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 enough reallocation of labor between construction and tradable goods 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 has a new mechanism coming from labor reallocation between tradable goods and construction. Moreover, the model gives a key role to 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

[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 (2020). Landvoigt, Piazzesi and Schneider (2015) is a bridge between the credit and the expectations theories. They show that a combination of over-optimistic expectations together with lower downpayment constraints and lower interest rates can fully explain the capital gains observed in the data.

[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.

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 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).

Enough reallocation of labor between construction and non-tradable goods, 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 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 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.

The model is also consistent with cross-sectional facts from U.S. MSAs. For example, in the model, as in the data, the correlation between price-to-rents and the trade balance-to-GDP is increasing in the housing supply elasticity. Also, in model and in the data, the same change in house prices cause larger changes in the trade balance-to-GDP for low housing supply elasticities or high borrowing constrained households.

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 (2019), 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 in-

[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.

terest 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 facts. 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 studies a foreign shock and the capital account. Section 7 has the quantitative exercise. Section 8 shows that the model is consistent with the cross-sectional facts. Section 9 shows that consumption has an asymmetric reaction during the housing boom versus during the bust. Section 10 concludes.

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.

Insert Figure 1 here

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

[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.

Insert Figure 2 here

Figures 3 to 5 show three facts that will support the mechanism highlighted in the paper. First, Figure 3 shows that, across U.S. MSAs, the correlation between price-to-rents and the trade balance-to-GDP is increasing in the housing supply elasticity.[7] Figure 4 shows that, for the same change in housing prices, MSAs with relatively low housing supply elasticities have larger changes in the trade balance-to-GDP. Figure 5 shows the same result but for MSAs with a higher share of black and Hispanic population. This share will be the empirical proxy for the borrowing constrained households in the model discussed in the next section.

Insert Figures 3, 4 and 5 here

3 Model

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

3.1 Domestic Households

At period t there is a mass N_d 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 households is larger than for the impatient households ($\beta_p > \beta_i$).[8] 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.

[7] Here we use trade balance as a proxy of current account due to data availability. The appendix discusses the data.

[8] This is a standard mechanism to allow for credit relations with the impatient household borrowing from the patient household (Iacoviello 2005).

Households supply labor inelastically in their home country. Every period in the domestic country, there are $(1-\phi)\, N_d$ patient households, and ϕN_d 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 is N_d. It is important to stress that although the fraction of impatient population is the same over time, their consumption is not a constant share of the aggregate consumption. Their aggregate consumption depends on the individual consumption that can change over time.

3.1.1 Domestic Patient Households

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

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

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 consumption of housing services in total expenditure.

The aggregate variables for the domestic patient households are defined with capital letters:

$$\begin{aligned} C_{d,t}^p &= (1-\phi)\, N_d c_{d,t}^p, \\ H_{d,t}^p &= (1-\phi)\, N_d h_{d,t}^p, \\ B_{d,t}^p &= (1-\phi)\, N_d b_{d,t}^p, \end{aligned}$$

and

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

where $\hat{b}_{d,t}$ 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

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

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 relation between the rental rate and the house price:

$$q_t = p_{l,t} + \beta(1-\delta)E_t\left[q_{t+1}\frac{u^p_{c,d,t+1}}{u^p_{c,d,t}}\right], \tag{4}$$

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

$$p_{l,t} = \frac{u^p_{h,d,t}}{u^p_{c,d,t}}, \tag{5}$$

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

The first order conditions also give the non-arbitrage restriction between the return of the two bonds:

$$R_t\left[1+\psi_B\hat{b}_{d,t}\right] = \hat{R}_t. \tag{6}$$

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

$$E_0 \sum_{t=0}^{\infty} \beta_i^t \phi N_d u(c_{d,t}^i, h_{d,t}^i), \tag{7}$$

$$u\left(c_{d,t}^i, h_{d,t}^i\right) = \frac{\left[\left[(1-\theta)\left(c_{d,t}^i\right)^{\frac{\varepsilon-1}{\varepsilon}} + \theta\left(h_{d,t}^i\right)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}\right]^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \tag{8}$$

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 $C_{d,t}^i = \phi N_d c_{d,t}^i$, $H_{d,t}^i = \phi N_d h_{d,t}^i$ and $B_{d,t}^i = \phi N_d b_{d,t}^i$.

The domestic impatient household chooses per capita housing, tradable consumption, and domestic bond holdings $\left(b_{d,t}^i\right)$ to maximize $(7)-(8)$ subject to her aggregate budget constraint:

$$C_{d,t}^i + B_{d,t}^i + q_{d,t}\left(H_{d,t}^i - (1-\delta) H_{d,t-1}^i\right) = R_{t-1} B_{d,t-1}^i + \phi I_{d,t}. \tag{9}$$

Impatient households' per capita borrowings $(b_d^i < 0)$ equal a fraction m_t of the discounted future value of their current houses. That is,

$$-b_{d,t}^i = \frac{m_t E_t\left(q_{d,t+1} h_{d,t}^i\right)}{R_t}. \tag{10}$$

3.2 Domestic Firms

Firms produce tradable goods (Y_T) using labor (N_T). Every period there is an exogenous flow of land L. New houses (Y_h) are a combination of housing appliances (Y_a), labor (N_s) and land (L). The appliances and the land are non-tradable intermediate inputs. I refer to housing structures (Y_s) as the combination of labor (N_s) and land (L). These are the production functions:

$$Y_{Td,t} = N_{Td,t}^{\alpha}, \tag{11}$$

$$Y_{sd,t} = \left[N_{sd,t}^{\alpha}\right]^{\gamma} L_d^{1-\gamma}, \tag{12}$$

$$Y_{ad,t} = N_{ad,t}^{\alpha} \tag{13}$$

$$Y_{hd,t} = \left(Y_{sd,t}\right)^{\tau}\left(Y_{ad,t}\right)^{1-\tau}, \tag{14}$$

where α, γ, τ are parameters of input shares.

Since the domestic households own the firm and the land, households' income is the firms' revenue from selling new houses and new tradable goods:

$$I_{d,t} = q_{d,t}Y_{hd,t} + Y_{Td,t}. \tag{15}$$

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

$$E_0 \sum_{t=0}^{\infty} \beta_p^t N_f u(c_{f,t}, h_{f,t}), \tag{16}$$

$$u(c_{f,t}, h_{f,t}) = \frac{\left[\left[(1-\theta)c_{f,t}^{\frac{\varepsilon-1}{\varepsilon}} + \theta h_{f,t}^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}\right]^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \tag{17}$$

subject to her aggregate budget constraint:

$$C_{f,t} + \hat{B}_{f,t} + q_{f,t}\left(H_{f,t} - (1-\delta)\,H_{f,t-1}\right) + N_f \frac{\psi_B}{2}\hat{b}_{f,t}^2 = \hat{R}_{t-1}\hat{B}_{f,t-1} + I_{f,t}. \tag{18}$$

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

Foreign firms have the same technology as domestic firms. Thus, the equivalent of $(11)-(15)$ hold for the foreign economy with f subscripts.

3.4 Market Clearing

In each country, the labor used to produce structures, appliances and tradable goods must equal the total labor supply:

$$N_f = N_{Tf,t} + N_{sf,t} + N_{af,t}, \tag{19}$$

$$N_d = N_{Td,t} + N_{sd,t} + N_{ad,t}. \tag{20}$$

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

$$H^i_{d,t} + H^p_{d,t} - (1-\delta)\left(H^i_{d,t-1} + H^p_{d,t-1}\right) = Y_{hd,t}, \tag{21}$$

$$H_{f,t} - (1-\delta)\, H_{f,t-1} = Y_{hf,t}. \tag{22}$$

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

$$C_{f,t} + C^p_{d,t} + C^i_{d,t} + (1-\phi)\, N_d \frac{\psi_B}{2} \hat{b}^2_{d,t} + N_f \frac{\psi_B}{2} \hat{b}^2_{f,t} = Y_{Td,t} + Y_{Tf,t}.$$

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

$$B^p_{d,t} + B^i_{d,t} = 0. \tag{23}$$

Market clearing in international bonds implies:

$$\hat{B}_{d,t} + \hat{B}_{f,t} = 0. \tag{24}$$

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

$$TB_{d,t} = Y_{Td,t} - C^p_{d,t} - C^i_{d,t} - (1-\phi)\, N_d \frac{\psi_B}{2} \left(\hat{b}_{d,t}\right)^2.$$

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

$$CA_{d,t} = \hat{B}_{d,t} - \hat{B}_{d,t-1}. \tag{25}$$

4 Calibration

Some parameters are selected based on values that are common in the literature, or on evidence from OECD countries. 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. Table 1 summarizes the parameters.

1. *Exogenously selected parameters.* For the intertemporal elasticity of substitution (σ), I follow the real business cycle literature that usually assumes $\sigma = \frac{1}{2}$. 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.[9]

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 (10) is always binding. For an annual model, I choose $\beta^i = 0.85$, which is within the range of values used in the literature.[10]

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.[11]

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 parameters (τ, θ, γ, ψ_B, $\frac{L_d}{N_d}$) control the size of the housing

[9] Results are robust if I use an intratemporal elasticity of 1.

[10] 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.

[11] 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.

sector, appliances and the elasticity of the housing supply. I calibrate them to match the following targets in a world with symmetric country sizes in the steady state:[12] 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). Household's spending varies from 16% to 27% in OECD countries (OECD 2011). 3) The share of employment in the construction sector is 5% (Boldrin et al. 2013). 4) The aggregate housing price-to-rent ratio is 22 (Davis, Lehnert and Martin, 2008). 5) An average price-elasticity of housing supply equal to 1.1 over the first two years. This value is consistent with the evidence for OECD economies of Caldera and Johansson (2013).

5 Transmission Channels from Housing to the Current Account

This section analyzes the transmission channel from housing shocks to the current account. First, Figures 6 to 9 illustrate the standard channel in open economy versions of Iacoviello (2005), for example Punzi (2013) or Ferrero (2015). The figures differ in the persistence of the loan-to-value (LTV) shock. Also, to better illustrate the mechanisms, the figures compare the benchmark economy with a Small Open Economy (SOE) in which interest rates are constant and thus international bond markets do not clear.[13]

Insert Figures 6 to 9 around here

Figures 6 to 9 show that following an increase in the loan-to-value parameter the impatient constrained households borrow (negative bond holdings) and consume more (remark that in the model collateral constraints are always binding). Because housing services and tradable consumption are complements, these constrained households consume more of both of them.

These households, given their low discount factor, allocate most of their new borrowing into the consumption of the non-durable good, which is tradable. That is, even if they increase consumption of both tradables and housing they increase tradable consumption by more. Their tradable consumption grows faster than their housing consumption.

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

[13] Mathematically, in the Small Open Economy, market clearing equations (23) and (24) do not exist, there is a single international bond with exogenous constant rate and, following Schmitt-Grohé and Uribe (2003), there are quadratic bond adjustment costs to ensure a well-defined steady state. Thus, in the SOE, there is no connection between the savings of the patient households and the borrowing of the impatient households.

It is important to stress that once the LTV becomes tight, because debt is one-period in the model, the impatient households need to repay and therefore revert all dynamics. Here it is very useful to compare with the SOE since in the SOE the amount to repay is smaller as interest rates did not increase (in the benchmark economy higher demand for credit from the impatient leads to higher rates).

Patient households react to accommodate the demands from the impatient. That is, they reduce their consumptions of housing and tradables. In other words, they save and finance the impatient households. In the SOE economy this is not so much needed (the SOE economy can run a larger external deficit since rates do not increase) and thus the patient households react less.

On the aggregate, Figures 7 and 9 show that, at impact, following the softening of the LTV constraint, total consumption of tradable goods increases due to the high demand from the impatient households. Housing decreases because, to meet the large demand for tradable goods, the economy reallocates labor from housing construction to produce tradable goods. Moreover, the economy imports tradables (current-account deficit). The labor reallocation from construction implies a drop in housing production. The initial dynamics reported in Figures 7 and 9 match the simple two-period model discussed in the Online Appendix with the standard Production Possibility Frontier of Introductory Economics courses.

In this class of models, housing prices have a one-to-one mapping with the reallocation of labor. This can be seen from the first-order-conditions:

$$q_{d,t}\left[(N_{ad,t})^{\alpha}\right]^{1-\tau}\alpha\gamma\tau\left[(L_d)^{1-\gamma}\right]^{\tau}(N_{sd,t})^{(\alpha\gamma\tau-1)}=\alpha\left(N_{Td,t}\right)^{\alpha-1},$$

$$q_{d,t}\left[(L_d)^{1-\gamma}\left((N_{sd,t})^{\alpha}\right)^{\gamma}\right]^{\tau}\alpha\left(1-\tau\right)(N_{ad,t})^{\alpha(1-\tau)-1}=\alpha\left(N_{Td,t}\right)^{\alpha-1}.$$

Thus, if labor moves from housing construction towards the production of tradables then relative prices of tradables must increase relative to housing. Intuitively, relative prices signal where to allocate labor. Thus, since the model is real, that is, tradables are the numeraire, then housing prices fall relative to tradables (i.e. the prices of tradables increase).

Housing rents are marginal utility of housing over the marginal utility of consumption of the patient (if we included a renter he would behave as the saver following LTV shocks because he is not borrowing constrained). Housing rents increase at impact because the marginal utility of housing increases more than that of consumption. This happens because the drop in tradable consumption can be smoothed out with tradable imports but this is not the case for housing that it is non-tradable.

The fact that debt is one period implies that dynamics can be "boom/bust" and reactions are short-lived. The amount to be repaid is smaller in the SOE economy as interest rates did not increase. Thus, housing variables have smoother reactions in the SOE.

Figures 6 to 9 show a counterfactual observation new in the literature: the housing price-to-rent ratio decreases.[14] House 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.

The larger the share of impatient households, the larger the current account deficit generated by the collateral consumption channel, but then the counterfactual price-to-rent ratio is also larger as more impatient households have a higher preference for the housing flow. Figure A6 in the online appendix shows that when the economy is highly leveraged and the collateral channel is weaker, then permanent LTV shocks imply higher price-to-rent. This insight is summarized in Figure A7, that compares economies with high and zero external debt in Steady State. The level of initial leverage controls the intensity of the collateral channel and thus determines whether the price-to-rent falls or increases for the same permanent LTV shock.

Figure 10 shows an alternative mechanism for housing markets to generate current account deficits. In this new mechanism 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.[15]

Insert Figure 10 here

All panels in Figure 10 assume that the share of impatient households is zero ($\phi = 0$) in order to shut down the collateral consumption channel analyzed in Figures 6 to 9. Since there are no impatient 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

$$q^e_{d,t+1} = q_{d,t+1} + e_t, \tag{26}$$

[14] See for example Piazzesi and Schneider (2016) for a survey.
[15] The appendix shows a two period model to illustrate this mechanism in Figures A1 and A2.

where e_t is a shock to housing price expectations.[16] Garriga, Manuelli and Peralta-Alva (2019) use a similar methodology to give shocks to expectations.

Figure 10 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. In a housing boom labor reallocates from the sector producing tradable goods towards construction. Since labor is in fixed supply, to smooth consumption across goods, the country imports tradable goods and there is a current account deficit.

Since marginal utilities are decreasing (as it is standard) then this means that a larger housing stock will lead to lower value for extra unit of housing services. In addition, since the economy is producing more housing and labor is in fixed supply the production (and consumption) of tradable goods collapses. Decreasing consumption of tradables translate into higher marginal utility of tradables. Thus, the reason why rents decrease at impact is because the reactions of the housing stock and tradable consumption, because marginal utilities are decreasing, and because in this exercise there are only the patient households. These are all standard in this class of models. Figure 10 shows that the drop of rents at impact is larger if the housing supply elasticity is low since there more labor has to reallocate away from tradables and towards building houses, thus larger drop in tradable consumption.[17]

Figure 11 illustrates the previous labor reallocation with a different exercise. Figure 11 shows how the steady state variables change as the domestic housing preference θ changes.[18] In steady state, the current account balance is zero. But Figure 11 shows that when preferences for housing increase, house prices and rents are higher. More labor is devoted to build houses and the housing stock goes up. House prices increase more when housing supply is inelastic and higher construction cannot accommodate higher demand.[19]

Insert Figure 11 here

Thus, to recap, 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

[16] In other words, the model is a system of equations with housing prices at period t and in expected form. Now the expectations are exogenous and calibrated to data on expectations. That is, in the system of equations the expected prices become an exogenous variable imputed from the data.

[17] Housing supply elasticity is low when the γ parameter makes housing to be mostly land, which cannot be produced. (1 - γ) is the land intensity in housing sector. In Figure 10 this means γ moves from the benchmark 0.8 to 0.7.

[18] Appendix A2 contains the equations.

[19] The appendix contains comparative statics in steady state relative to LTV and other parameters in Figures A3 to A5.

expense of counterfactual price-to-rent ratios. A model that focuses on changes in housing price expectations can be consistent with both the current account and the price-to-rent ratios if there is enough reallocation of labor between construction and tradable goods. As Section 7 will show, this model can generate large current account deficits with a conservative share of impatient constrained households.

6 Housing and the Capital Account

This section studies a transmission channel that complements the previous section. Here the shock happens outside the domestic economy. Figure 12 reports the responses to a transitory increase in the foreign discount factor. This is akin to a "savings glut shock". The foreigners are more patient and want to save more.

Insert Figure 12 here

Figure 12 shows that higher global savings cause lower interest rates. Domestic borrowers can borrow cheaper and increase their demand for housing. Housing prices increase. However, like in Section 5, there is a counterfactual price-to-rent decrease.

Figure 12 shows that "savings glut shock" generate domestic housing booms and domestic current account deficits. However, the mechanism for the current account differs from the mechanism of Section 5. In Section 5 domestic factors pull money inflows as the domestic economy wants to borrow. In Figure 12, foreign shocks push inflows into the domestic economy causing a domestic current account deficit. To see this, Figure 12 reports the capital account ($KA_{d,t}$), which is the reverse of the current account since overall the balance of payments must be balanced:

$$KA_{d,t} = -CA_{d,t}.$$

7 Historical Simulations

In this section I use the model to study a historical episode. I evaluate the "new narrative of the crisis" that points toward changes in housing price expectations, more than to an expansion in credit supply, as the main driver of the housing boom.[20] To do so, I input into the model

[20]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**?**).

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.[21] 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 13 compares the expectations of real housing prices with the realized housing prices for each county.[22] Households underestimated housing price growth until 2005, then overestimate it.

Insert Figure 13 here

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 (26) 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 14 contains LTV shocks, the exact expectations that the model uses and also the data from Figure 13.

Insert Figure 14 here

Then, I input the exogenous driving forces (LTV and the housing price expectations of Figure 14) into the model and Figure 15 reports the reactions of its endogenous variables comparing them with data.[23] This is the same methodology that Garriga, Manuelli and Peralta-Alva (2019) 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.

Insert Figure 15 here

[21] 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.

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

[23] The model is solved using a nonlinear Newton-type algorithm (Adjemian et al. 2011) for a perfect foresight version. The e_t shocks into (26) ensure that $q^e_{d,t+1}$ matches the series reported in Figure 13.

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 15 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.

Figure 15 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.

8 Cross-Sectional Simulations

To validate the mechanisms of the model, Figures 16 to 18 try to replicate the facts of Figures 3 to 5. The results are successful.

Insert Figures 16, 17 and 18 here

Figure 16 shows that in the model, as in the data of Figure 3, the correlation between price-to-rents and the trade balance-to-GDP is increasing in the housing supply elasticity.

Figures 17 and 18 show that, in model and in the data, the same change in housing prices cause larger changes in the trade balance-to-GDP for low housing supply elasticities, or for relatively high borrowing constrained households.

9 Consumption Asymmetries

Figure 19 shows that the reaction of consumption is asymmetric during the boom and bust of the housing market simulated in Section 7. Aggregate consumption increases less during the housing boom than decreases during the bust. During the boom households are shifting their preferences towards housing. During the bust the previous mechanism is reversed. Moreover, the tightening of the collateral constraint depresses consumption. Thus, the effects on consumption during the bust are stronger. This result is new in an open economy setting relative to the existing literature (see Gelain, Lansing, and Natvik 2018 for example).

Insert Figure 19 here

10 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) Enough labor reallocation between construction and the tradable sector. 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.

Another avenue for future research is the analysis of the effects of different types of shocks on home-ownership and price-to-rent ratios in a richer model of heterogeneous agents. The current model with two types of agents à la Iacoviello (2005) provides several interesting insights that are confirmed by the data. For example, shocks that improve expectations of housing prices lead to higher price-to-rent ratios as households' demand for housing expands. Intuitively, households want to hold the asset that will experience capital gains. There is ample evidence supporting this mechanism (see for example Landvoigt, Piazzesi and Schneider 2015). However, shocks that provide resources to credit constrained agents (e.g. changes in loan-to-values or in mortgage rates) may cause lower price-to-rent ratios. The intuition is that constrained households are constrained for a reason, like higher impatience that translates into a higher preference for non-housing consumption. That is, they would like to consume more than what they can afford. Thus, they channel the new funds towards consumption goods instead of towards more housing demand. This is consistent with empirical evidence that innovations to use a house as an ATM (e.g. home equity credit lines) cause mostly higher consumption of non-housing goods (Chen, Michaux and Roussanov 2020).

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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
Structures parameter	τ	0.989
LTV parameter	m	0.92
Share of housing services in utility	θ	0.15
Labor share in production	α	0.67
Land parameter	$1-\gamma$	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}
Adjustment cost of international bond	ψ_B	0.008

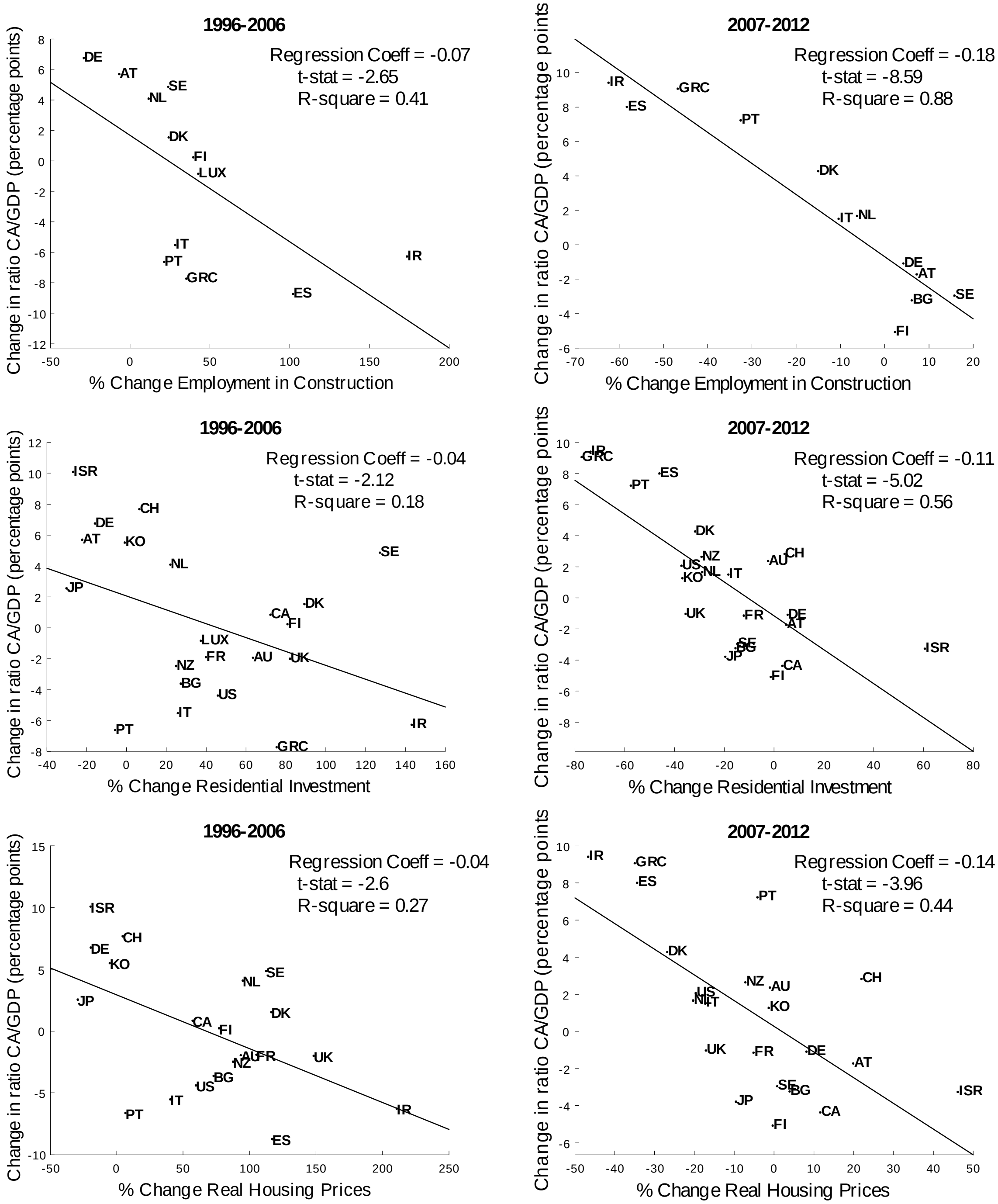

Figure 1. Cross-Country Correlations between Changes in the Current Account to GDP ratio and Changes in Housing Variables. The first row is the scatter-plot of the change in the current account to GDP ratio against the change in the share of employment in construction. The second and third rows replace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

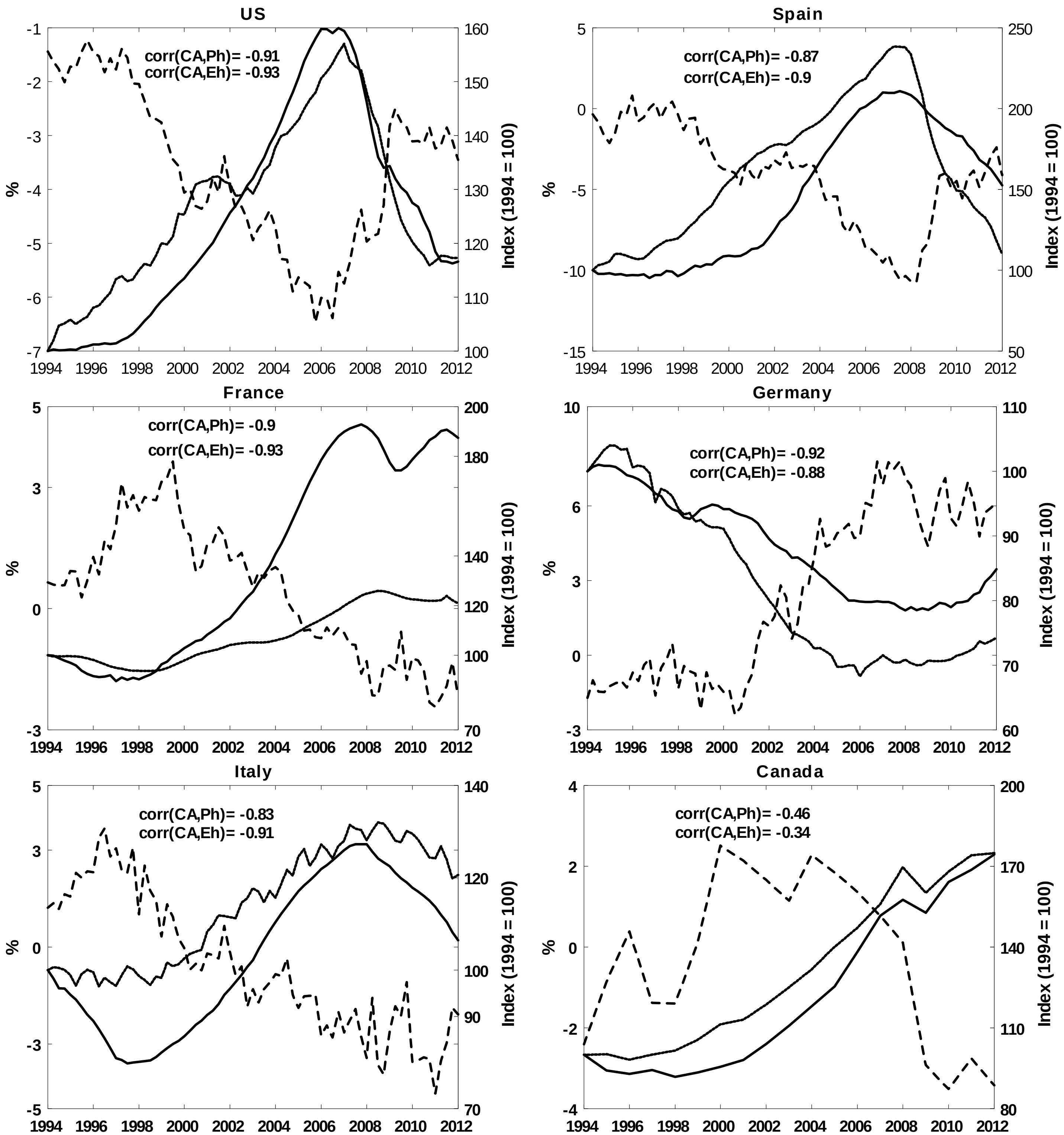

Figure 2. Within-Country Correlations. The Current Account-to-GDP ratio (CA) is the dashed line (left scale), Employment in Construction (Eh) is the dotted line (right scale), and House Prices (Ph) are the solid line (right scale). The correlations are also displayed. Data source: OECD.

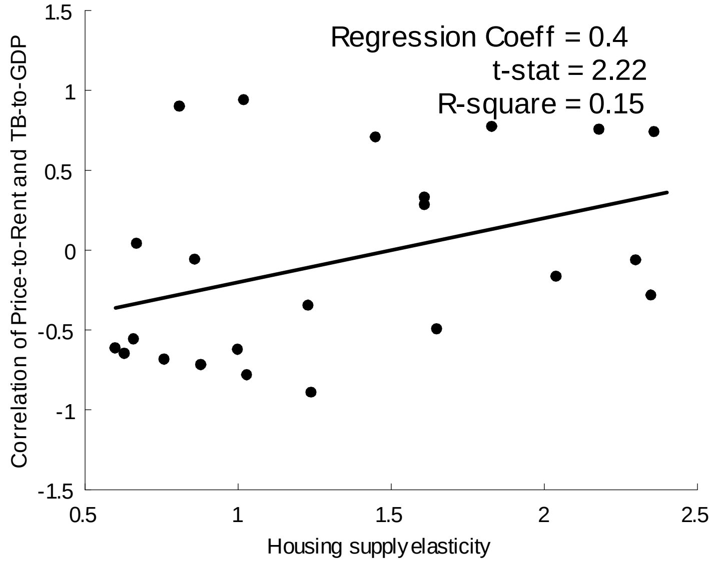

Figure 3. Correlation of housing price-to-rent and trade balance-to-GDP for different elasticities of housing supply. The x-axis is the housing supply elasticity, the y-axis is the correlation between price-to-rent and trade balance-to-GDP. The figure reports the scatter-plot and the OLS regression line with robust standard errors for the available U.S. MSAs. The appendix describes the data sources.

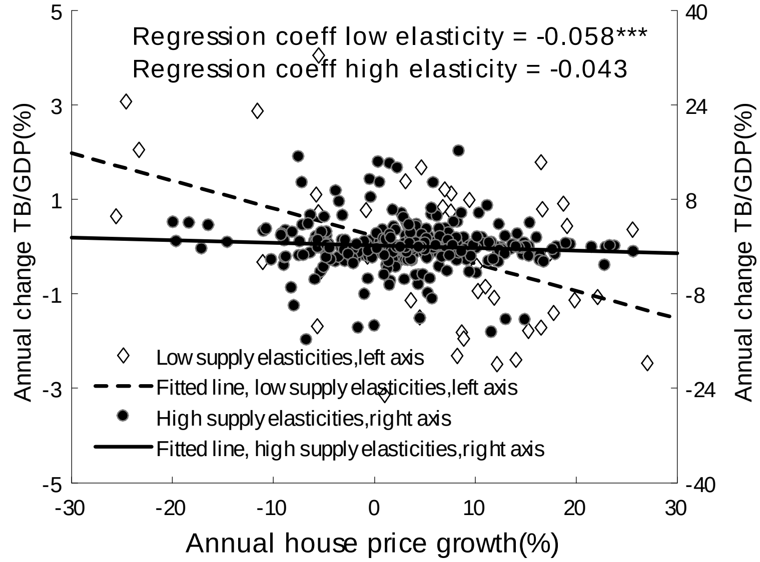

Figure 4. Changes in trade balance-to-GDP and house price growth for U.S. MSAs. The role of housing supply elasticity. The x-axis is the annual house price growth, the y-axis is the annual change in the trade balance-to-GDP. The figure reports the scatter-plots and the OLS regression lines with robust standard errors. The available U.S. MSAs are classified in two groups: high or low housing supply elasticity. Low elasticity are those MSAs with housing elasticities lower than the 10th percentile of the entire sample. *** means significant at 1%, ** at 5% and * at 10% respectively. The appendix describes the data sources.

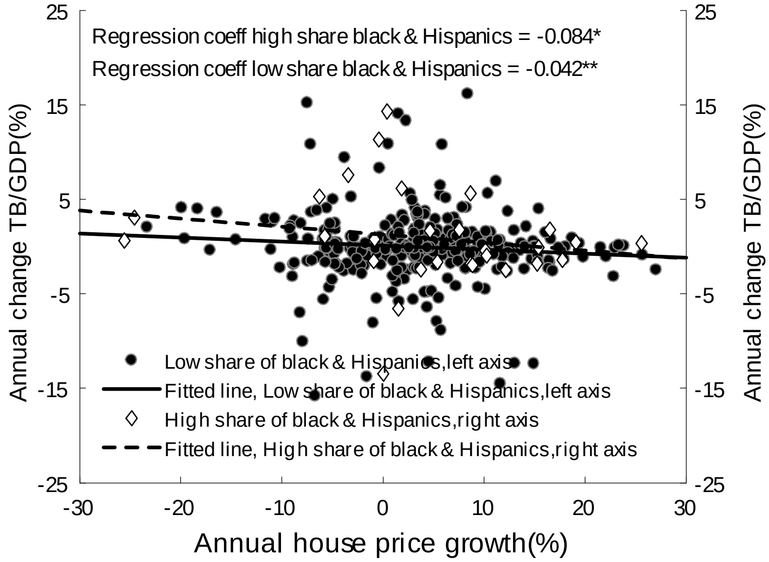

Figure 5. Changes in trade balance-to-GDP and house price growth for U.S. MSAs. The role of the share of black and Hispanics. The x-axis is the annual house price growth, the y-axis is the annual change in the trade balance-to-GDP. The figure reports the scatter-plots and the OLS regression lines with robust standard errors. The available U.S. MSAs are classified in two groups: high or low share of black and Hispanics. MSAs with high share of black and Hispanics are those MSAs with a share higher than the 90th percentile of the entire sample. *** means significant at 1%, ** at 5% and * at 10% respectively. The appendix describes the data sources.

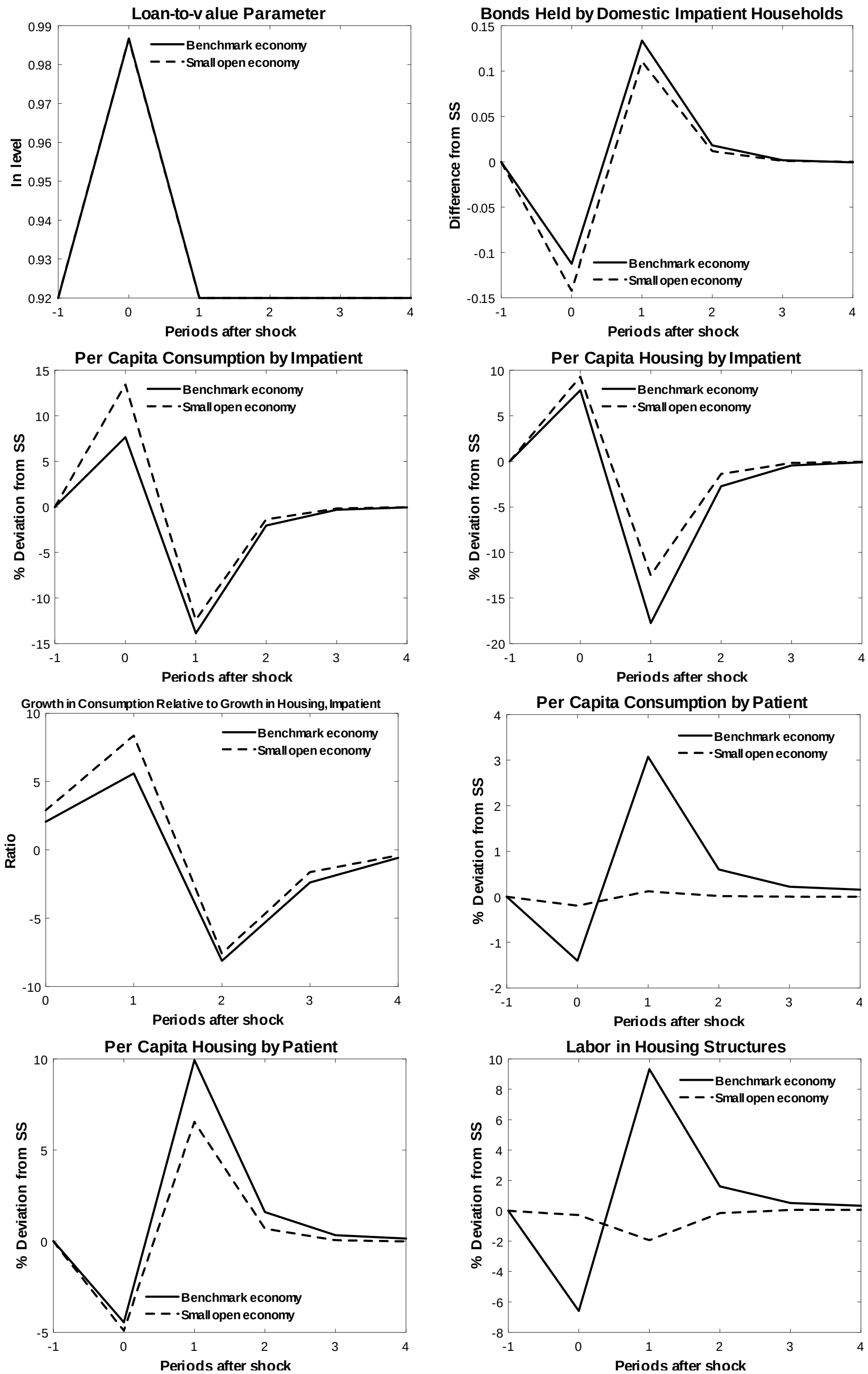

Figure 6. Domestic responses to transitory LTV shock. In the Small Open Economy, interest rates are constant and both types of households have access to an international bond.

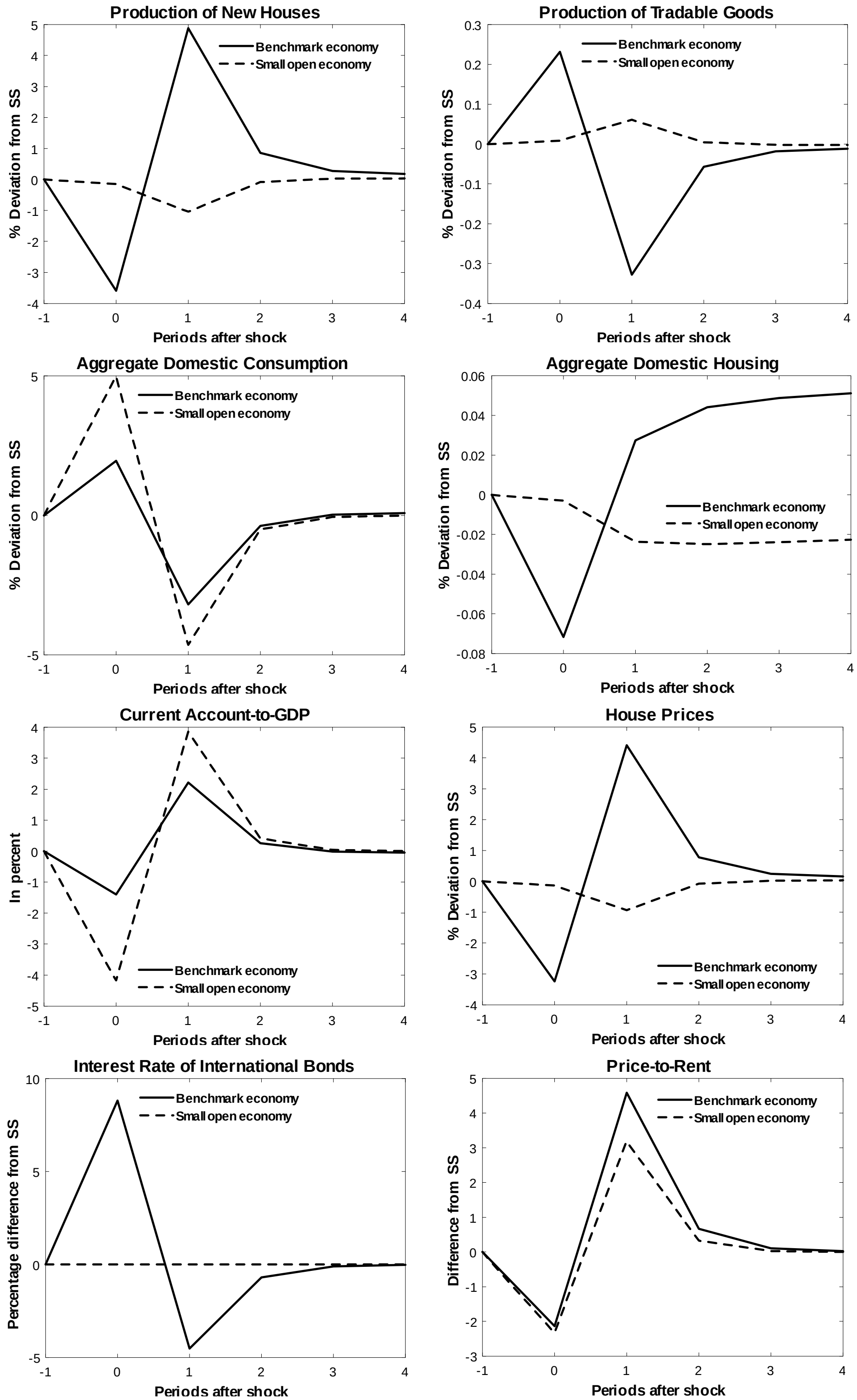

Figure 7. Responses in the domestic country to transitory LTV shock. The shock is the increase in the LTV parameter shown in Figure 6 top left panel. In the Small Open Economy, interest rates are constant and both types of households have access to an international bond.

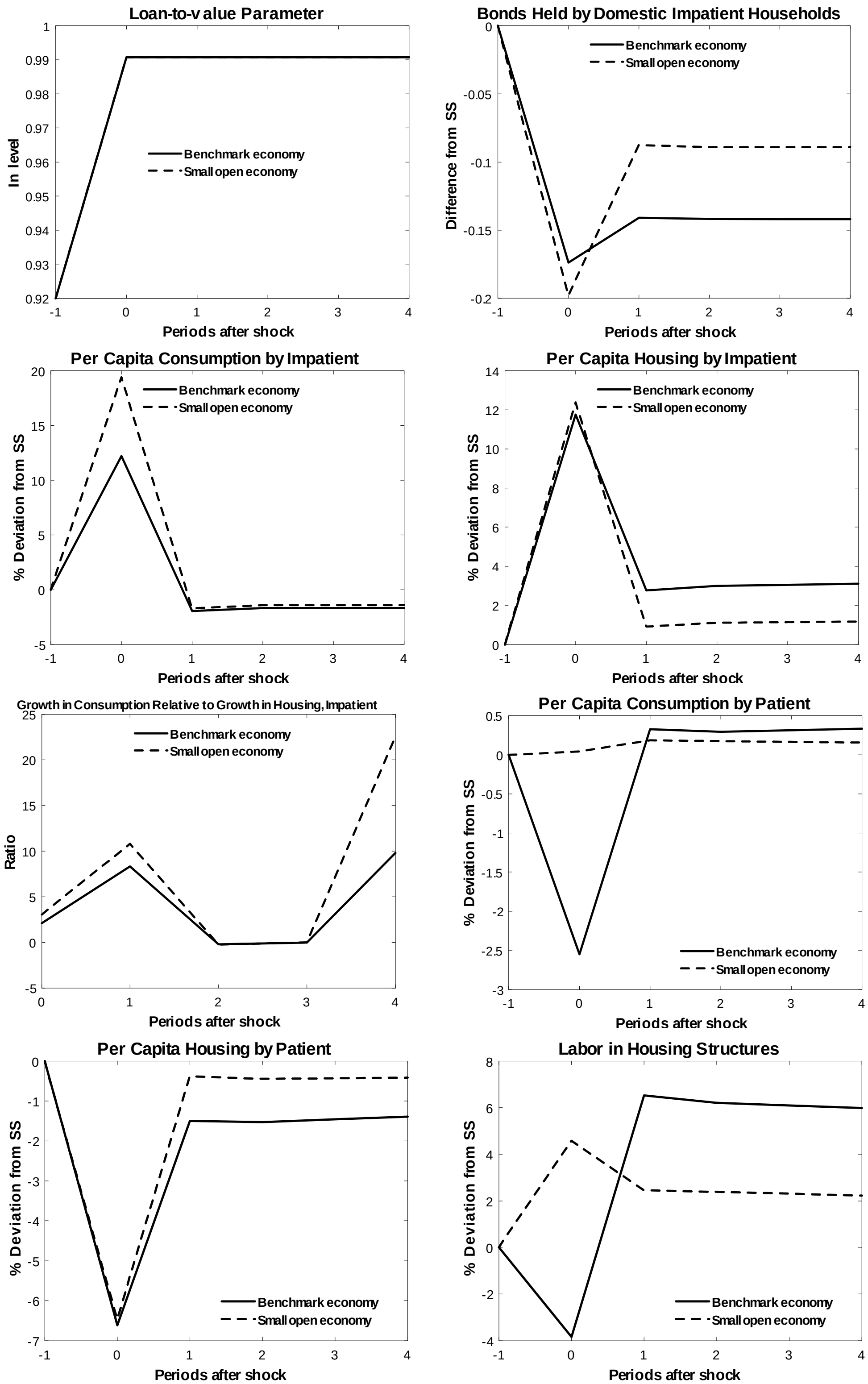

Figure 8. Responses in the domestic country to permanent LTV shock. The shock is shown in the top left panel. In the Small Open Economy, interest rates are constant and both types of households have access to an international bond.

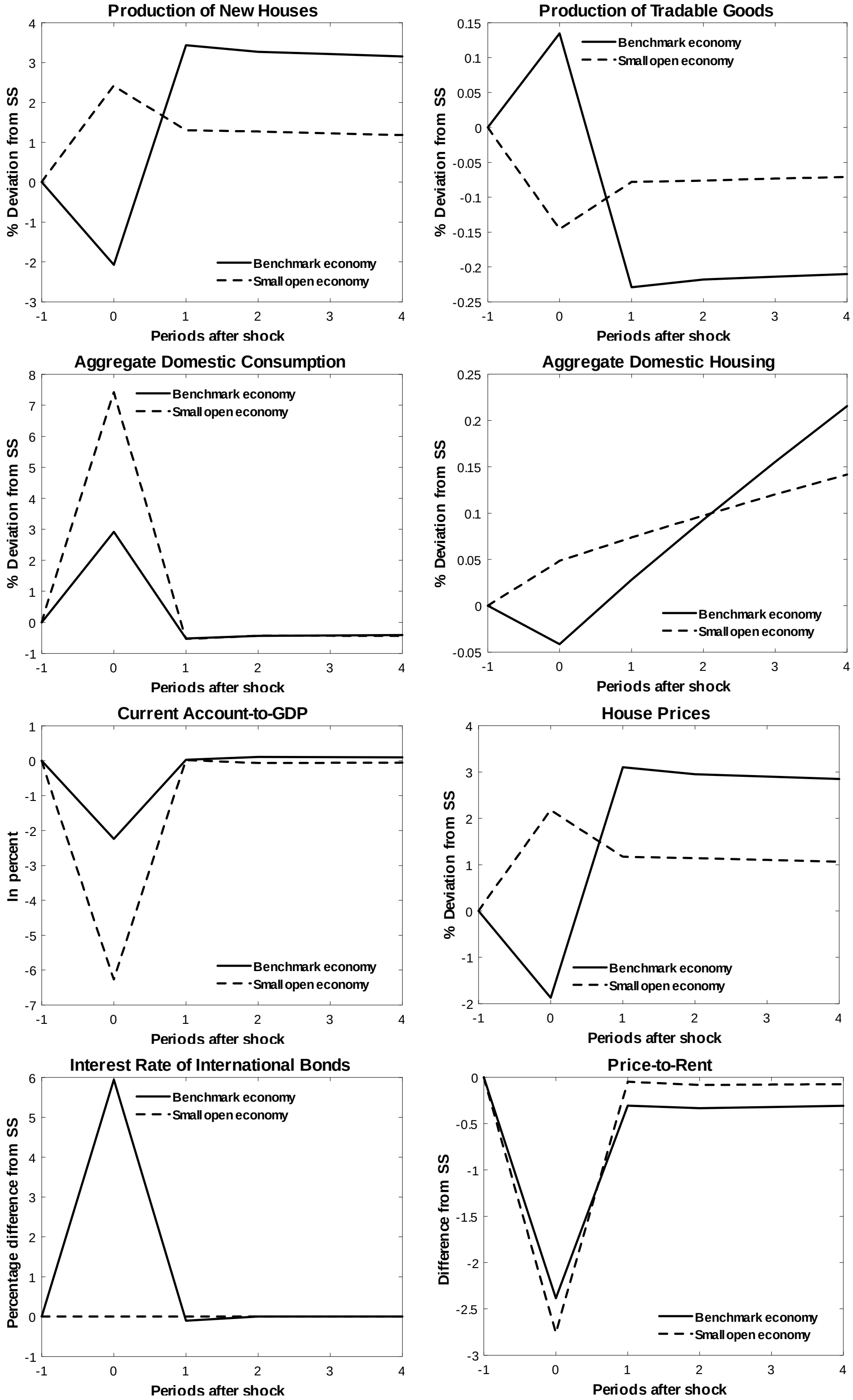

Figure 9. Responses in the domestic country to permanent LTV shock. These panels plot the responses to the increase in the LTV parameter shown in Figure 8 top left panel.

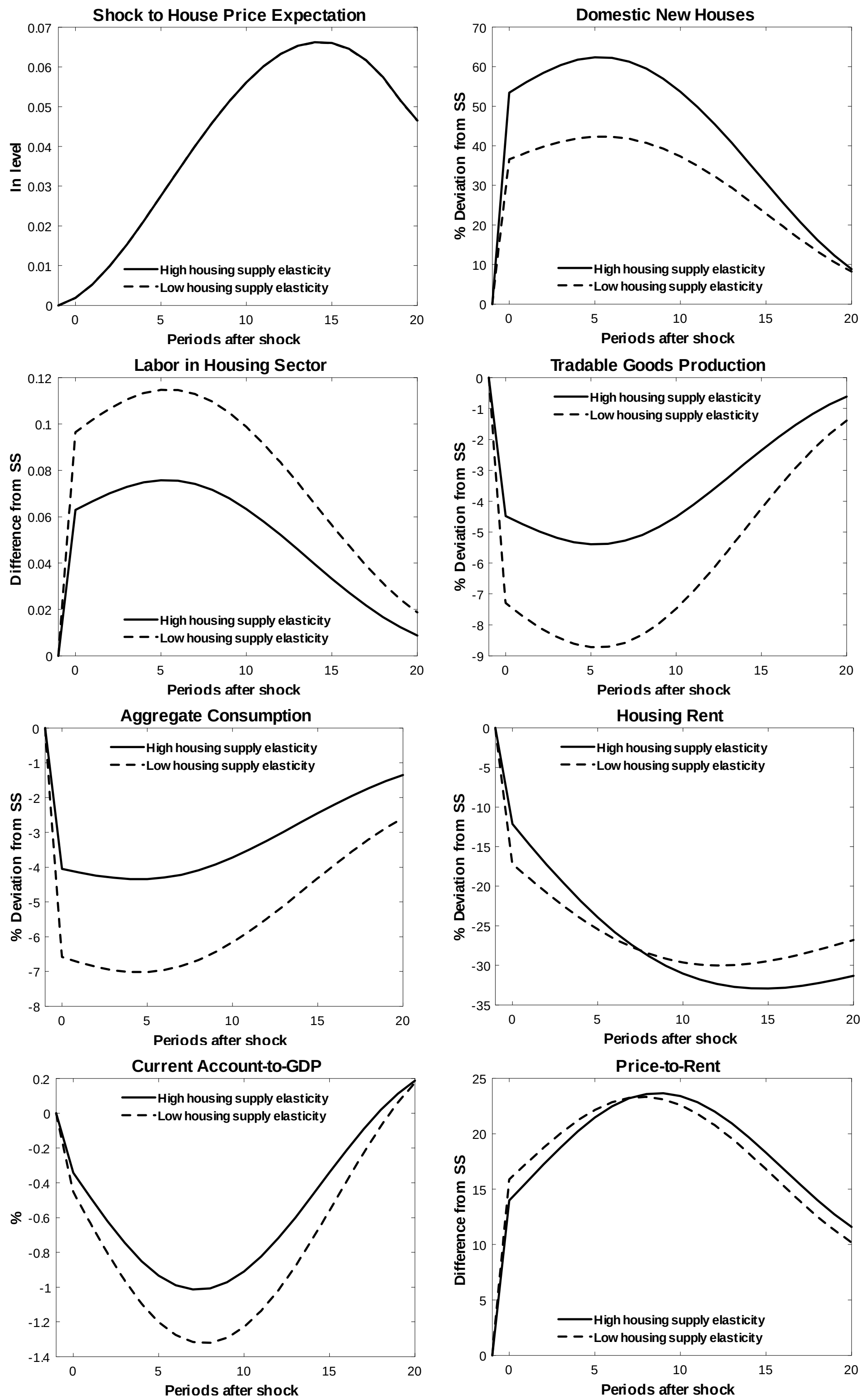

Figure 10. Responses in the domestic country to housing expectation shock. The shock is shown in the top left panel and discussed in Section 5. In all panels there are no impatient households ($\phi = 0$) to shut down the collateral channel.

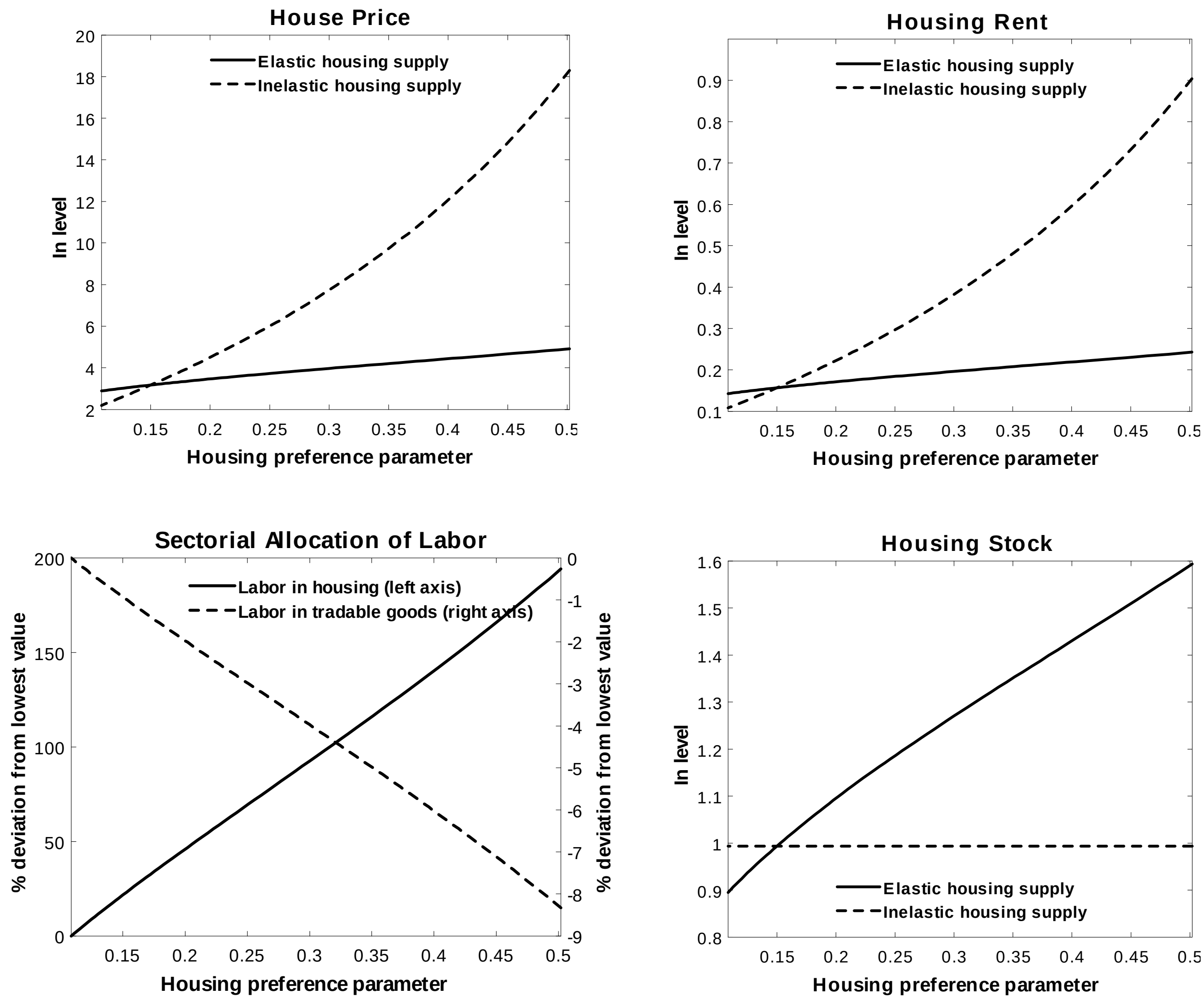

Figure 11. Comparative statics in the steady state of the domestic country for different levels of the housing preference parameter θ. Inelastic housing supply is the case when housing is in fixed supply.

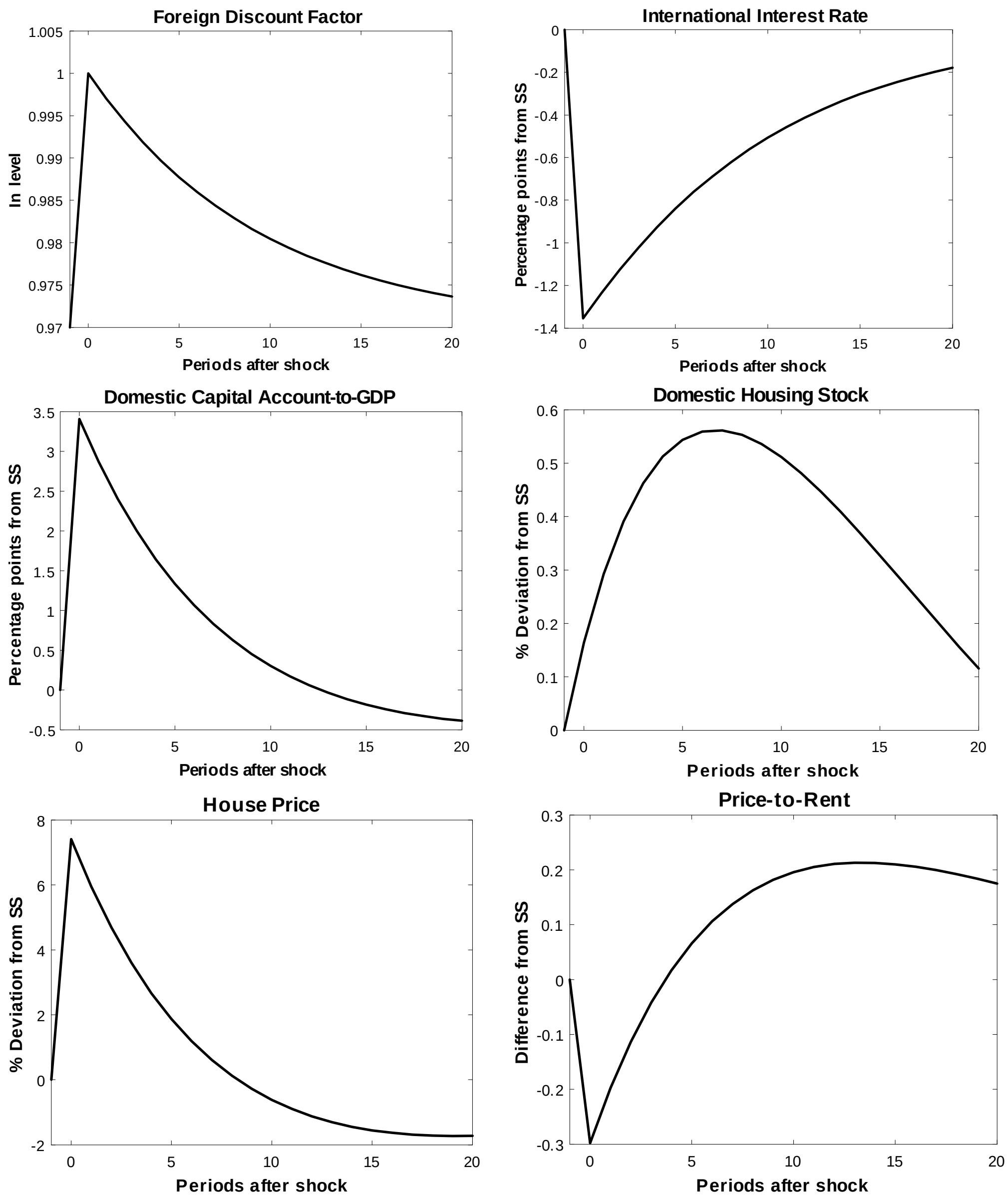

Figure 12. Responses in the domestic country to a foreign discount factor shock. These panels plot the responses to an increase in the foreign discount factor.

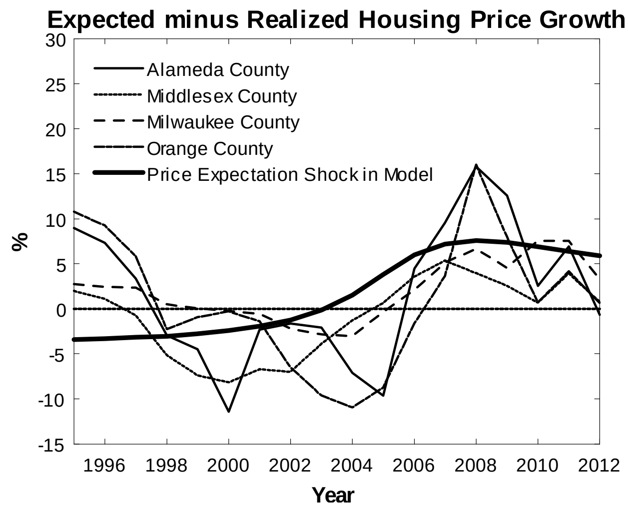

Figure 13. Comparing House Price Expectations with Realized House Prices. The figure compares the model expected housing prices and the realized housing prices.

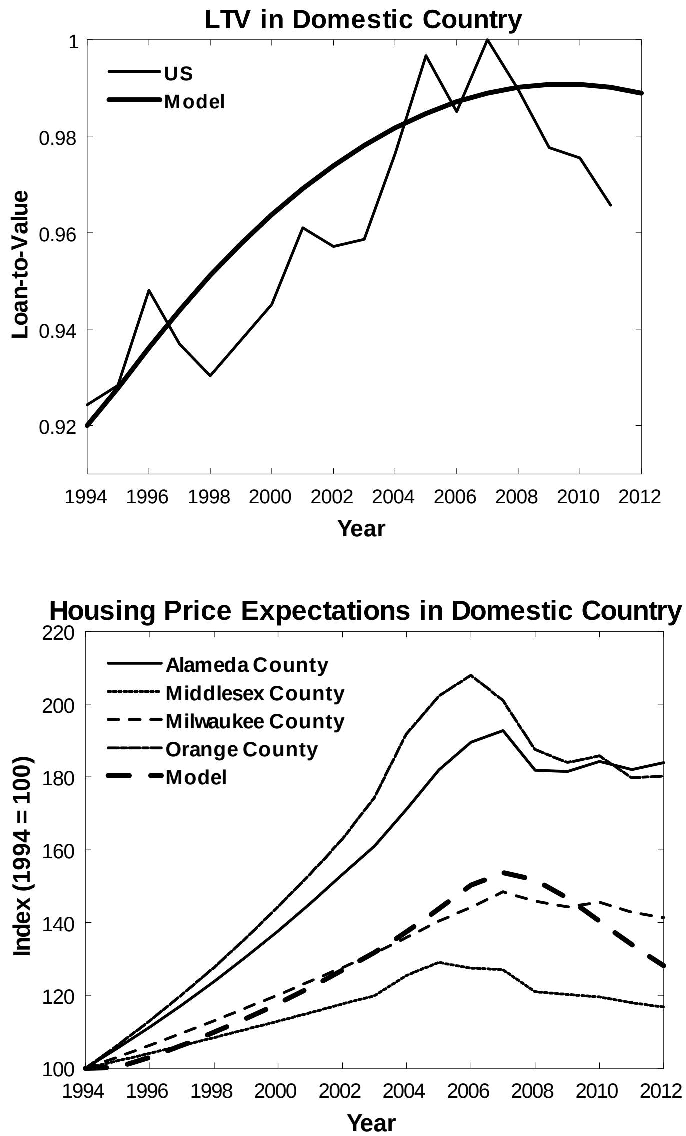

Figure 14. LTV shock and Housing Expectations in the Model. This figure plots the LTV shock consistent with data, and housing expectations that I feed in the model comparing with the Case, Shiller and Thompson (2012) data.

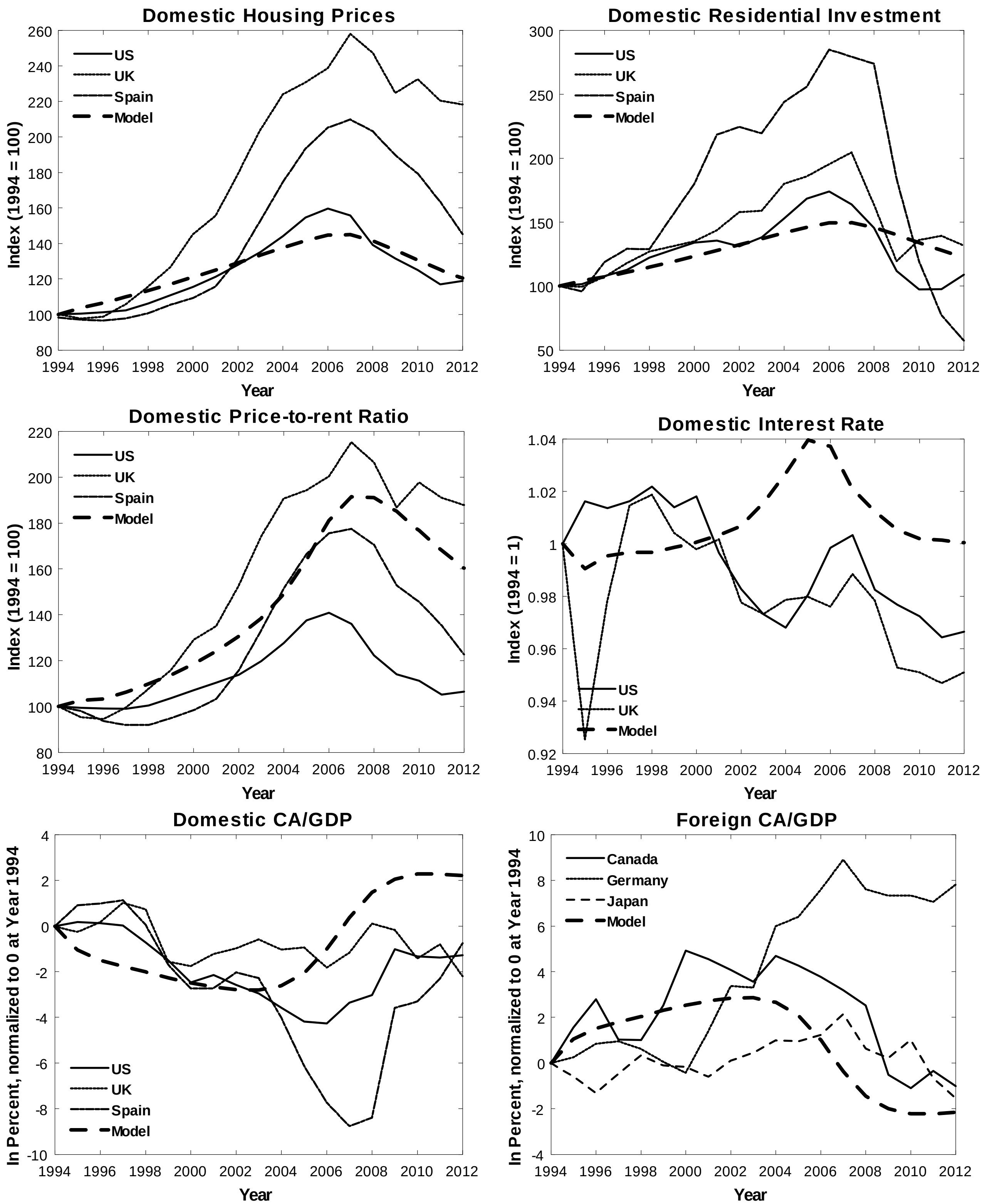

Figure 15. Data vs Model. This figure compares the data with the model driven by LTV and the housing expectations reported in Figure 14.

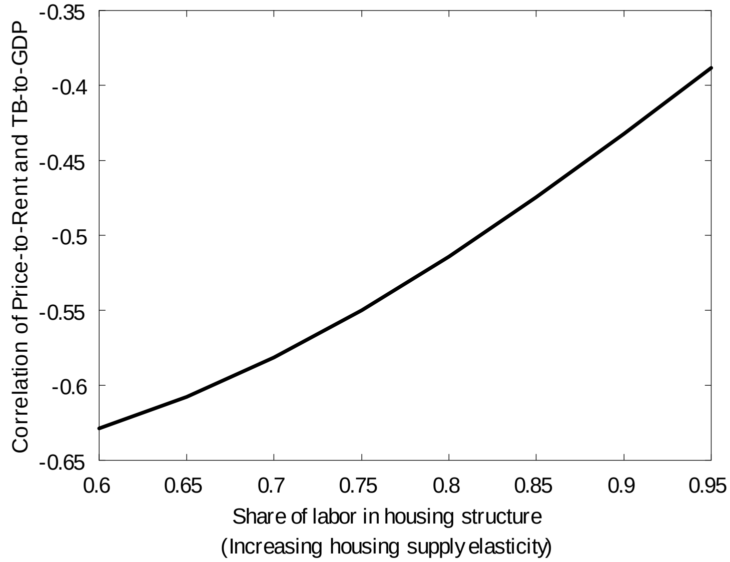

Figure 16. Correlation between price-to-rent and trade balance-to-GDP in the domestic country for different housing supply elasticities. The correlations are calculated over the first 100 period after the impact of the housing price expectation shock of Figure 10.

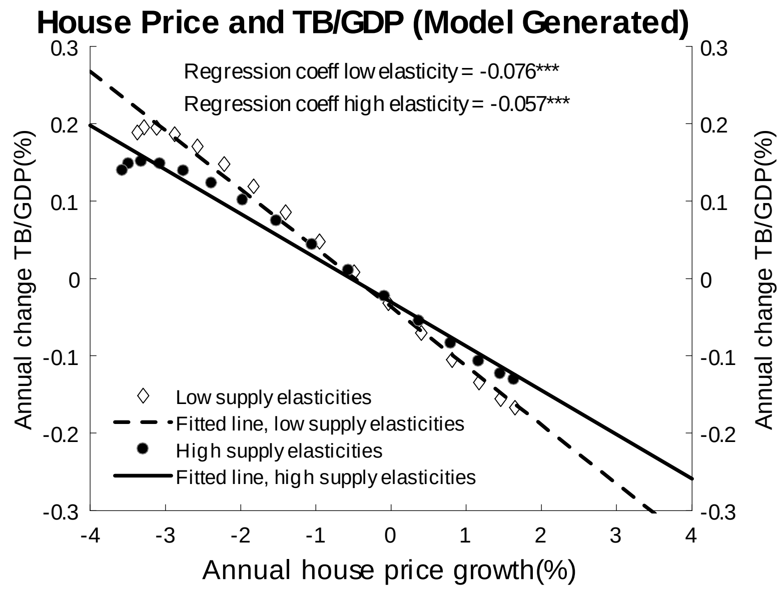

Figure 17. Model generated relationship between house price growth and Trade Balance-to-GDP. Model simulations generate the observations and then there are two regression lines. The standard errors are robust. *** significant at 1%, ** at 5%, * at 10%.

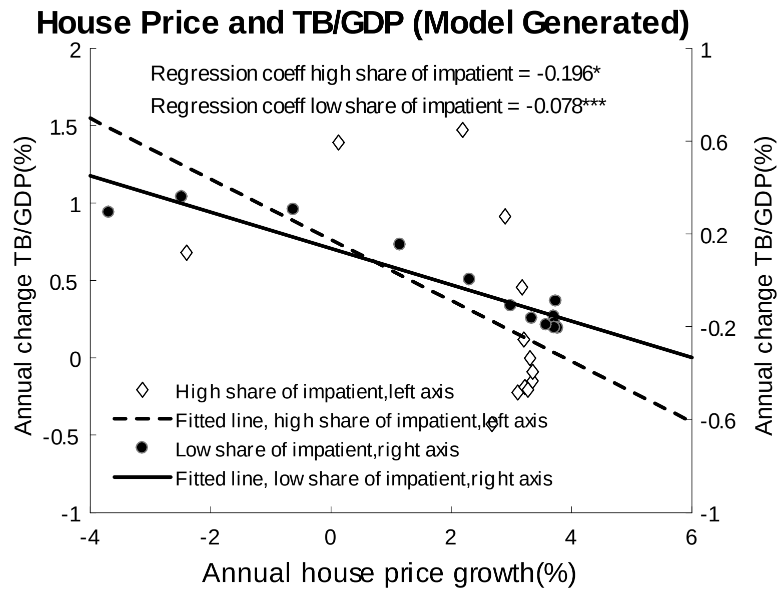

Figure 18. Model generated relationship between house price growth and trade balance-to-GDP by share of impatient. Model simulations generate the observations and then there are two regression lines. The model with high share of impatient is the benchmark calibration ($\phi = 0.4$). The model with low share of impatient households uses $\phi = 0.1$. The standard errors are robust. *** significant at 1%, ** at 5%, * at 10%.

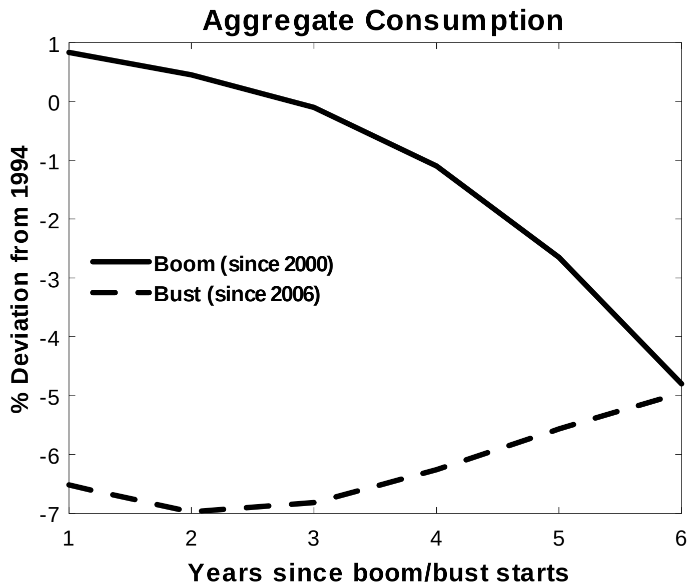

Figure 19. Asymmetries in consumption. This figure reports the dynamics of aggregate consumption in the domestic economy for the housing boom and for the housing bust.

NOT FOR PUBLICATION. ONLINE APPENDIX.

A First-Order Conditions and Steady State Equations

When the foreign equations are equivalent to the domestic equations, I only list the equations for the domestic country. I follow the same rule when the equations are equivalent for patient and impatient households.

A1 First-Order Conditions

Marginal utilities from tradable goods and housing services:

$$u_c\left(c_{d,t}^p, h_{d,t}^p\right) = (1-\theta)\left[f(c_{d,t}^p, h_{d,t}^p)\right]^{\left(\frac{1}{\varepsilon}-\frac{1}{\sigma}\right)}\left(c_{d,t}^p\right)^{-\frac{1}{\varepsilon}}, \tag{A1}$$

$$u_h\left(c_{d,t}^p, h_{d,t}^p\right) = \theta\left[f(c_{d,t}^p, h_{d,t}^p)\right]^{\left(\frac{1}{\varepsilon}-\frac{1}{\sigma}\right)}\left(h_{d,t}^p\right)^{-\frac{1}{\varepsilon}}, \tag{A2}$$

where

$$f(c_{d,t}^p, h_{d,t}^p) = \left[(1-\theta)c_{d,t}^{p\frac{\varepsilon-1}{\varepsilon}} + \theta h_{d,t}^{p\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{A3}$$

Euler equation for international bonds for patient households:

$$u_c\left(c_{d,t}^p, h_{d,t}^p\right)\left[1+\psi_B \hat{b}_{d,t}^p\right] = \beta_t^p \hat{R}_t E_t\left[u_c\left(c_{d,t+1}^p, h_{d,t+1}^p\right)\right]. \tag{A4}$$

Euler equation for domestic bonds for domestic patient households:

$$u_c\left(c_{d,t}^p, h_{d,t}^p\right) = \beta_t^p R_t E_t\left[u_c\left(c_{d,t+1}^p, h_{d,t+1}^p\right)\right]. \tag{A5}$$

Euler equation for domestic bonds for domestic impatient households:

$$u_c\left(c_{d,t}^i, h_{d,t}^i\right) = \beta_t^i R_t E_t\left[u_c\left(c_{d,t+1}^i, h_{d,t+1}^i\right)\right] + \mu_t. \tag{A6}$$

where μ_t is the Lagrange multiplier associated with the collateral constraint.

Euler equation for housing for patient and impatient households:

$$u_h\left(c^p_{d,t}, h^p_{d,t}\right) = u_c\left(c^p_{d,t}, h^p_{d,t}\right) q_{d,t} - \beta^p_t E_t\left\{u_c\left(c^p_{d,t+1}, h^p_{d,t+1}\right)\left[q_{d,t+1}\left(1-\delta\right)\right]\right\}, \tag{A7}$$

$$u_h\left(c^i_{d,t}, h^i_{d,t}\right) + \frac{\mu_t m_t E_t\left(q_{d,t+1}\right)}{R_t} = u_c\left(c^i_{d,t}, h^i_{d,t}\right) q_{d,t} - \beta^i_t E_t\left\{u_c\left(c^i_{d,t+1}, h^i_{d,t+1}\right)\left[q_{d,t+1}\left(1-\delta\right)\right]\right\}. \tag{A8}$$

Same marginal return to labor in the two sectors:

$$q_{d,t}\left[\left(N_{ad,t}\right)^{\alpha}\right]^{1-\tau} \alpha\gamma\tau\left[\left(L_d\right)^{1-\gamma}\right]^{\tau}\left(N_{sd,t}\right)^{(\alpha\gamma\tau-1)} = \alpha\left(N_{Td,t}\right)^{\alpha-1}, \tag{A9}$$

$$q_{d,t}\left[\left(L_d\right)^{1-\gamma}\left(\left(N_{sd,t}\right)^{\alpha}\right)^{\gamma}\right]^{\tau}\alpha\left(1-\tau\right)\left(N_{ad,t}\right)^{\alpha(1-\tau)-1} = \alpha\left(N_{Td,t}\right)^{\alpha-1}. \tag{A10}$$

A2 Steady State Conditions

The output equations:

$$Y_{sd} = \left(L_d\right)^{1-\gamma}\left(\left(N_{sd}\right)^{\alpha}\right)^{\gamma}, \tag{A11}$$

$$Y_{Td} = \left(N_{Td}\right)^{\alpha}, \tag{A12}$$

$$Y_{ad} = \left(N_{ad}\right)^{\alpha}, \tag{A13}$$

$$Y_{hd} = \left(Y_{sd}\right)^{\tau}\left(Y_{ad}\right)^{1-\tau}. \tag{A14}$$

Collateral constraint:

$$b^i_d = \frac{-m q_d h^i_d}{R}. \tag{A15}$$

Aggregate conditions:

$$C^p_d = \left(1-\phi\right) N_d c^p_d, \tag{A16}$$

$$H^p_d = \left(1-\phi\right) N_d h^p_d, \tag{A17}$$

$$B^p_d = \left(1-\phi\right) N_d b^p_d, \tag{A18}$$

$$C^i_d = \phi N_d c^i_d, \tag{A19}$$

$$H^i_d = \phi N_d h^i_d, \tag{A20}$$

$$B^i_d = \phi N_d b^i_d. \tag{A21}$$

Budget constraints:

$$C_d^p + B_d^p + q_d \delta H_d^p = RB_d^p + (1-\phi)\left(q_d Y_{hd} + Y_{Td}\right), \tag{A22}$$

$$C_d^i + B_d^i + q_d \delta H_d^i = RB_d^i + \phi\left(q_d Y_{hd} + Y_{Td}\right). \tag{A23}$$

Housing market clearing:

$$Y_{hd} = \delta\left(H_d^p + H_d^i\right). \tag{A24}$$

Consumption Euler equation of the domestic patient:

$$1 = \beta_t^p R_t. \tag{A25}$$

Consumption Euler equation of the domestic impatient:

$$\mu = u_c\left(c_d^i, h_d^i\right)\left(1 - \beta^i R\right). \tag{A26}$$

Housing Euler equations:

$$u_h\left(c_d^p, h_d^p\right) = u_c\left(c_d^p, h_d^p\right) q_d - \beta^p u_c\left(c_d^p, h_d^p\right) q_d (1-\delta), \tag{A27}$$

$$u_h\left(c_d^i, h_d^i\right) + \frac{\mu m q_d}{R} = u_c\left(c_d^i, h_d^i\right) q_d - \beta^i u_c\left(c_d^i, h_d^i\right) q_d (1-\delta). \tag{A28}$$

Marginal utility equations:

$$u_c\left(c_d^p, h_d^p\right) = (1-\theta)\left[f\left(c_d^p, h_d^p\right)\right]^{\left(\frac{1}{\varepsilon}-\frac{1}{\sigma}\right)}\left(c_d^p\right)^{-\frac{1}{\varepsilon}}, \tag{A29}$$

$$u_h\left(c_d^p, h_d^p\right) = \theta\left[f\left(c_d^p, h_d^p\right)\right]^{\left(\frac{1}{\varepsilon}-\frac{1}{\sigma}\right)}\left(h_d^p\right)^{-\frac{1}{\varepsilon}}. \tag{A30}$$

Same marginal return to labor in the two sectors:

$$q_d\left[\left(N_{ad}\right)^{\alpha}\right]^{1-\tau}\alpha\gamma\tau\left[\left(L_d\right)^{1-\gamma}\right]^{\tau}\left(N_{sd}\right)^{(\alpha\gamma\tau-1)} = \alpha\left(N_{Td}\right)^{\alpha-1}, \tag{A31}$$

$$q_d\left[\left(L_d\right)^{1-\gamma}\left(\left(N_{sd}\right)^{\alpha}\right)^{\gamma}\right]^{\tau}\alpha(1-\tau)\left(N_{ad}\right)^{\alpha(1-\tau)-1} = \alpha\left(N_{Td}\right)^{\alpha-1}. \tag{A32}$$

B Data sources

1. Trade balance: a) The exports and imports by MSA are obtained from the U. S. Trade Database of the Census Bureau;[24] b) Exports and imports are world-level aggregates for all commodities; c) The data are available for 41 MSAs from 1992 to 2017; d) The trade balance is export values net of import values; e) The data exclude import duties, freight, insurance, and other charges incurred in moving the merchandise; f) The data series measures only the dollar value of merchandises (goods that can physically be transported across the border), that is, there are no data on services (like in the model there are no services); g) The exports (imports) series are exports (imports) of goods that are grown, produced, or manufactured in (outside) the MSA, or which have been enhanced in value by further processing or manufacturing in (outside) the MSA; h) The data come from the U. S. Trade Database of the Census Bureau. To compute the MSA aggregates the Census Bureau matches the five-digit zip codes entered on U.S. export and import declarations with the five-digit zip codes specified for each MSA using concordance files from the Census Bureau's Geography Division and the U.S. Postal Service. The boundaries of official metropolitan CBSAs are county-based and are defined by the Office of Management and Budget.

2. GDP data by MSA come from the Bureau of Economic Analysis.[25] The data are available from 2001 to 2016. Trade Balance-to-GDP data are available for 33 MSAs.

3. Housing data:

(a) House price indices are from the Federal Housing Finance Agency with seasonal adjustment.[26]

(b) Price-to-rents come from Zillow.

(c) The housing supply elasticity is from Saiz (2010).

4. The share of population of blacks and Hispanics is obtained from the 2012-2016 American Community Survey 5-Year estimates computed by the U.S. Census Bureau.

[24] https://usatrade.census.gov/index.php

[25] "GDP by Metropolitan Area" at https://www.bea.gov/regional/downloadzip.cfm

[26] https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx#qpo.

C A Two Period Model

Here I discuss the intuition of why higher demand for housing can generate a current account deficit when there is a construction sector. I use 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

$$u\left(c_t, h_t\right) = \frac{\left(((1-\theta_t)c_t^{\frac{\varepsilon-1}{\varepsilon}} + \theta_t h_t^{\frac{\varepsilon-1}{\varepsilon}})^{\frac{\varepsilon}{\varepsilon-1}}\right)^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \ t = 1, 2. \tag{A33}$$

In the competitive equilibrium the representative household maximizes

$$U(c_1, h_1, c_2, h_2) \equiv u(c_1, h_1) + \beta u\left(c_2, h_2\right) \tag{A34}$$

subject to the intertemporal budget constraint in terms of tradable goods

$$c_1 + \frac{c_2}{R} = y_{c1} + \frac{y_{c2}}{R}, \tag{A35}$$

to the production functions of housing in each period,

$$y_{ht} = AN_{ht}^{\alpha}, \tag{A36}$$

$$y_{ct} = BN_{ct}^{\alpha}, \tag{A37}$$

and feasibility in labor and housing markets:

$$N_{ht} + N_{ct} = N, \qquad \text{for } t = 1, 2 \tag{A38}$$

$$h_t = y_{ht}. \tag{A39}$$

The First-Order Conditions are the Euler equation and the equalization of the marginal rate of substitution with the marginal rate of transformation

$$u_c(c_1, h_1) = \beta R u_c(c_2, h_2), \tag{A40}$$

$$u_h(c_t, h_t)\frac{y_{ht}}{n_{ht}} = u_c(c_t, h_t)\frac{y_{ct}}{n_{ct}} \qquad \text{for } t = 1, 2. \tag{A41}$$

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

$$c_t = y_{ct} \qquad \text{for } t = 1, 2, \tag{A42}$$

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

$$\frac{u_h(y_{c1}, y_{h1})}{u_c(y_{c1}, y_{h1})} = \frac{n_{h1}}{y_{h1}} \frac{y_{c1}}{n_{c1}}. \tag{A43}$$

The upper left panel of Figure A1 graphs this condition. The left hand side of equation (A43) 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 (A43).

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 $(\tilde{c}_1^c < c^*)$.[27] 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 intertemporal 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

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

of the intertemporal budget constraint, in a closed economy as

$$R^{aut} \equiv \frac{u_c(\tilde{c}_1^c, \tilde{h}_1^c)}{\beta u_c(c^*, h^*)}. \tag{A44}$$

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 one.[28] 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 (A35). FOC (A41) only requests that the slope of the indifference curve is the same at both points. Point C was not available for the closed economy because it implies a transfer of tradable goods across periods. Interest rates raised to prevent this.

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

$$u_c(c_1, h_1) = (1 - \theta_1) C_1^{\frac{1}{\varepsilon} - \frac{1}{\sigma}} c_1^{\frac{-1}{\varepsilon}}, \tag{A45}$$

$$C_1 \equiv ((1 - \theta_1) c_1^{\frac{\varepsilon-1}{\varepsilon}} + \theta_1 h_1^{\frac{\varepsilon-1}{\varepsilon}})^{\frac{\varepsilon}{\varepsilon-1}}. \tag{A46}$$

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 FOR ONLINE APPENDIX. NOT-FOR-PUBLICATION.

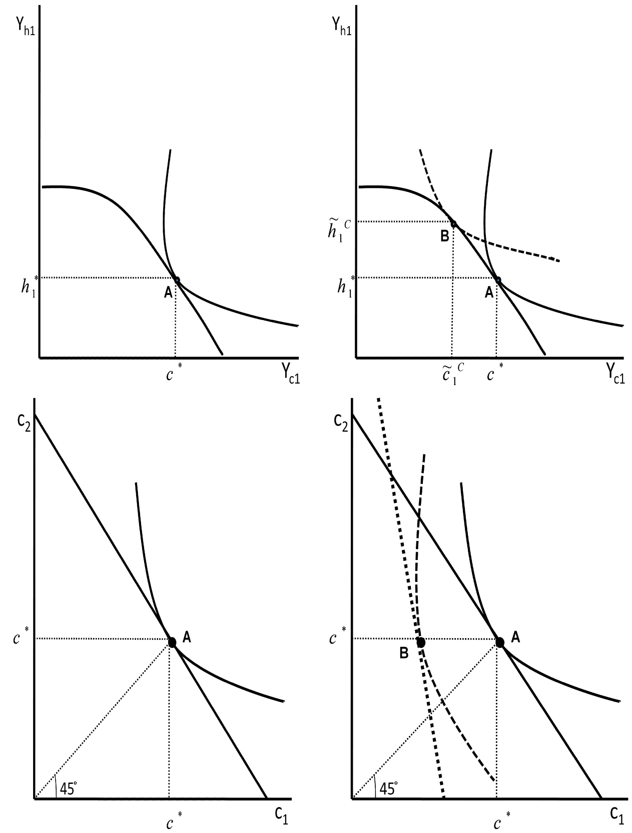

Figure A1. The Two Period Model: the Closed Economy. The figures on the top report the production possibilities frontier and the utility curves. The figures at the bottom are the intertemporal budget constraints.

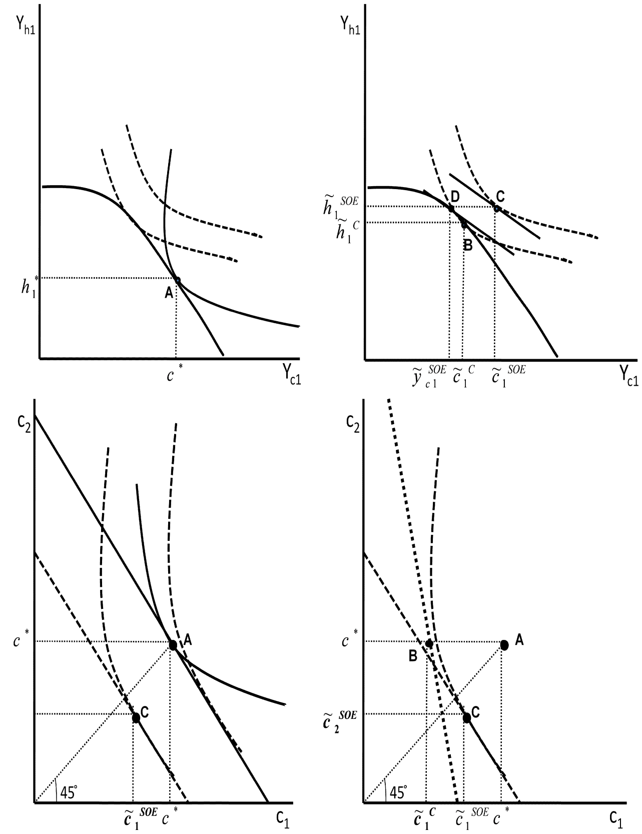

Figure A2. The Two Period Model: the Small Open Economy. The figures on the top report the production possibilities frontier and the utility curves. The figures at the bottom are the intertemporal budget constraints.

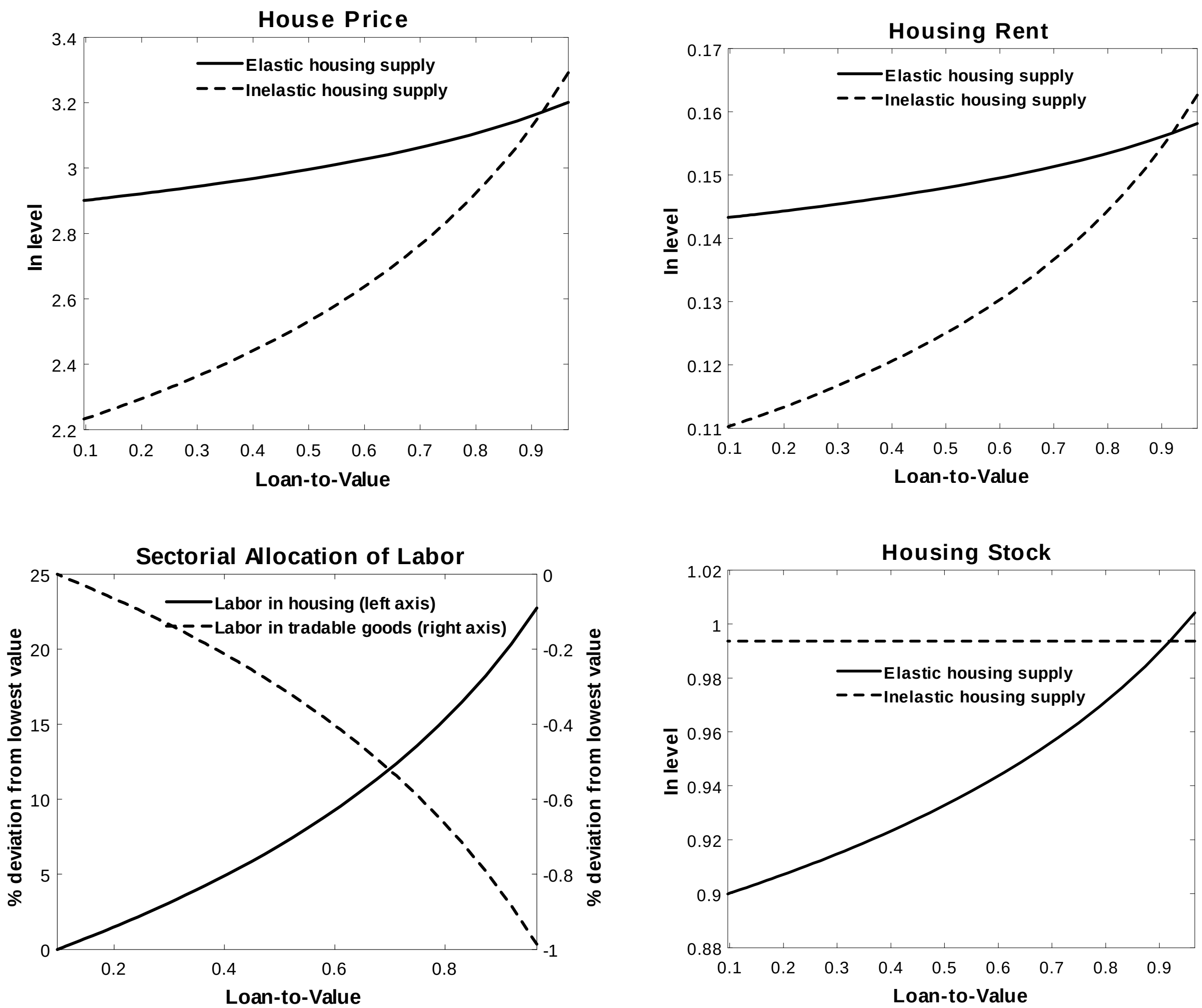

Figure A3. Comparative statics in steady state of the domestic country for different levels of the LTV parameter m. Inelastic housing supply is the case when housing is in fixed supply.

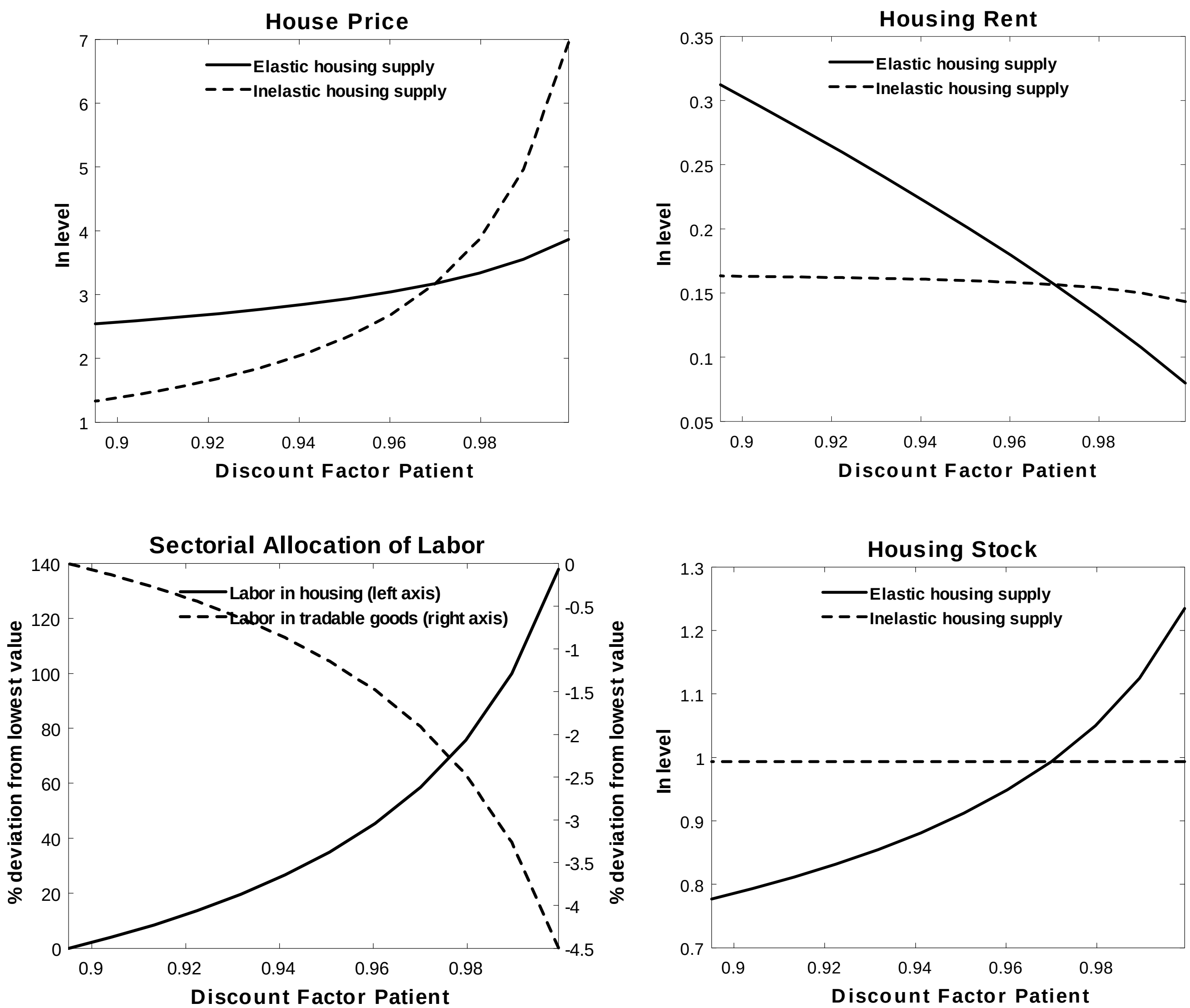

Figure A4. Comparative statics in steady state of the domestic country for different levels of the patient household's discount factor. Inelastic housing supply is the case when housing is in fixed supply.

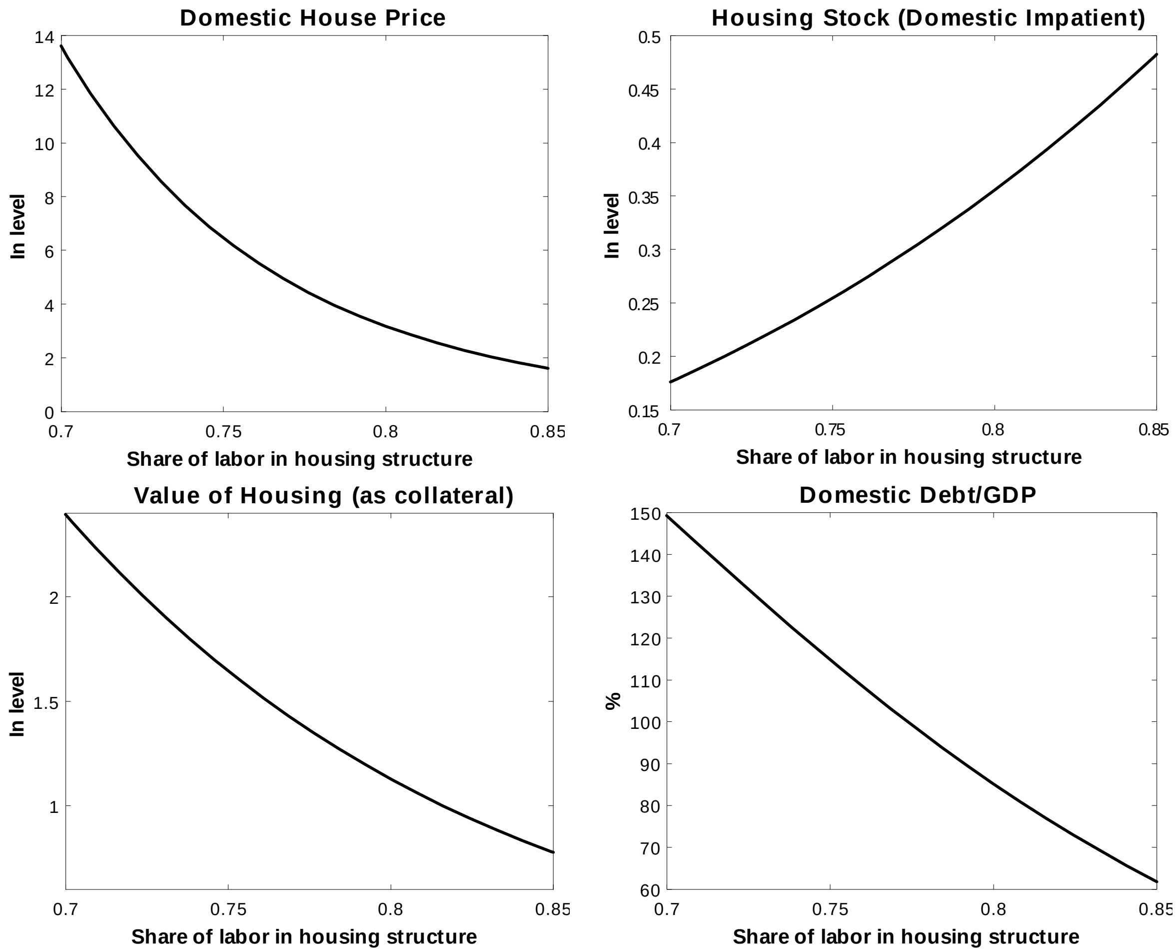

Figure A5. Comparative statics in steady state of the domestic country for different levels of the share of labor in housing production.

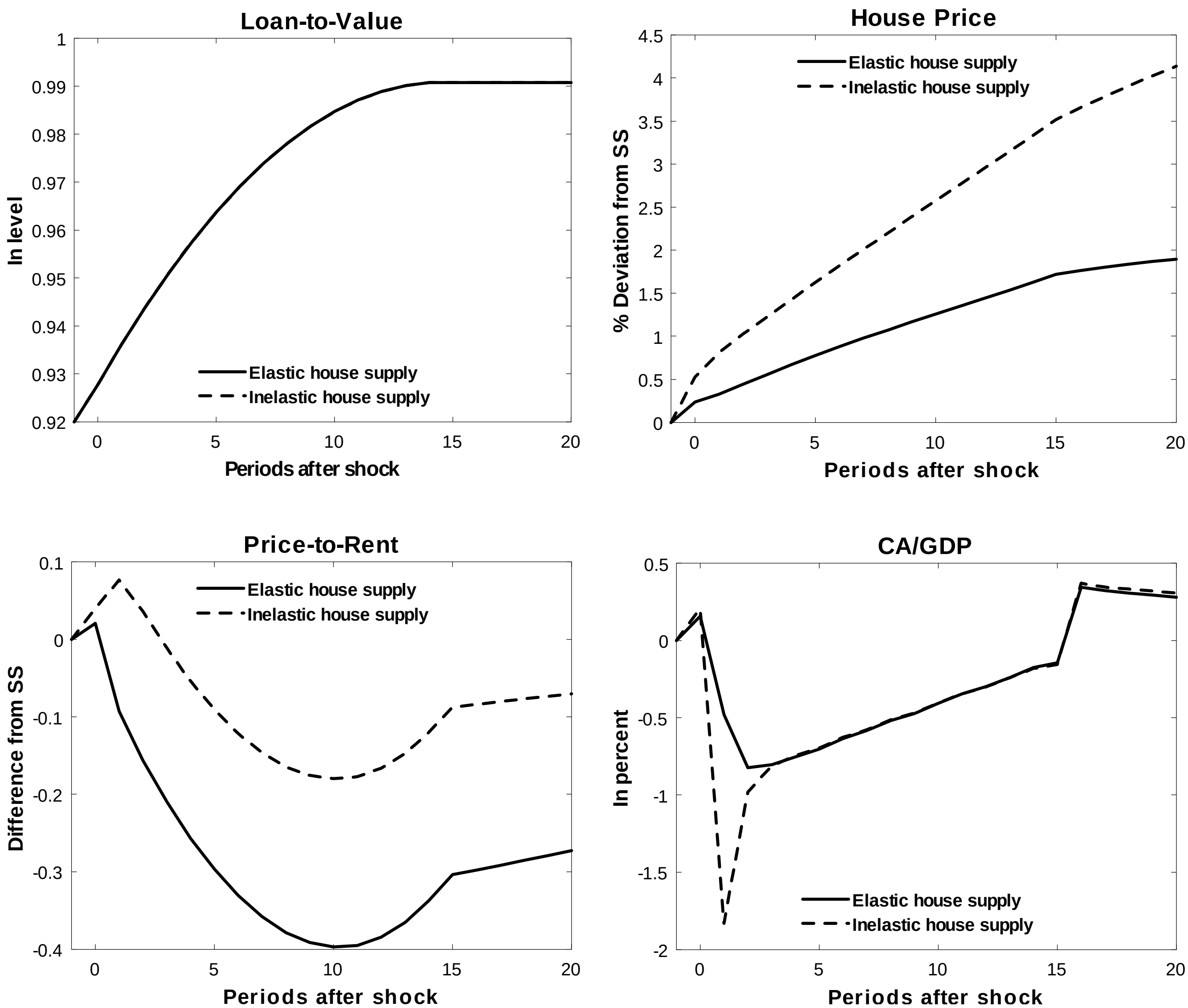

Figure A6. Responses in the domestic country to permanent LTV shock when there is a high current account deficit in steady state. The economy is calibrated such that in steady state the domestic country's external debt to GDP $\left(\frac{\hat{B}_d^p}{GDP_d}\right)$ targets the average level of external debt to GDP for the top 30 indebted countries as of 2019, that is, 700% (Wikipedia, IMF, CEIC and National Central Banks).

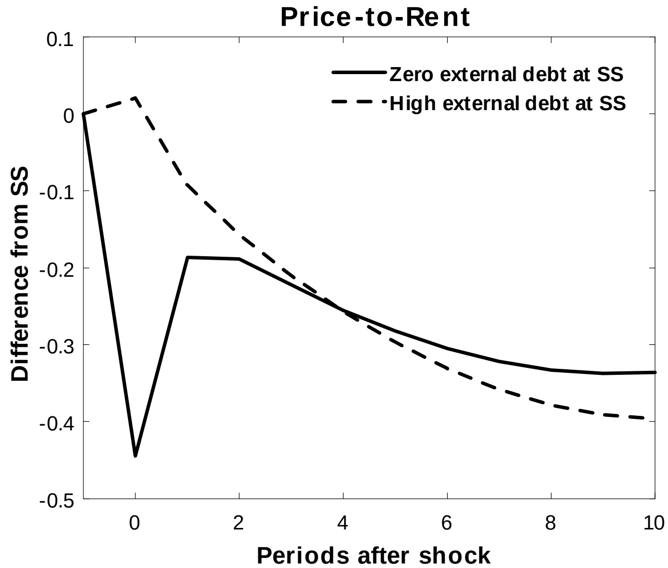

Figure A7. **Responses in the domestic country to permanent LTV shock for zero or high current account deficit in steady state**. This figure compares the economy calibrated as in Figure A6 with the economy calibrated to have zero debt in steady state.