictions are present, with the impact effect depending in an important way on λ and χ. The effects on durable output are less dramatic, and they can be nonmonotonic with respect to λ when the loan-to-value ratio is high (χ is low). The consequences of having tighter financial frictions on output change critically when the model economy experiences a positive housing preference shock. Under our baseline calibration, non-durable output experiences a small decline after a positive housing demand shock, which coincides with the VAR evidence. However, as financial constraints become tighter, a positive comovement between durable and non-durable output emerges. Hence, we conclude that introducing financial constraints does not help the model explain the data. This result is of course Spain-specific, and is somewhat expected due to the low marginal propensity to consume out of wealth. It does not mean that financial frictions cannot be helpful to explain other countries' experiences.

4.3.2 The effect of labor market rigidities

The ι parameter in the model measures the degree of labor market rigidity in reallocating the labor force instantaneously across sectors. In the case that $\iota = 0$, which is the case analyzed by Monacelli (2006), labor can be reallocated across sectors freely. On the other hand, Iacoviello and Neri (2008) estimate a value of $\iota = 1$. Our benchmark calibration is in between, since we pick a value of $\iota = 0.5$. Given that the shocks that we are analysing imply substantial reallocation of the labor force across sectors, we study how the role of these rigidities alters the transmission mechanism. The reasons to study the interaction between labor and financial market frictions are two: first, we want to capture the importance of the reallocation rigidity across sectors that might arise as a result of the growing importance of the non-durable sector when the share of credit-constrained agents increases; second, it allows us to better grasp the relative importance that each friction plays in the transmission

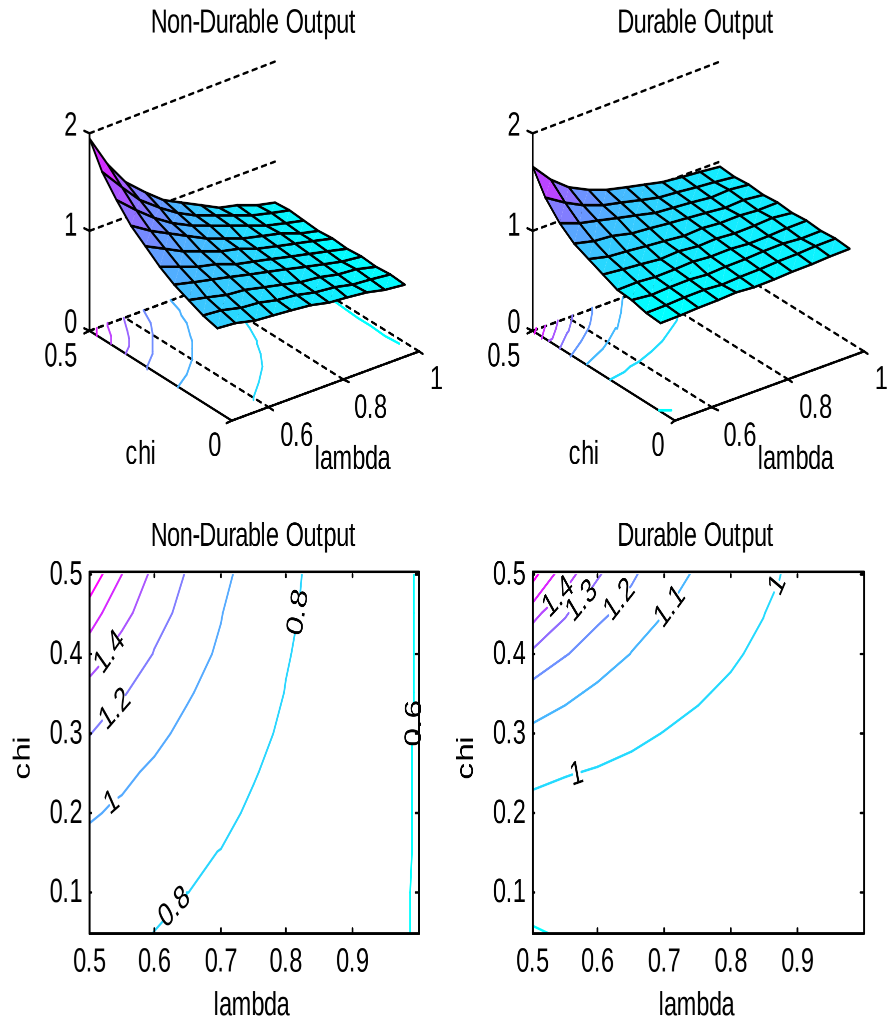

Figure 13: Impact response of a monetary policy shock. The role of financial frictions.

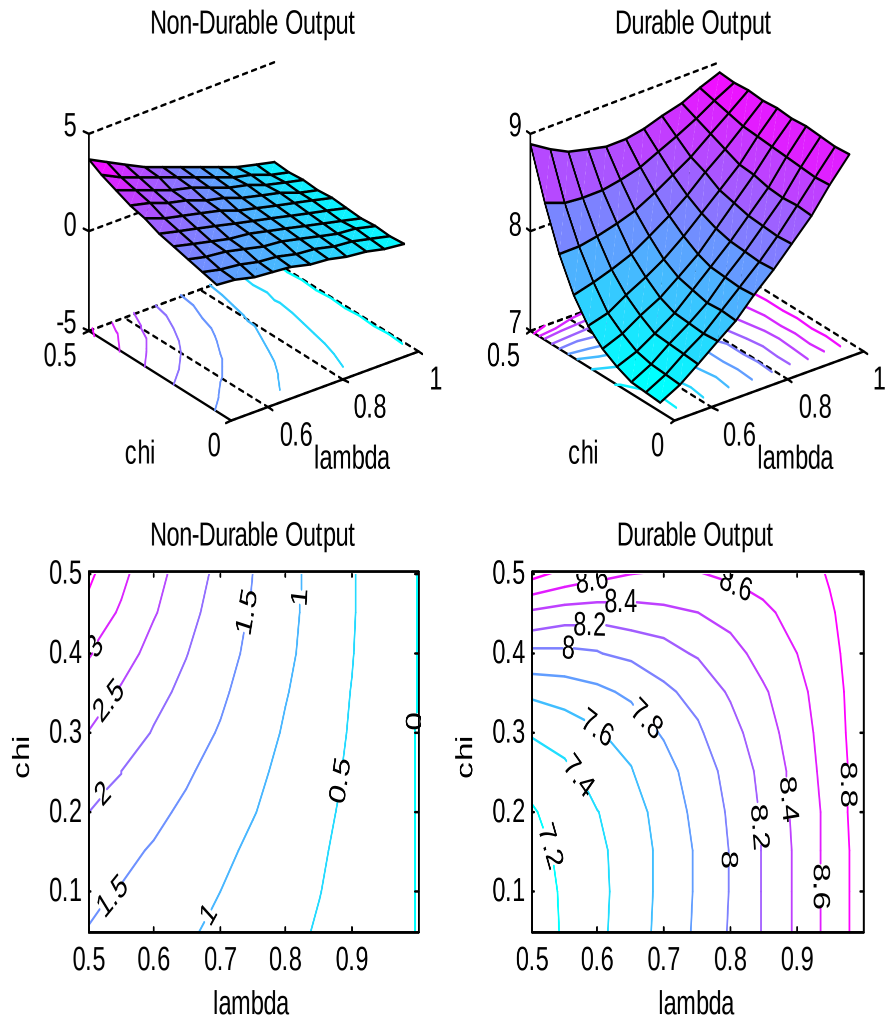

Figure 14: Impact response of a housing preference shock. The role of financial frictions.

mechanism of shocks.

In Figures 15 and 16 we repeat the same analysis than in Figures 13 and 14 in the (λ, ι) space, and setting $\chi = 0.25$. These figures show that, for both types of shocks, the effect of having a fully flexible labor market on durables output is quite remarkable, and it is far more important than any gain from a reduction of financial frictions. More concretely, if labor reallocation was costless, the response of investment in durable goods under either shock becomes highly volatile. On the other hand, the reponse of non-durable output decreases with more labor market flexibility under a monetary shock, and it is pretty much unaltered under a housing preference shock. Possibly, the fact the latter is 90 percent of the economy contributes to its relative stability. Note that our baseline calibration allows us to explain a positive comovement of variables under a monetary policy shock but a negative comovement under a housing demand shock. Using the value suggested by Iacoviello and Neri (2008) of $\iota = 1$ delivers a positive comovement under either shock contradicting our VAR evidence, while using the costless value suggested by Monacelli (2006) delivers too high volatility of durable output. Hence, it seems that to explain the evidence in Spain a lower degree of labor market rigidity is needed than in the US.

4.3.3 The Role of Nominal Rigidities

The higher price flexibility of the durable sector with respect to the non-durable sector documented by Bils and Klenow (2004) has tested the capacity of new Keynesian models to replicate the observed co-movement between the durable and non-durable sectors after a monetary policy shock. As argued by Calstrom and Fuerst (2007) and Monacelli (2006), if prices are flexible in one sector but sticky in the other, then a monetary policy contraction will imply that output falls in the sticky price sector but will increase in the flexible price sector, contradicting VAR evidence using US data. These papers suggest that introducing credit constraints and/or labor market rigidities might help solve the comovement problem even under heterogeneous degrees of nominal rigidity. Hence, we study how the impact of a monetary and demand shocks changes for different degrees of price rigidities in the context of our model.

In Figures 17 and 18 we plot how the effect of the model's shocks changes as we change the probability of the Calvo lottery in both sectors. The first result to notice is that we do not find a problem of lack of comovement under a monetary policy

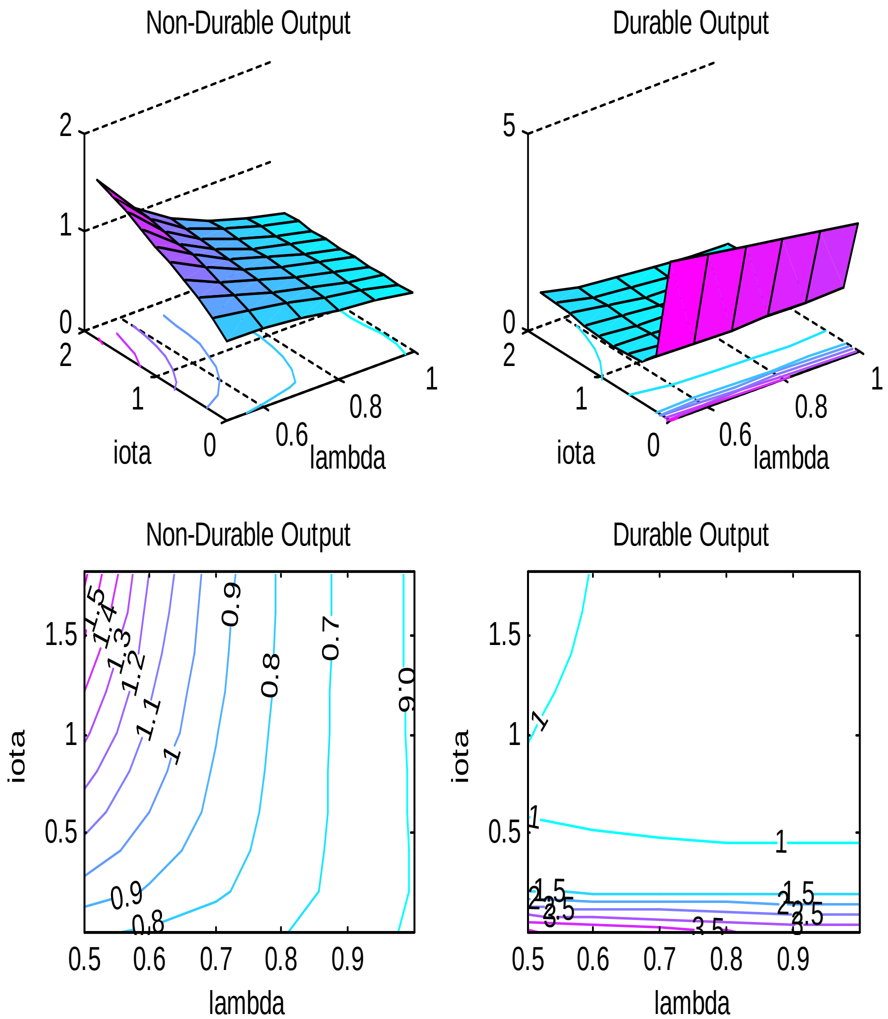

Figure 15: Impact response of a monetary policy shock. The role of financial and labor market frictions.

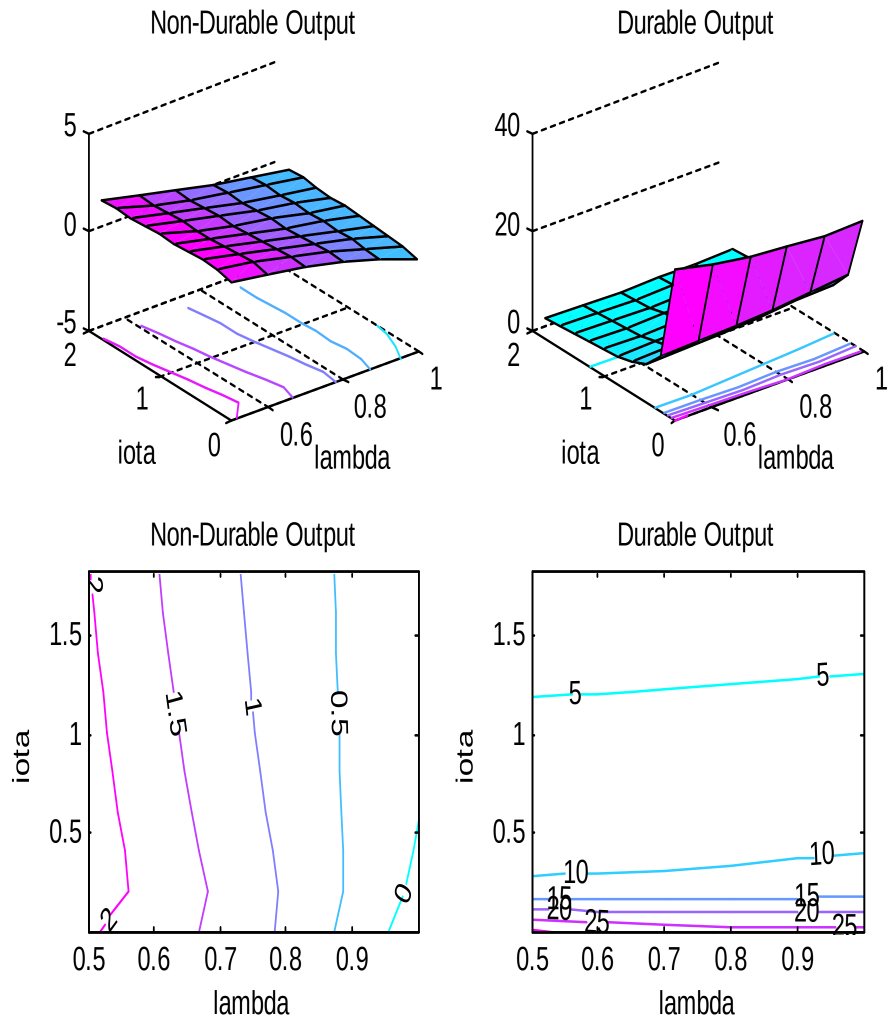

Figure 16: Impact response of a housing demand shock. The role of financial and labor market frictions.

shock: even when one sector is very flexible and the other is not, the response of both sectors to a monetary policy shock has the same sign. What is behind this result is the role of labor market rigidities: since labor reallocation is costly, there is no combination of parameters that deliver a "comovement problem". Actually, when we repeat the same exercise as in Figure 17 but with $\iota = 0$, we do find a "comovement problem" for some parameter combinations. On the other hand, we do find opposite signs in the response of the two sectors under a housing preference shock when the non-durable sector is very sticky and the durable sector is almost flexible: in this case, the relative price effect dominates the costly labor reallocation effect. Also, the effect of changing the degree of nominal rigidity in the durable sector θ_d is much more important than changing the degree of rigidity in the non-durable sector θ_c.

Overall, the conclusion to all the robustness exercises is that in the neighborhood of our calibration, the most important rigidities are the degree of nominal rigidity in the durable sector, and the degree of costly labor reallocation. Financial frictions and nominal rigidites play a stronger role in determining the quantitative results, but not the qualitative ones. Bayesian estimation of the model, which is the next step in our research agenda, will allow us to obtain a better grasp of which parameter estimates are necessary to explain, and how they differ from those estimated or calibrated for the United States, for instance.

5 Concluding Remarks

In this paper we have reviewed the recent evidence on interest rates, housing prices, residential investment and current account deficits in Spain. We have presented some evidence based on a VAR model, and then we have rationalized our findings with a two-country two-sector model with demand and monetary shocks. In particular, we have shown that declining risk premium in the convergence process with the partners in the euro area has fueled residential investment and the current account deficit. Positive housing demand shocks are also good candidates to explain part of the recent housing boom.

We have also examined the costs of losing monetary autonomy by belonging to a currency union. We conclude that the behavior of the Spanish economy under autonomous monetary policy, or by belonging to the euro area does not differ much

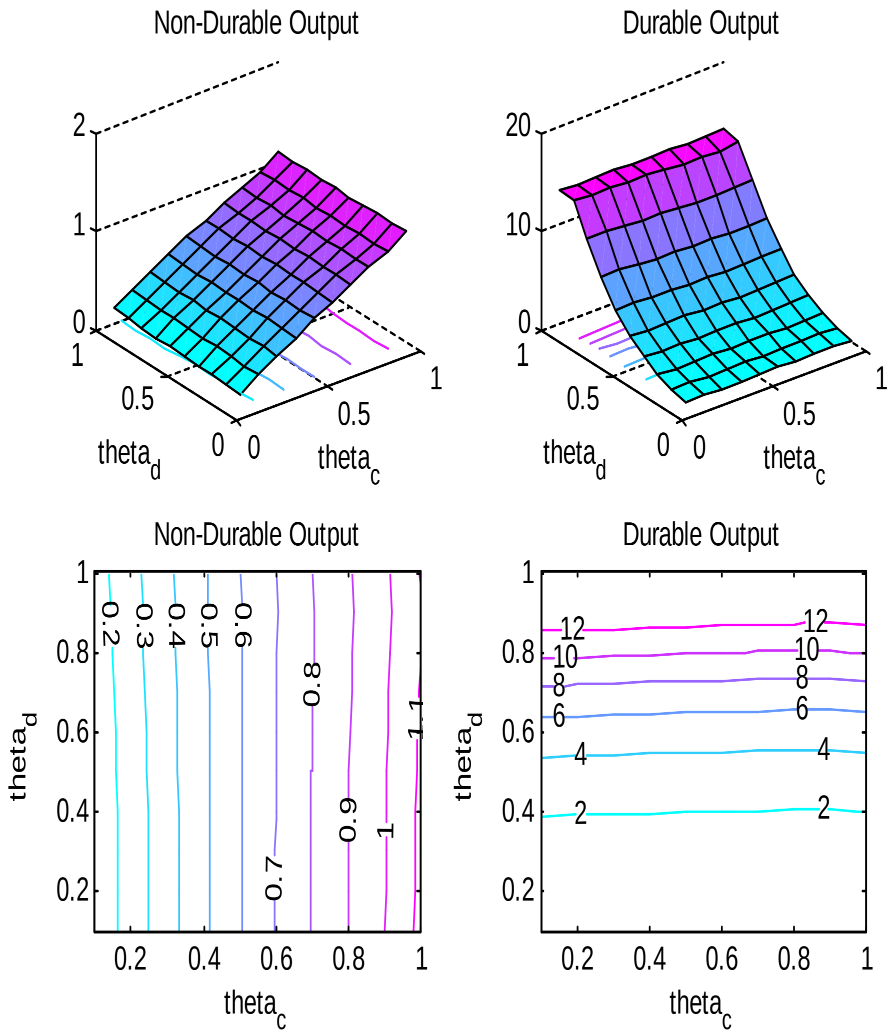

Figure 17: Impact response of a monetary policy shock. The role of nominal rigidities.

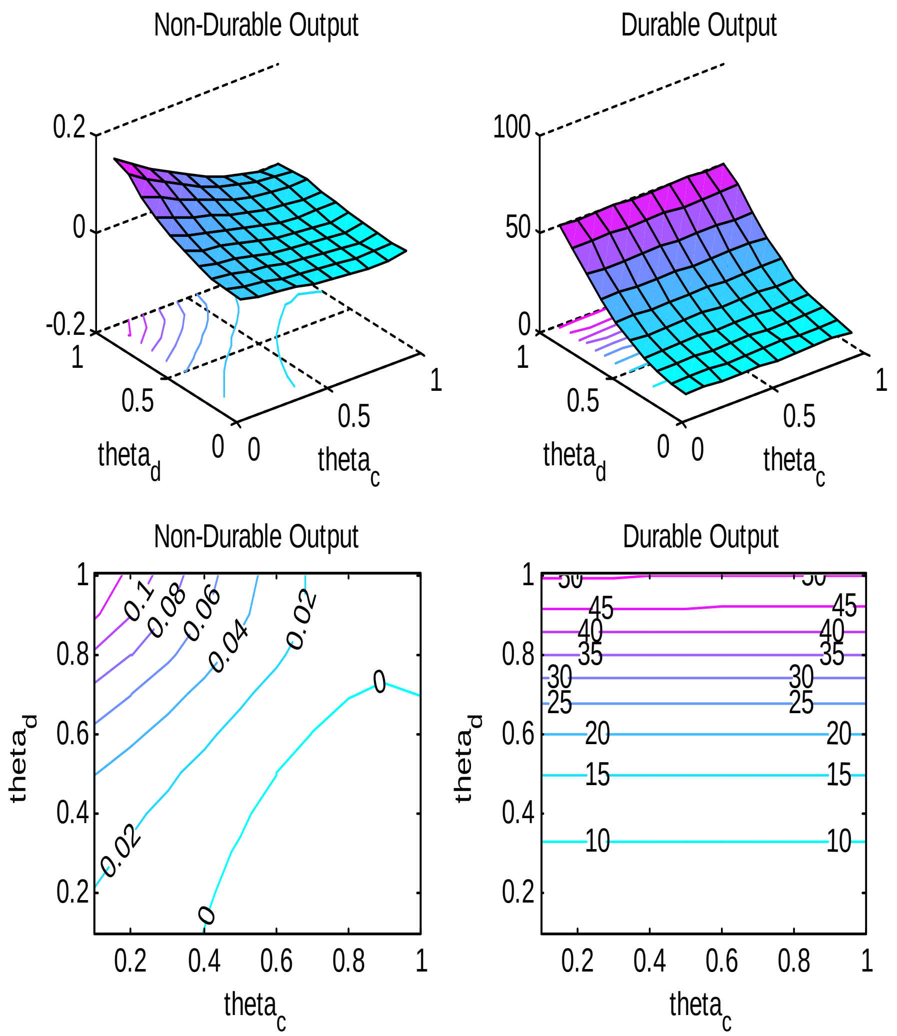

Figure 18: Impact response of a housing preference shock. The role of nominal rigidities.

when the economy faces a housing demand shock. The reason: even if the shock has important effects on output, Spanish inflation does not exceed moderate levels, and hence an inflation targeting monetary authority remains passive in either case. However, the ability to run autonomous monetary policy is important when the economy is hit by a risk premium shock. This shock produces first order effects to Spanish inflation and output, and the ability to run an independent monetary policy is fundamental to cushion them.

We have also examined the key features of the model driving the results. Out of all the mechanisms suggested in the literature, labor market rigidities appear to be very important to obtain the right comovement between the two sectors of the economy. The role of financial frictions are more related with increasing the response of non-durable goods output to both shocks, but this increase can also be achieved under other modelling assumptions.

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A Appendix: Linear approximation

Here we present the loglinear conditions. Also, we define the relative price of durables in terms of non-durables as $Q_t = \frac{P_t^D}{P_t^C}$, and the terms of trade as $T_t = \frac{P_{F,t}}{P_{H,t}}$. Also, ω_t^i denotes deviations from the real wage from steady-state values, defined as nominal wage (W_t^i) divided by the CPI (P_t), for $i = C, D$.

$$q_t = c_t - [1 - \beta(1-\delta)]\, d_t + \beta(1-\delta)E_t(q_{t+1} - c_{t+1}) + \xi_t \tag{41}$$

$$q_t = q_{t-1} + \Delta p_t^D - \Delta p_t^C \tag{42}$$

$$c_t = E_t c_{t+1} - (\tilde{r}_t - E_t \Delta p_{t+1}^C) \tag{43}$$

$$c_t + [(\varphi - \iota)\alpha + \iota]\, l_t^C + (\varphi - \iota)(1-\alpha) l_t^D = \omega_t^C + (1-\gamma) q_t \tag{44}$$

$$c_t + [(\varphi - \iota)(1-\alpha) + \iota]\, l_t^D + (\varphi - \iota)\alpha l_t^C = \omega_t^D + (1-\gamma) q_t \tag{45}$$

The relationship between the two nominal interest rates is as follows:

$$\tilde{r}_t = r_t - \bar{\kappa}\hat{b}_t + \vartheta_t \tag{46}$$

where $\hat{b}_t =(B_t/Y_tP_t)$ denotes the deviation of foreign assets as percent of GDP from its steady-state value of zero, and $\bar{\kappa} = \kappa\beta$. In practice we calibrate $\bar{\kappa}$ instead of κ and β separately.

The evolution of net foreign assets is:

$$\hat{b}_t = \frac{1}{\beta}\hat{b}_{t-1} + \frac{(1-n)(1-\tau^*)}{n}\left(c_{H,t}^* - t_t\right) - (1-\tau)c_{F,t} \tag{47}$$

The evolution of domestic and imported non-durable consumption is

$$c_{H,t} = (1-\tau)t_t + c_t \tag{48}$$

$$c_{F,t} = -\tau t_t + c_t \tag{49}$$

Here we list the evolution of the foreign country variables for households:

$$q_t^* = c_t^* - [1 - \beta^*(1-\delta)]\, d_t^* + \beta(1-\delta)E_t(q_{t+1}^* - c_{t+1}^*) \quad (50)$$

$$c_t^* = E_t c_{t+1}^* - (r_t - E_t \Delta p_{t+1}^{C^*}) \quad (51)$$

$$q_t^* = q_{t-1}^* + \Delta p_t^{D^*} - \Delta p_t^{C^*}. \quad (52)$$

$$c_t^* + [(\varphi^* - \iota^*)\alpha^* + \iota^*]\, l_t^{C^*} + (\varphi^* - \iota^*)(1-\alpha^*) l_t^{D^*} = \omega_t^{C,*} + (1-\gamma^*) q_t^* \quad (53)$$

$$c_t^* + [(\varphi^* - \iota^*)(1-\alpha^*) + \iota^*]\, l_t^{D^*} + (\varphi^* - \iota^*)\alpha^* l_t^{C^*} = \omega_t^{D,*} + (1-\gamma^*) q_t^* \quad (54)$$

$$c_{H,t}^* = \tau^* t_t + c_t^* \quad (55)$$

$$c_{F,t}^* = -(1-\tau^*) t_t + c_t^* \quad (56)$$

where we have used the definition of the terms of trade, the fact that $t_t = -t_t^*$, and the evolution of the terms of trade is given by:

$$t_t = t_{t-1} + \Delta p_t^F - \Delta p_t^H. \quad (57)$$

The consumer price indices are:

$$\Delta p_t = \gamma \Delta p_t^C + (1-\gamma)\Delta p_t^D \quad (58)$$

$$\Delta p_t^* = \gamma^* \Delta p_t^{C^*} + (1-\gamma^*)\Delta p_t^{D^*} \quad (59)$$

where

$$\Delta p_t^C = \tau \Delta p_{H,t} + (1-\tau)\Delta p_{F,t} \quad (60)$$

$$\Delta p_t^{C^*} = (1-\tau^*)\Delta p_{H,t} + \tau^* \Delta p_{F,t} \quad (61)$$

The production functions are given by:

$$y_t^C = l_t^C \quad (62)$$

$$y_t^D = l_t^D \quad (63)$$

$$y_t^{C^*} = l_t^{C^*} \quad (64)$$

$$y_t^{D^*} = l_t^{D^*} \tag{65}$$

And the pricing equations are given by

$$\Delta p_t^H - \varphi_C \Delta p_{t-1}^H = \beta E_t(\Delta p_{t+1}^H - \varphi_C \Delta p_t^H) + \kappa^C \left[\omega_t^C + (1-\gamma)q_t + (1-\tau)t_t\right] \tag{66}$$

where $\kappa^C = \frac{(1-\theta_C)(1-\beta\theta_C)}{\theta_C}$.

$$\Delta p_t^D - \varphi_D \Delta p_{t-1}^D = \beta E_t(\Delta p_{t+1}^D - \varphi_D \Delta p_t^D) + \kappa^D \left[\omega_t^D - \gamma q_t\right] \tag{67}$$

where $\kappa^D = \frac{(1-\theta_D)(1-\beta\theta_D)}{\theta_D}$.

$$\Delta p_t^F - \varphi_{C^*} \Delta p_{t-1}^F = \beta E_t(\Delta p_{t+1}^F - \varphi_{C^*} \Delta p_t^F) + \kappa^{C^*} \left[\omega_t^{C,*} + (1-\gamma^*)q_t^* - (1-\tau^*)t_t\right] \tag{68}$$

where $\kappa^{C^*} = \frac{(1-\theta_{C^*})(1-\beta\theta_{C^*})}{\theta_{C^*}}$.

$$\Delta p_t^{D^*} - \varphi_{D^*} \Delta p_{t-1}^{D^*} = \beta E_t(\Delta p_{t+1}^{D^*} - \varphi_{D^*} \Delta p_t^{D^*}) + \kappa^{D^*} \left[\omega_t^{D,*} - \gamma^* q_t^*\right] \tag{69}$$

where $\kappa^{D^*} = \frac{(1-\theta_{D^*})(1-\beta\theta_{D^*})}{\theta_{D^*}}$.

The market clearing conditions for the goods sectors read as follows:

$$y_t^C = \tau c_{H,t} + \frac{(1-n)(1-\tau^*)}{n} c_{H,t}^* \tag{70}$$

$$y_t^{C^*} = \tau^* c_{F,t}^* + \frac{n(1-\tau)}{1-n} c_{F,t} \tag{71}$$

$$d_t = (1-\delta)d_{t-1} + \delta y_t^D \tag{72}$$

$$d_t^* = (1-\delta)d_{t-1}^* + \delta^* y_t^{D^*} \tag{73}$$

while for the labor market it is:

$$l_t^{tot} = \alpha l_t^C + (1-\alpha) l_t^D \tag{74}$$

$$l_t^{tot,*} = \alpha^* l_t^{C^*} + (1-\alpha^*) l_t^{D^*} \tag{75}$$

To close the model, we specify a monetary policy Taylor rule conducted by the ECB:

$$r_t = \gamma_R r_{t-1} + (1-\gamma_R)(\Delta p_t^{EMU}) + \varepsilon_t^m \tag{76}$$

where the euro area CPI is given by

$$\Delta p_t^{EMU} = n\Delta p_t + (1-n)\Delta p_t^* \tag{77}$$