Housing Markets and Current Account Dynamics*

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November, 2008

JOB MARKET PAPER

Abstract

I model global imbalances as arising from changes in preferences for housing relative to tradable goods. The key ingredients in the model are labor reallocation across sectors and consumption smoothing between housing and tradable goods. Countries import goods during periods when more domestic labor is devoted to housing construction. Housing booms are larger in countries that can run trade deficits. This occurs despite the absence of wealth effects, and even if trade is not primarily concentrated in capital goods. I provide several types of evidence to support the theory. First, over the last decade housing variables have decoupled from the business cycle while durable and total consumption expenditures have not. Second, for the same period there has been a strong cross-country correlation between housing variables and current account dynamics. Third, in a parameterized version of the model, housing demand shocks that match the cross-country dynamics of housing quantities generate current account dynamics matching recent global imbalances. Fourth, I use sign restrictions implied by the model to estimate a vector autoregression and identify the effects of housing shocks on the U.S. trade deficit. The results suggest that housing shocks are an important driving force of current account dynamics.

*I am very grateful to Anil Kashyap, Sam Kortum and Monika Piazzesi for their advice and support. I thank Fernando Alvarez, Maris Goldmanis, Veronica Guerrieri, Bin Li, Robert Lucas, Priscilla Man, Ezra Oberfield, Héctor Pérez-Saiz, Hyun Song Shin, Nancy Stokey, Harald Uhlig and workshop participants at the Board of Governors of the Federal Reserve, Chicago-GSB and the University of Chicago for helpful comments. Financial support from Banco de España, La Caixa and the University of Chicago is gratefully acknowledged. I also thank the Bank of Spain and the Board of Governors of the Federal Reserve for hospitality while part of this research was undertaken. Christophe Andre, Luca Dedola, Markus Kramer and Kathleen Stephansen were very kind to provide me some data.

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1 Introduction

What explains current account dynamics? In the last several years this question has attracted a significant amount of attention in academic and policy circles. The U.S. and some other developed economies have run large and persistent current account deficits, often referred to as "global imbalances". This paper makes a theoretical and an empirical contribution to the debate. I show that trade deficits arise in periods of increased demand for nontradable goods relative to tradable goods. I focus on housing, which I model as a durable nontradable good. I then show that housing demand shocks (shocks to the aggregate marginal rate of substitution between housing and tradables) help to explain recent global imbalances.

The model is a two-country multisector neoclassical model. Capital and labor can be used to produce either tradable goods or housing, though housing also requires land. Land and labor are in fixed supply. I assume exogenous shifts of the aggregate preferences towards housing. These shifts increase the demand for housing relative to other goods. Depending on the elasticity of the supply of housing, the increase in housing demand implies either higher housing prices or higher housing consumption, or both. Housing is not tradable. Thus, to increase the quantity consumed the economy has to move labor and capital from producing tradable goods to constructing houses. The opportunity cost of building new houses is the foregone production of tradable goods due to reallocation of resources to the construction sector. Trade deficits lower this cost because they decouple consumption from production. By importing consumer tradables the economy can reduce its production of tradables while still consuming them. Thus trade deficits allow for smooth consumption across goods while building faster and more. Hence housing booms are larger when the economy can run a trade deficit.

I provide four types of evidence to support the theory. First, I document that in the U.S. the cross correlations at different lags between GDP and residential investment have decreased dramatically since the middle of the 1990s. Housing has decoupled from the business cycle while total consumption expenditure and durable consumption expenditure have not. Standard sources of economic fluctuations, such as technology, money, fiscal and aggregate demand shocks, cannot explain this decoupling. Housing demand shocks potentially can.

Second, over the last decade there has been a strong cross-country correlation between current account balances and housing variables (real housing prices and especially housing quantities, such as labor share in construction or value added by this sector). During this time the countries with large deficits have experienced housing booms. Residential investment and homeownership rates have climbed to levels well above their historical averages.

Third, in a parameterized version of the model, housing shocks that match the observed cross-country dynamics of housing quantity variables generate current account dynamics matching recent global imbalances. I discuss the results for a parameterization where the elasticity of the supply of housing is low, and for a parameterization where

this elasticity is high.

Fourth, the model provides two identification restrictions for a housing demand shock: conditional on a positive shock, the correlation between the shock and residential investment is positive. Moreover, the conditional correlation of the shock with tradable consumption is negative. I use these sign restrictions to estimate a vector autoregression and identify the effects of housing shocks on the U.S. trade deficit. The results from this estimation suggest that housing shocks are an important driving force of current account dynamics.

The paper proceeds as follows. Section 2 discusses related work. Section 3 documents facts regarding housing and current account dynamics. Section 4 describes the model and characterizes its equilibrium. In Section 5, I parameterize the model and perform impulse response analysis to illustrate its mechanics and predictions. Section 6 shows that the model can account for recent patterns of global imbalances. In Section 7, I estimate a vector autoregression and use sign restrictions implied by the model to identify the effects of housing shocks on trade deficits. Section 8 concludes.

2 Related work

There are three main branches of literature attempting to explain global imbalances (for surveys, see Eichengreen (2005), Roubini (2006) and Bracke et al. (2008)). The first focuses on U.S.-specific factors, such as the U.S. fiscal deficit (Kraay and Ventura (2005)); misalignments of the U.S. nominal exchange rate leading to excessively low import prices (Dooley et al. (2004)); persistent positive U.S. return differentials (Gourinchas and Rey (2005)); asset price inflation or the "Great Moderation" causing low private saving in the U.S. (Fratzscher et al. (2007); Foggli and Perri (2006)); and accounting deficiencies (incorrectly imputed intangible investments or FDI (Hausmann and Sturzenegger (2006); McGrattan and Prescott (2008))). The second branch relies on differences in expected or realized income and productivity paths (Backus et al. (2006); Engel and Rogers (2006)). Finally, Bernanke (2005), Caballero et al. (2008), and Mendoza et al. (2008) have proposed a theory based on a "savings glut" in emerging economies and differences in financial development across countries.

This paper focuses on housing shocks as a driving force of the imbalances. Housing shocks provide a global explanation consistent with the fact that large and persistent current account deficits have not been a U.S.-specific pattern. Moreover, there has been substantial heterogeneity in the current account dynamics of developed and emerging economies. These facts have been a challenge for models that focus on differences in financial development or in income growth, because several countries that are similar across these dimensions have behaved differently (Eichengreen (2006), Gruber and Kamin (2008), Roubini (2006)). In Section 3, I show that there are large cross country differences in housing dynamics and these differences strongly correlate with current account dynamics. Moreover, a large part of the deficits have been financed through sales

of securities backed by private mortgage pools (Shin (2008) discusses the U.S. case). It is unclear why, in the absence of shocks increasing the funding needs in the housing sector, foreigners should express such a strong preference for those securities, especially when the private label mortgage pools contain low quality subprime assets. Housing shocks may have important aggregate implications because the housing sector is large. For example, in the U.S. from 2001 to 2006 the housing contribution to total employment was at least 28% from residential construction and at least 41% if mortgage finance, real estate agents, construction materials etc. are included (The Economist (2005), Roubini (2006b)).

What explains the housing booms that took place in many countries? Mayer and Hubbard (2008) argue that economic growth alone cannot explain the high levels of returns to real estate. Davis and Heathcote (2005) show that productivity shocks in a real business cycle model explain U.S. residential investment until the late 1990s, but that these shocks cannot explain the housing boom that started in the late 1990s. Declines in long term interest rates appear to coincide with the time period when the boom began to accelerate, but they cannot explain the whole story (Mayer and Hubbard (2008)). Several countries with low interest on mortgages did not see much house price appreciation, and others saw house prices and construction continually rising, even as real mortgage rates were increasing. Moreover, durable consumption expenditure and residential investment historically had similar cycles as they have similar sensitivity to interest rates (Erceg and Levin (2006), Leamer (2007)). Nevertheless, Table 1 documents that this relation changed in the last housing boom: residential investment decoupled, while durable consumption expenditure did not. I interpret this as evidence of housing-specific shocks.

An increasingly large literature is devoted to identifying specific drivers of housing markets. It provides several candidates for my housing shocks:[1] bubbles, demographic changes (the baby boom and changes in household formation patterns), deregulation in mortgage markets, inflation illusion with collateral constraints, loosened lending standards, mortgage innovation (smaller down payments and greater flexibility in the timing of payments), public policies to increase homeownership rates or preference changes between single and multi-unit houses. In this paper I do not try to separate these hypotheses.[2]

Few papers have studied the effect of housing movements on current account dynamics. The standard ingredients are trade concentrated on investment goods, and aggregate wealth effects of housing on consumption (Roubini (2006) and Punzi (2008)). The model that I present does not have aggregate wealth effects. Instead, it focuses

[1] In this paper, I use the word "shock" as a synonym of an exogenous, unanticipated event that impacts the economy, and alters the aggregate marginal rate of substitution between housing and tradable goods.

[2] As additional evidence, Doms and Krainer (2007) examine data from American Housing Surveys between 1997 and 2005 and report a substantial increase in the share of household income devoted to housing and the propensity for households to own their homes. They find that these results hold true across all income quintiles, ages and education levels. They do not depend on market location; that is, the higher expenditures do not simply reflect higher house prices, but a general increase in the demand for housing.

on consumption smoothing across goods. These features are appealing for two reasons. First, there is a lack of consensus on the magnitude and sign of aggregate housing wealth effects (see, for discussion, Buiter (2008), Muellbauer (2007) and Kiyotaki et al. (2007);[3] Congressional Budget Office (2007) surveys recent U.S. studies). To my knowledge, only Matsuyama (1990) has discussed the effects of housing dynamics on the current account in a model without aggregate wealth effects on consumption. Matsuyama (1990) is a theoretical study. He shows that if the income elasticity of the demand for housing services is non-zero, then changes in government purchases may imply current account surpluses because of income effects on residential investment. Second, net imports of consumer goods accounted for a larger fraction of deficit dynamics than net imports of capital goods (see Section 3 for evidence). Moreover, most of the capital employed to build houses is not tradable. Burstein et al. (2003) report that the share of construction gross output attributable to tradable materials was at most 24% in France in 1995, 19% in the U.K. in 1998 and 31% in the U.S. in 1997.

3 Motivating facts

In this section I present three types of evidence motivating my model. First, I document that over the last decade housing variables have decoupled from the business cycle, while total consumption expenditure and durable consumption expenditure have not. Second, I show that over the period of the global imbalances there is a strong negative cross-country correlation between housing and current account dynamics. Finally, I discuss some facts with which any theory of global imbalances should be consistent.

3.1 Housing decoupled from the cycle

Housing variables are highly cyclical, but during the last decade they have been relatively decoupled from the business cycle in the U.S. and other OECD countries. Figure 1 illustrates this fact for the U.S. It compares the time series for the ratio of residential investment to GDP, with the business cycle defined as the deviation from a Hodrick-Prescott trend. The turning points of both series roughly coincided from 1970

[3] There are several reasons why changes in house prices do not imply the traditional aggregate wealth effect on consumption that arises from a change in the value of households' financial assets. First, people usually live in their houses and value directly the services provided by their home. Thus, the benefit of an increase in house prices is directly offset by an increase in the opportunity cost of housing services. Second, houses are usually not traded internationally, so the capital gain to a last-time seller is also a loss to a first-time buyer, who is a consumer in the same country. An aggregate wealth effect requires that the marginal propensity to spend out of wealth differs between existing homeowners (usually the elderly) and future homeowners (usually the young). Other channels through which house prices can affect aggregate consumption is via credit effects due to the collateralisability of housing wealth and the availability of mortgage equity withdrawal. In any case, if a positive wealth effect is transitory consumption smoothing arguments may imply savings ("for a rainy day") and trade surpluses as in an intertemporal current account model (Obstfeld and Rogoff (1996)).

to the mid-1990s, but then housing dynamics fell strikingly out of step with the business cycle until the mid-2000s. Girouard et al. (2006) report similar evidence for the OECD.

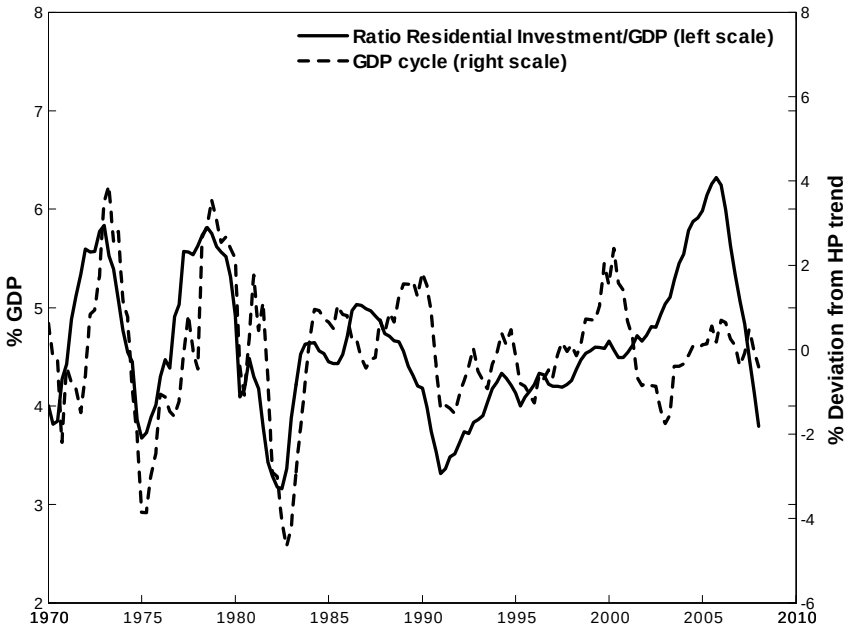

Fig. 1. Ratio of residential investment to GDP versus the real GDP cycle (HP filtered with lambda 1600). U.S. quarterly data.

Table 1 reports the cross correlations with GDP at different annual lags for residential investment, total consumption expenditure and durable consumption expenditure. Until the mid-1990s all three series were strongly correlated with the business cycle. But since then the GDP's correlation with residential investment decreased dramatically. This did not happen for total consumption expenditure or for durable consumption expenditure.

Why did housing decouple from the business cycle while expenditures in total and durable consumption did not? Popular sources of economic fluctuations, such as technology, oil, money, fiscal and aggregate demand cannot account for it.

Table 1: Cross Correlation with output at different lags

	1970-1995						
	-3	-2	-1	0	1	2	3
Residential investment	-.13	.39	.81	.82	.22	-.26	-.55
Consumption	-.21	.24	.73	.95	.58	.13	-.26
Consumer durables	.1	.53	.84	.84	.31	-.21	-.53
	1995-2006						
	-3	-2	-1	0	1	2	3
Residential investment	-.42	.06	.23	.18	-.11	-.3	-.16
Consumption	-.82	-.51	.21	.77	.86	.63	.14
Consumer durables	-.81	-.29	.4	.68	.65	.48	.08

Note. U.S. annual data. Real variables filtered with the Hodrick Prescott filter, lambda=400

3.2 Housing and current account dynamics

Global imbalances grew almost monotonically from the mid 1990s to the mid 2000s. OECD data show a strong negative cross-country correlation between housing and current account dynamics over this period. The correlations are particularly strong for variables related to the quantity of housing (such as the share of labor employed in construction or the value added by this sector) and are weaker for price variables (such as the real price of housing). Figure 2 illustrates these facts for a sample of seventeen OECD countries between 1994 and 2006. Given the trend behavior of the time series, I concentrate on the changes between these two dates. This provides a good idea of the size of the changes.

The top panel of Figure 2 plots on the horizontal axis the percentage change in the labor share in construction and on the vertical axis the change in percentage points in the current account to GDP ratio. The middle and bottom panels plot respectively the change in percentage points in the current account to GDP ratio against the percentage change in the share of value added by the construction sector and the percentage change in an index of real housing prices. The figure shows that countries that experienced housing booms also had larger current account deficits.

The scatterplots also show substantial heterogeneity in the behavior of housing markets among OECD countries. The model in this paper uses this heterogeneity to explain the differences in current account balances reported in Table 2.

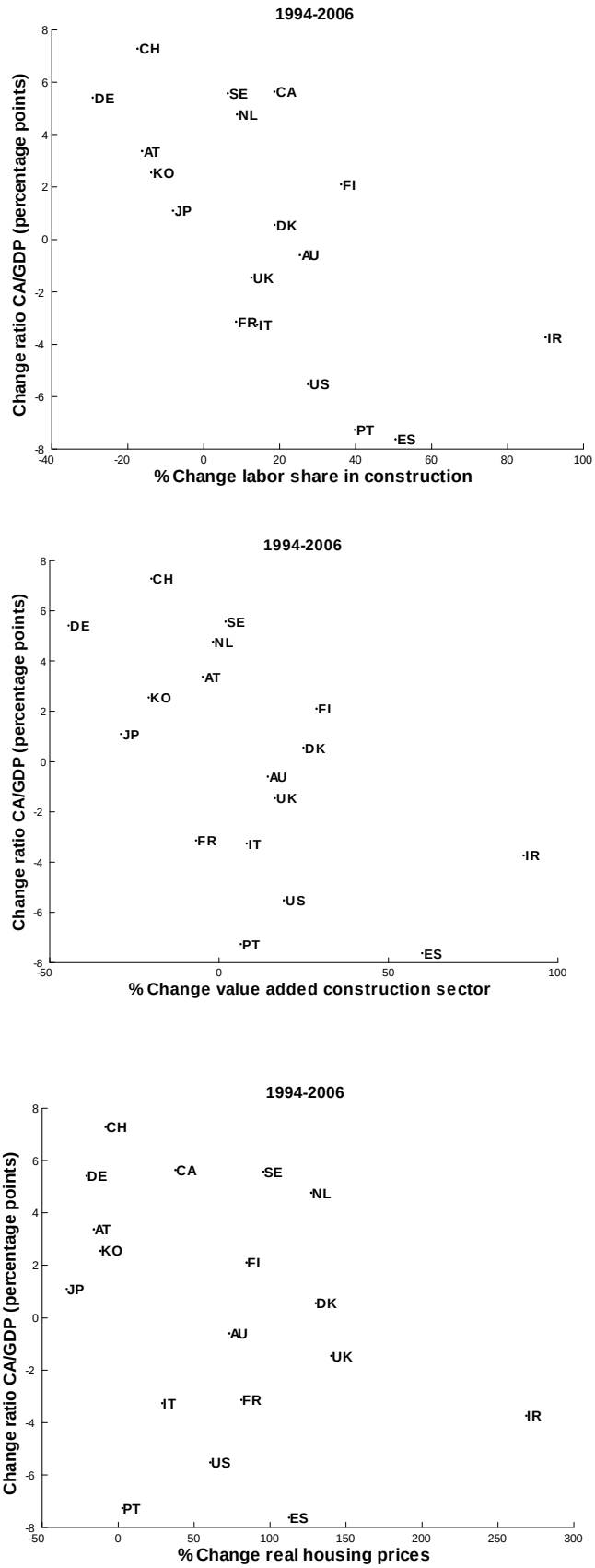

Fig. 2. Percentage changes in labor share in construction, in value added by construction, and in real housing prices versus the percentage-points change in the ratio of the CA to GDP

3.3 Four facts about current account dynamics

In this subsection I present four additional features of recent current account dynamics in developed economies and discuss their implications for theories aimed at explaining recent global imbalances.

First, large and persistent deficits are not a U.S. specific pattern, as Figure 3 illustrates. Several other developed economies have had a persistent downward trend similar to that of the United States, with deficits reaching similar levels of GDP.

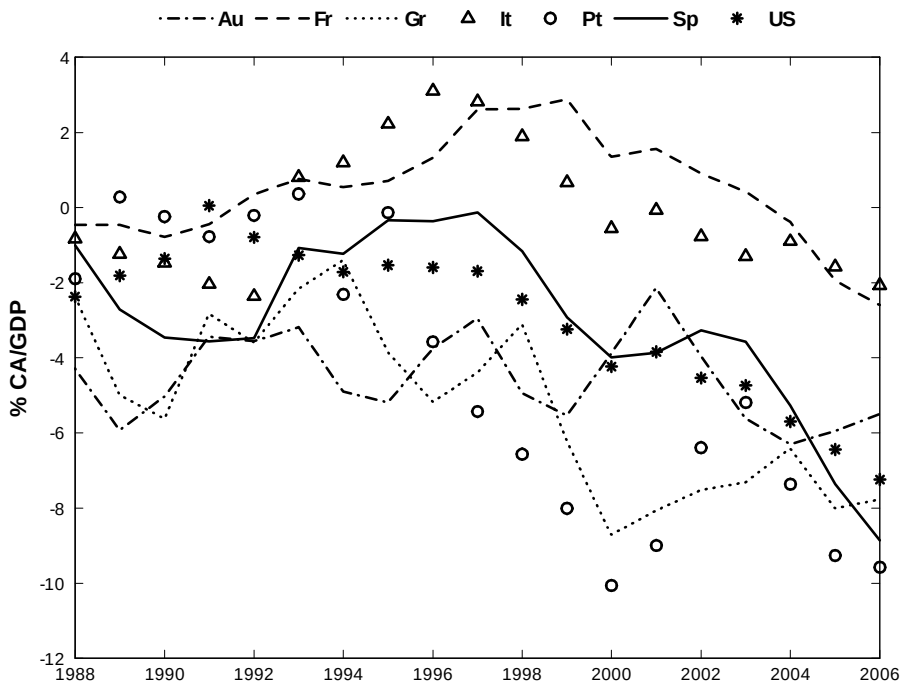

Fig. 3. Ratio of current account to GDP for Australia, France, Greece, Italy, Portugal, Spain, and the U.S.

Second, there has been substantial heterogeneity in the current account dynamics of developed economies. Table 2 reports this: while the countries on the left panel moved into surpluses, those in the right panel moved into deficits. The heterogeneity within Europe is especially interesting, because the European Union as a whole has a nearly balanced current account. There is a puzzling pattern among emerging economies (IMF (2008)): while emerging Asia moved into current account surpluses, emerging Europe moved into current account deficits. These facts have been a challenge for models that focus on differences in financial development, because countries with similar measures of financial development have behaved quite differently (Gruber and Kamin (2008)). Intertemporal current account models and international real business cycle models are more successful, because developed countries are more heterogeneous in terms of income and

productivity paths (Backus et al. (2006)). In those models, positive productivity shocks imply trade deficits, because the desire to increase investment, or the pro-borrowing effect caused by expected relative growth, dominates the pro-saving effect induced by an increase in current output. Campa and Gavilan (2006), Engel-Rogers (2006) and Henriksen and Lambert (2007) provide evidence for deficits driven by rational expectations of future income growth. However, Blanchard (2007) suggests that those expectations could be overoptimistic for Portugal and Spain. It is still an open question whether income growth heterogeneity alone is sufficient to explain the imbalances.

Table 2: Current account as % of GDP

Rising surpluses			Growing deficits		
	1994	2006		1994	2006
Austria	-1.47	1.9	Australia	-4.9	-5.49
Germany	-1.41	4	France	0.54	-2.59
Japan	2.75	3.9	Ireland	2.69	-1.04
Korea	-0.95	1.6	Italy	1.18	-2.07
Netherlands	4.75	9.52	Spain	-1.23	-8.86
Switzerland	6.22	13.5	Portugal	-2.31	-9.58
Canada	-2.3	3.34	UK	-0.99	-2.45
Sweden	1.13	6.7	USA	-1.71	-7.24

Third, net imports of capital goods account for a smaller fraction of the deficit dynamics than do net imports of consumption goods. This is shown in Figure 4, which decomposes the time series for the U.S. trade balance in goods in different groups (autos, capital goods, consumption goods and energy). Net imports of consumer goods are twice the net imports of capital goods and their downward trend has accelerated since the mid 1990s. This fact suggests that consumption smoothing may be a more important driving force of trade deficits that capital dynamics. The model that I present in Section 4 shows that net imports of tradable goods rise in periods of increasing demand for housing.

Fourth, in most of the countries the current account and the trade balance generally have had the same dynamics. Figure 5 plots both time series for the U.S. They behave very similarly and are roughly of the same magnitude. I use this fact as a justification for not making any distinction between current account and trade balance dynamics. Hence the model in Section 4 assumes complete markets and focuses on the trade balance as the variable of interest. In a complete-markets model, the current account is zero, as net exports are offset by insurance flows (recorded as current transfers).

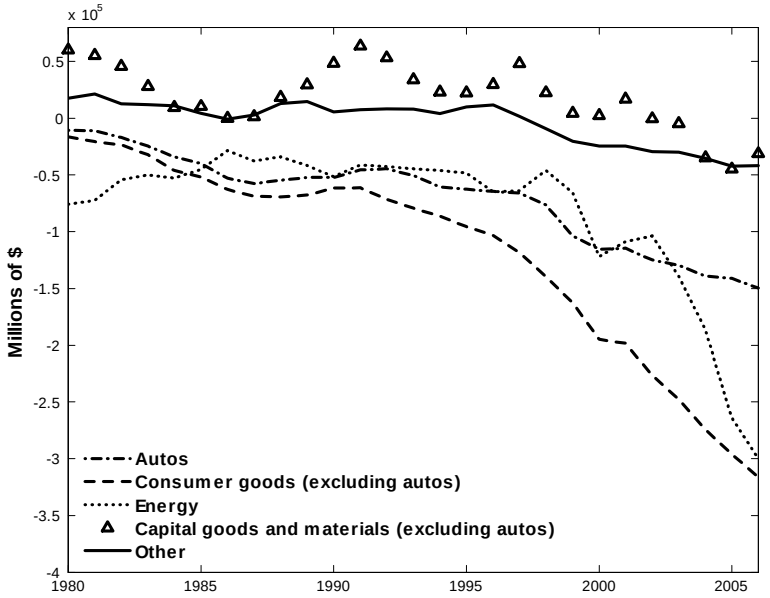

Fig. 4. Decomposition of the U.S. trade balance in goods by type of good

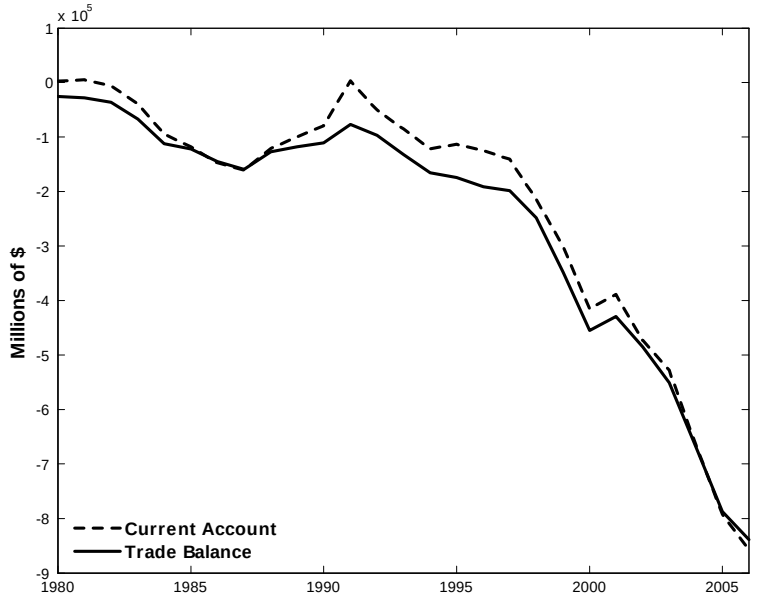

Fig. 5. Trade balance and current account in the U.S.

4 The Model

The facts in the previous section suggest that net imports of consumption goods are an important driver of trade deficits. Moreover, countries that experience a housing boom also have current account deficits, especially when housing decouples from the business cycle. In this section I describe a model that is consistent with these facts.

4.1 Technology and preferences

The model is a two-country, two-sector, frictionless neoclassical growth model. Preferences and technologies have the same structure and parameters in both countries. There is only one tradable good, which can be used as capital or as a consumption good. This good is identical for both countries, hence there is only intertemporal trade.

In each country the construction sector produces new structures (Y_s) and the tradable sector produces tradable goods (Y_c). Both sectors use capital (K) and labor (N) according to a Cobb-Douglas constant-returns-to-scale production function. The aggregate production functions in country i are:

$$Y_{ist} = e^{z_{it}} K_{ist}^{1-\alpha_s} \left(\eta_s^t N_{ist}\right)^{\alpha_s} \tag{1}$$

$$Y_{ict} = e^{z_{it}} K_{ict}^{1-\alpha_c} \left(\eta_c^t N_{ict}\right)^{\alpha_c} \tag{2}$$

where α_c and $\alpha_s \in (0,1)$, η_c and η_s are the deterministic rates of technical progress in each sector, and z_i is a country-specific technology shock, which is common across sectors and follows the process specified below.

Structures (S) are durable and non-tradable, and are used to produce housing services. Investment in the stock of structures must equal domestic production of new structures. There are two other stocks: the capital in the construction sector and the capital in the tradable sector. It takes one period to build a new structure. Each unit of date t investment in capital (X_t) augments the date $(t+1)$ stock by one unit. Both capital stocks depreciate geometrically at the same rate $\delta_k \in (0,1)$; structures depreciate at rate $\delta_s \in (0,1)$. The accumulation laws are:

$$S_{it+1} = (1-\delta_s)S_{it} + Y_{ist} \tag{3}$$

$$K_{ict+1} = (1-\delta_k)K_{ict} + X_{ict} \tag{4}$$

$$K_{ist+1} = (1-\delta_k)K_{ist} + X_{ist} \tag{5}$$

Labor and capital are mobile between both sectors with no adjustment costs, but labor is not mobile between countries. There are no irreversibilities in capital investment. Feasibility implies that world production of tradable goods must equal world capital investment plus world consumption of tradable goods. Moreover, labor allocated to each

sector must sum to the total population of the country. The resource constraints are

$$\sum_i (C_{it} + X_{ist} + X_{ict}) = \sum_i Y_{ict} \tag{6}$$

$$N_{ist} + N_{ict} = N_{it} \tag{7}$$

I model a house as a physical structure on a plot of land. Each country i has an exogenous and non-tradable stock of land (L). Land does not depreciate and is not reproducible. It is combined with the stock of structures via a Cobb-Douglas function to produce the flow of housing services (H) available for country i

$$H_{it} = L^{1-\gamma} S_{it}^{\gamma} \tag{8}$$

where γ is the elasticity of housing supply with respect to structures for a fixed level of land.

There is an infinitely lived representative household in each country, with identical preferences. They enjoy consumption of housing and consumption goods without any home bias. They supply their labor inelastically in their home country. Population (N) grows at gross rate η in both countries. The representative household in country i maximizes expected utility over per capita consumption of housing services (h) and tradable goods (c)

$$E_0 \sum_{t=0}^{\infty} N_{it} \beta^t u(c_{it}, h_{it}, \theta_{it}) \tag{9}$$

where $\theta_{it} \in (0,1)$ is a country-specific housing preference shock and β is the discount factor. I assume power utility over a Cobb-Douglas aggregator of housing services and tradable consumption:

$$u(c_{it}, h_{it}, \theta_{it}) = \frac{\left(c_{it}^{1-\theta_{it}} h_{it}^{\theta_{it}}\right)^{1-\sigma}}{1-\sigma} \tag{10}$$

where σ is the coefficient of relative risk aversion (as well as the inverse of the elasticity of intertemporal substitution) and θ_{it} is the stochastic share of consumption of housing services in total expenditure for country i. The Cobb-Douglas functional form implies that the intratemporal elasticity of consumption between housing and tradable goods equals one. This is convenient because I can derive an equilibrium where there is no structural change (only transitory shocks alter the reallocation of capital and labor across sectors). Piazzesi et al. (2007) estimate this elasticity and conclude that it does not seem to be far from one. Recent general equilibrium models with housing, such as Davis and Heathcote (2006) or Kiyotaki et al. (2007), have also assumed Cobb-Douglas.

There are two sources of independent shocks for each country: technology and housing preferences. Both are transitory deviations from the growth path. To assure that $\theta_{it} \in (0,1)$ for any preference shock, I define the transformation

$$\hat{\theta}_{it} \equiv \log\left(\frac{\theta_{it}}{1-\theta_{it}}\right) \tag{11}$$

Then, I assume that the shocks follow an exogenous stationary vector autoregression with no cross-country spillovers:

$$S_t = (I - B)\,\Omega + BS_{t-1} + \epsilon_t \tag{12}$$

$$S_t \equiv \begin{pmatrix} z_{1t} \\ z_{2t} \\ \hat{\theta}_{1t} \\ \hat{\theta}_{2t} \end{pmatrix}, \Omega \equiv \begin{pmatrix} 0 \\ 0 \\ \hat{\theta}^* \\ \hat{\theta}^* \end{pmatrix}, B \equiv \begin{pmatrix} \rho_z & 0 & 0 & 0 \\ 0 & \rho_z & 0 & 0 \\ 0 & 0 & \rho_\theta & 0 \\ 0 & 0 & 0 & \rho_\theta \end{pmatrix} \tag{13}$$

where ρ_z, $\rho_\theta \in (0,1)$ and ϵ_t is an *i.i.d.* and normally distributed vector of shocks with zero mean and diagonal covariance matrix Σ.

4.2 Equilibrium

I assume that there are no distortions and that markets are complete. Then I characterize an equilibrium by exploiting the equivalence between competitive equilibria and Pareto optima. A competitive equilibrium is the solution to the problem of a world planner who maximizes the weighted utility of both countries

$$E_0 \sum_{t=0}^{\infty} \sum_{i} \lambda_i N_{it} \beta^t u\left(c_{it}, h_{it}, \theta_{it}\right) \tag{14}$$

subject to equations $(1) - (8)$ and $(11) - (13)$ for country weights λ_i. I will compute the equilibrium associated with $\lambda_1 = \lambda_2$. These weights give the same allocations that arise in a competitive equilibrium in which the representative household in country i has no initial debts, owns the initial stocks of capital, structures and land in country i, and all the labor income in country i.

Under complete markets, the current account would be zero, as insurance flows (recorded as current transfers) completely offset net exports. Hence I focus on net exports, which behave very similarly to the current account in most of the countries (Figure 5 plots this for the U.S.).

The unitary intratemporal elasticity of substitution implies that there is no structural change (Acemoglu and Guerrieri (2008)). Capital and labor shares are constant across sectors along the equilibrium path. Even if output levels grow at different rates, only transitory shocks alter the reallocation of resources (i.e., the planner's problem has a solution where per capita variables grow at the constant rates shown in Table 3).

To get a stationary system, I redefine the variables by dividing by their long term trend. The solution is described by a system of non-linear stochastic difference equations, whose steady state is the equilibrium growth path of the original economy.

Table 3: Growth rates along the equilibrium path

Variable	Growth rate
R, n_c, n_s	zero
$c, k_c, k_s, y_c, x_s, x_c$	η_c
y_s, s	$[\eta_s^{\alpha_s}\eta_c^{1-\alpha_s}]$
l	$\frac{1}{\eta}$
h	$\left(\frac{1}{\eta}\right)^{1-\gamma}\left(\eta_s^{\alpha_s}\eta_c^{1-\alpha_s}\right)^{\gamma}$

Note. All variables, except R, are in per capita terms

5 Theoretical effects of housing demand shocks

This section studies the effects of transitory shocks that increase the preference for housing relative to tradable goods. I show why such shocks imply trade deficits and discuss why the theory does not need aggregate wealth effects, nor trade that is concentrated in capital goods. To do so, I solve numerically a parameterized version of the model and perform impulse response analysis.

5.1 Parameters

I calibrate a world with two symmetric countries ($i = 1, 2$) that face different housing shocks. If both countries face shocks of the same size, they are like closed economies. If one country is very large compared to the other, then the small one is like a small open economy; its own shocks do not alter the interest rate. I abstract from this last case and assume that both countries have the same size. The length of a period in the model is one year. To choose parameters, I will follow previous empirical studies and use U.S. data. I abstract from technological differences between sectors to minimize the number of parameters needed. None of the parameter values are chosen to help the model match net export dynamics. There are two sets of parameters:

1. Technology parameters: I set the productivity growth to be the same for both sectors and equal to 2% ($\eta_c = \eta_s = 1.02$), which is roughly the average growth rate of per capita GDP in the postwar U.S. For population growth, I set $\eta = 1.01$; 1% has been roughly the annual average population growth rate in the U.S. for the last two decades. For the labor share, I assume that it is the same across sectors and set $\alpha_c = \alpha_k = 0.67$, the average postwar U.S. estimate. I choose the discount factor to match a steady state interest rate of 5%. I set zero spillovers and $\rho_z = 0.8$, based on the baseline calibration used by Kehoe and Perri (2002). These values are consistent with the results of Baxter

and Crucini (1995) and Kollman (1996), who found little evidence of technology spillovers and some evidence of substantial persistence of technology shocks. For the depreciation of the stock of structures I use 2% ($\delta_s = 0.02$) which is consistent with the BEA (2004) report that depreciation rates for one-to-four-unit residential structures are between 1.1% and 3.6%. I assume the capital stock depreciates 10% annually ($\delta_k = 0.1$), which implies a ratio of output to capital in the tradable sector of 0.45. I set the stock of land (L) to match a steady-state ratio of the price of housing services to tradables equal to 1.75. Finally, for the share of structures in housing (γ) I calibrate $\gamma = 0.3$ to match a ratio of residential investment to consumption of 0.05, which is the NIPA average for the last thirty years. This parameter is essential for the allocation of resources across sectors. It is the elasticity of housing supply with respect to structures for a fixed level of land. When γ is low, housing is mostly land, which is not reproducible. Thus, housing is very inelastic and increases in the demand for housing result mostly in price adjustments, rather than quantity adjustments. Increasing γ increases the reallocation of resources towards housing. In Section 6, when I study the ability of the model to account for the global imbalances, I will also report results for $\gamma = 0.9$.

2. Preference parameters: I assume the value for risk aversion standard in the real business cycle literature ($\sigma = 2$). For the unconditional mean of the share of housing in the economy I use $\theta^* = 0.3$. This number is consistent with recent data on the weight of the housing sector in the U.S. economy (The Economist (2005), Roubini (2006b)). I assume that housing shocks are as persistent as technology shocks ($\rho_\theta = 0.8$), which is consistent with the persistence of the share of income spent on housing that I estimated with data from the Harvard Housing Center. I assume that there are no country spillovers from a housing shock.

5.2 Impulse responses

Since an analytic solution to the model cannot be computed, I log-linearize the stationary system of first order conditions around a non-stochastic steady state. In steady state, trade is balanced and the shocks equal their unconditional means. Then I solve the linearized system using the method of undetermined coefficients as described in Uhlig (1995).

To illustrate the mechanics of the model I give a housing preference shock to Country 1 that increases θ_{1t} from its unconditional mean θ^*. Figure 6 reports the behavior of the endogenous variables in Country 1 for both the closed and the open economy cases. When both countries face shocks of the same size, countries behave exactly as if they were closed economies. In a closed economy, the equation (6) is replaced by

$$C_{it} + X_{ist} + X_{ict} = Y_{ict} \ , \quad i = 1, 2. \tag{15}$$

The response to the preference shock is graphed in Figure 6a. To better illustrate the mechanics of the model, in this section the shock is large (the housing share reaches

0.5). In the next section I will choose the size of the shock to match observed housing dynamics.

After a housing preference shock, the country wants to consume more housing services. Since these are not tradable, the country needs to build more residential structures. This implies reallocating labor and capital to the construction sector to produce new structures. Capital can be imported, but labor cannot (and capital and labor are complements). Producing new structures implies sacrificing production of tradable goods. This happens both in the open and in the closed economy. The open economy can decouple consumption decisions from production decisions because it can import tradables for consumption. But the closed economy cannot. In the closed economy, building more residential structures requires reducing tradable consumption. This is an implicit adjustment cost, because housing services and tradable consumption are complements, i.e., optimality requires smooth consumption across goods (and across periods). Therefore the open and closed economies react differently to the same housing shock. The open economy allocates more resources to the construction sector and runs a trade deficit importing tradables for consumption and investment. Tradables imported for consumption enable consumption smoothing across goods and reduce the adjustment cost of building residential structures. Employing more labor in the construction sector allows for more capital investment. Thus, the open economy builds more, which allows it to consume more housing services. These dynamics are shown in Figures 6b,c, d, e and h.

Two prices govern the competitive equilibrium of this economy:[4] *i*) the relative price of housing services in terms of consumer tradables, which equals the real exchange rate because housing services are nontradables and the law of one price applies for tradable goods (there is only one tradable good); *ii*) the real interest rate (the price of one unit of the tradable good today in terms of tradable goods tomorrow).

The housing shock implies an increase in the demand for housing, which results in an equilibrium adjustment. The elasticity of the supply of housing services determines how much of the adjustment occurs via prices or via quantities. If $\gamma = 0$, housing is all land, so it is completely inelastic. Any increase in demand is only reflected in a higher price of housing. If $\gamma = 1$, land plays no role; new housing equals new residential structures that are produced with a constant returns to scale production function. Adjustments to changes in demand happen via quantities. In this parameterization $\gamma = 0.3$. The supply of housing services is inelastic, and after a housing shock the price of housing must go up to induce the households to consume the amount of housing services available. Thus the real exchange rate appreciates in the country receiving the shock. Fig. 6f shows this. Moreover, two other factors affect the supply of housing. Structures are

[4] There are alternative arrangements of market institutions. For example, one can think that there are households and two types of competitive firms: productive firms and leasing firms. Productive firms rent labor and sectorial capital from the households and produce tradables and new structures. Leasing firms own the existing land and structures, buy the new structures and lease housing services to the households. Households buy the tradables and either consume or invest them in capital for each type of sector. Moreover the households trade equity shares of the firms and face a complete contingent-claims market where outputs can be written contingent on outcomes of any of the goods.

nontradable durables, hence the amount of housing services available today depends on production in the past. Another factor is the one year time-to-build in the capital stock. Labor and capital are complements, hence the amount of capital allocated the previous year to the construction sector influences the quantity of labor that will be used there. This explains the dynamics of Fig. 6f. At impact, capital in the construction sector is already given, which reduces the elasticity of the supply of housing services. Thus the short-run equilibrium adjustment occurs mostly through prices. The following period the economy can freely allocate capital and labor to construction. The adjustment is done mostly via quantities.

The real interest rate is the price that governs intertemporal trade. The housing shock reduces preferences for tradable goods. However, at impact the production of tradable goods is mostly given since capital in each sector is predetermined and labor and capital are complements. It is possible that initially the economy is producing too much of the tradable goods. This explains why interest rates may decrease at impact. If Country 1 has too many tradable goods its price (the interest rate) has to decrease to encourage Country 2 to consume them. But, as soon as Country 1 can fully reallocate resources towards housing, tradables become valuable, because they allow smoothing of foregone consumption of labor reallocated to housing, and they allow the country to invest in capital for the housing sector. The increase in demand requires interest rates to rise. In an open economy, interest rates jump less than in a closed economy because Country 2, by financing a trade deficit, helps to satisfy demand for tradables in Country 1. Fig. 6g plots these dynamics.

The model is a representative agent model and housing is not tradable. There are no wealth effects from a housing shock. But this does not preclude the housing boom from causing a trade deficit.

Trade deficits and housing reactions are quantitatively large in the model. This happens because there are no frictions and because markets are complete. Finally, the dynamics are short-lived, because the absence of frictions allows the economy to reallocate resources quickly. In a couple of periods it has built the desired housing stock.

5.3 Summarizing the implications of the model

To sum up, the model's predictions after a housing shock are as follows:

First, trade deficits arise in periods of housing boom. The next section builds on this prediction to show that the model, using housing variables as explanatory variables, generate current account dynamics matching recent global imbalances.

Second, housing booms are larger in open economies that can run trade deficits. This prediction is confirmed by recent housing dynamics in the OECD. Girouard et al. (2006) document more generalized housing upswings across OECD countries in recent years than in the past. These upswings coincided with the OECD opening to trade with non-OECD economies and starting to run an aggregate trade deficit.

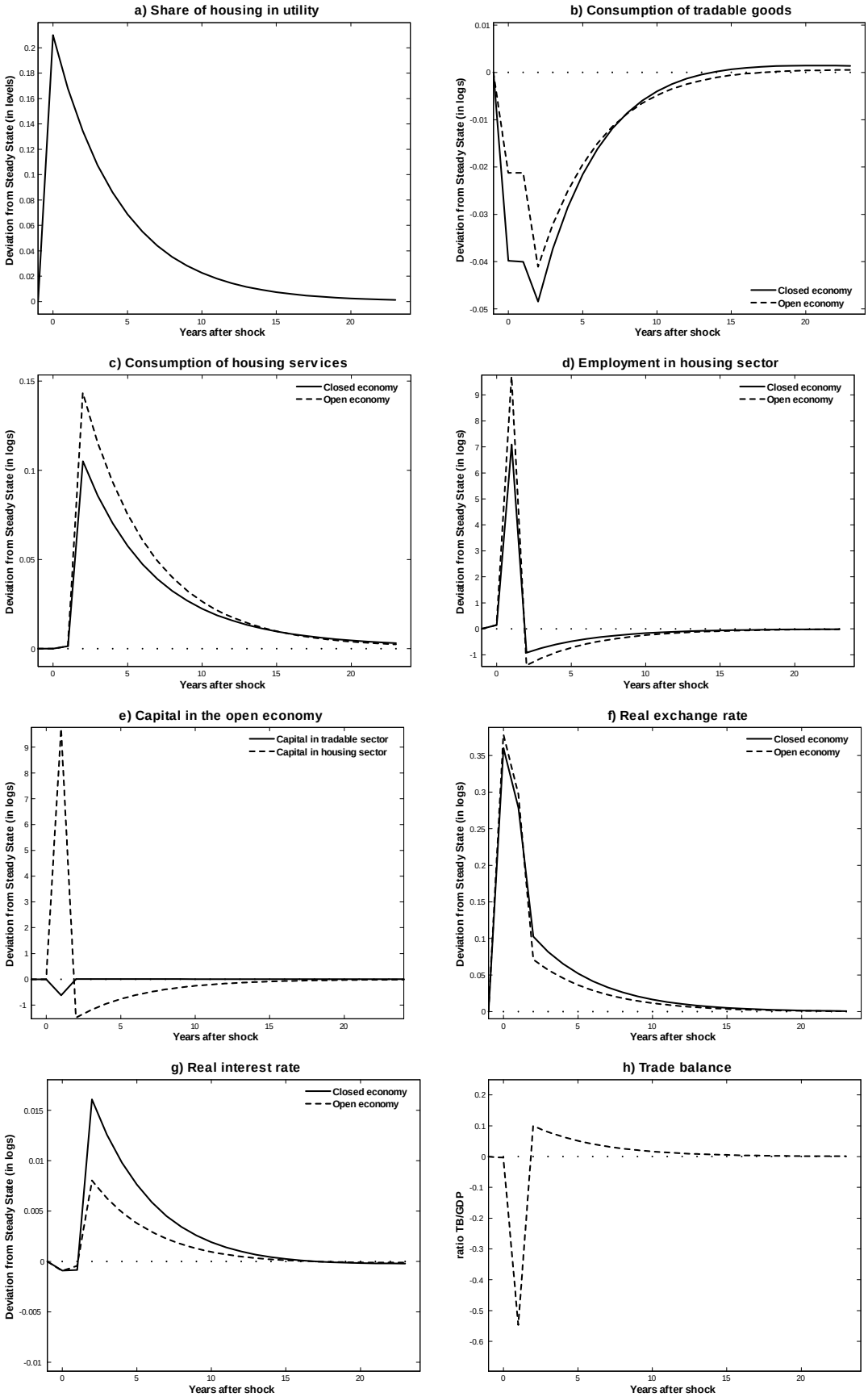

Fig 6. Theoretical responses in Country 1 to a positive housing shock in Country 1

Third, conditional on a shock that raises the demand for housing the correlation between the shock and residential investment is positive. This conditional correlation is negative with tradable consumption. In Section 7, I use these sign restrictions to estimate a vector autoregression and identify the effects of housing specific shocks on the U.S. trade deficit.

Finally, two other predictions emerge from the model: the real exchange rate (in this model it equals the relative price of housing, because the law of one price holds exactly) appreciates after a positive housing shock. In addition, real interest rates may go down at impact, but they have to rise subsequently, when labor and capital reallocate to the housing sector.

6 Reconciling the model with the global imbalances

I consider now if the model can rationalize recent global imbalances. I show that it can account for Figure 2 as the outcome of housing shocks that match observed housing dynamics. That is, using the housing variables as explanatory variables, the model generates global imbalances matching those observed in the data. First I present the results for the parameterization where the share of land in housing is high. Then I consider the case when it is low.

6.1 Parameterization 1: low elasticity of housing to structures

I use the parameterized model of Section 5 to simulate the global imbalances implied by the model when housing shocks account for all the housing movements. I perform the following experiment: I assume that Country 1 experiences a housing shock while Country 2 does not. I simulate a series of positive shocks as plotted in Figure 7. Then, I obtain the reaction of the labor share in construction, the production of new structures and the trade balance from the steady state to the peak of the housing boom (for the current parameterization this happens in two periods because in the absence of frictions the country can build very quickly). To label the countries of Fig. 2 as Country 1 or Country 2 I assume that positive housing movements in Fig. 2 come from Country 1. Negative movements come from Country 2. This introduces a kink at zero in my simulation because, except for the trade balance, Countries 1 and 2 do not react symmetrically to a Country 1 shock. This is shown in Fig. 8. The asymmetry arises because labor is nontradable. Country 1 adjusts via two channels after the shock: it reallocates resources between its two sectors (Fig. 6e), and it runs a trade deficit, which implies resource reallocation in Country 2. These two channels are not symmetric, because labor can only be reallocated domestically.

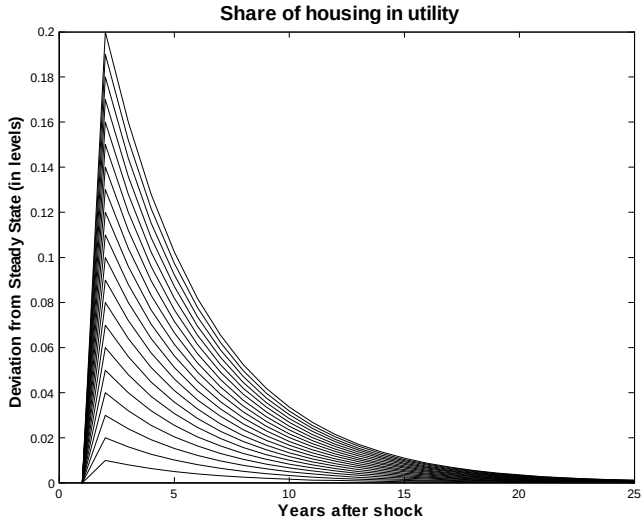

Fig. 7. Simulated housing shocks

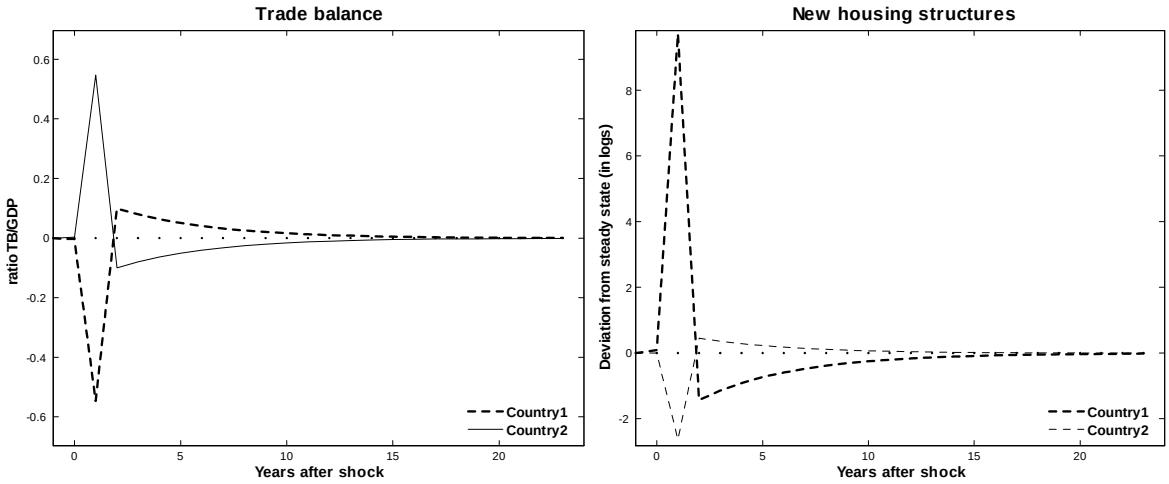

Fig. 8. Theoretical responses in Countries 1 and 2 to a positive housing shock in Country 1

Figure 9 plots the results of my simulation. The top panel graphs the global imbalances predicted by the model for a series of shocks that trace out a change in the value added by the construction sector, as displayed on the horizontal axis. To obtain the second panel, I create a shock that generates the percentage change of the construction sector that each country had between 1994 and 2006. Then I plot it together with the current account changes that the model predicts. The third panel follows the procedure of panel two, but matches the observed movements in the labor share employed in construction. In all the simulations, countries with positive housing movements are considered to be Country 1 in the model. For both the value added and the labor share employed in construction, the model generates current account dynamics very similar to the observed global imbalances. I interpret this as support for housing shocks as a driver

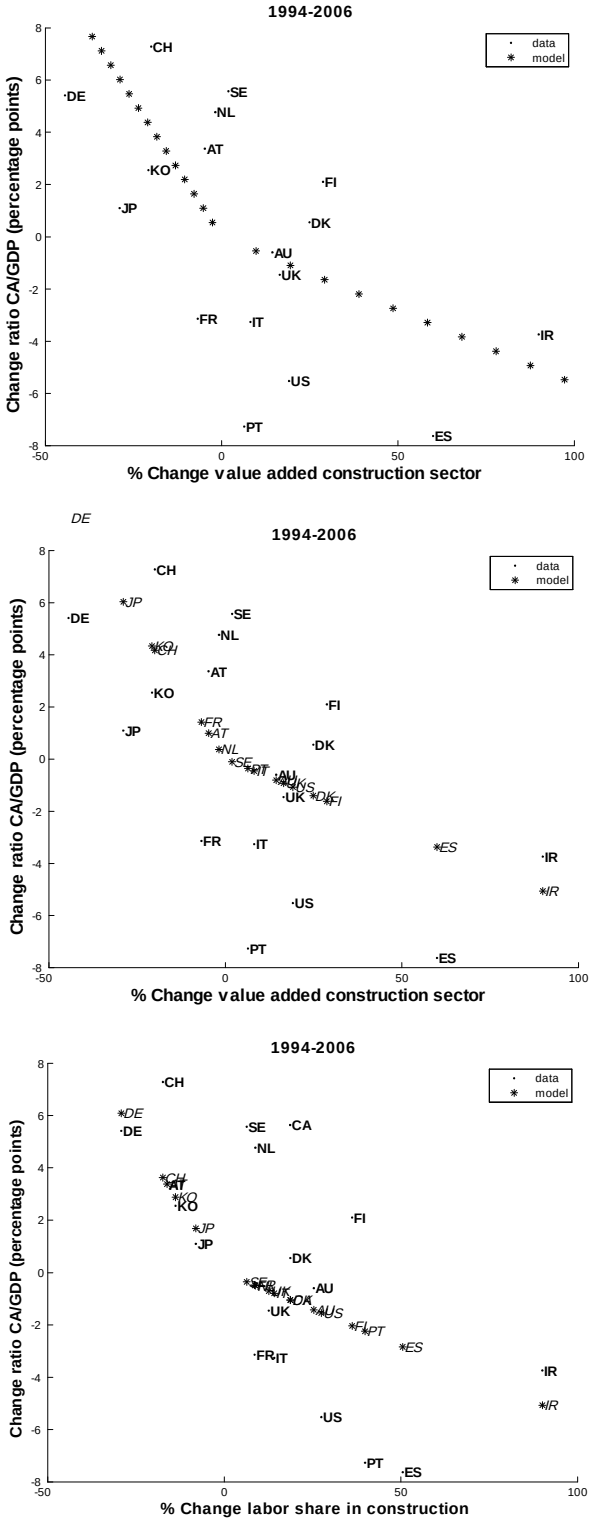

Fig. 9. Data and model-predicted global imbalances when the elasticity of housing to structures is low

of current account dynamics.

6.2 Parameterization 2: high elasticity of housing to structures

The share of land in housing (γ) governs the elasticity of the supply of housing services. Positive housing shocks increase the demand for housing services. The elasticity of the supply of housing services determines whether the increase in demand results in price or quantity adjustments. When γ is low, the equilibrium adjusts via prices. When γ is high, the adjustment happens via quantities, i.e., by building new structures. High γ implies reallocation of more resources towards housing, hence higher trade deficits.

Figure 10 exhibits the results for the same exercise in Subsection 6.1, but for $\gamma = 0.9$. All other parameters are kept the same. The model continues to be able to account for the global imbalances, and its fit even improves with the deficit countries.

Bover and Jimeno (2007) estimate a model of labor demand in the construction sector with OECD data. They conclude that building constraints explain international differences in the reallocation of employment after house price changes. Building constraints in my model are captured in the parameter γ.

7 Sign restriction identification

The model in Section 4 provides two identification conditions for a housing demand shock: conditional on a positive shock, the correlation between the shock and residential investment is positive, while the conditional correlation of the shock with tradable consumption is negative. Standard economic shocks like aggregate demand, fiscal, money, oil, and technology shocks do not imply these reactions. This section exploits these sign restrictions to identify housing shocks from the forecast errors of a reduced form vector autoregression.

7.1 Methodology

Faust (1998), Canova and De Nicoló (2002) and Uhlig (2005) have proposed different ways to impose sign restrictions directly on impulse responses to identify economic shocks in a structural vector autoregression (SVAR). I will follow Uhlig (2005), using an efficient algorithm proposed by Rubio-Ramirez et al. (2006). I start by estimating a reduced form VAR, which contains the three variables central for my identification: real residential investment (I_h), real tradable consumption (C) and the trade balance/GDP ratio $\left(\frac{NX}{GDP}\right)$. I also include the variables commonly used in the SVAR literature to identify other economic shocks: relative price of equipment (pe), non farm business labor

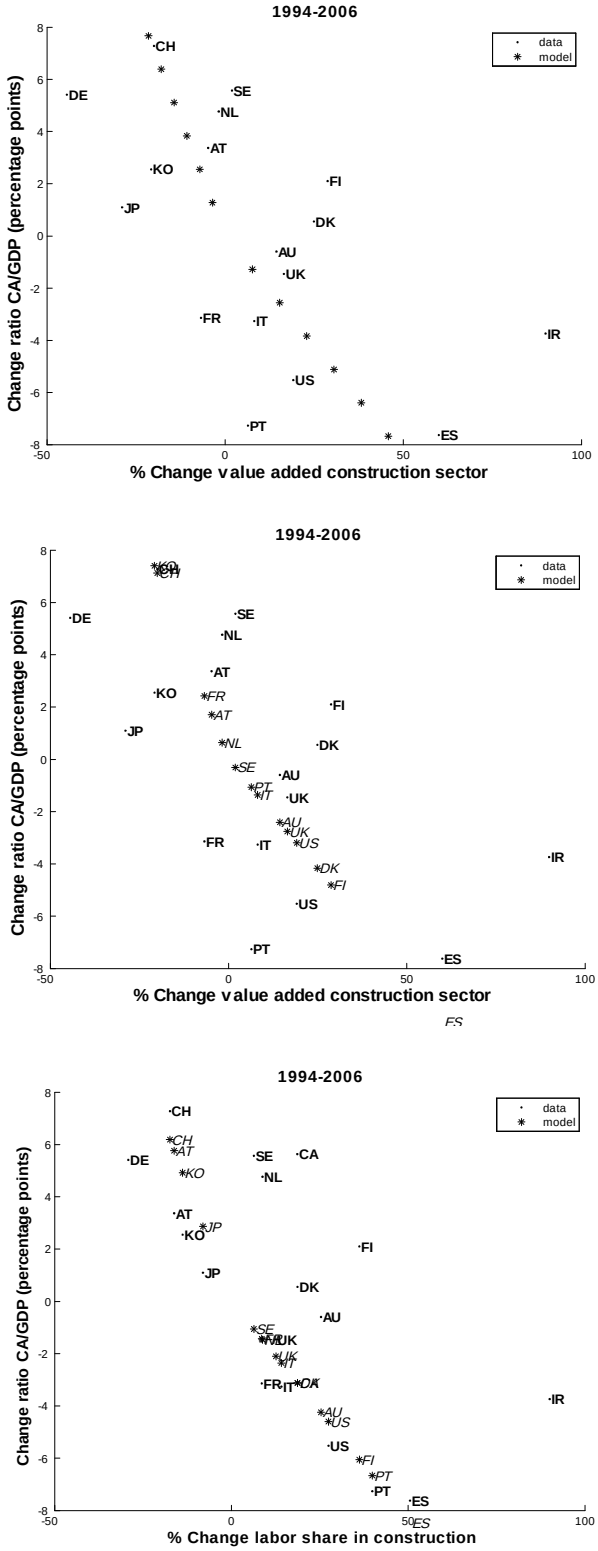

Fig. 10. Data and model-predicted global imbalances when the elasticity of housing to structures is high

productivity (z), total government fiscal deficit (G),the price level (P), and the Fed Funds rate (FF).

I estimate a VAR in four lags:

$$\begin{aligned} Y_t &= B(L)Y_{t-1} + u_t \\ B(L) &\equiv B_1 + B_2 L + B_3 L^2 + B_4 L^3 \end{aligned} \tag{16}$$

where

$$Y_t \equiv \begin{bmatrix} \log pe_t \\ \log z_t \\ G_t \\ \log P_t \\ FF_t \\ \log C_t \\ \log I_{h_t} \\ \frac{NX_t}{GDP_t} \end{bmatrix}$$

and $E(u_t u_t') \equiv \Sigma$. I assume that the forecast errors (u_t) and the structural shocks (ε_t) are related by

$$u_t = A\varepsilon_t \tag{17}$$

where $E(\varepsilon_t \varepsilon_t') = I$. This implies that $\Sigma = AA'$. The impulse responses to the economic shocks are

$$\frac{\partial Y_{t+j}}{\partial \varepsilon_t} = B^j A \tag{18}$$

I want to identify the column of A associated with the housing shock. Without loss of generality, I assume that the housing shock is the first entry in ε_t. Denoting the ith variable in Y_t by Y_{it}. I impose the following sign restrictions:

$$\frac{\partial Y_{6t+j}}{\partial \varepsilon_{1t}} < 0, \ \frac{\partial Y_{7t+j}}{\partial \varepsilon_{1t}} > 0 \tag{19}$$

where j is the number of quarters on which I impose the sign restrictions. I do not impose any restriction on $\frac{NX_t}{GDP_t}$, since this is the variable of interest.

The matrix A is unique up to an orthonormal transformation, i.e., wherever $QQ' = I$ then $\Sigma = AQQ'A'$. I need to search for the set of AQ matrices satisfying (19). I draw 1000 elements of that set.[5]

[5] I followed the algorithm of Rubio et al. (2006): without loss of generality, I assume $A = chol(\Sigma)$, then I draw a matrix X, whose cells come from a standard normal distribution. Then I compute the QR decomposition of X. I normalize the diagonal of R to be positive and check if AQ satisfies (19). If it does, I keep AQ, if not I discard and draw again. I keep drawing until I have 1000 successes.

7.2 Results

My sample covers the period 1982:q1 to 2006:q4. Bems et al. (2007) provide several arguments for starting in 1982, and I use their series for the price of equipment. They make two main arguments. First, we want the sample to cover a period when trade was widely liberalized. Second, we also want to avoid both the structural break in monetary policy associated with the appointment of Paul Volcker (Clarida et al. (2000)) and the structural break in the price of equipment reported by Fisher (2006).

I estimate the VAR in levels of the logs of the variables (except for the Fed Funds rate, the ratio Net Exports/GDP and the Net Government Deficit, for which I do not take logs). I do not model cointegration relationships, Sims et al. (1990) have shown that the system's dynamics can be consistently estimated in a VAR in levels even in the presence of unit roots. I also include a constant term. I use three proxies for tradable consumption: consumer durables, consumer nondurables excluding energy related goods, and the sum of the previous two.

Figure 11 reports the range of impulse responses for the ratio Trade Balance/GDP to a positive housing shock. The first column has the sign restrictions imposed for one year, the second for two. The top row uses consumer durables as a proxy for tradable goods. The middle row uses consumer non-durables excluding gasoline, fuel, oil, and other energy goods. The bottom row uses consumer durables plus non durables excluding energy related goods. The results mostly confirm that housing shocks imply a trade deficit.

To assess the quantitative importance of housing shocks for net export dynamics, I compute the percentage of the variance of the trade balance forecasting error that is attributable to a positive housing shock. Figure 12 contains the results at different time horizons for the sign restrictions imposed for four and eight quarters respectively. I report the results for the same three proxies of consumer tradables. Housing shocks may be important driving forces of current account dynamics.

Finally, I use the relation (17) to plot the time paths of the housing shocks for each proxy of tradable consumption and for the sign restrictions imposed for four and eight quarters, respectively. Two results seem robust to the different specifications: the volatility of the shocks increased in the early 2000s, and there were some large spikes during this period.

8 Concluding remarks

I present a simple model that shows that increases in the demand for nontradables relative to tradables imply trade deficits. Then I document evidence of housing-specific demand shocks. A parameterized version of the model, for observed cross-section housing movements, generates trade balance dynamics consistent with recent OECD current account dynamics. Finally, I use model-consistent sign restrictions to identify housing

demand shocks in a SVAR. The results suggests that housing shocks help to explain recent global imbalances. Preliminary work shows that they may also explain the puzzling divergence in current account behavior between emerging countries in Asia and emerging countries in Europe reported in IMF (2008).

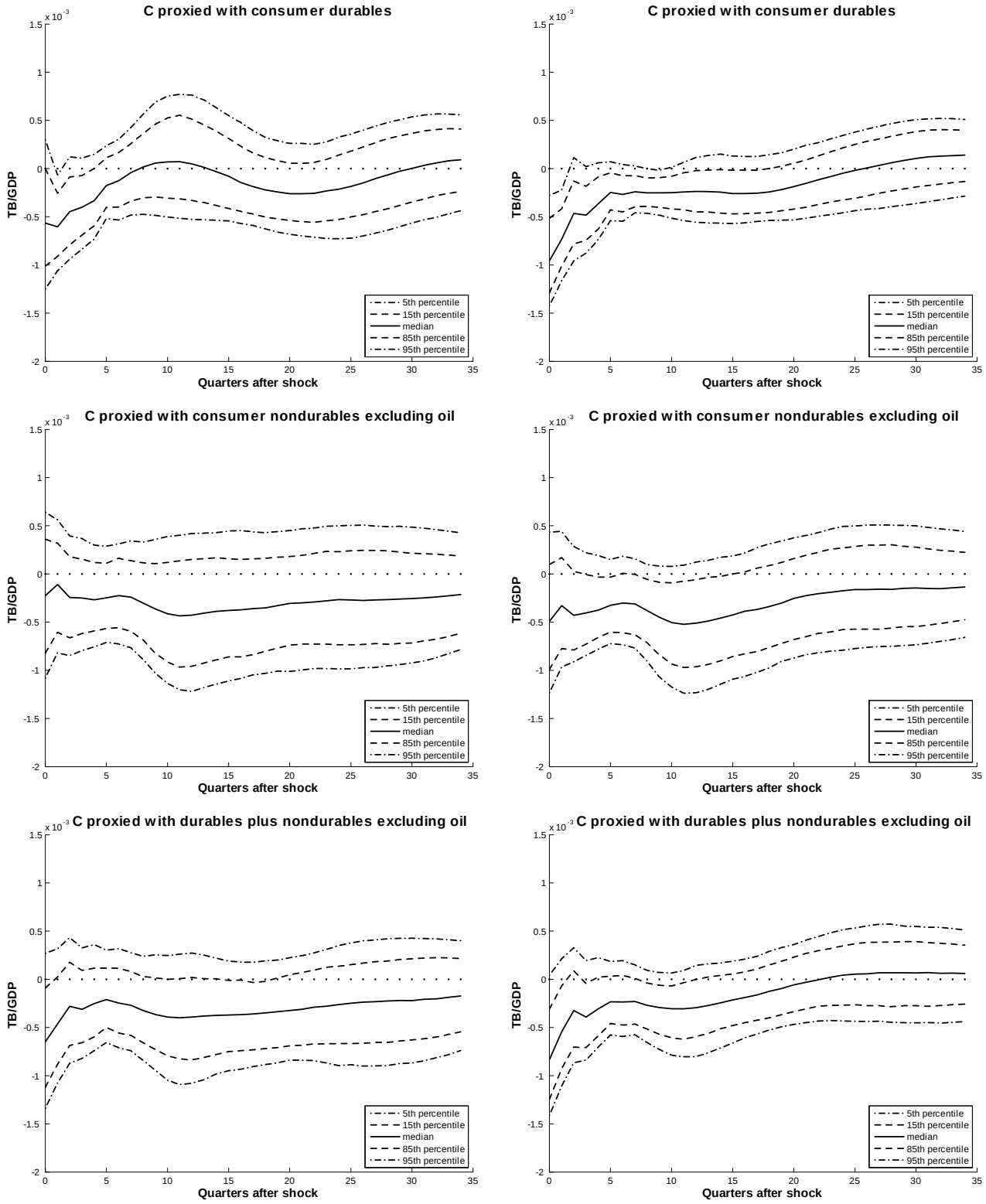

Fig. 11. Range of impulse responses for the ratio Trade Balance/GDP to a positive housing shock. Each row uses a different proxy for tradable consumption. In the left column, the sign restrictions are imposed for four quarters. In the right column, for eight quarters.

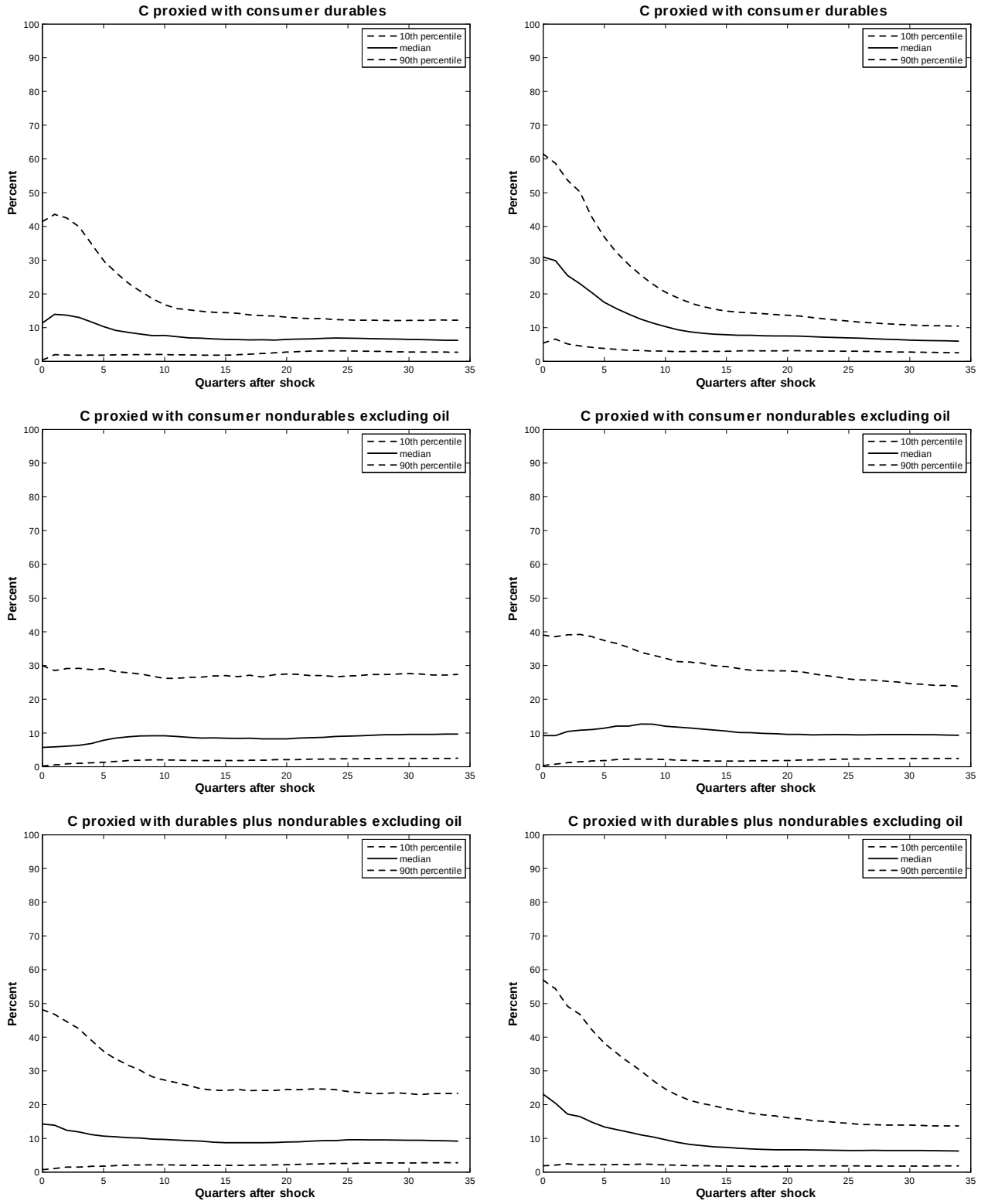

Fig. 12. Range of contribution of housing shocks to the variance of Trade Balance/GDP. Each row uses a different proxy for tradable consumption. In the left column, the sign restrictions are imposed for four quarters. In the right column, for eight quarters.

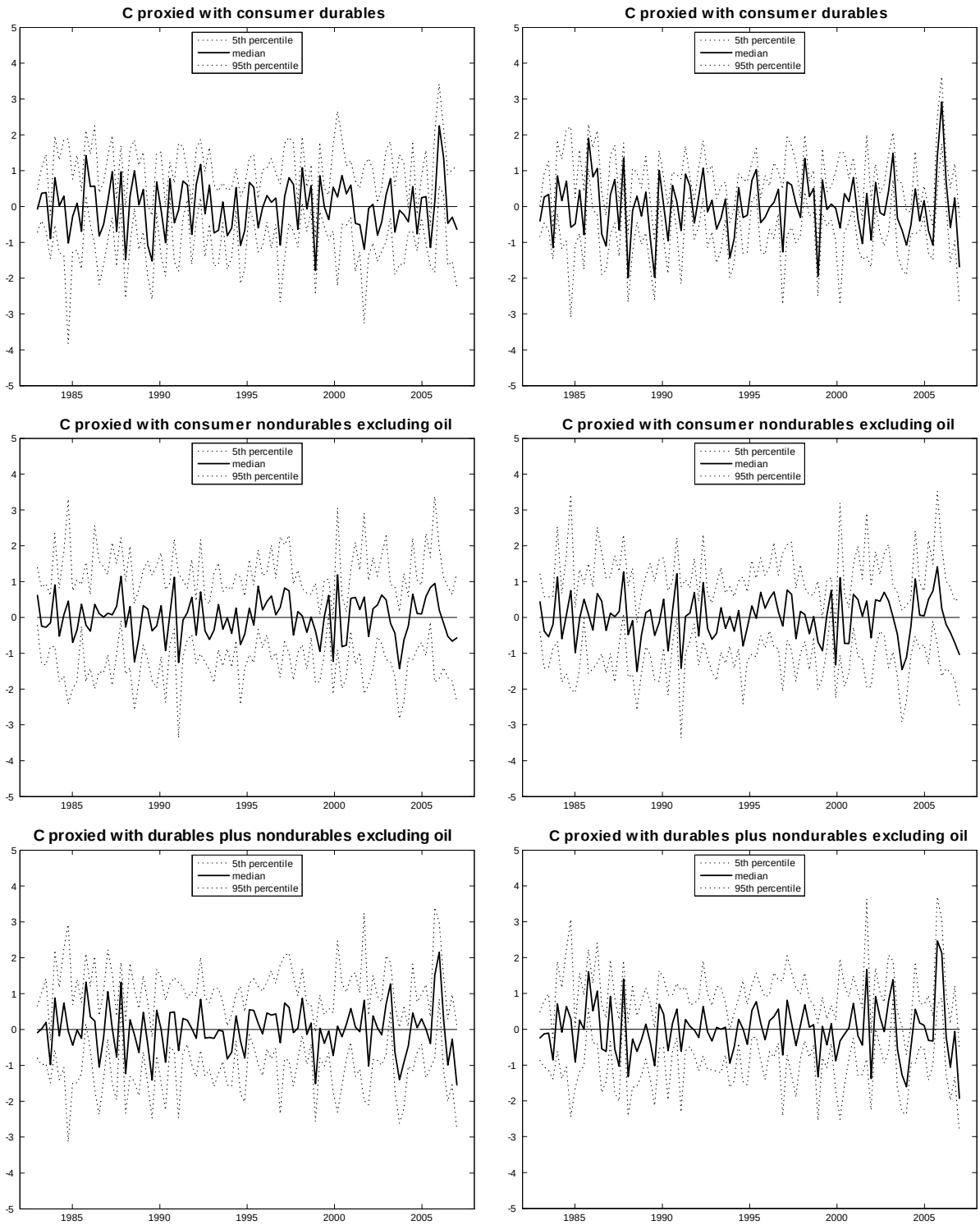

Fig. 13: Range of time paths of housing shocks. Each row uses a different proxy for tradable consumption. In the left column, the sign restrictions are imposed for four quarters. In the right column, for eight quarters.

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Data sources

Figure 1 and Table 1 summarize data series for consumer durables, total consumption, gross domestic product, and residential investment from the NIPA tables published by the BEA (http://www.bea.gov/national/nipaweb/index.asp).

The series for current account and gross domestic product in Fig. 2, Fig. 3, and Table 2 are from the OECD. The series for labor share and value added from the construction sector are obtained from Datastream, which collects these data from domestic sources. The real house prices have been provided by the Bank of International Settlements and are compiled using national sources. The house price indices are not strictly comparable across countries due to differences in definitions. In most countries, the house price index reflects national average house prices. There are also a few exceptions. In Australia, the index is a weighted average of house prices in capital cities and regional areas. In Germany, only the prices of houses located in Western Germany are included. In Japan, the price index refers to residential land prices. Furthermore, the indices also differ in terms of their treatment of existing versus new housing, owner-occupied residences versus second residences, and housing with different financing structure.

The series for the trade balance in goods and its decomposition come from Table 2a in the U.S. International Transactions Accounts Data published by the BEA.

In Section 7, I used the series described in Bems et al. (2007) together with data on consumer durables and nondurables from the FRED database.