Expectations and the Housing Boom and Bust. An Open Economy View.*

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Abstract

I show that both before and after the Great Recession, housing dynamics strongly correlate with current account dynamics, both across and within countries. In a benchmark DSGE model of housing markets, housing price-to-rent ratios are counterfactual if the transmission channel from housing to the current account is only through the consumption effects from relaxed borrowing constraints. Utilizing a model with a sufficiently high housing supply elasticity resolves the problem. In this model, using survey data on housing price expectations generates dynamics of housing variables and the current account consistent with the data. However, interest rate dynamics are counterfactual.

Keywords: Construction; Current Account; Expectations; Global Imbalances; Housing Prices.

JEL Classification: F32, G28, R21

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1 Introduction

The Great Recession has triggered an active literature studying the macroeconomic effects of housing markets.[1] This paper studies two related questions that remain unresolved: what are the causes behind the boom and bust of housing markets over the past two decades? What are the transmission channels from housing to the aggregate economy? First, I demonstrate that over the past two decades housing dynamics are negatively correlated with current account dynamics, both across and within countries. These correlations are so strong that narratives of housing booms and busts should also be consistent with the current account. I argue that the way the literature has studied the transmission channel from housing markets to the current account is incomplete as it generates counterfactual price-to-rent ratios. I propose a model that avoids this problem because it makes housing supply sufficiently elastic and focus on changes in housing price expectations. Finally, I use the model to evaluate the role of housing expectations as a driver of housing and current account dynamics. In these past years a "new narrative of the crisis" has emerged that points toward changes in housing prices expectations, more than an expansion in credit supply, as the main driver of the housing boom.[2]

Gete (2009), Bernanke (2010) and Aizenman and Jinjarak (2013) documented the strong link between housing variables and current account dynamics in the pre-crisis period. Section 2 in this paper shows that the strong correlation was also present during the Great Recession. For example, pre-Great Recession, countries like Spain or the U.S., among others, had large housing booms and current account deficits. Current account reversals coincided with the decline in housing markets. Meanwhile, in countries like Canada, Germany or Switzerland, residential investment and housing prices decreased before 2007 in the midst of large current account surpluses. These surpluses moved towards deficits as housing dynamics improved in the Great Recession period.[3]

The standard way in the literature to connect housing and the current account builds on the seminal work of Iacoviello (2005). Open economy versions of that model generate the negative correlation between housing prices and the current account through the consumption reaction of the borrowing constrained households (see for example Punzi 2013 or Ferrero 2015). That is, higher housing prices relax borrowing constraints and the higher consumption of the impatient

[1] Davis and Van Nieuwerburgh (2015), Guerrieri and Uhlig (2016) and Piazzesi and Schneider (2016) provide recent surveys of the literature.

[2] See for example Foote, Gerardi and Willen (2012), Cheng, Raina, and Xiong (2014), Gelain and Lansing (2014), Adelino, Schoar and Severino (2016), Albanesi, De Giorgi and Nosal (2016), Foote, Loewenstein and Willen (2016) or Kaplan, Mitman and Violante (2017).

[3] For data availability reasons I focus on OECD economies. China conforms to the group of countries whose current account surplus shrank after 2007 while its housing markets boomed.

households leads to a current account deficit. Section 5 in this paper shows that relying only on that mechanism generates counterfactual housing price-to-rent ratios. This results from the impatient agents that value the present flow of housing (rental rates) more than the stock (housing prices). That is, the impatient agents, once they own a sufficient quantity of housing, desire present consumption and do not value the durable goods (houses).

Making housing supply elastic with a construction sector and allowing for changes in housing expectations can remedy the previous problem. Expectations of higher housing prices generate demand for housing as an investment asset, thus, it generates higher price-to-rent. Higher residential investment requires imports of tradable goods, for example, for construction, furniture and related sectors. Moreover, residential investment promotes reallocation of labor and capital from industries producing tradable goods towards nontradable industries such as construction. Countries import tradable goods to replace the goods that were produced by the inputs reallocated to the construction sector. That is, trade deficits decouple consumption from production.

In the previous model, I evaluate the role of housing expectations as a driver of both housing and current account dynamics. I perform the following exercise: I input into the model the data on housing expectations collected by Case, Shiller and Thompson (2012), which is the longest survey data on expected housing prices. This exercise does not say from where the expectations come from, but it tests the ability of the observed changes in expectations to generate plausible dynamics.

The model generates dynamics similar to the data, both in size and in timing, for housing variables (prices, residential investment, employment in construction and price-to-rent ratios) and for the current account. The model does not use exchange rate driven expenditure switching to account for the data. That is, current account dynamics are driven by changes in savings and investment decisions, not by trade balance dynamics driven by exchange rate fluctuations.

Consistent with the new narrative of the crisis, the previous result supports that changes in people's beliefs about house prices may have been the main driver of both the boom and bust in housing markets. However, the simulations highlight that housing demand shocks cannot be the only drivers of the boom phase, as during that period they generate counterfactual increases in interest rates because credit demand increases. Thus, the model suggests that both housing expectations and capital inflows played a role during the boom and bust associated with the Great Recession.

In terms of contribution to the literature, to my knowledge, the literature has only documented the correlations between housing variables and the current account during the pre-Great

Recession period. Only this paper and Aizenman and Jinjarak (2014) study both the housing boom and bust periods. Aizenman and Jinjarak (2014) look at within country correlations for housing prices and the current account. In this paper I look at more variables and I stress the correlation across countries. That is, pre-Great Recession, the countries with housing booms had current account deficits, while those countries with current account surpluses had depressed housing markets. The situation reverted post-Great Recession. It is important to stress these cross-country patterns because they suggest international connections across housing markets. For this reason this paper studies a two country model and compares against the data the predictions for both the country with a housing boom and for the country without it.

In terms of model analysis, the paper relates to both open economy models of housing markets, and to models which study the ingredients to match the main aggregate facts of the last two decades. I briefly discuss below how this paper complements the more related work.

Punzi (2013) and Ferrero (2015) study the current account implications of housing shocks.[4] Both use a two-country version of Iacoviello (2005). To maximize the collateral channel, Ferrero (2015) assumes that all agents in the domestic economy are constrained. This paper shows that models that intend to be consistent with the dynamics of both the current account and the price-to-rent ratio require an elastic supply of housing. If the model only relies on the consumption response of the impatient households with high marginal propensity to consume then price-to-rent ratios are counterfactual.

Garriga, Manuelli and Peralta-Alva (2014), in a "semi-open"economy with segmented markets, point out the importance of households' expectations to explain the housing boom. They do not match the expectations to survey data. This paper, by directly using survey data, complements their insights in a two-country economy, which allows to look at both housing and current account dynamics across countries.

Ferrero (2015), Justiniano, Primiceri and Tambalotti (2017) and Favilukis, Ludvigson, and Van Nieuwerburgh (2017) also show that housing demand drivers generate countercyclical interest rates. To my knowledge, this is the first paper to show that models with patient and impatient agents could lead to counterfactual price-to-rent ratios.

The paper proceeds as follows. Section 2 documents the empirical connection between housing and current account dynamics. Section 3 describes the model and Section 4 the calibration. Section 5 analyzes the theoretical mechanisms that connect housing and current account dynamics. Section 6 has the quantitative exercise. Section 7 concludes.

[4] Basco (2014), Justiniano, Primiceri and Tambalotti (2014) and Favilukis, Ludvigson, and Van Nieuwerburgh (2017) study the effects of the global imbalances on housing markets.

2 Facts about Housing and the Current Account

Figure 1 highlights that both pre and post Great Recession, there is a negative cross-country correlation between housing variables and the current account. The left column contains scatterplots of changes in housing variables and changes in the current account-to-GDP ratios between 1996 and 2006, while the right column recreates the scatterplots for the period from 2007 through 2012.[5,6]

Figure 1 shows wide cross-country heterogeneity in the dynamics of housing variables (residential investment, housing prices and employment in construction). For example, countries like Spain or the U.S. have had large housing booms since the mid-1990s to around 2006. Meanwhile, real housing prices and residential investment decreased in countries like Germany and Switzerland, among others. Housing dynamics reversed after 2006, when housing markets collapsed in countries like Spain and the U.S., and started to rise in the countries that did not experience a boom in the previous decade. Countries that experienced housing booms also had larger current account deficits. Moreover, the current account reversals coincided with the decline in housing markets.

Figure 2 shows the within-country correlations. It confirms the strong negative correlation between housing and current account dynamics.

3 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.

3.1 Domestic Households

At period t there is a mass $N_{d,t}$ of infinitely-lived domestic households who can be patient or impatient. These two types differ in three dimensions: 1) The discount factor for the patient

[5] Housing variables and the current account had monotonic behavior between these dates.

[6] I use all OECD countries with available data in the OECD database. For housing prices these countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, UK and US. For residential investment and employment in construction some countries were not available. I excluded Norway because of the weight of oil prices in its current account dynamics.

households is larger than for the impatient households ($\beta_p > \beta_i$).[7] 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. In fact, the impatient domestic households can borrow 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. Every period in the domestic country, there are $(1-\phi) N_{d,t}$ patient households, and $\phi N_{d,t}$ impatient households. The parameter ϕ controls both the share of impatient households over the total domestic population, and their share in the income of the domestic country. The total population of the domestic country, $N_{d,t}$, can change over time.

3.1.1 Domestic Patient Households

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

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

where $c_{d,t}^p$ and $h_{d,t}^p$ are the per capita consumption of tradable goods and housing. The subscript d denotes domestic variables. 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

$$u\left(c_{d,t}^p, h_{d,t}^p\right) = \frac{\left[\left[(1-\theta)\left(c_{d,t}^p\right)^{\frac{\varepsilon-1}{\varepsilon}} + \theta\left(h_{d,t}^p\right)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}\right]^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \tag{2}$$

where σ is the elasticity of intertemporal substitution as well as the inverse of the coefficient of relative risk aversion. ε 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

[7] This is a standard mechanism to allow for credit relations in which the impatient household borrows from the patient household (Iacoviello 2005).

consumption of housing services in total expenditure.

The aggregate variables for the domestic patient households are:

$$C_{d,t}^{p} = (1-\phi) N_{d,t} c_{d,t}^{p},$$
$$H_{d,t}^{p} = (1-\phi) N_{d,t} h_{d,t}^{p},$$
$$B_{d,t}^{p} = (1-\phi) N_{d,t} b_{d,t}^{p},$$

and

$$\hat{B}_{d,t} = (1-\phi) N_{d,t} \hat{b}_{d,t}.$$

$\hat{b}_{d,t}$ is the patient households' per capita holdings of the international bond, and $b_{d,t}^{p}$ is the per capita holdings of domestic bonds.

The budget constraint for the domestic patient household is

$$\begin{aligned} C_{d,t}^{p} + B_{d,t}^{p} + \hat{B}_{d,t} + q_{d,t}\left(H_{d,t}^{p} - (1-\delta) H_{d,t-1}^{p}\right) + (1-\phi) N_{d,t} \frac{\psi_B}{2} \hat{b}_{d,t}^{2} = \\ = R_{t-1} B_{d,t-1}^{p} + \hat{R}_{t-1} \hat{B}_{d,t-1} + (1-\phi) I_{d,t}, \end{aligned} \quad (3)$$

where $q_{d,t}$ is the price of a domestic house in terms of tradable goods, δ 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 the households' income (to be defined below), ψ_B is the parameter that controls the adjustment costs in the holdings of international bonds. The adjustment costs ensure that there is a unique steady state (Schmitt-Grohe and Uribe 2003).

The first order conditions of the domestic patient households give 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 when the adjustment cost goes to zero, as well as in the steady state.

3.1.2 Domestic Impatient Households

The domestic impatient household maximizes the expected utility of its members

$$E_0 \sum_{t=0}^{\infty} \beta_i^t \phi N_{d,t} u(c^i_{d,t}, h^i_{d,t}), \tag{5}$$

$$u\left(c^i_{d,t}, h^i_{d,t}\right) = \frac{\left[\left[(1-\theta)\left(c^i_{d,t}\right)^{\frac{\varepsilon-1}{\varepsilon}} + \theta\left(h^i_{d,t}\right)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}\right]^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \tag{6}$$

where all variables are as defined for the patient household, but now they have the superscript of the impatient household. I assume that $\beta_i < \beta_p$. The aggregate variables for the impatient households are $C^i_{d,t} = \phi N_{d,t} c^i_{d,t}$, $H^i_{d,t} = \phi N_{d,t} h^i_{d,t}$ and $B^i_{d,t} = \phi N_{d,t} b^i_{d,t}$.

The domestic impatient household chooses per capita housing, tradable consumption, and domestic bond holdings $\left(b^i_{d,t}\right)$ to maximize $(5)-(6)$ subject to her aggregate budget constraint:

$$C^i_{dt} + B^i_{dt} + q_{dt}\left(H^i_{dt} - (1-\delta) H^i_{dt-1}\right) = R_{t-1} B^i_{d,t-1} + \phi I_{d,t}. \tag{7}$$

Impatient households' per capita borrowings $(b^i_{dt} < 0)$ cannot be larger than a fraction m_t of the discounted future value of their current houses. That is,

$$-b^i_{dt} = \frac{m_t E_t\left(q_{d,t+1} h^i_{dt}\right)}{R_t}. \tag{8}$$

3.2 Domestic Firms

Firms produce tradable goods (Y_T) using labor (N_T). To build housing structures (Y_s), firms use labor (N_s) and land (L). Every period there is an exogenous flow of land L. New houses (Y_h) are produced using the housing structures (Y_s) and housing appliances (Y_a) according to the production functions:

$$Y_{Td,t} = N^{\alpha}_{Td,t}, \tag{9}$$

$$Y_{sd,t} = \left[N^{\alpha}_{sd,t}\right]^{\gamma} L_d^{1-\gamma}, \tag{10}$$

$$Y_{hd,t} = \min\left(Y_{sd,t}, \tau Y_{ad,t}\right), \tag{11}$$

where α, γ, τ are parameters. The housing appliances (Y_a) are tradable goods which could be produced domestically (that is, some tradable goods $Y_{Td,t}$ can be used as appliances) or imported. The Leontief assumption in (11) captures the complementarities between tradable and non-tradable goods in producing houses. It implies that, in equilibrium,

$$Y_{sd,t} = \tau Y_{ad,t}.$$

Thus, the parameter τ controls how many tradable goods the construction sector requires.

There is a quadratic adjustment cost (ψ_n) to moving labor across sectors. The cost is paid in units of tradable goods. Since the domestic households own the firm and the land, households' income is the firms' revenue from selling new houses and new tradable goods net of the appliances used to produce houses and the adjustment costs:

$$I_{d,t} = q_{d,t} Y_{hd,t} + Y_{Td,t} - Y_{ad,t} - \frac{\psi_n}{2} \left(N_{sd,t} - N_{sd,t-1}\right)^2 . \tag{12}$$

3.3 Foreign Country

I assume there are only patient unconstrained households in the foreign country. The representative foreign household chooses per capita consumption of tradable goods, non-tradable foreign housing, and international bonds $\left(\hat{b}_{f,t}\right)$ to maximize

$$E_0 \sum_{t=0}^{\infty} \beta_p^t N_{f,t} u(c_{f,t}, h_{f,t}), \tag{13}$$

$$u(c_{f,t}, h_{f,t}) = \frac{\left[\left[(1-\theta) c_{f,t}^{\frac{\varepsilon-1}{\varepsilon}} + \theta h_{f,t}^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}\right]^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \tag{14}$$

subject to her aggregate budget constraint:

$$C_{f,t} + \hat{B}_{f,t} + q_{f,t} \left(H_{f,t} - (1-\delta) H_{f,t-1}\right) + N_{f,t} \frac{\psi_B}{2} \hat{b}_{f,t}^2 = \hat{R}_{t-1} \hat{B}_{f,t-1} + I_{f,t}. \tag{15}$$

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 $\hat{B}_{f,t} = N_{f,t} \hat{b}_{f,t}$.

Foreign firms have the same technology as domestic firms:

$$Y_{Tf,t} = N_{Tf,t}^{\alpha}, \tag{16}$$

$$Y_{sf,t} = \left[N_{sf,t}^{\alpha}\right]^{\gamma} L_f^{1-\gamma}, \tag{17}$$

$$Y_{hf,t} = \min\left(Y_{sf,t}, \tau Y_{af,t}\right), \tag{18}$$

where $N_{Tf,t}$ and $N_{sf,t}$ are the 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:

$$I_{f,t} = q_{f,t} Y_{hf,t} + Y_{Tf,t} - Y_{af,t} - \frac{\psi_n}{2}\left(N_{sf,t} - N_{sf,t-1}\right)^2. \tag{19}$$

3.4 Market Clearing

In each country, the labor used to produce in the two sectors must equal the total labor supply:

$$N_{Td,t} + N_{sd,t} = N_{d,t}, \tag{20}$$

$$N_{Tf,t} + N_{sf,t} = N_{f,t}. \tag{21}$$

The increase in the housing stock is the new houses produced minus the depreciation:

$$H_{d,t}^{i} + H_{d,t}^{p} - (1-\delta)\left(H_{d,t-1}^{i} + H_{d,t-1}^{p}\right) = Y_{hd,t}, \tag{22}$$

$$H_{f,t} - (1-\delta) H_{f,t-1} = Y_{hf,t}. \tag{23}$$

Tradable goods are used for consumption, as housing appliances, and to pay for the portfolio and labor movement adjustment costs:

$$C_{ft} + C_{d,t}^{p} + C_{d,t}^{i} + Y_{ad,t} + Y_{af,t} + (1-\phi) N_{d,t}\frac{\psi_B}{2}\hat{b}_{d,t}^2 + N_{f,t}\frac{\psi_B}{2}\hat{b}_{f,t}^2 =$$
$$= Y_{Td,t} + Y_{Tf,t} - \frac{\psi_N}{2}\left(N_{sd,t} - N_{sd,t-1}\right)^2 - \frac{\psi_N}{2}\left(N_{sf,t} - N_{sf,t-1}\right)^2$$

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

$$B_{d,t}^{p} + B_{d,t}^{i} = 0. \tag{24}$$

Market clearing in international bonds implies:

$$\hat{B}_{d,t} + \hat{B}_{f,t} = 0. \tag{25}$$

The trade balance is the difference between the tradable goods produced and those consumed:

$$TB_{d,t} = Y_{Td,t} - Y_{ad,t} - C^{p}_{d,t} - C^{i}_{d,t} - (1-\phi) N_{d,t} \frac{\psi_B}{2} \left(\hat{b}_{d,t}\right)^2 - \frac{\psi_n}{2} \left(N_{sd,t} - N_{sd,t-1}\right)^2 .$$

While the current account is the change in the net foreign asset position:

$$CA_{d,t} = \hat{B}_{d,t} - \hat{B}_{d,t-1}. \tag{26}$$

4 Calibration

I select plausible parameters using aggregate and micro data from OECD countries, although for some series only U.S. data were available. Table 1 summarizes the parameters. Some parameters are 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 $\left(\hat{B}_d = 0\right)$. I assume that one period in the model is one year.

1. *Exogenously selected parameters.* For the intertemporal elasticity of substitution (σ), 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 papers have argued for elasticities below 1, 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. Since a key element of housing in the model is its nontradability, I work with $\varepsilon = 0.4$, a value close to the 0.44 estimated by Tesar (1993) for the elasticity between traded and nontraded goods.

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%.

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 (β^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, in quarterly models, Iacoviello (2005) chooses $\beta^i = 0.95$ while Punzi (2013) uses $\beta^i = 0.98$. Ferrero (2015), in a quarterly model, 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 in which the model's distribution of net worth is in line with the data (Heathcote, Storesletten, and Violante 2009). On the other extreme, Ferrero (2015) assumes that 100% of households face borrowing constraints. Iacoviello (2005) estimates that 64% of the wage income goes to the patient households. I assume that 40% of the domestic households are impatient ($\phi = 0.4$). This number is consistent with recent papers which measure the share of constrained households using data on liquidity-constrained households. For example, Justiniano, Primiceri, and Tambalotti (2015) estimate that these households represent 61% of the population and 46% of the labor income. Kaplan and Violante (2014) 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, Schneider and Tufano (2011) show that 25% of U.S. households are certainly unable to "come up with $2,000 within a month", and 49% probably could not come up with the $2,000 at all.

I choose the steady state value of the LTV parameter, $m = 0.92$, to match the 1994 median LTV for first-time home buyers (this is the most important marginal group of home buyers), as computed by Duca, Muellbauer and Murphy (2011). I normalize the population to be one in the steady state. The remaining six parameters (τ, θ, γ, ψ_n, ψ_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:[8] 1) A ratio of residential investment to output of 5%. This is the U.S. long-term average. 2) A ratio of spending on housing services relative to consumption of durables and services of 17% (Davis and Van Nieuwerburgh 2015). The level of housing costs in household budgets varies from 16% to 27% in the OECD countries (OECD 2011). 3) The average homebuyer spends around 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).

[8] That is, $N_d = N_f$, $L_d = L_f$.

5) The aggregate housing price-to-rent ratio is 22 (Davis, Lehnert and Martin, 2008). 6) An average price-elasticity of housing supply equal to 1.15 over the first two years. This value is consistent with the evidence for OECD economies of Caldera and Johansson (2013).

5 Housing and the Current Account

This section analyzes the transmission channel from shocks that increase housing prices or quantities to the current account. First, Figure 3 illustrates the standard channel in open economy versions of Iacoviello (2005), for example Punzi (2013) or Ferrero (2015).

Following an increase in the loan-to-value parameter the constrained households borrow and consume more. These households, given their low discount factor, allocate most of their new borrowing into the consumption of the non-durable good, which is tradable (Figure 3c). This generates the current account deficit of Figure 3d. However, as Figure 3b plots, this leads to a counterfactual observation: the housing price-to-rent ratio decreases. Housing prices (the value of the housing asset) increase less than housing rents (the value of the housing flow) because the collateral channel encourages consumption by the impatient households, who value the durable good less.[9]

The larger the share of impatient households, the larger the current account deficit generated by the collateral consumption channel. A larger share of impatient households also highlights the counterfactual, as the price to rent ratio decreases. Shocks to the preferences for housing (the parameter θ in the utility function), which drive housing dynamics in many models of housing markets, also generate counterfactual price-to-rent ratios because they increase the preference for the housing flow.

Figure 4 shows an alternative mechanism for housing markets to generate current account deficits. All panels assume that the share of impatient households is zero ($\phi = 0$) in order to shut down the collateral consumption channel analyzed in Figure 3. Since there are no impatient

[9] The relation between the rental rate and the house price is

$$q_t = p_{l,t} + \beta(1-\delta)E_t\left[q_{t+1}\frac{u^p_{c,d,t+1}}{u^p_{c,d,t}}\right],$$

where $p_{l,t}$ is the rental rate,

$$p_{l,t} = \frac{u^p_{h,d,t}}{u^p_{c,d,t}},$$

and $u^p_{h,d,t}$ and $u^p_{c,d,t}$ are the marginal utility of housing and tradable consumption of the domestic patient household.

households, the driving shock is a change to expected house prices. To generate these shocks, I depart from rational expectations and make house price expectations exogenous. That is, when I input price expectations in the Euler equations, I replace $q_{d,t+1}$ by an expected price

$$q^e_{d,t+1} = q_{d,t+1} + e_t, \tag{27}$$

where e_t is a shock to housing price expectations. Garriga, Manuelli and Peralta-Alva (2014) use a similar methodology to give shocks to expectations.

In Figure 4, when the land share in structures is high (γ is low) then housing supply is inelastic since most of the structures are land, which is exogenously fixed. In that case, an increase in expected house prices does not lead to a substantial amount of new building, nor does it lead to labor reallocation towards housing construction. Figure 4 shows that the current account reacts more when housing supply is elastic. This is because construction needs tradable goods (housing appliances), and because the reallocation of labor towards nontradables (construction) encourages imports of consumption goods to smooth the opportunity cost of building new houses, which is the foregone production of tradable goods. By importing consumer tradables the economy can build non-tradables while still consuming tradables.[10]

Figure 5 shows that expectations of higher housing prices generate the right price-to-rent ratios because they lead to demand for housing assets. Households want to buy assets whose prices are expected to increase. Figure 5 shows that the reaction of the current account is stronger when there are more impatient households since these households have higher demand for tradable goods following an increase in housing prices that relaxes their borrowing constraints.

Thus, this section has shown that models driven by positive loan-to-value shocks with many constrained impatient households generate large current account deficits at the expense of counterfactual price-to-rent ratios. A model that focuses on changes in housing price expectations and has an elastic supply of housing can be consistent with both the current account and the price-to-rent ratios. As the next section will show, this model can generate large current account deficits with a conservative share of impatient constrained households ($\phi = 0.4$).

[10] The Online Appendix discusses a two period model to illustrate this mechanism.

6 Evaluating the New Narrative of the Crisis

In this section I use the model to evaluate the "new narrative of the crisis" that points toward changes in housing prices expectations, more than to an expansion in credit supply, as the main driver of the housing boom.[11] To do so, I input into the model the data on housing expectations collected by Case, Shiller and Thompson (2012), which is the longest survey data on expected housing prices. This exercise is agnostic on the source of the expectations, but it allows to test the ability of the survey data as drivers of macroeconomic variables.

Case, Shiller and Thompson (2012) surveyed around 5000 recent homebuyers in four U.S. counties regarding the nominal housing prices they expected to see next year.[12] To construct series of expectations of real prices I merge the Case, Shiller and Thompson (2012) data with the inflation expectations from the Michigan Survey of Consumers. Figure 6 compares the expectations of real housing prices (dashed lines) for each county with the realized housing prices (solid lines).[13] The figure compares both levels (top panel) and growth rates (bottom panel). Households underestimated housing price growth until 2005, then overestimate it.

I give exogenous shocks to housing price expectations to force the model to generate expectations like those from the Case, Shiller and Thompson (2012) survey. That is, I input a series of e_t shocks into (27) such that $q^e_{d,t+1}$ matches the data from Case, Shiller and Thompson (2012). In steady state there are no expectation shocks and expectations match realized house prices. Figure 7 contains the exact expectations that the model uses and also the data from Figure 6.

Then, I input the exogenous driving force (the housing price expectations of Figure 7) into the model and Figure 8 reports the reactions of its endogenous variables comparing them with data.[14] This is the same methodology that Garriga, Manuelli and Peralta-Alva (2014) and Justiniano, Primiceri and Tambalotti (2015) use to analyze U.S. housing markets, and how Meza and Urrutia (2011) study net exports dynamics. The goal is to evaluate the ability of the model to account for both housing and current account dynamics.

[11] See for example Foote, Gerardi and Willen (2012), Cheng, Raina, and Xiong (2014), Gelain and Lansing (2014), Adelino, Schoar and Severino (2016), Albanesi, De Giorgi and Nosal (2016), Foote, Loewenstein and Willen (2016) or Kaplan, Mitman and Violante (2017).

[12] 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 use the average growth of real expected house prices computed with the Case, Shiller and Thompson (2012) data for 2003-2006.

[13] I computed the realized prices using housing prices from Freddie Mac and inflation from the Bureau of Labor Statistics.

[14] The model is solved using a nonlinear Newton-type algorithm (Adjemian et al. 2011) for a perfect foresight version. The e_t shocks into (27) ensure that $q^e_{d,t+1}$ matches the series reported in Figure 7.

The model generates housing dynamics quite similar (both in terms of the size of the changes and in the turning points) to the data from Spain, the U.K. and the U.S., which are countries representative of the housing boom and bust. Since the housing expectation is a demand shock, housing prices and quantities have a positive comovement, like in the data.

The expectations of higher house prices from the Case, Shiller and Thompson (2012) survey allow the model to generate the right sign for the housing price-to-rent ratio because they encourage demand for the asset.

Figure 8e) shows that, as in 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, the constrained households borrow more and allocate most of their borrowings to consumption of tradable goods, thus pushing the current account towards a deficit. Moreover, as workers reallocate towards the construction sector the economy imports tradable goods to smooth the opportunity cost of building new houses, which is the foregone production of tradable goods. In addition, the construction sector imports tradable goods such as housing appliances or furniture.

Figure 8f) shows that the foreign economy runs a current account surplus while lending to the housing boom country. Since the foreign economy is allocating its workers to produce tradable goods, its construction sector is subdued.

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 with the collapse of employment in construction after 2007. Thus, current account dynamics are accounted for with expansions and contractions in demand. The model does not seem to need exchange rates and expenditure switching across goods to generate dynamics as in the data.

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. These dynamics are very similar to those of countries like Canada, which are key trade partners of economies as the U.S.

However, the model with only housing demand drivers generates counterfactual dynamics for the real interest rates. Higher housing demand increases credit demand and interest rates rise to achieve equilibrium. Accounting for lower interest rates requires capital inflows. Thus, the exercise shows strong support for the "new narrative of the crisis", but it also points out that this new narrative needs to be complemented with other explanations.

7 Conclusions

This paper documented that the strong correlation, both across and within countries, between housing and current account dynamics was present before and after the Great Recession. I also demonstrated that a DSGE model à la Iacoviello (2005) expanded with a construction sector is able to explain the dynamics of both housing variables and the current account.

The model needs two main ingredients to be consistent with the data: 1) A high enough housing supply elasticity. If the transmission channel operates only through the consumption effects from relaxed borrowing constraints then housing price-to-rent ratios become counterfactual. 2) The model needs to be consistent with observed housing expectations measured from survey data. Expectations of higher housing prices generate a demand for houses that causes higher price-to-rent as in the data.

I used the model to evaluate "the new narrative of the crisis" that assigns a dominant role to changes in expectations. For the observed survey data on housing price expectations, the model generates dynamics of housing variables and the current account consistent with the data. However, interest rate dynamics are counterfactual. Thus, this exercise suggests that expectations played a key role but that they cannot be the only explanation. The exercise is agnostic about the cause of the changes in expectations. This is an avenue for future research.

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Tables and Figures

Table 1: Parameters

Description	*Parameter*	*Value*
Patient households' discount factor	β^p	0.97
Impatient households' discount factor	β^i	0.85
Share of impatient households	ϕ	0.4
Intertemporal elasticity of substitution	σ	0.5
Intratemporal elasticity of substitution	ε	0.4
Housing depreciation rate	δ	0.02
Ratio of housing appliances over structures	$\frac{1}{\tau}$	0.2
LTV parameter	m	0.92
Share of housing services in utility	θ	0.18
Labor share in production	α	0.67
Land share in housing production	$1-\gamma$	0.2
Steady state population	$N_d = N_f$	1
Land supply per capita	$\frac{L_d}{N_d} = \frac{L_f}{N_f}$	10^{-6}
Labor adjustment cost	ψ_n	7
Adjustment cost of international bond	ψ_B	0.008

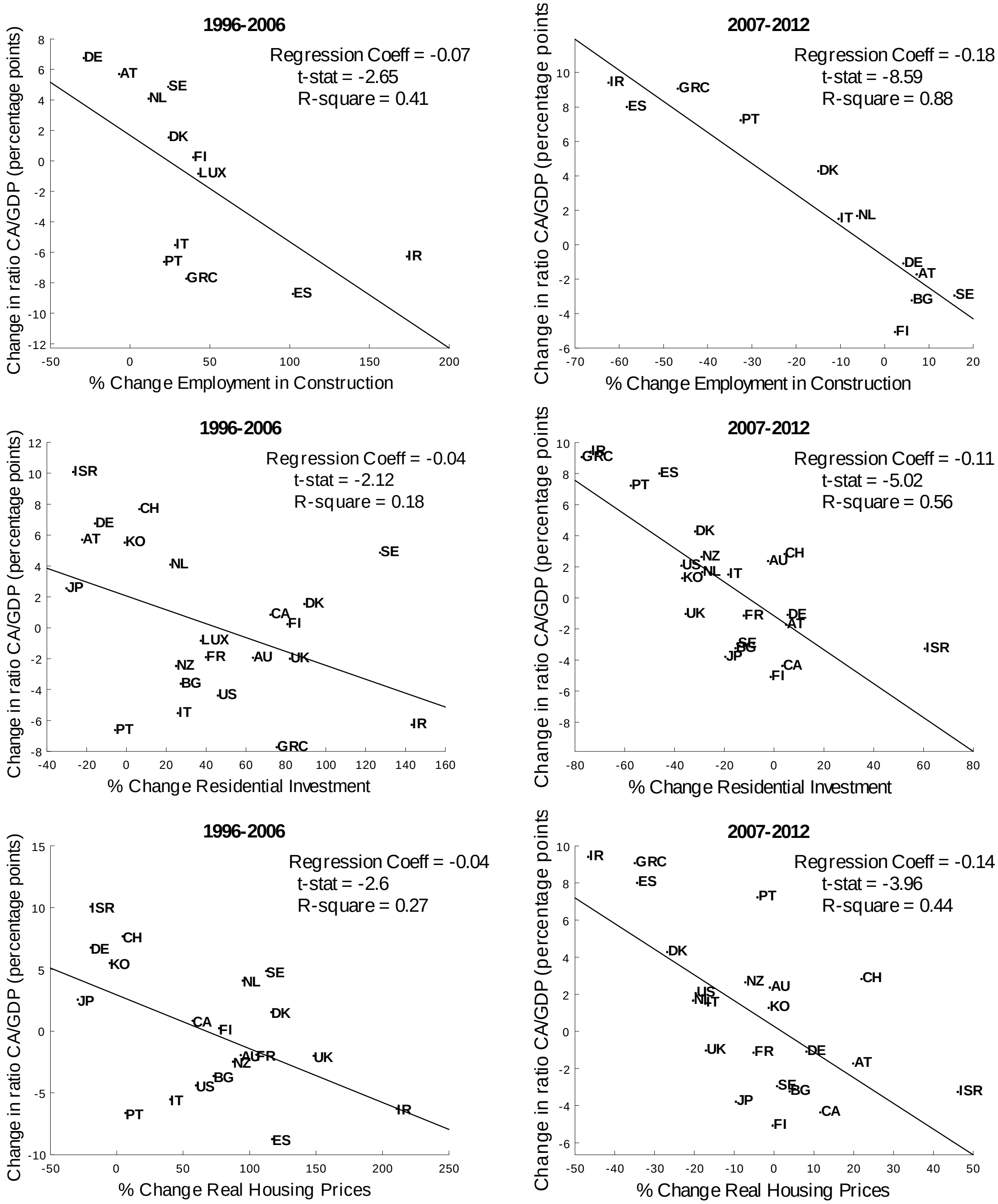

Figure 1. Cross-Country Correlations between Changes in the Current Account to GDP ratio and Changes in Housing Variables. The first row is the scatter-plot of the change in the current account to GDP ratio against the change in the share of employment in construction. The second and third rows replace 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. Data source: OECD subject to country availability.

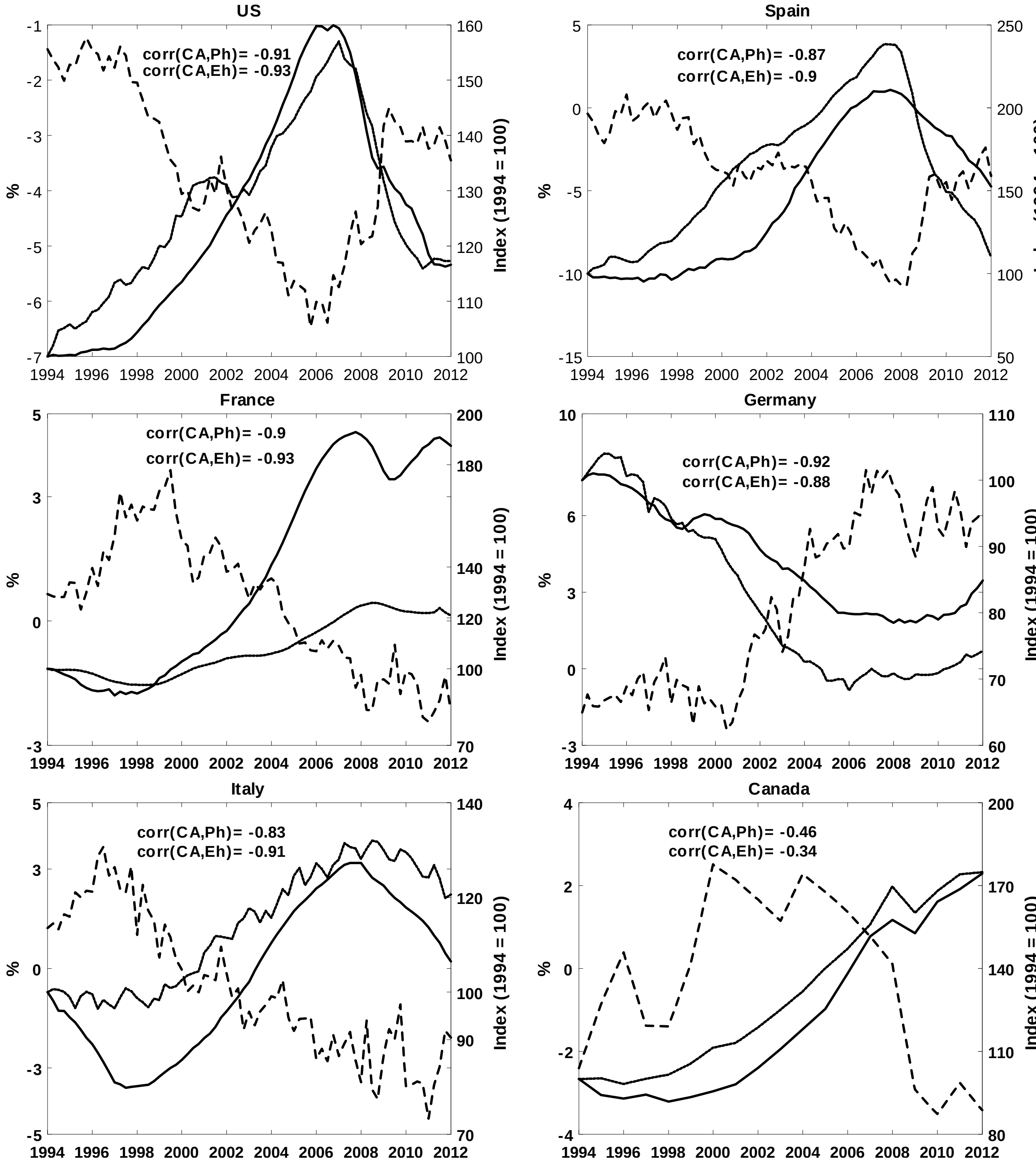

Figure 2. Within-Country Correlations between the Current Account (CA), Employment in Construction (Eh) and Housing Prices (Ph). Each panel shows the dynamics of the current account to GDP ratio (dashed line with scale in the left axis), employment in construction (dotted line with scale in the right axis) and housing prices (solid line with scale in the right axis) in an OECD country. The correlations are also displayed. Data source: OECD.

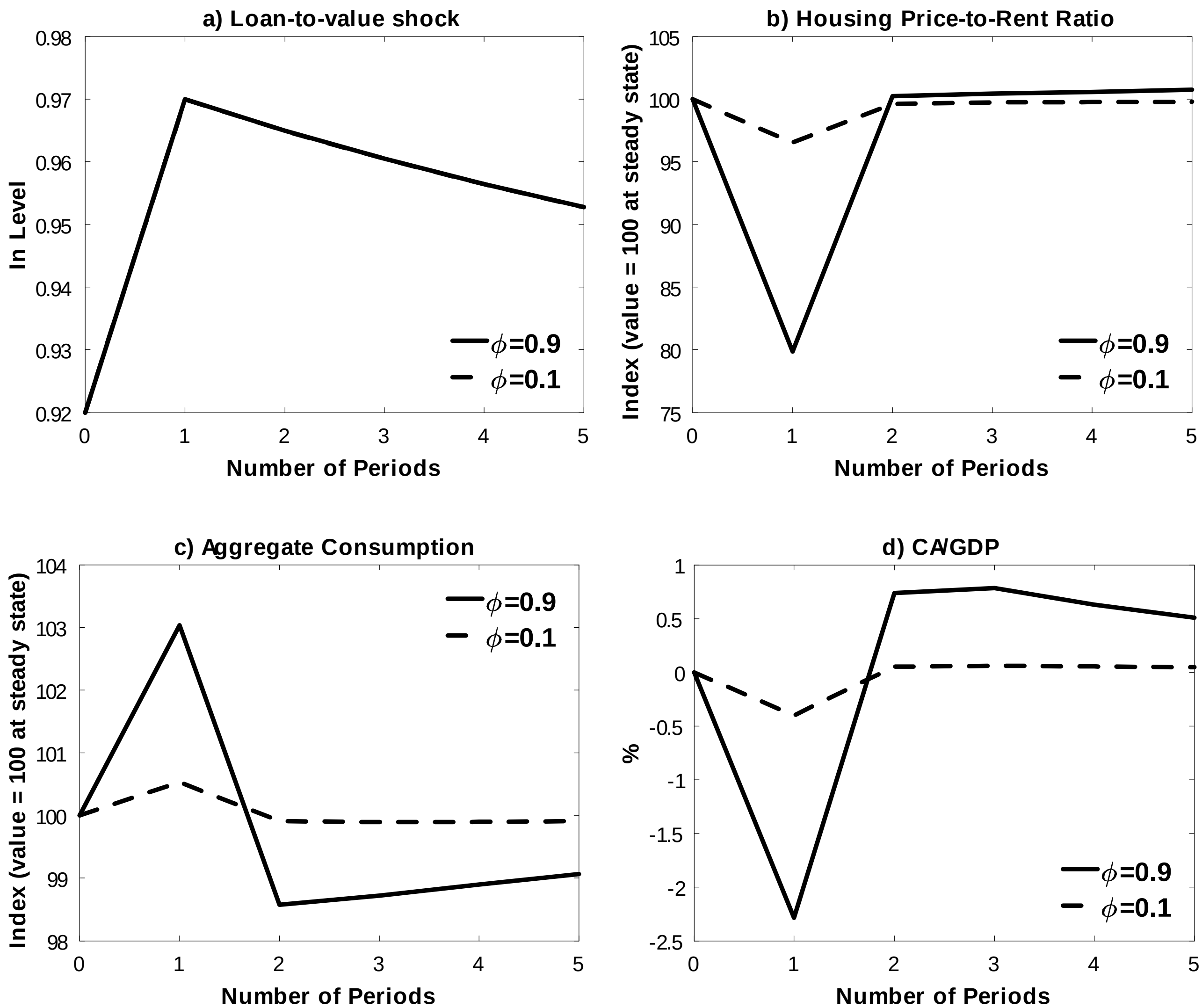

Figure 3. Responses to Loan-to-Value Shock for Different Share of Households Being Constrained. The panels compare impulse responses to an increase in the loan-to-value parameter (from 0.92 to 0.97) when the share of the population composed by impatient households (ϕ) is high ($\phi = 0.9$) or low ($\phi = 0.1$). All panels are for the domestic economy.

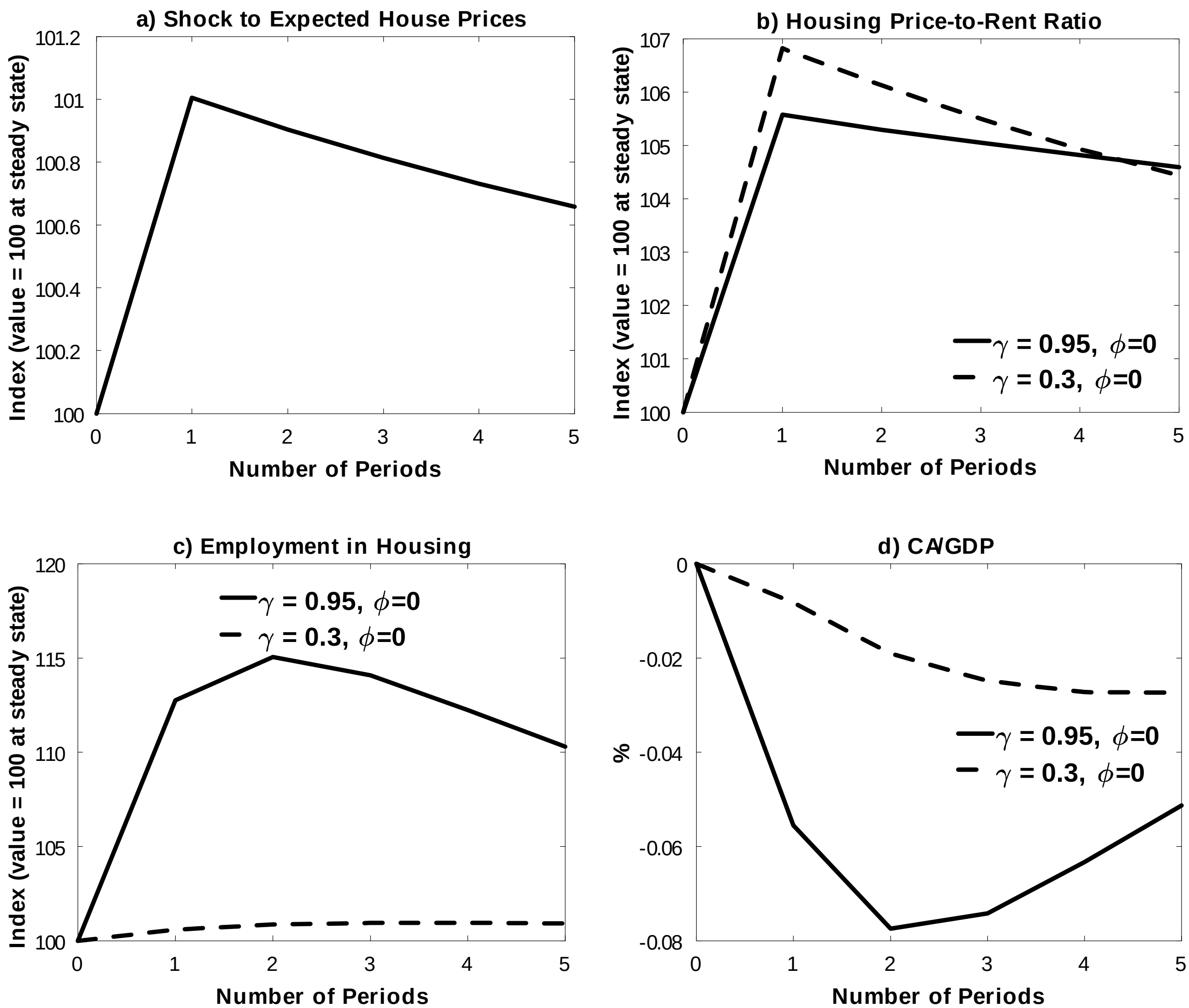

Figure 4. Responses to Housing Expectation Shock for Different Housing Supply Elasticities. These panels compare impulse responses to an increase in the expectations of domestic housing prices when the supply of new structures is elastic (low land share, high γ) and when it is not (low γ). All panels are for the domestic economy. In all panels there are no impatient households ($\phi = 0$) to shut down the collateral channel.

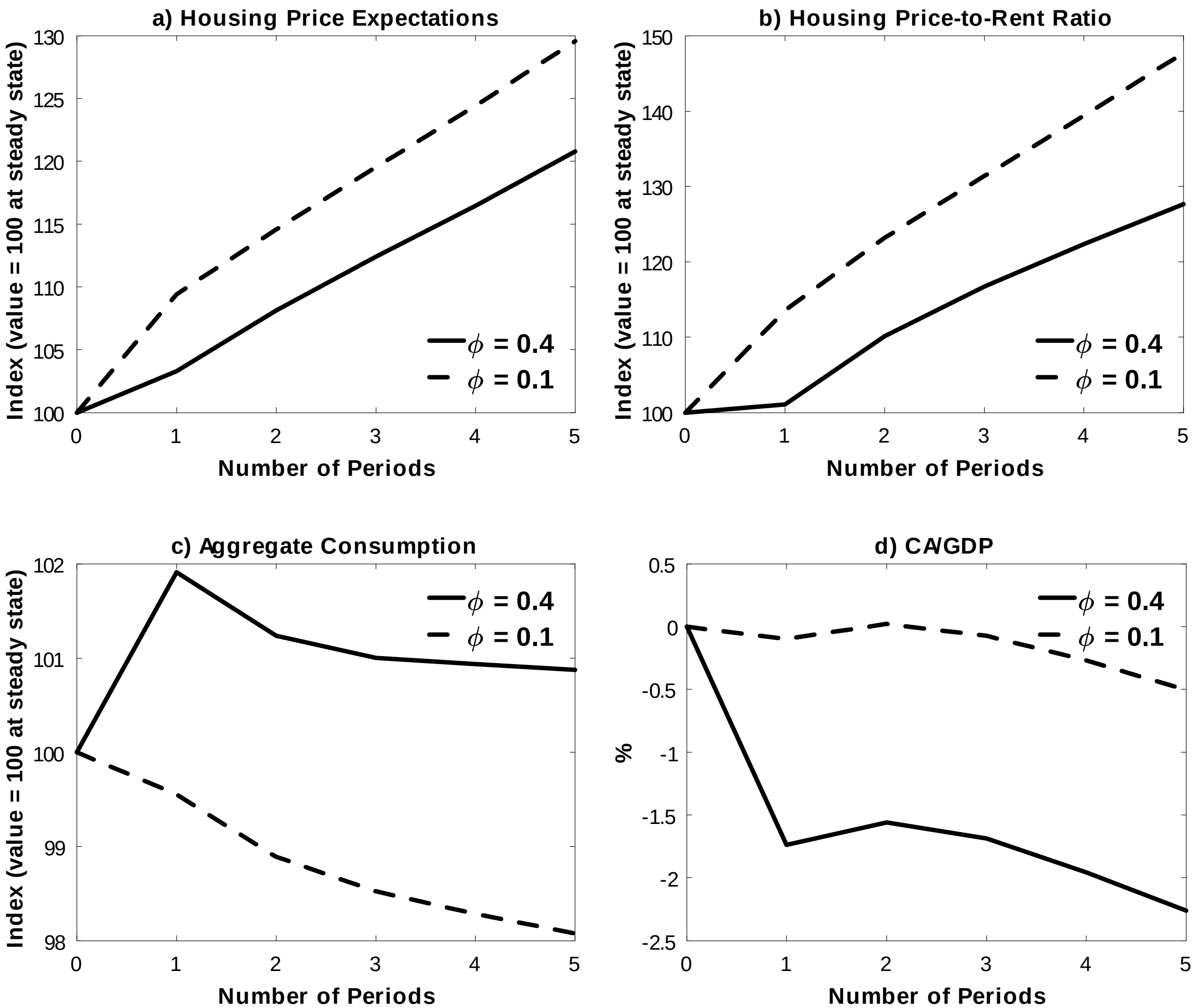

Figure 5. Expected Housing Price Increases for Different Shares of Households Being Constrained. The panels compare the responses to expected increase in domestic housing prices when the share of the population composed by impatient households (ϕ) is at the benchmark 0.4 and when it is low. All panels are for the domestic economy.

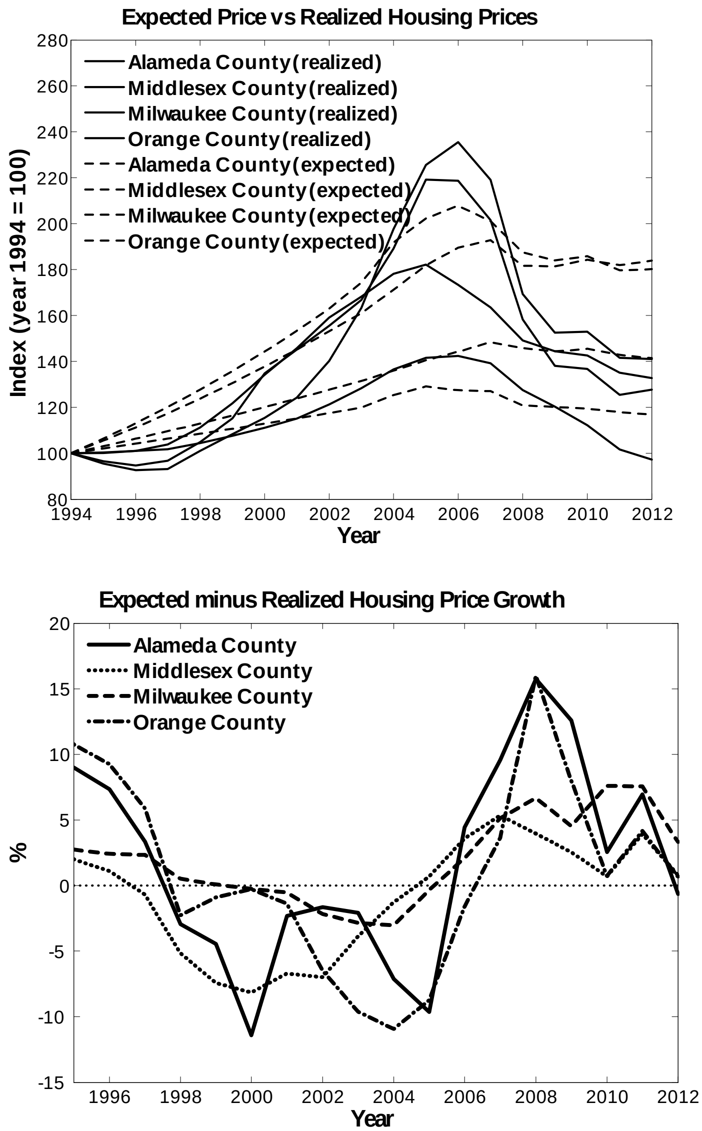

Figure 6. Comparing House Price Expectations from Case, Shiller and Thompson (2012) with Realized House Prices. The top panel compares the survey data on real house price expectations (dashed lines) from Case, Shiller and Thompson (2012) with the realized real house prices for those U.S. counties. The bottom panel redoes the same comparison but for the growth rates.

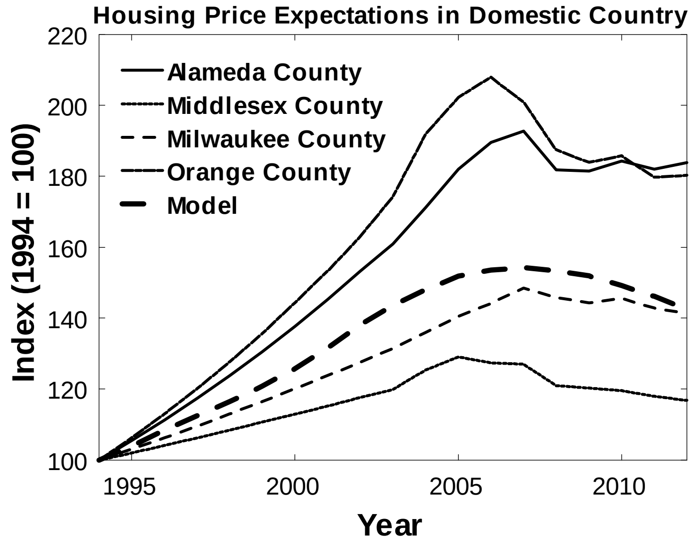

Figure 7. Housing Expectations in the Model. This figure plots the housing expectations that I feed in the model comparing with the Case, Shiller and Thompson (2012) data.

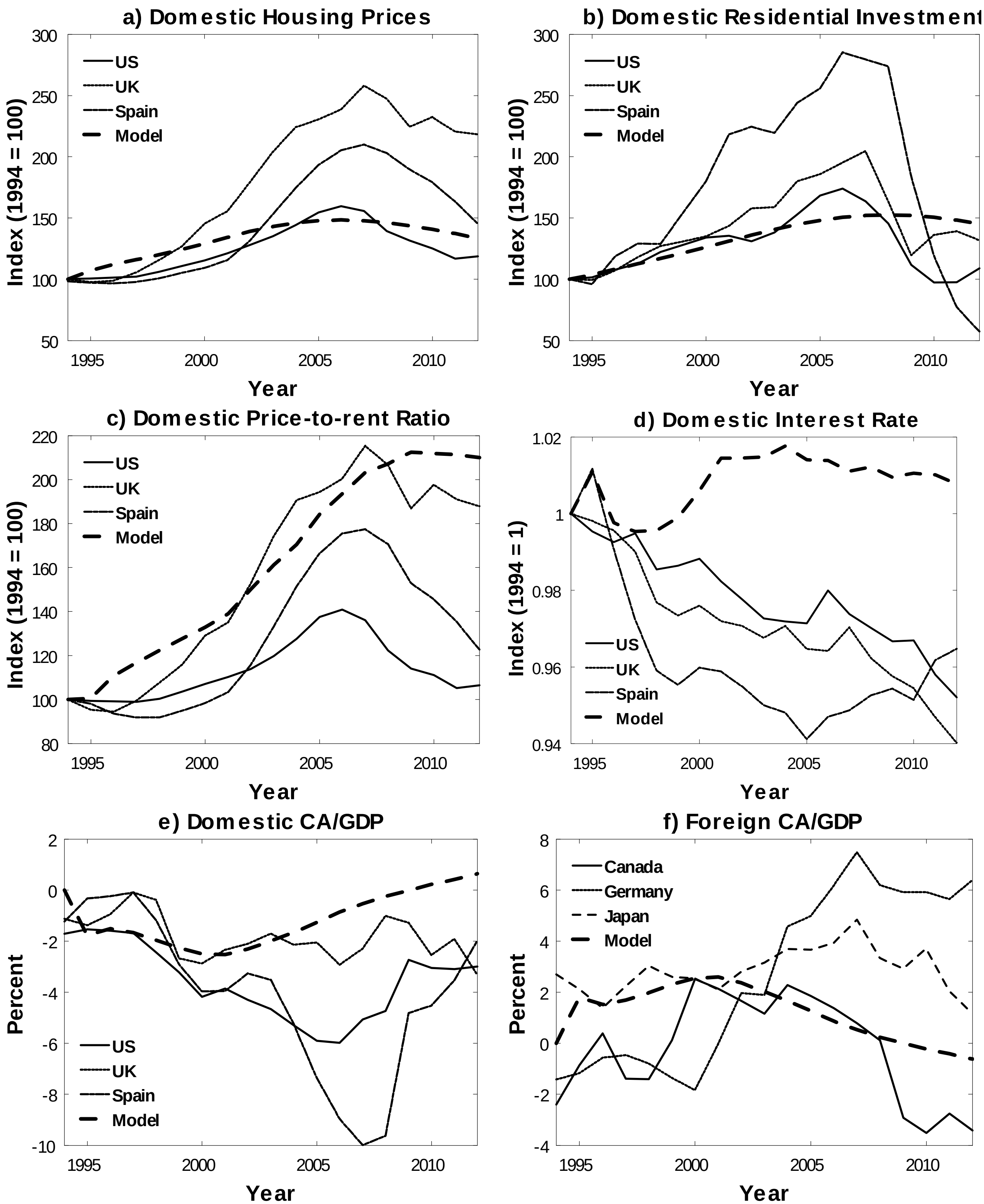

Figure 8. Data vs Model driven by Housing Expectations. This figure compares the data with the model driven by the housing expectations reported in Figure 7.

ONLINE APPENDIX: NOT FOR PUBLICATION

A Two Period Model

This appendix discusses the intuition of why higher demand for housing can generate a current account deficit when there is a construction sector. It is a simplified version of the model of Section 3.

It is a two period economy with a single household who is both the producer and the consumer. Housing is assumed non-durable to stress that the key ingredient is that housing is non-tradable. I compare the equilibrium in a closed economy and that in a small open economy after an unanticipated change in the share of housing in the first period utility (θ_1). Preferences are

$$u\left(c_t, h_t\right) = \frac{\left(((1-\theta_t)c_t^{\frac{\varepsilon-1}{\varepsilon}} + \theta_t h_t^{\frac{\varepsilon-1}{\varepsilon}})^{\frac{\varepsilon}{\varepsilon-1}}\right)^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \ t = 1, 2. \tag{A1}$$

In the competitive equilibrium the representative household maximizes

$$U(c_1, h_1, c_2, h_2) \equiv u(c_1, h_1) + \beta u\left(c_2, h_2\right) \tag{A2}$$

subject to the intertemporal budget constraint in terms of tradable goods

$$c_1 + \frac{c_2}{R} = y_{c1} + \frac{y_{c2}}{R}, \tag{A3}$$

to the production functions of housing in each period,

$$y_{ht} = AN_{ht}^{\alpha}, \tag{A4}$$

$$y_{ct} = BN_{ct}^{\alpha}, \tag{A5}$$

and feasibility in labor and housing markets:

$$N_{ht} + N_{ct} = N, \qquad \text{for } t = 1, 2 \tag{A6}$$

$$h_t = y_{ht}. \tag{A7}$$

The FOCs are the Euler equation and the equalization of the marginal rate of substitution with the marginal rate of transformation

$$u_c(c_1, h_1) = \beta R u_c(c_2, h_2) \tag{A8}$$

$$u_h(c_t, h_t)\frac{y_{ht}}{n_{ht}} = u_c(c_t, h_t)\frac{y_{ct}}{n_{ct}} \qquad \text{for } t = 1, 2 \tag{A9}$$

In a closed economy there is not an option to transfer tradable consumption across periods, so production and consumption of tradable goods must be equal in every period

$$c_t = y_{ct} \qquad \text{for } t = 1, 2 \tag{A10}$$

Thus, the equilibrium of the closed economy in period 1 is characterized by

$$\frac{u_h(y_{c1}, y_{h1})}{u_c(y_{c1}, y_{h1})} = \frac{n_{h1}}{y_{h1}}\frac{y_{c1}}{n_{c1}}. \tag{A11}$$

The upper left panel of Figure A1 graphs this condition. The left hand side of equation (A11) is the slope of the indifference curve, which, at the initial equilibrium point A, is tangent to the Frontier of Possibilities of Production (FPP), whose slope is the right hand side of equation (A11).

An unexpected higher demand for housing (an increase in θ_1) decreases the slope of the indifference curves as graphed in the upper right panel of Figure A1. The household now prefers housing, hence she asks for more tradable goods per unit of housing. The shift of the indifference curves moves the equilibrium from point A to point B, where consumption of housing services is higher $\left(\tilde{h}_1^c > h^*\right)$ and consumption of tradable goods lower $(\tilde{c}_1^c < c^*)$.[15] There are two reasons why consumption of tradable goods is lower. One reason comes from the preference change: the household now likes tradable goods relatively less, hence she consumes less of them. The second reason comes from the opportunity cost of building; to increase the consumption of housing services the country needs to move along the FPP, reducing production of tradable goods. The more concave the FPP, the higher the drop in c_1, since more resources need to reallocate to produce an extra unit of housing.

As plotted in the upper right panel of Figure A1, for any parameter value consistent with the concavity of the FPP and the convexity of the indifference curves, in the closed economy the higher demand for housing increases h_1 and decreases c_1. Depending on the intratemporal elasticity of substitution between housing and tradable consumption (SES, ε) and on the in-

[15] I use * to denote steady state, superscript c to denote the closed economy and SOE for the small open economy.

tertemporal substitution (IES, σ) it may be that the country may want to borrow to smooth the drop in c_1. This is equivalent with having the marginal utility of tradable consumption in the first period increasing in θ_1. To see this we can define the interest rate, which is the slope of the intertemporal budget constraint, in a closed economy as

$$R^{aut} \equiv \frac{u_c(\tilde{c}_1^c, \tilde{h}_1^c)}{\beta u_c(c^*, h^*)}. \tag{A12}$$

The closed economy is a sequence of static problems. An increase in θ_1 does not alter second period variables. The unexpected increase in θ_1 moves the closed economy equilibrium from point A to point B in Figure A1, but c_2^c remains at steady state value c^*. Thus, R^{aut} increases if $u_c(\tilde{c}_1^c, \tilde{h}_1^c)$ increases.

The interesting case is when the higher demand for housing leads to an increase in $u_c(\tilde{c}_1^c, \tilde{h}_1^c)$. For example, the lower the SES, the less willing the household is to substitute housing and tradable consumption within the period. Low SES households dislike unbalanced consumption across goods, thus an extra unit of the tradable good is valued more when building houses forces the economy to reduce production and consumption of tradables. In this case, the higher demand for housing increases the marginal utility of a tradable good in period 1.[16] To ensure that the closed economy does not transfer tradable goods across periods, the interest rate, increases. This is what the lower right panel of Figure A1 plots.

If in the small open economy, or in a two country model, an increase in θ_1 does not increase interest rates to the new autarky level, then the country will borrow and run a trade deficit. The trade deficit allows better consumption smoothing across goods in the open economy. Figure A2 depicts this case. The increase in θ_1 shifts the marginal rate of substitution as in the closed economy, but for the small economy the interest rate is exogenous and does not change. The slope of the intertemporal budget constraint remains the same, although the budget constraint shifts because both Y_{c1} and Y_{c2} will change.

The open economy does not have to move to point B, where consumption equals production. The open economy can instead consume at the point C while producing at the point D of the upper right panel of Figure A2 if it respects its intertemporal budget constraint (A3). FOC (A9) only requests that the slope of the indifference curve is the same at both points. Point C

[16] For preferences (2) the marginal utility of tradable consumption in the first period is

$$u_c(c_1, h_1) = (1-\theta_1) C_1^{\frac{1}{\varepsilon}-\frac{1}{\sigma}} c_1^{\frac{-1}{\varepsilon}} \tag{A13}$$

$$C_1 \equiv ((1-\theta_1) c_1^{\frac{\varepsilon-1}{\varepsilon}} + \theta_1 h_1^{\frac{\varepsilon-1}{\varepsilon}})^{\frac{\varepsilon}{\varepsilon-1}} \tag{A14}$$

was not available for the closed economy because it implies a transfer of tradable goods across periods. Interest rates raised to prevent this.

Thus, in open economies, higher demand for housing can cause trade deficits because housing is non-tradable and the trade deficit allows for the smoothing of the opportunity cost of building new houses, which is the foregone production of tradable goods. That is, to decouple consumption from production and increase welfare.

Figures Online Appendix

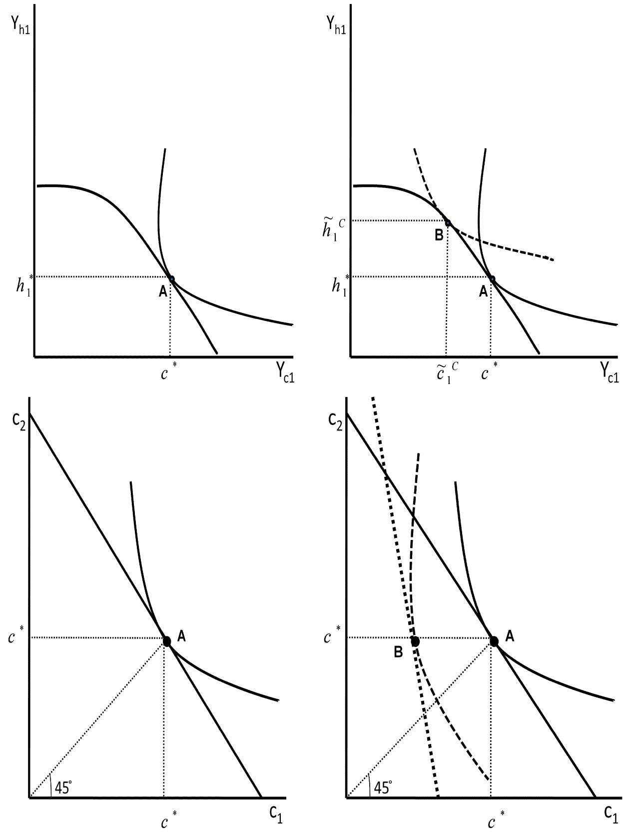

Figure A1. The Two Period Model: the Closed Economy. The figures on the top report the production possibilities frontier and the utility curves. The figures at the bottom are the intertemporal budget constraints.

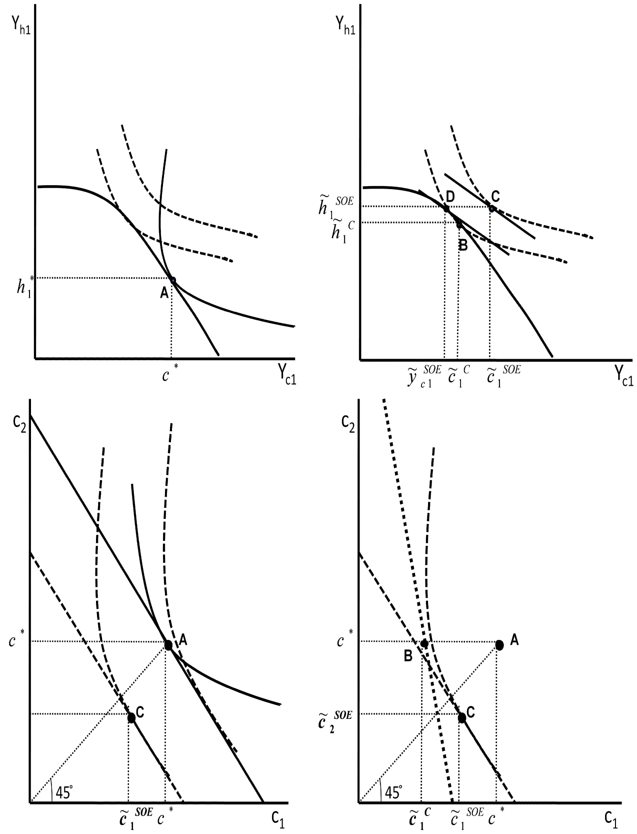

Figure A2. The Two Period Model: the Small Open Economy. The figures on the top report the production possibilities frontier and the utility curves. The figures at the bottom are the intertemporal budget constraints.