Housing Markets and Current Account Dynamics

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Abstract

I document a strong negative correlation, both across and within countries, between housing and current account dynamics. I use two methodologies to analyze three potential drivers of housing markets. First, in a quantitative two-country model, I input the dynamics of population, loan-to-value and housing price expectations that have been observed in the OECD economies since the mid 1990s. The model generates housing and current account dynamics very similar to the data. Second, I derive sign restrictions to identify the previous shocks in a vector autoregression. The results confirm the importance of housing demand shocks in driving both housing and current account dynamics.

JEL codes: E32, F32, F44, G28, R21
1 Introduction

During the last two decades, there has been considerable heterogeneity in the dynamics of housing markets and the current account in OECD economies. These dynamics have a strong negative correlation, both within and across countries. For example, countries like Spain or the U.S., among others, had large housing booms and current account deficits. Current account reversals coincided with a decline in housing markets. Meanwhile, residential investment and housing prices decreased in countries like Germany or Switzerland in the midst of large current account surpluses. Reductions in their surpluses coincided with an improvement in housing dynamics. I document these facts in Section 3. Then, I use two different methodologies to study three potential drivers of housing demand: population changes, relaxation of credit conditions that I proxy with loan-to-values, and housing price expectations.

First, I study a quantitative two-country model calibrated to match average patterns of advanced economies. I show that if we input into the model dynamics for population, loan-to-value (LTV) and housing price expectations similar to those observed in OECD economies since the mid 1990s, then the model generates dynamics for residential investment, housing prices, price-to-rent ratios, employment in construction, and the current account to GDP ratio that are very similar to the data, both in size and in timing. This exercise suggests that housing demand may have been a key driver of current account dynamics, both during the period of the Global Imbalances, in which several OECD countries accumulated large current account deficits, and during the sharp reversal of the deficits that took place after the housing collapse.

Moreover, this quantitative exercise highlights the crucial role of housing price expectations in housing markets. DSGE models of housing markets can only generate housing booms and busts patterns similar to the data if preference shocks for housing services play a relevant role. However, these shocks are problematic for at least two reasons: 1) they are reduced-form shocks; and 2) they cannot generate booms in the price-to-rent ratio, as an increase in the preference towards housing services increases demand for housing services from both renting and from homeownership. This paper shows that a pretty standard DSGE model can match housing dynamics if it gets the housing price expectations right, which I input from survey data. Thus, DSGE models of housing markets may be failing to explain housing dynamics because they fail to match housing price expectations.

As a complement to the quantitative model, I study the same questions with structural vector autoregressions (SVARs) identified with sign restrictions. I derive restrictions that allow me to identify shocks to population, LTV and housing price expectations. These restrictions ensure

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1I discuss the literature in the next Section.
that the identified shocks are different from other alternative explanations such as productivity, monetary policy or savings glut shocks. The results from a sample of OECD economies confirm the importance of the three housing demand drivers in explaining both housing and current account dynamics.

The paper proceeds as follows. Section 2 discusses the related literature. Section 3 documents three facts about housing and current account dynamics. Section 4 describes the model and Section 5 the calibration. Section 6 discusses the quantitative exercise. Section 7 estimates the SVARs. Section 8 concludes.

2 Related Work

This paper is related to two broad literatures. On one side, it is related to the literature on the dynamics of housing markets, and on the other, to the literature about the Global Imbalances.

The paper makes two contributions to the literature on the dynamics of housing markets. First, it shows that DSGE models of housing markets do not need shocks in housing preferences if they get the dynamics of housing price expectations right.\(^2\) Davis and Heathcote (2005) were the first to highlight the inability of a representative agent model to match housing price booms with standard productivity shocks. Kahn (2008) shows that a model in which agents learn about productivity growth cannot generate the observed large swings in housing markets. Aspachs-Bracons and Rabanal (2010) and Iacoviello and Neri (2010) showed that estimated DSGE models could only explain the dynamics of housing markets if shocks to the preferences for housing services played a substantial role. Liu et al. (2013) obtained the same result in a model in which firms, instead of households, are credit constrained. Justiniano et al. (2014) confirmed the result in a calibrated model in which they compare LTV shocks and house preference shocks. LTV shocks fall short of explaining housing dynamics, a result also shown by Kiyotaki et al. (2011). Garriga et al. (2012) show that a model of perfect foresight of interest rates and LTV shocks cannot generate the recent large swings in housing dynamics observed in the U.S. To fully match housing dynamics, their model needs continuous surprises to the agents’ expectations of interest rates and LTV. In this paper, I show that those continuous surprises are not needed, and that a perfect foresight model can match both housing booms and busts if it matches the expectations of housing prices. Moreover, the model can explain

\(^2\)The literature on heterogeneous agents has been more successful in explaining housing booms. See for example Favilukis et al. (2010) or Chu (2014).
the dynamics of both housing prices and the price-to-rent ratio. Garriga et al. (2012) showed
the importance of focusing on both variables since some models can explain the dynamics of
the price-to-rent ratio but fail with the dynamics of both prices and rents.

This paper provides quantitative support to a growing literature that focuses on the role of
expectations in housing markets. For example, Piazzesi and Schneider (2009) use a search model
to analyze the influence of optimistic traders in housing markets. Burnside et al. (2011) develop
a model with heterogenous expectations about future fundamentals. Gelain and Lansing (2014)
show that a standard asset pricing model in which agents use moving-average forecast rules can
match the volatility and persistence of the U.S. price-rent ratio, as well as other quantitative
and qualitative features of the data. Kashiwagi (2014) study a search model with sunspot-
driven equilibria. Kuang (2014) presents a model in which Bayesian learning about housing
prices can endogenously generate self-reinforcing booms and busts in housing prices. Williams
(2013) shows that a model of learning about fundamentals can create a sustained rise in housing
prices that deviates substantially from true fundamentals. Cheng et al. (2013), Foote et al.
(2012), Ling et al. (2013), Soo (2013), and Van der Cruijsen (2014), among others, provide
evidence that homebuyers’ beliefs played a key role in recent housing dynamics.

Second, this paper contributes to the literature that has used SVARs to analyze housing
markets. For example, Lastrapes (2002) and Musso et al. (2011) use short or long run restric-
tions to identify monetary shocks in housing markets. Vargas-Silva (2008) identifies monetary
shocks with sign restrictions. Sign restrictions have not been used much to study housing mar-
kets, even if this methodology is increasingly popular in the study of the dynamics of different
shocks, such as fiscal, monetary, news or technology shocks. Sa and Wiedalek (2014) used sign
restrictions to identify monetary and savings glut shocks. Bian and Gete (2014) study housing
dynamics in China identifying TFP, population, savings gluts, preference and credit shocks.

Concerning the literature on the Global Imbalances, this paper complements alternative
theories. For example, Caballero et al. (2008) model the savings glut hypothesis proposed by
Bernanke (2005). Broer (2014) studies models in which higher income risk can explain the
observed fall in the U.S. asset position. Fogli and Perri (2006) show that reductions in aggre-
gate volatility caused by the “Great Moderation” could have reduced precautionary savings in
the U.S. more than in other countries, and caused a current account deficit. Mendoza et al.
(2009) attribute the current account imbalances to financial globalization among countries with
idiosyncratic risks and heterogeneous domestic financial markets. Housing demand is an inter-
esting complementary explanation because it can account for the heterogeneity in the current

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3See for example, among others, Canova and Nicolo (2002), Charnavoki and Dolado (2014), or Fratzscher
and Straub (2013).
account positions of countries with similar levels of financial development. Models focused on U.S.-specific factors have trouble explaining why the dynamics of the U.S. current account have been so similar to other developed economies.

There are a few papers that address the link between housing markets and the Global Imbalances. Aizenman and Jinjarak (2013), and this paper, are the first papers to document and study the strong correlation between housing and current account dynamics both during the housing boom and bust periods. Aizenman and Jinjarak (2013) is a panel regression study that shows that the most significant variable in accounting for real estate valuation changes is the lagged real estate valuation appreciation, followed by lagged declines of the current account to GDP ratio. Other papers have focused on the correlation between housing and the current account during the housing boom. Gete (2009) documents the correlation during the booms, and theorizes that input reallocation between tradable and non-tradable sectors may help in explaining why housing demand can generate trade deficits. Matsuyama (1990) theoretically studies the current account consequences of income effects on residential investment. Laibson and Mollerstrom (2010) relate housing and current account dynamics assuming a behavioral bubble and aggregate wealth effects. Adam et al. (2011) study a small open economy asset pricing model with a collateral constraint in which Bayesian learning about housing prices amplifies the effects of interest rate cuts. Punzi (2013) studies business cycle simulations of a two-country version of the Iacoviello (2005) model of housing collateral effects. Also, using a two-country version of Iacoviello (2005), Ferrero (2013) focuses on impulse responses to monetary policy and LTV shocks. To maximize the collateral channel, he assumes that all agents in the domestic economy are constrained. Justiniano et al. (2014b) and Favilukis et al. (2012) study the effects of global imbalances on housing markets. Favilukis et al. (2012) argue that changes in international capital flows played, at most, a small role in driving housing price movements in the recent years and that, instead, the key causal factor was a financial market liberalization and its subsequent reversal. Justiniano et al. (2014b) claim that foreign capital flows account for between one fourth and one third of the increase in U.S. housing prices.

3 Some Facts about Housing and Current Account Dynamics

In this Section I document three facts that motivate the remainder of this paper. First, as Figure 1 illustrates, several OECD economies have had large and persistent current account deficits since the mid 1990s. Most current account deficits have decreased significantly since
2006. The U.S. is not a special case; its current account dynamics have been similar to those of several other countries.

Second, there has been substantial heterogeneity in both the current account and housing dynamics of developed economies. For example, countries like Spain or the U.S. have had large increases in residential investment, housing prices and employment in construction since the mid 1990s to around 2006. Meanwhile, real housing prices and residential investment decreased in countries like Germany or Switzerland, among others. The dynamics reversed after 2006, when housing markets collapsed in countries like Spain or the U.S. and started to rise in the countries that did not experience a boom in the previous decade. The x-axis in Figure 2 shows the wide heterogeneity in housing dynamics among OECD countries. The y-axis shows the heterogeneity in the dynamics of the current account to GDP ratio.

Third, changes in housing dynamics have a strong negative correlation with changes in current account dynamics, both within and across countries. The strong correlation holds both during the period of housing booms (mid 1990s to around 2006), and during the period of housing busts (2007-2012). Figure 2 shows the cross-country correlations. Figure 3 focuses on the within-country correlations. The left column of Figure 2 contains scatterplots of changes in housing variables and changes in the current account ratios between 1996 and 2006, while the right column redoes the scatterplots for the period from 2007 through 2012. Housing variables and the current account had monotonic behavior between these dates. Countries that experienced housing booms also had larger current account deficits. Moreover, the current account reversals coincided with the decline in housing markets.\footnote{Anecdotal evidence suggests that emerging markets also followed the patterns reported in Figure 3.} The heterogeneity within Europe is especially interesting, because the European Union as a whole had a nearly balanced current account.

4 Model

There is a domestic and a foreign country. In both countries, there is a housing sector, which is non-tradable, and a sector producing tradable goods. All trade between countries is intertemporal since there is only one tradable good.
4.1 Domestic Households

At period $t$ there is a mass $N_{d,t}$ of domestic households facing an infinite time horizon who can be patient or impatient. These two types differ in three dimensions: 1) The discount factor for the patient households is larger than the discount factor for the impatient households ($\beta_p > \beta_i$). This is a standard mechanism to allow for credit relations in which the impatient household will borrow from the patient household (Iacoviello 2005). 2) The impatient households face a collateral constraint that limits their borrowings to a fraction of the discounted expected value of the houses they hold. 3) Patient domestic households have access to two types of one-period bonds: an international bond, $\hat{B}$, with real interest rate $\hat{R}$, to borrow or save with the foreign households; and domestic bonds, $B$, with real interest rate $R$ to lend to the domestic impatient households. A non-arbitrage condition governs the relation between the two types of bonds. The impatient domestic households can only borrow from the domestic patient households. This is a simplifying assumption without loss of generality. As I will discuss, the impatient domestic households borrow from the domestic patient households, but also from the foreign households through the domestic patient households, who in that regard behave as financial intermediaries.

Households supply labor inelastically in their home country. The parameter $\phi$ controls both the share of impatient households over the total domestic population, and their share in the income of the domestic country. That is, in every period in the domestic country, there are $(1 - \phi)N_{d,t}$ patient households, and $\phi N_{d,t}$ impatient households. The total population of the domestic country, $N_{d,t}$, can change over time to analyze how population dynamics affect housing markets.

4.1.1 Domestic Patient Households

There is a representative domestic patient household that maximizes the expected utility of its members

$$E_0 \sum_{t=0}^{\infty} \beta_p^t (1 - \phi) N_{d,t} u \left( c_{d,t}^p, h_{d,t}^p \right),$$

where $c_{d,t}^p$ and $h_{d,t}^p$ are the per capita consumption of tradable goods and housing. The flow of housing consumption is equal to the per capita stock of housing. Preferences are constant relative risk aversion over a constant elasticity of substitution aggregator of housing services.
and tradable goods consumption

\[ u(c^p_{d,t}; h^p_{d,t}) = \frac{\left[ (1 - \theta) \left( c^p_{d,t} \right)^{\frac{1}{\theta}} + \theta \left( h^p_{d,t} \right)^{\frac{1}{\theta}} \right]^{\frac{1}{1-\frac{1}{\theta}}}}{1 - \frac{1}{\theta}}, \quad (2) \]

where \( \sigma \) is the elasticity of intertemporal substitution as well as the inverse of the coefficient of relative risk aversion. \( \varepsilon \) is the static, or intratemporal, elasticity of substitution between housing and tradable goods consumption. \( \theta \in (0, 1) \) is a parameter that affects the share of consumption of housing services in total expenditure.

By multiplying per capita values by the number of patient households, I obtain the aggregates for the domestic patient households: \( C^p_{d,t} = (1 - \phi) N_{d,t} c^p_{d,t} \), \( H^p_{d,t} = (1 - \phi) N_{d,t} h^p_{d,t} \), \( B^p_{d,t} = (1 - \phi) N_{d,t} b^p_{d,t} \), and \( \hat{B}_{d,t} = (1 - \phi) N_{d,t} \hat{b}_{d,t} \). \( b_{d,t} \) are the patient households’ per capita holdings of the international bond, and \( b^p_{d,t} \) are the per capita holdings of domestic bonds.

The budget constraint for the representative domestic patient household is

\[ C^p_{d,t} + B^p_{d,t} + \hat{B}_{d,t} + q_{d,t} \left( H^p_{d,t} - (1 - \delta) H^p_{d,t-1} \right) + (1 - \phi) N_{d,t} \frac{\psi_B}{2} \hat{b}^2_{d,t} = R_{t-1} B^p_{d,t-1} + \hat{R}_{t-1} \hat{B}_{d,t-1} + (1 - \phi) I_{d,t}, \quad (3) \]

where \( q_{d,t} \) is the price of a domestic house in terms of tradable goods, \( \delta \) is the house depreciation rate, \( R_t \) is the domestic gross real interest rate, \( \hat{R}_t \) is the international gross real interest rate, \( I_{d,t} \) is a households’ income (to be defined below), \( \psi_B \) is the parameter that controls the adjustment costs in the holdings of international bonds. Later on I will compare the price of a house with the price of a unit of housing flow (the rental price). I use the adjustment costs to ensure that there is a unique steady state; this is a standard mechanism to close international models with incomplete markets (Schmitt-Grohe and Uribe 2003, Boileau and Normandin 2008).

From the first order conditions of the domestic patient households, I can derive the non-arbitrage restriction between the return of the two bonds:

\[ R_t \left[ 1 + \psi_B \hat{b}_{d,t} \right] = \hat{R}_t. \quad (4) \]

Both bonds give the same return \( R_t = \hat{R}_t \) when the adjustment cost goes to zero, and in the steady state.
4.1.2 Domestic Impatient Households

The representative domestic impatient household maximizes the expected utility of its members

\[
E_{0} \sum_{t=0}^{\infty} \beta_{t}^{i} \phi N_{d,t} u(c_{d,t}^{i}, h_{d,t}^{i}),
\]  

where all variables are as defined for the patient household, but now they have the superscript of the impatient household. I assume that \( \beta_{t} < \beta_{p} \). The aggregate variables for the impatient households are \( C_{d,t}^{i} = \phi N_{d,t} c_{d,t}^{i} \), \( H_{d,t}^{i} = \phi N_{d,t} h_{d,t}^{i} \) and \( B_{d,t}^{i} = \phi N_{d,t} b_{d,t}^{i} \).

The representative domestic impatient household chooses per capita housing, tradable consumption, and domestic bond holdings \((b_{d,t}^{i})\) to maximize (5) – (6) subject to the aggregate budget constraint:

\[
C_{d,t}^{i} + B_{d,t}^{i} + q_{d,t} (H_{d,t}^{i} - (1 - \delta) H_{d,t-1}^{i}) = R_{t-1} B_{d,t-1}^{i} + \phi I_{d,t}. \tag{7}
\]

Impatient households’ per capita borrowings cannot be larger than a fraction \( m_{t} \) of the discounted future value of their current houses. That is,

\[
b_{d,t}^{i} \geq \frac{-m_{t} E_{t} (g_{d,t+1} h_{d,t}^{i})}{R_{t}}. \tag{8}
\]

4.2 Domestic Firms

Firms use labor to produce tradable goods \((Y_{T_{d,t}})\). They use labor and land \((L_{d})\) to produce non-tradable housing structures \((Y_{sd,t})\). Then firms use housing structures and housing appliances \((Y_{ad,t})\) to produce new houses \((Y_{hd,t})\). Tradable goods \((Y_{T_{d,t}})\) can be used for consumption by households in both countries, or as housing appliances. That is, a share of \( Y_{T_{d,t}} \) can be used as \( Y_{ad,t} \). The production functions are:

\[
Y_{T_{d,t}} = N_{T_{d,t}}^{\alpha}, \tag{9}
\]

\[
Y_{sd,t} = \left[ N_{sd,t}^{\alpha} \right]^{\gamma} L_{d}^{1-\gamma}, \tag{10}
\]

\[
Y_{hd,t} = \min (Y_{sd,t}, \tau Y_{ad,t}), \tag{11}
\]

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where $\alpha$, $\gamma$, $\tau$ and $L_d$ are constants. $N_{T_d,t}$ and $N_{sd,t}$ are the domestic labor allocated to tradable goods and the housing sector, respectively. I assume that the structures are non-tradable. Appliances ($Y_{ad,t}$) are the tradable goods used to produce a house. Equation (10) captures that land plays a role in the production of housing. The Leontief assumption in (11) captures the complementarities between tradable and non-tradable goods in producing houses. It implies that, in equilibrium, $Y_{sd,t} = \tau Y_{ad,t}$.

The firm decides how to allocate labor across productive sectors. There is a quadratic adjustment cost ($\psi_n$) to moving labor across sectors. The cost is paid in units of tradable goods. In equilibrium, the value of one unit of labor must be equal across sectors. Since the domestic households own the firm and the land, households’ income is the total revenue of the firms:

$$I_{d,t} = q_{d,t}Y_{hd,t} + Y_{T_d,t} - Y_{ad,t} - \frac{\psi_n}{2} (N_{sd,t} - N_{sd,t-1})^2.$$  

(12)

4.3 Foreign Country

To simplify, I assume there are only patient unconstrained households in the foreign country. Their representative agent maximizes the expected utility of its members

$$E_0 \sum_{t=0}^{\infty} \beta_t^p N_{f,t} u(c_{f,t}, h_{f,t}),$$  

(13)

$$u(c_{f,t}, h_{f,t}) = \frac{[\theta (c_{f,t}^{-\sigma} + \theta h_{f,t}^{-\sigma})]^{1-\frac{1}{\sigma}}}{1 - \frac{1}{\sigma}}.$$  

(14)

As before, the aggregate variables for the foreign households are $C_{f,t} = N_{f,t}c_{f,t}$, $H_{f,t} = N_{f,t}h_{f,t}$ and $\hat{B}_{f,t} = N_{f,t}\hat{b}_{f,t}$.

The representative foreign household chooses per capita consumption of tradable goods, non-tradable foreign housing, and international bonds ($\hat{b}_{f,t}$) to maximize (13) – (14) subject to her aggregate budget constraint:

$$C_{f,t} + \hat{B}_{f,t} + q_{f,t} (H_{f,t} - (1 - \delta) H_{f,t-1}) + N_{f,t} \frac{\psi_B}{2} \hat{b}_{f,t}^2 = \hat{R}_{t-1} \hat{B}_{f,t-1} + I_{f,t}.$$  

(15)
Foreign firms have the same technology as domestic firms:

\[ Y_{Tf,t} = N_{Tf,t}^\alpha, \]
\[ Y_{sf,t} = \left[N_{sf,t}^\alpha \right]^\gamma F_1^{-\gamma}, \]
\[ Y_{hf,t} = \min(Y_{sf,t}, \tau Y_{af,t}), \]

where \( N_{Tf,t} \) and \( N_{sf,t} \) are the amounts of labor allocated to tradable goods and the housing sector in the foreign country. The income of foreign households is the total revenue of the foreign firms:

\[ I_{f,t} = q_{f,t} Y_{hf,t} + Y_{Tf,t} - Y_{af,t} - \frac{\psi_\alpha}{2} (N_{sf,t} - N_{sf,t-1})^2. \]

### 4.4 Market Clearing

Labor is mobile between the sectors of each country but not internationally:

\[ N_{Td,t} + N_{ad,t} = N_{d,t}, \]
\[ N_{Tf,t} + N_{sf,t} = N_{f,t}. \]

The increase in the housing stock of each country is the new houses produced minus the depreciation,

\[ H_{d,t}^i + H_{d,t}^p - (1 - \delta) \left( H_{d,t-1}^i + H_{d,t-1}^p \right) = Y_{hd,t}, \]
\[ 1 - \delta \right) H_{f,t-1} = Y_{hf,t}. \]

 Tradable goods are used for consumption, and to pay for the portfolio adjustment costs

\[ C_{d,t}^p + C_{d,t}^i + C_{f,t} = \]
\[ = Y_{Td,t} - Y_{ad,t} - (1 - \phi) N_{d,t} \frac{\psi B_{d,t}}{2} b_{d,t}^2 + Y_{Tf,t} - Y_{af,t} - N_{f,t} \frac{\psi B_{f,t}}{2} b_{f,t}^2. \]

The net supply of domestic bonds between the patient and impatient households equals zero,

\[ B_{d,t}^p + B_{d,t}^i = 0. \]
The net supply of international bonds between the two countries equals zero,

$$\dot{B}_{d,t} + \dot{B}_{f,t} = 0.$$  \tag{26}

The trade balance and the current account in the domestic country are

$$TB_{d,t} = Y_{T_{d,t}} - Y_{ad,t} - C^p_{d,t} - C^i_{d,t} - (1 - \phi) N_{d,t} \frac{\psi_B}{2} \left( \dot{b}_{d,t} \right)^2 - \frac{\psi_n}{2} (N_{sd,t} - N_{sd,t-1})^2; \tag{27}$$

$$CA_{d,t} = \dot{B}_{d,t} - \dot{B}_{d,t-1}. \tag{28}$$

## 5 Calibration

I calibrate the model using aggregate and micro data from OECD countries, although for some series only U.S. data were available. Some parameters are exogenously selected based on values that are common in the literature or on micro-evidence. The other parameters are selected for the steady state of the model to match some key statistics. In the steady state there is no international debt ($\dot{B}_d = 0$). I assume that one period in the model is one year.

1. **Exogenously selected parameters.** For the intertemporal elasticity of substitution ($\sigma$), I follow the real business cycle literature that usually assumes $\sigma = \frac{1}{2}$, which under CRRA preferences implies a value for risk aversion of 2. Concerning the elasticity of substitution between consumption of goods and housing services, several recent papers have argued for elasticities below one, implying complementarity between tradable goods and housing services. For example, Davidoff and Yoshida (2008) obtain estimates for this elasticity ranging from 0.4 to 0.9. Kahn (2008) provides evidence based on both aggregate and microeconomic data that is less than one. Lustig and Van Nieuwerburgh (2006) use 0.05 to match the volatility of U.S. rental prices in an asset pricing model with housing collateral. Flavin and Nakagawa (2002) estimate 0.13 between housing and nondurable consumption (proxied by food consumption at home and eaten out). Since a key element of housing in my model is its nontradability, I work with $\varepsilon = 0.4$, a value close to the estimate in Tesar (1993) that the elasticity between traded and nontraded goods is 0.44.

I assume the same labor share across sectors and set it to the standard $\alpha = 0.67$. For the depreciation of the stock of houses, I use 2% annual depreciation, $\delta = 0.02$, which is consistent with the report from the Bureau of Economic Analysis (2004) that annual depreciation rates for one-to-four-unit residential structures are between 1.1% and 3.6%.

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2. **Endogenously selected parameters.** I set the discount factor of the patient households to $\beta^p = 0.97$ to target a 3% annual real interest rate in the steady state. As discussed in Iacoviello and Neri (2010), the impatient households’ discount factor ($\beta^i$) needs to be small enough to guarantee that the borrowing constraint (8) is always binding. For an annual model, I choose $\beta^i = 0.85$, which is within the range of values used in the literature. For example, Iacoviello (2005) chooses $\beta^i = 0.95$ in a quarterly model. Punzi (2013) uses $\beta^i = 0.98$ for her quarterly model. Ferrero (2014) argues that the choice of $\beta^i$ depends on the change in the LTV ratio. In a quarterly model, he chooses $\beta^i = 0.96$ when the LTV changes from 0.75 to 0.99, and a smaller $\beta^i = 0.89$, when the LTV changes from 0.85 to 0.95.

There is no consensus in the literature regarding the share of households whose borrowing is constrained. This is an important parameter for the reaction of the domestic economy to LTV shocks. In the standard life-cycle model with one risk-free asset, the fraction of constrained households is very small (usually below 10%) under parameterizations where the model’s distribution of net worth is in line with the data (Heathcote et al. 2009). On the other extreme, Ferrero (2014) assumes 100% of households face borrowing constraints. Iacoviello (2005) estimates that the wage income share of the patient households is 0.64. Justiniano et al. (2014) identify the impatient households as liquidity constrained households. According to the 1992, 1995 and 1998 U.S. Surveys of Consumer Finances (SCF) these households represent 61% of the population and 46% of labor income. Kaplan and Violante (2012) look at the 2001 SCF and find that between 25% and 66% of households hold sizeable amounts of illiquid wealth, yet consume all of their disposable income during a pay-period. Lusardi et al. (2011) show that 25% of U.S. households are certainly unable to "$2,000 within a month", and 49% probably could not come up with the $2,000 at all. Based on this range, I assume that 40% of the domestic households are impatient.

I choose the steady state value of the LTV parameter, $m = 0.92$, to match the 1994 median LTV for first-time home buyers (the most important marginal group of home buyers), as computed by Duca et al. (2011) using data from the American Housing Survey. I normalize population to be one in the steady state. The remaining six parameters ($\tau, \theta, \gamma, \psi_n, \psi_B, \frac{L_d}{N_d}$) control the size of the housing sector, appliances and the elasticity of the housing supply. I calibrate them to match the following six targets in a world with symmetric country sizes in the steady state:

\begin{enumerate}
\item A ratio of residential investment to output of 5%. This is the U.S. long-term average.
\item A ratio of spending on housing services relative to consumption of durables and services of 17% (Davis and Van Nieuwerburgh 2014).
\item The average homebuyer spends around 25% of disposable income on housing.
\item The level of housing costs in household budgets varies from 16% to 27% in the OECD countries (OECD 2011).
\end{enumerate}
5% of the value of their house on appliances, furnishings, and remodeling activities (Siniavskaia 2008). 4) The share of employment in the construction sector is 5% (Boldrin et al. 2013). 5) The aggregate housing price-to-rent ratio is 22 (Davis et al. 2008). 6) An average price-elasticity of housing supply equal to 1.15 in the simulations included in the next Section. This value is consistent with the evidence for OECD economies of Caldera and Johansson (2013). The parameters of the calibrated model are summarized in Table 1.

6 Quantitative Exercise

I solve a perfect foresight version of the model using a nonlinear Newton-type algorithm (Adjemian et al. 2011). To drive the model, I input in the domestic economy dynamics for population, LTV and expectations of housing prices similar to those observed in the OECD economies with housing boom and bust patterns. Then, I report the reactions of the endogenous variables of the model and compare them with OECD data. This is the same methodology that Garriga et al. (2012) and Justiniano et al. (2014) use to analyze U.S. housing markets, and how Meza and Urrutia (2011) study exchange rates and net exports dynamics. This quantitative exercise sheds light on the ability of the model and its exogenous driving forces to explain both housing and current account dynamics.

6.1 Exogenous Processes

Figure 4 plots the dynamics of population in OECD countries with housing boom-bust patterns. For example, in Spain and in the U.S., immigration lead to nearly a 20% increase in population between 1994 and 2006. The model line shows the exact pattern that the model uses to simulate population dynamics in the domestic country.

Figure 5 plots the median LTV series for first time home buyers estimated by Duca et al. (2011). I could not find an equivalent series for more countries, but anecdotal evidence suggests LTV ratios were relaxed in many other countries. For example, Akin et al. (2014) document how the manipulation on appraisal values permitted Spanish banks to lend at higher LTV ratios than what banking regulations allowed. The U.S. data estimated by Duca et al. (2011) clearly show an increase in loan-to-values from the mid-1990s until 2006, at which point a reversal occurred. Figure 5 shows that the dynamics of LTV in the model (variable \( m_t \)) follow the series from Duca et al. (2011). I assume that the LTV returns to the steady state in about 30 years. As I will discuss later, the results that I obtain for the housing boom are very similar
to Justiniano et al. (2014), who also matched Duca’s LTV series up to 2006 but then assumed that the agents take the 2006 LTV levels as permanent.

Finally, I computed real expected housing prices using the expectations about nominal price changes collected by Case et al. (2012), and the inflation expectations from the Michigan Survey of Consumers. Case et al. (2012) surveyed around 5000 recent homebuyers in four U.S. counties regarding the nominal housing prices they expected to see next year.\footnote{To my knowledge, Case et al. (2012) is the longest survey with quantitative data on expected housing price growth. The data start in 2003. Table 41 in the Michigan Survey, which has been available since 1978, offers qualitative answers to the question of when is a good time to buy a house. To interpolate the series of expectations back to 1994, I used the average growth of real expected house prices computed with the Case et al. (2012) data for 2003-2006. The series are consistent with the qualitative answers from Table 41 of the Michigan Survey.} Figure 6 plots the expected real housing prices together with the model line that shows the dynamics of expectations that I input into the domestic country.\footnote{Technically, when I input price expectations in the Euler equations I replace \( q_{d,t+1} \) by an expected price \( q_{d,t+1}^e = q_{d,t+1} + e_t \). Then, I input a series of \( e_t \) shocks such that \( q_{d,t+1}^e \) matches the data from Case et al. (2012). In steady state there are no expectation shocks and expectations match realized house prices.} Figure 7 compares the expectations of housing price growth with the realized housing price growth that I computed using housing prices from Freddie Mac and inflation from the Bureau of Labor Statistics. Households underestimated housing prices growth until more or less 2005.

6.2 Endogenous Dynamics

Figures 8 to 11 show the reaction of housing prices, employment in housing, residential investment and the housing price-to-rent ratio in the domestic economy once I input the exogenous dynamics discussed above.\footnote{I obtain the rental prices from the problem of the domestic patient household. The rental price is the marginal rate of substitution between consumption and housing, that is, the value of one unit of flow of housing services. The housing price is the value of one house, that is, the value of the stock.} The model generates dynamics quite similar, both in terms of the size of the changes; and in the turning points, to the data from the countries I examine. It is especially interesting that the model with just the three drivers can match both housing prices and the price-to-rent ratio. For example, shocks to the preferences for housing, which drives housing dynamics in most of the DSGE literature, generate counterfactual price-to-rent ratios. Garriga et al. (2012) show that when a perfect foresight model matches interest rates and LTV dynamics, it can explain the dynamics of the price-to-rent ratio but then fails to explain both prices and rents dynamics. Here, the expected increases in housing prices shown in Figure 6 encourage demand for homeownership, not for rental, as seen in the data.

Figure 12, which focuses on the current account, shows that the model dynamics are similar
to the data. The countries with an increase in housing prices and residential investment run a current account deficit. Increases in housing prices soften collateral constraints and allow for an increase in consumption that generates imports and a current account deficit in the domestic economy. Moreover, the construction sector imports tradable goods as housing appliances or furniture. The reversal of the current account in the domestic economy is driven by the collapse of the housing boom. Lower housing prices tighten collateral constraints and reverse the imports for consumption. Moreover, activity in the construction sector slows, as shown in Figure 9, with the collapse of employment in construction after 2007.

Figure 13 shows that interest rates increase, which encourages the foreign economy to finance the current account deficits associated with the housing boom. In this regard the model generates counterfactual predictions, which suggests that the model needs some other shocks to get the interest rates right. That is, housing demand helps to explain Global Imbalances but cannot tell the full story.

While the domestic economy has a housing boom in the period from 1994 to 2006, the foreign economy moves inputs away from residential investment to produce more tradables, which it will then export to the domestic economy. Housing prices fall in the foreign economy to encourage the input reallocation towards tradables. Figures 14 through 16 show these dynamics, which are also very similar to those of countries like Germany. Once the housing boom is gone in the domestic economy, the foreign economy starts to run a current account deficit, and housing prices and residential investment increase.

Figures 17 and 18 analyze the shocks in isolation to compare the quantitative importance of each driving force. That is, I input the dynamics of population, LTV and expected housing prices one by one. Expectations are rationally determined inside the model when I do not input them from the data. Figure 17 shows that, in the model and for the observed exogenous processes, housing price expectations are the main driver of housing dynamics. They generate housing dynamics that are much more substantial than the dynamics that LTV and population generate. The observed changes in loan-to-values do not generate more than a 2% increase in housing prices. This is the same result than Justiniano et al. (2014) obtain. However, LTV shocks are proportionally more relevant to current account dynamics. When housing prices increase, the constrained households borrow more and allocate most of their borrowings to consumption of tradable goods, thus pushing the current account towards a deficit.
7 Sign Restriction Vector Autoregressions

This section exploits sign restrictions provided by the model to identify the three housing demand shocks studied before using the reduced-form errors of vector autoregressions. Then, I study how much of the fluctuations in housing and current account dynamics are accounted for by these three shocks, and analyze their historical decomposition.

7.1 Identification

The sign restrictions methodology (Faust 1998, Canova and De Nicoló 2002, and Uhlig 2005) identify economic shocks by exploiting differences in the correlations among variables conditional on a given shock. That is, if there are correlations between economic variables that can only be generated by one type of shock, then that shock can be identified with sign restrictions in the impulse responses of a VAR.

Table 2 contains the sign restrictions that I use to identify the three housing demand shocks. First, the correlation between housing prices and per capita consumption allows for the separation of population from the other two housing demand shocks. This correlation is negative only for population shocks since in that case, population growth increases demand for housing, thus raising housing prices. Population growth also means growth in the labor supply, which reduces the marginal productivity of labor, as in any standard neoclassical growth model, and leads to lower per capita income and consumption.

Second, the correlation between housing prices and the ratio of aggregate consumption to residential investment distinguishes shocks to housing price expectations from shocks to LTV. Positive shocks to LTV allow the borrowing-constrained households to borrow more. Most of the new borrowings are spent on non-durables and the ratio of aggregate consumption to residential investment therefore increases. In other words, LTV shocks increase both housing and tradable consumption, but the composition of consumption shifts towards tradables as the constrained borrowers are impatient and prefer the nondurable goods. Increases in housing price expectations lead to higher residential investment and lower the ratio of aggregate consumption to residential investment.

The restrictions in Table 2 separate the demand shocks from other structural shocks. For example, the positive correlation between housing prices and residential investment differentiates demand shocks from productivity shocks. Productivity shocks make prices and quantities to move in opposite directions. The positive correlation between housing prices and real inter-
est rates distinguishes housing demand from shocks to interest rates. Monetary policy, savings
glut shocks or risk premium shocks predict a negative correlation between interest rates and
housing variables. The lower interest rates cause an increase in housing demand. Housing
demand shocks increase demand for borrowing and this leads to higher interest rates to achieve
an equilibrium in credit markets.

7.2 Methodology

I follow Rubio-Ramirez et al. (2010) in my implementation of the sign restrictions. First,
I use consumption of nondurable goods as a proxy for non-tradable consumption. I estimate a
reduced-form VAR with the ratio of nondurable consumption to residential investment \( \frac{C_t}{I_{ht}} \),
the current account to GDP ratio \( \frac{CA_{t}}{GDP_{t}} \), log real housing prices \( (p_{ht}) \), log residential investment
\( (I_{ht}) \), log per capita nondurable consumption \( (c) \) and real long term interest rates \( (R_t) \). I also
include a constant term.\(^{10}\) I use quarterly data for the longest time series available for a set
of countries.\(^{11}\) I compared different criteria to select the number of lags (Akaike, Schwarz and
Hannan-Quinn) and two lags capture the dynamics of the system well. I estimate the following
VAR(1) in companion matrix form

\[
Y_t = BY_{t-1} + u_t, \tag{29}
\]

where \( Y_t \) contains the data,

\[
Y_t \equiv \begin{bmatrix}
C_t \\
\frac{I_{ht}}{I_{ht}} \\
\frac{CA_{t}}{GDP_{t}} \\
(p_{ht}) \\
(I_{ht}) \\
(c) \\
R_t
\end{bmatrix}.
\]

The reduced-form shocks are \( u_t \). The goal of any SVAR is to relate the reduced-form shocks to
structural shocks with an economic interpretation, which I denote as \( \varepsilon_t \). The structural shocks \( \varepsilon_t \)
are orthogonal between them; that is, \( E(\varepsilon_t \varepsilon_t') = I \). Without loss of generality, the reduced-form

\(^{10}\)I do not model cointegration relationships. Sims et al. (1990) have shown that the system’s dynamics can
be consistently estimated in a VAR in levels even in the presence of unit roots.

\(^{11}\) All series, except housing prices, come from Datastream. The real housing prices have been compiled by
the OECD. For Spain, consumption of nondurable goods is proxied by final consumption to maximize data
availability. For France, Spain and the U.K. the data cover since 1980Q1 to 2012Q4. For the US, the data cover
since 1970Q1 to 2012Q4.
and the structural shocks can be related by

$$u_t = A\varepsilon_t.$$  \hspace{1cm} (30)

The impulse responses to the structural economic shocks are

$$\frac{\partial Y_{t+j}}{\partial \varepsilon_t} = B^j A,$$  \hspace{1cm} (31)

where $j$ is the number of periods of the impulse response. The goal of the SVAR is to identify the matrix $A$. Once $A$ is identified, we can study the effect of the structural shocks on the economic variables of interest. Recursive or Cholesky identification assumes that $A$ is lower triangular. The sign restrictions methodology identifies a set of $A$ matrices consistent with the theoretical signs of the correlations between economic variables. I identify a set of $A$ matrices whose impulse responses satisfy the sign restrictions of Table 2 for two periods. The results are similar if I impose the restrictions for more periods. I follow the common procedure in the literature and show the results for the median of the set of $A$ matrices (see for example Charnavoki and Dolado 2014, or Sa and Wiedalek 2014).

### 7.3 Results

To present variance decompositions, I focus on Spain and the U.S. as representative countries. Tables 3 and 4 show the variance decompositions of the 1, 3 and 5 years ahead forecast-error of the housing variables for the full sample. Population shocks are the more important drivers of housing prices in both countries over the full sample (1980Q1 to 2012Q4 for Spain, 1970Q1 to 2012Q4 for the U.S.). In both countries, shocks to housing price expectations account for around 10% of the variability in housing prices. In the U.S., they account for around 30% of the variability of residential investment, while in Spain, they account for around 10-15%. LTV shocks do not appear to be very relevant explanations of residential investment, but account for up to 13% of housing price variability in Spain.

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12 The matrix $A$ is unique up to an orthonormal transformation. That is, wherever $QQ' = I$ then $E(u_t u'_t) = AQQ'A' = AA'$.

13 The algorithm of Rubio-Ramirez et al. (2010) is as follows: 1) Compute $E(u_t u'_t) = \Sigma$, and assume $A = \text{chol}(\Sigma)$. 2) Draw a matrix $X$, whose cells come from a standard normal distribution. 3) Compute the $QR$ decomposition of $X$. 4) Normalize the diagonal of $R$ to be positive and check if $AQ$ satisfies the sign restrictions. If it does, keep $AQ$, if not, discard and draw again. 5) Keep drawing until obtaining 1000 successes.

14 I also explored what Fry and Pagan (2005) call "the median target method", that is, selecting the $AQ$ matrix whose impulse responses are as close to the median values as possible. The results are similar. This is also the case in Sa and Wiedalek (2014).
Tables 4 and 5 display the variance decompositions of the current account to GDP ratio for the full sample. The three housing demand shocks can account for a relevant share of the current account dynamics in both countries. For both Spain and the U.S., LTV shocks are more important drivers of current account dynamics than of housing dynamics. This is a result consistent with the quantitative model. LTV shocks relax borrowing constraints for households who prefer non-housing consumption and thus have a greater effect on the current account.

Figures 19 and 20 show the historical decomposition of housing prices, residential investment and the current account for France, Spain, the U.K. and the U.S. All three shocks played a role in the last housing boom. Population played a larger role in the countries with larger population increases (Spain, the U.K. and the U.S.) than in France, which had low population growth. House price expectations and LTV shocks played a more significant role in the housing boom that started in the mid 1990s than in the boom of the 1980s. The three demand shocks alone cannot account for all the dynamics in the last housing boom. This is especially the case in Spain, where the interest rate shocks probably played a larger role.

8 Conclusions

This paper used two methodologies to analyze three potential drivers of housing and current account dynamics. First, using a quantitative two-country model, I showed that when the model matches the observed dynamics of population, loan-to-value and housing price expectations, it endogenously generates dynamics for housing variables and the current account very similar to data in various international housing markets. The key to matching housing dynamics is to get the housing price expectations right. Thus, this paper suggests that DSGE models of housing markets would not need reduced-form housing preference shocks if the models could generate more realistic housing price expectations. Incorporating mechanisms such that the endogenous expectations could match survey data is an important avenue for future research.

Second, SVARs identified with theory-consistent sign restrictions confirm the relevance of the three previous housing demand drivers in explaining both housing and current account dynamics. However, housing demand cannot be the only driver of those dynamics. The SVARs need more than those three shocks to fully match the housing booms and busts. Moreover, as shown by the quantitative model, housing demand shocks imply interest rate increases, while real interest rates decreased over the housing boom period. Thus, housing demand is a relevant explanation, but not the only one. Future quantitative work should try to integrate housing demand drivers with other drivers, such as monetary policy or savings gluts.
References


Bureau of Economic Analysis: 2004, "BEA Depreciation Estimates".


Case, K. E., Shiller, R. J. and Thompson, A.: 2012, "What Have They Been Thinking? Home Buyer Behavior in Hot and Cold Markets".


22


Kahn, J. A.: 2008, "What Drives Housing Prices?".


23


Ling, D. C., Ooi, J. and Le, T.: 2013, "Explaining House Price Dynamics: Isolating the Role of Non-Fundamentals".


Lusardi, A., Schneider, D. J. and Tufano, P.: 2011, "Financially Fragile Households: Evidence and Implications".

Lustig, H. and Van Nieuwerburgh, S.: 2006, "Can Housing Collateral Explain Long-Run Swings in Asset Returns?".


Soo, C. K.: 2013, "Quantifying Animal Spirits: News Media and Sentiment in the Housing Market".


### Table 1: Calibrated Parameters

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<thead>
<tr>
<th>Description</th>
<th>Parameters</th>
<th>Value</th>
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<tr>
<td>Patient households’ discount factor</td>
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<td>Impatient households’ discount factor</td>
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<tr>
<td>Intratemporal elasticity of substitution</td>
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<td>Land supply per capita</td>
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<td>Labor adjustment cost</td>
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<td>Adjustment cost on international bond</td>
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### Table 2: Sign Restrictions for Positive Shocks

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<th>LTV Shock</th>
<th>Expectations</th>
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Table 3: Variance Decompositions in the U.S.

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<th>Forecast Horizon:</th>
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<th>Residential Investment</th>
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<td>3 Years</td>
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<td>Housing Price Expectations</td>
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Table 4: Variance Decompositions in Spain

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<th>Forecast Horizon:</th>
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<th>Residential Investment</th>
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</thead>
<tbody>
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<td></td>
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<td>3 Years</td>
</tr>
<tr>
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Table 5: Variance Decompositions in the U.S.

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</table>

Table 6: Variance Decompositions in Spain

<table>
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<th>Forecast Horizon:</th>
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<tbody>
<tr>
<td>Population</td>
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<td>LTV shock</td>
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<td>Housing Price Expectations</td>
<td>15.58</td>
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Figures

Figure 1. Ratio of the Current Account to GDP for some OECD Countries.
Figure 2. Cross-Country Correlations between Changes in the Current Account to GDP ratio, Employment in Construction, Residential Investment and Housing Prices. The first row is the scatter-plot of the change in the current account to GDP ratio against the change in the share of employment in construction. The second and third rows replace the x-axis with the change in residential investment and with the change in housing prices, respectively. The left column shows the 1996-2006 period, while the right column displays the 2007-2012 period.
Figure 3. Within-Country Correlations between the Current Account (CA), Employment in Construction (Eh) and Housing Prices (Ph). Each subplot shows the dynamics of the current account to GDP ratio (dashed line with scale in the left axis), employment in construction (dotted line with scale in the right axis) and housing prices (solid line with scale in the right axis) in an OECD country. The correlations between these variables are also displayed.
**Figure 4. Exogenous Population Dynamics.** This figure plots the population dynamics that I input into the model for the domestic economy and compares with OECD countries.

**Figure 5. Exogenous LTV Dynamics.** This figure plots the LTV dynamics that I input into the model for the domestic country and compares with U.S. median LTV for first time home buyers from Duca et al. (2011).
Figure 6. Exogenous Expectations of Housing Prices. This figure plots the expectations of housing prices that I input into the model for the domestic country and compares with data collected by Case et al. (2012) for a sample of U.S. counties.

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Figure 8. Endogenous Dynamics of Housing Prices in the Domestic Country.

Figure 9. Endogenous Dynamics of Employment in Construction in the Domestic Country.
Figure 10. Endogenous Dynamics of Residential Investment in the Domestic Economy.

Figure 11. Endogenous Dynamics of the Housing Price-to-Rent Ratio in the Domestic Country.
Figure 12. Endogenous Dynamics of the Current Account to GDP ratio in the Domestic Country.

Figure 13. Endogenous Dynamics of Real Interest Rates in the Domestic Country.
Figure 14. Endogenous Dynamics of Housing Prices in the Foreign Country.

Figure 15. Endogenous Dynamics of Employment in Construction in the Foreign Country.
Figure 16. Endogenous Dynamics of the Current Account to GDP ratio in the Foreign Country.

Figure 17. Endogenous Dynamics of Housing Prices in the Domestic Country if only One Exogenous Driving Force. This figure plots the dynamics of housing prices in the domestic economy when only the population, LTV or housing price expectations shocks are driving the model.
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Figure 19. Historical Decompositions of Housing Prices, Residential Investment and the Current Account using the SVAR Estimated Shocks.
Figure 20. Historical Decompositions of Housing Prices, Residential Investment and the Current Account using the SVAR Estimated Shocks.