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GROWTH, HOUSING, AND GLOBAL IMBALANCES*

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In the decade leading to the Great Recession, the United States experienced rising house prices and current account deficits, whereas China and other fast-growing Asian economies saw rising house prices accompanied by current account surpluses. To explain these differences, we study a transition path in a two-country life-cycle model with housing once the two economies become financially integrated. We allow for asymmetries in productivity growth, the loan-to-value ratio, the life-cycle wage profile, and the population structure across countries. Our findings highlight that differences in the life-cycle pattern of the wage income profile are key to obtaining our results.

1. INTRODUCTION

The period between the mid-1990s and the Great Recession has been characterized by the rise of global imbalances, namely, the emergence of large and persistent current account deficits in some countries (most notably the United States) financed by large and persistent current account surpluses in other countries (like China). At the same time, some economies, in particular the ones with current account deficits like the United States, experienced housing booms. A large literature points to diverging patters in household saving and borrowing in countries with positive and negative current account balances as a leading explanation of global imbalances.[1] Since housing is one of the main components of households' wealth,[2] and mortgages are by far the largest type of household debt,[3] another strand of literature has focused on the empirical relationship between current account balances and house prices. Typically, this literature uses the data from developed economies. Aizenman and Jinjarak (2009), Gete (2020), and others document a negative correlation between current account balances and house prices. Aizenman and Jinjarak (2009) find that this relationship is strong among the sample of the OECD countries. However, they find that "weaker patterns apply to non-OECD countries." Does a similar relationship between current account balances and house

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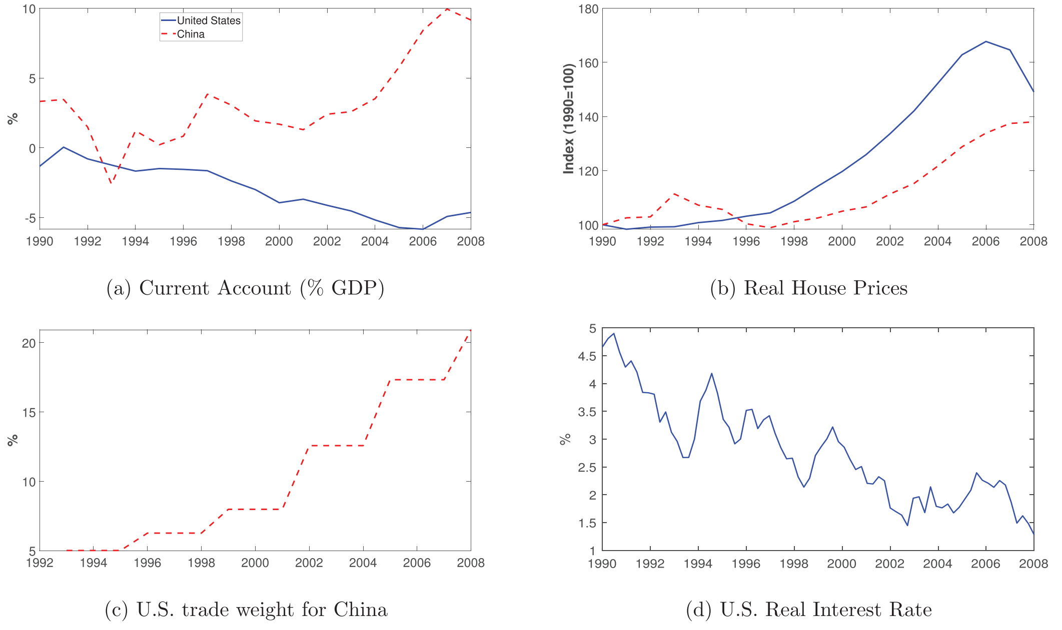
[1] See, for example, Caballero et al. (2008), Mendoza et al. (2009), Gourinchas and Jeanne (2013), or Coeurdacier et al. (2015).

[2] For example, Díaz and Luengo-Prado (2010) document that housing wealth represents around 95% of total wealth for those households at the bottom 80% of the wealth distribution; Iacoviello (2011) reports that housing wealth represents almost two-thirds of the total wealth of the median household.

[3] Figure A.2 in Appendix shows that mortgage debt accounts for close to 70% of the total household debt in the United States.



Source: CA-to-GDP ratios constructed as five-year moving averages current account (% GDP) from the OECD and the National Bureau of Statistics of China (NBS). Real House Price constructed using data from the OECD, the Economist, and NBS. Trade weight from the BIS. Real Interest Rate data from Gourinchas and Rey (2014).

Figure 1

current account, house prices, trade weight, and interest rate

prices hold when one looks at the capital flows between a developed economy like the United States and an emerging fast-growing economy like China? What are the factors that determine the evolution of house prices and capital flows in these two types of economies? How do house prices interact with capital flows? Our article addresses these questions.

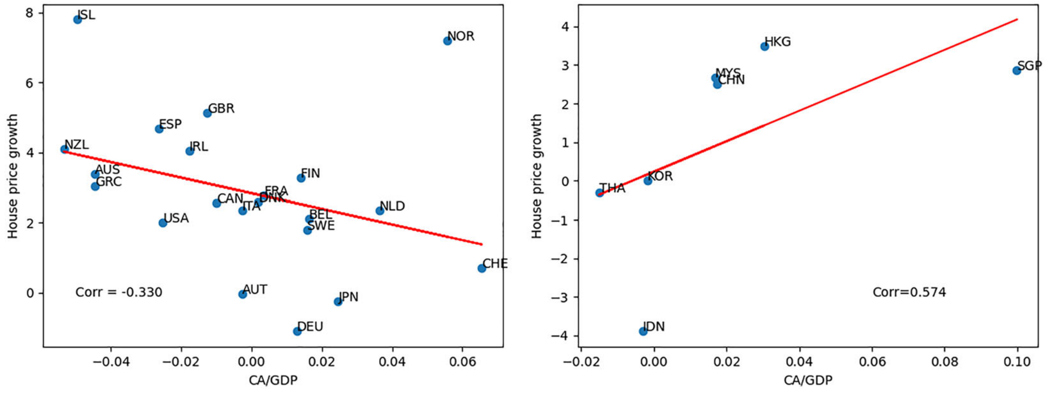
Figure 1 shows the current account and real house prices in the United States and China during the 1990–2008 period, the U.S. real interest rate,[4] and the growing importance of China as the trade partner for the United States during the same period. Parts (a) and (b) of this figure show that the dynamics of the current account and house prices in the United States prior to the Great Recession displays the negative correlation documented in the literature: persistent negative current account balances have been accompanied by house price increases. During the same period, current account balances and house prices in China displayed a positive correlation: current account surpluses were accompanied by house price increases. At the same time, China has become an important trade partner of the United States, as shown in panel (c) of Figure 1. This period was also characterized by a substantial decline in the U.S. real interest rate, as displayed in panel (d) of Figure 1.

Figure 2 shows that this relationship is not specific to the United States and China but holds more generally: there is a negative correlation between current account balances and house price growth among developed economies during the 1980–2007 period, but a positive correlation among the fast-growing East Asian countries.[5,6]

[4] The U.S. real interest rate is measured as the 10-year yield on U.S. Treasuries minus 10-year expected inflation from Gourinchas and Rey (2014).

[5] During this period, these two groups of countries displayed substantial differences in their growth rates: the average growth rate of the real GDP per capita among the "developed economies" group has been 2.2%, and 5.1% among the East Asian countries. Part (a) of Figure 3 shows that there were differences of similar magnitude between the GDP growth rates in the United States and China.

[6] We obtained similar differences in the correlation between current accounts and house prices between developed and fast-growing East Asian economies when using the cumulative current account deficits and cumulative house price appreciation from 2001 to 2005 with the data from table 1 in Aizenman and Jinjarak (2009).



SOURCE: House prices data from Mack and Martínez-García (2011) and Cesa-Bianchi et al. (2015). Current Account data from Lane and Milesi-Ferretti (2007). Data computed as averages values over the 1980–2007 period.

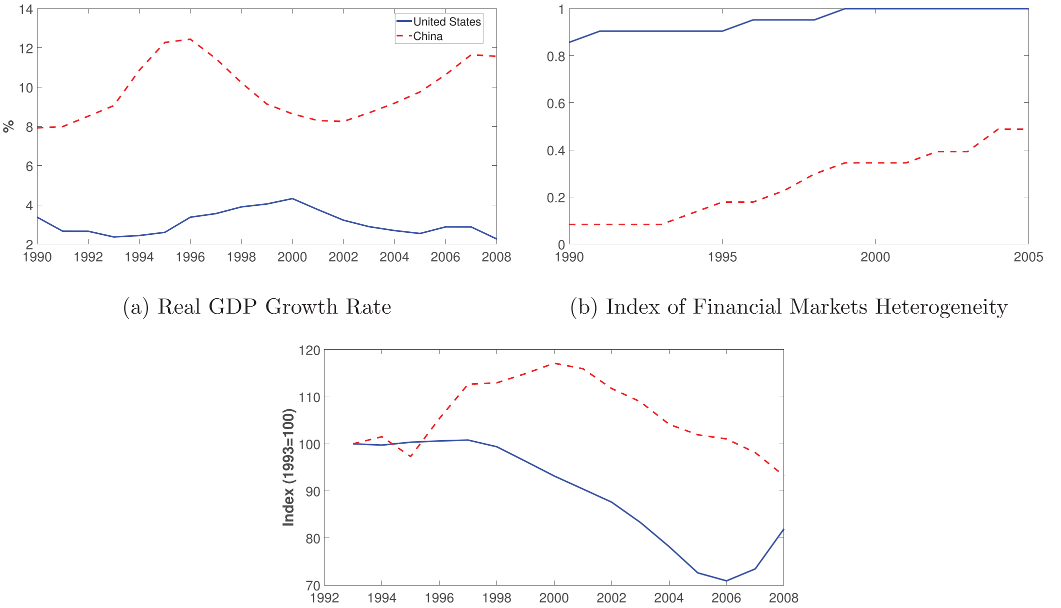
FIGURE 2

CURRENT ACCOUNT AND HOUSE PRICE GROWTH, 1980–2007

In this article, we develop a two-country life-cycle model with housing that rationalizes these observations. The key feature of our model that differs from most existing papers that study jointly current account dynamics and house prices is as follows: whereas one of the countries in our model (the United States) starts at the steady sate, the other one is a fast-growing country (China) that is on a transition path toward its corresponding steady state and it is temporarily growing faster than at the balanced growth path.[7] We use our model to match the dynamics of the current account and house prices in both the United States and China. In particular, we show that, after the two countries open up to trade (which we assume happened in the 1980s), the slower-growing country (the United States) experiences current account deficits, whereas the faster-growing country (China) experiences current account surpluses. At the same time, both countries in our model experience an increase in house prices. In a counterfactual autarky transition, however, we show that the house prices in China would grow even *faster* than they do in the open-economy equilibrium. Thus, our model delivers a negative correlation between the current account balances and the *difference* between the house prices in the integrated and the counterfactual autarkic equilibrium. These results can help us account for the different correlation patterns between the house prices and current accounts that we find for the developed and fast-growing emerging economies in the data. The theoretical mechanism uncovered by our model relates the current account and the difference between the house prices in the open-economy equilibrium and the counterfactual house prices that the country would experience in autarky. In the early 1980s, we assume that developed OECD economies were close to their balanced growth path; thus, their counterfactual autarky dynamics is close to such balanced growth path with a balanced current account and constant effective house prices, that is, house prices grow at the same rate as labor productivity. The actual house price dynamics in OECD economies can therefore be interpreted as the difference relative to counterfactual, constant autarky effective house prices, with such difference stemming from trade with developing economies.

For developing countries like China, on the other hand, autarky house prices grow faster than on the balanced growth path because the economy is on a transition path. In fact, our model shows that house prices in the developing economy would grow faster in autarky than in the integrated equilibrium; current account surpluses lower the rate of growth of house prices. In other words, the correlation between current account balances and house

[7] Coeurdacier et al. (2015) use the same assumption in their analysis of global imbalances; their model, however, does not feature housing.



(a) Real GDP Growth Rate (b) Index of Financial Markets Heterogeneity

(c) Rent-to-Price Ratio

Source: Growth rates constructed as five-year mean GDP growth rate from World Bank (WDI) data. The financial development index from Abiad et al. (2008). Rent-to-price ratio constructed using data from the OECD and National Statistics Offices.

Figure 3

growth rates, financial markets, and rent-to-price

prices needs to be interpreted through the lens of the economy's position relative to its long-run equilibrium.

To clarify the mechanism behind our results, we conduct a series of counterfactual exercises, in which we study both the integrated and autarkic equilibrium paths.[8] In particular, we investigate the autarky real interest rate paths in the two countries in our model. Intuitively, the country with the higher autarky real interest rate will be running a current account deficit in the integrated equilibrium, and vice versa. We find that modeling the life cycle is the key element that allows us to obtain these results. In particular, with the hump-shaped income profile, the young generations are the ones who would like to borrow, but this is limited in China due to tighter borrowing constraints. In addition to this, we follow Coeurdacier et al. (2015) who document that the income profile in China peaks at an earlier age than in the United States. As a result, the young generations in China have an incentive to *save* to smooth their consumption later on in their life cycle. We find that this substantially amplifies the differences in the autarky real interest rates, and leads to larger current accounts after financial integration.

In the period under analysis, the rent-to-price ratio has declined substantially in the United States (see part (c) in Figure 3); this decline has been the focus of some studies, like Sommer et al. (2013). Our model assumes that the younger households are renters, which enables us to study the behavior of the rent-to-price ratio and sheds light on its dynamics in the United States and China. Moreover, our model predicts that housing market developments have an impact on the real exchange rate. More precisely, the rental price enters the consumer price index (CPI) and therefore the real exchange rate. In fact, the ratio between the rental prices represents a measure of the real exchange rate in our two-sector model (as the other good is

[8] We thank an anonymous referee for this suggestion.

tradable) and our theoretical real exchange rate displays the dynamics consistent with the one observed in the data.

1.1. *Related Literature.* Our article is related to the literature that studies the joint behavior of current account balances and house prices. This literature documents empirically, and provides theoretical justification for the negative correlation between house prices and current account balances, focusing on the United States and other developed economies. In particular, Punzi (2013) builds on Iacoviello (2005) and develops a two-country model that differentiates between patient and impatient households in the domestic economy, and analyzes the business cycle properties after exogenous shocks to technology, housing preference and the loan-to-value (LTV) ratio. In a similar model, Ferrero (2015) studies the response to monetary policy and LTV ratio shocks. Adam et al. (2012) use Bayesian learning in a small open-economy model with collateral constraints in order to quantify the effect of an exogenous decrease in the international interest rate. Basco (2014) studies the relationship between globalization and rational bubbles (in particular, the dot-com and the housing bubbles) in a model that theoretically predicts a negative correlation between current account balances and house prices. Arslan (2014) and Franjo (2018) study the effect of an exogenous decrease in the international interest rate and in the downpayment required to buy a house in a small open-economy life-cycle model. Gete (2020), in a model with patient and impatient households, analyzes the effect of a shock to house price expectations and the LTV on the joint determination of the current account and house prices in the domestic economy; he also studies the effects of a transitory increase in the foreign discount factor. Whereas these papers use models with stationary economies that fluctuate around their steady states, we build on Coeurdacier et al. (2015) and develop a life-cycle model with housing where one of the two countries is a fast-growing economy like China that finds itself on a transition path when it opens to trade with the rest of the world. This allows us to provide a justification for the positive correlation between house prices and current account balances that we find in the data for China and other fast-growing East Asian economies.

Another branch of the literature that is related to our article focuses on the increase in housing prices in the U.S. economy before the Great Recession, but ignores current account imbalances and its relationship to the housing markets. Kiyotaki et al. (2011) study how interest rate and LTV shocks in a small open-economy model with growth determine house prices. Garriga et al. (2012) develop a representative agent model in which relaxed financial conditions and a decrease in the international interest rate generate housing prices dynamics. Favilukis et al. (2017) build a general equilibrium model with heterogeneous agents and time-varying risk premia and find that the decrease in housing risk premia prompted by a relaxation of the collateral constraints can generates large housing prices booms. They also find no effect of an *exogenous* international capital inflow into U.S. safe assets on house prices. They find that the reduction in the risk-free rate prompted by an *exogenous* increase in foreign demand for domestic safe assets is compensated by the increase in the housing risk premia because of the reallocation in the domestic agents' portfolio prompted by the foreign purchases of safe assets. Whereas the papers in this literature introduce capital inflows and changes in the international interest rate as exogenous shocks, in our model they arise endogenously as a result of asymmetries between our two economies. This allows us to study the two-way interaction between the house prices and current account dynamics.

Finally, there is a large literature on global imbalances that focuses on large current account balances in different countries before the Great Recession, but abstracts from the housing markets. Benhima (2013) looks at the investment side, assuming that investment is depressed in developing countries due to the existence of financial frictions. Other papers that analyze the effects of financial frictions on savings are closer to our approach. Caballero et al. (2008) and Mendoza et al. (2009) study, under different assumptions, the coexistence of low interest rates and global imbalances in the world economy. They stress how a large amount of savings coming from emerging economies during the 1990s led to a decrease in international interest rates. Caballero et al. (2008) model the inability of emerging economies to supply safe assets, and Mendoza et al. (2009) analyze the demand for riskless assets in developing economies when there are incomplete financial markets and uninsurable risk. Bacchetta and Benhima (2015) focus on the lack of liquidity for firms to carry out financial investment. Coeurdacier et al. (2015) study the importance of credit constraints and growth rate differentials in the global economy. Our work builds on Coeurdacier et al. (2015) and links global imbalances and dynamics in the world interest rate to house prices.

The article is organized as follows: Section 2 presents the two-country model with housing that we use for our analysis. Section 3 describes how the model is calibrated. In Section 4, we present the results from our benchmark model, and conduct a series of exercises to study the main mechanisms that drive our results. We also study the interaction between the house prices and current account balances in this section. Section 5 concludes.

2. MODEL

We build a model with two countries that we call "Home" (the United States) and "Foreign" (China). Each country is populated by overlapping generations of individuals who live for J periods. Every individual supplies inelastically one unit of labor. The productivity of a unit of labor varies with age and across countries: the number of efficiency units of labor supplied by an individual of age $j = \{1, \ldots J\}$ in country $i \in \{H, F\}$ is ε^i_j. The resulting labor income is bell-shaped: it is low for the young individuals, rises and reaches its peak for the middle-aged, and falls again for the old. The precise shape of the age profile of individual earnings, however, is country-specific, and is discussed in more details in the calibration section.

There are two production sectors in each country: a sector that produces consumption and capital goods, which are perfect substitutes, and a housing sector. Consumption and capital goods are tradable, whereas housing is a nontradable good.

The two countries in our model differ along four dimensions: (i) the degree of financial development, (ii) the growth rate of productivity in the consumption/capital goods sector, iii) the life-cycle labor income profiles, and (iv) population growth rates and the resulting population age structure. Financial development is captured in the model by the tightness of the borrowing limit, which we model as the maximum LTV ratio at which houses can be purchased. Since the age profile of labor income is bell-shaped, the young individuals are more likely to be constrained by the borrowing limit.

Both countries have the same preferences and the same production functions, except for the realization of the country-specific productivity path. We assume that labor is not mobile across countries whereas capital is.

2.1. *Production.*

2.1.1. *Consumption and capital goods.* Let K^i_t and L^i_t be the total amount of capital and labor employed in the production of consumption and capital goods at time t in country $i \in \{H, F\}$. Output in this sector is produced using a Cobb–Douglas production technology:

$$Y^i_t = (Z^i_t L^i_t)^{1-\alpha} \left(K^i_t\right)^{\alpha},$$

where $0 < \alpha < 1$ is the capital share and Z^i_t is the level of country-specific labor-augmenting productivity at time t in country i.

Since labor is supplied inelastically and is not internationally mobile, we have $L^i_t = \sum_{j=1}^{J} \varepsilon^i_j L^i_{j,t}$.

Capital follows the standard law of motion:

$$K^i_{t+1} = (1-\delta)K^i_t + I^i_t,$$

where δ is the rate at which capital depreciates, and I^i_t is the investment in capital at time t in country i.

Productivity and population in country i grow over time at rates $g^i_{Z,t}$ and $g^i_{L,t}$, respectively, so that: $Z^i_{t+1} = (1+g^i_{Z,t})Z^i_t$ and $L^i_{t+1} = (1+g^i_{L,t})L^i_t$.

Firms in country i choose labor L^i_t and capital K^i_t inputs to solve:

$$\max_{L^i_t, K^i_t} \quad (Z^i_t L^i_t)^{1-\alpha}(K^i)^\alpha_t - w^i_t L^i_t - (r^{k,i}_t + \delta)K^i_t.$$

Markets for capital and labor are competitive, so that w^i_t and $r^{k,i}_t$ are the marginal product of labor and capital at time t in country i.

2.1.2. *Housing.* We assume that there is a fixed supply of housing each period, H^i_t, such that:

$$H^i_t = N^i_t,$$

where N^i_t is the stock of residential land at time t in country i.[9] To ensure the existence of the balanced growth path, we assume that the stock of land grows over time at the same rate as the population, $g^i_{L,t}$, so that:

$$N^i_{t+1} = (1+g^i_{L,t})N^i_t.$$

2.2. *Households.* As explained above, households are composed of individuals who live for J periods. Housing must be purchased one period before it can be used. We do not model housing tenure choices. We assume that the individuals are born with no housing stock and must therefore rent a house in the first period of their life in order to get housing services; all other individuals must own a house.

In our experiments, we consider nonstationary environments where we need to keep track of the calendar time,[10] t. Households of age j in country i in period t decide on the amount of consumption, $c^i_{j,t}$, housing services, $x^i_{j,t}$, the housing capital stock for the next period, $h^i_{j+1,t+1}$ that can be purchased at price q^i_t, and the amount of savings in financial assets, $a^i_{j+1,t+1}$. They also need to solve a portfolio problem where they allocate their total financial savings among several financial assets available to them. We assume that in financial autarky, households can invest in domestic capital and rental housing units. With financial integration, they can invest in capital and rental housing units in both countries. We provide a more detailed characterization of this portfolio problem below.

Old individuals of age $j = J$ also decide how much to leave as bequests, $b^i_{J,t}$.

The optimization problem of the household of age j can be written recursively as follows:

$$v^i_t(a,h,j) = \max_{\{c,f,h',a',b\}} \left\{ u(c,x) + \beta v^i_{t+1}(a',h',j+1) + \phi\beta u_b(b)\mathbb{1}_{j=J} \right\} \tag{1}$$

[9] Since we do not model explicitly the housing production side, the house prices in the model may correspond more closely with the land prices in the data: land is one of the key inputs into house production with the exogenous supply. As you can see in panel (b) of Figure 1 and in Figure A.3 in the Appendix, both prices grow in the United States and in China, but at a different rate.

[10] In our experiment, country F will start far from its steady state.

s.t.:

$$c + r_t^{f,i} f + a' + q_t^i h' + b \leq w_t^i \varepsilon_j^i + (1 + r_t^i) a + q_t^i h + B_{j,t}^i, \tag{2}$$

$$a' \geq -\theta^i q_t^i h', \tag{3}$$

$$x = \begin{cases} f & \text{if } j = 1, \\ h & \text{if } j > 1, \end{cases} \tag{4}$$

where $x = f$ when $j = 1$ means that housing services take the form of rent in the first period of life, whereas $x = h$ for $j > 1$ means that housing services take the form of housing after the first period of life, namely, the agent rents in the first period and becomes a home owner afterward. $B_{j,t}^i$ is the amount of bequests left by generation J and redistributed to generation j. ϕ determines the strength of the bequest motive for saving. $r_t^{f,i}$ is the rental price of a housing unit, and r_t^i is the return on household savings.

We assume that the utility functions from consumption and bequests take the following form:

$$u(c, x) = \frac{\left(c^\gamma x^{1-\gamma}\right)^{1-\sigma}}{1-\sigma},$$
$$u_b(b) = \frac{\left(b^\gamma\right)^{1-\sigma}}{1-\sigma}.$$

We assume there is a minimum downpayment requirement when purchasing a house: an individual must pay a fraction $(1 - \theta^i)$ of the value of the house. The remaining balance on the house is financed by borrowing from financial institutions. Hence, θ^i denotes the maximum LTV ratio in country i and it captures the degree of financial development. More financially developed countries are characterized by higher θ^i.

2.3. *Household Financial Portfolios.* A household in country i in period t that decides to save a_{t+1}^i in the form of financial assets has to solve a portfolio problem and decide how to allocate this amount among several available financial assets. In particular, we assume that it can invest in domestic capital, $a_{t+1}^{K,(i,-i)}$, in the capital of the other country, $a_{t+1}^{K,(i,-i)}$, in domestic rental housing units, $a_{t+1}^{H,(i,i)}$, or in rental housing units in the other country, $a_{t+1}^{H,(i,-i)}$, so that:[11]

$$a_{t+1}^{K,(i,i)} + q_t^i a_{t+1}^{H,(i,i)} + a_{t+1}^{K,(i,-i)} + q_t^{-i} a_{t+1}^{H,(i,-i)} = a_{t+1}^i.$$

We define the corresponding portfolio shares of a household from country i as $\theta_{t+1}^{K,(i,i)} = \frac{a_{t+1}^{K,(i,i)}}{a_{t+1}^i}$, $\theta_{t+1}^{H,(i,i)} = \frac{q_t^i a_{t+1}^{H,(i,i)}}{a_{t+1}^i}$, $\theta_{t+1}^{K,(i,-i)} = \frac{a_{t+1}^{K,(i,-i)}}{a_{t+1}^i}$, and $\theta_{t+1}^{H,(i,-i)} = \frac{q_t^{-i} a_{t+1}^{H,(i,-i)}}{a_{t+1}^i}$. Since we assume that there is no uncertainty and that households have perfect foresight about the path of future returns on all assets, this problem can be formulated as follows:

$$\max_{\substack{\theta_{t+1}^{K,(i,i)}, \theta_{t+1}^{H,(i,i)}, \\ \theta_{t+1}^{K,(i,-i)}, \theta_{t+1}^{H,(i,-i)}}} (1 + r_{t+1}^{k,i}) \theta_{t+1}^{K,(i,i)} + R_{t+1}^{f,i} \theta_{t+1}^{H,(i,i)} + (1 + r_{t+1}^{k,-i}(1 - \tau_t^{-i})) \theta_{t+1}^{K,(i,-i)}$$
$$+ (1 + (R_{t+1}^{f,-i} - 1)(1 - \tau_t^{-i})) \theta_{t+1}^{H,(i,-i)}$$
$$\text{s.t.} \quad \theta_{t+1}^{K,(i,i)} + \theta_{t+1}^{H,(i,i)} + \theta_{t+1}^{K,(i,-i)} + \theta_{t+1}^{H,(i,-i)} = 1,$$

[11] We use $-i$ to denote the "other" country in our model. For instance, if country i is the United States, then country $-i$ is China.

where $R^{f,i}_{t+1} \equiv \frac{r^{f,i}_{t+1}+q^i_{t+1}}{q^i_t}$ is the gross return on investment in rental housing units in country i, and similarly $R^{f,-i}_{t+1} \equiv \frac{r^{f,-i}_{t+1}+q^{-i}_{t+1}}{q^{-i}_t}$ is the gross rate of return on investment in rental housing units in country i's trading partner.

Investing abroad entails an "iceberg" cost $\tau^{-i} \geq 0$, which is intended to capture both physical and informational costs of investing in another country. When both τ^H_t and τ^F_t are sufficiently high, we have financial autarky where investors in both countries find it optimal to invest only domestically.

Nonarbitrage condition for two types of domestic investment requires that $(1 + r^{k,i}_{t+1}) = R^{f,i}_{t+1}$. We thus define the rate of return on household savings in country i as $1 + r^i_t \equiv 1 + r^{k,i}_{t+1} = R^{f,i}_{t+1}$.

2.4. *Government.* The government in each country owns the new residential land and sells it on the market at price q^i_t. The government in country i at time t uses this revenue to finance wasteful spending, G^i_t:

$$G^i_t = q^i_t(N^i_{t+1} - N^i_t).$$

2.5. *Autarky versus Integrated Equilibrium.* We assume that initially, before period 0 in the model, the iceberg costs in both countries are so high that financial intermediaries in both countries choose to invest only at home. This leads to an autarkic equilibrium in both countries. Furthermore, we assume that in period 0, the iceberg costs in the United States drop to zero, whereas the iceberg costs in China decrease only gradually over time. This results in a *partially* integrated equilibrium, where the financial intermediaries from China can freely invest in the U.S. assets, whereas the American investors may still be discouraged from investing in China because of the iceberg costs.

The assumption that the iceberg costs in China are reduced only gradually is needed to match the size of the current account deficits in China during the early 1990s. As panel (a) of Figure 1 shows, during this time China has experienced a brief period with small current account deficit. Our results in Appendix A.4 show what would happen in our model if we assume that the iceberg costs in both the United States and China drop to zero simultaneously and instantaneously in period 0 in our model. Without iceberg costs in China, small initial capital and high productivity growth rates in China lead to high returns on investment, and so would lead to large investment inflows from the United States to China. As a result, there will be a brief period of current account deficits in China of the magnitude substantially larger than in the data. Our assumption about the path of iceberg costs in China allows us to bring the predictions of our model along this dimension closer to the data. However, it is worth to point out that our predictions about the behavior of current account and house prices in both countries in later periods when the direction of capital flows is reversed is similar in both versions of our model, and are not affected by the specific assumptions about the path of iceberg costs in China.

It is also worth to point out that our assumption about the iceberg costs in China are in line with the data on capital controls. Fernández et al. (2016) compute an index that summarizes the overall magnitude of cross-border capital controls for a large number of countries during 1995–2019 period, which takes the value between 0 and 1 (higher values corresponding to more restrictive capital controls). The average value of this index for China is 0.957, which is significantly larger than for the United States (0.137). In fact, capital controls appear to be among the highest in China: the value of this index in China is also significantly larger than the average among the East Asian and Pacific group of countries (0.506), or among middle-income countries (0.491). In fact, only India, Sri Lanka, and Tunisia have higher values of this index.

Autarky and integrated equilibria differ in terms of the market clearing conditions for the assets and goods markets.

In the autarkic equilibrium, the market clearing condition in the assets market is given by:

$$\sum_{j=1}^{J-1} L_{j,t}^{i} a_{j,t+1}^{i} = K_{t+1}^{i} + q_t^{i} H_{t+1}^{f,i}, \quad i \in \{H, F\}. \tag{5}$$

In words, the amount of net deposits held by individuals at financial institutions in each country equals the capital stock plus the market value of the housing rental stock in each country.

In the integrated equilibrium, this changes to

$$\sum_{i\in\{H,F\}} \sum_{j=1}^{J-1} L_{j,t}^{i} a_{j,t+1}^{i} = \sum_{i\in\{H,F\}} (K_{t+1}^{i} + q_t^{i} H_{t+1}^{i,f}). \tag{6}$$

In our *partially* integrated equilibrium (where $\tau_t^F > 0$), we need to add to Equation (6) the following complementary slackness conditions:

(a) $r_t^H < r_t^F \quad \Rightarrow \quad \sum_{j=1}^{J-1} L_{j,t}^F a_{j,t+1}^F \leq K_{t+1}^F + q_t^F H_{t+1}^{f,F}$

(b) $r_t^H > r_t^F(1 - \tau_t^F) \quad \Rightarrow \quad \sum_{j=1}^{J-1} L_{j,t}^F a_{j,t+1}^F \geq K_{t+1}^F + q_t^F H_{t+1}^{f,F}$.

With iceberg costs, the rates of return in the two countries do not need to be equalized. One possibility is that, in equilibrium, the rate of return in the United States is lower than in China, and Chinese investors only invest in their own country (as in case (a) above). Another possibility is that the rate of return in the United States is higher than the rate of return in China adjusted for the iceberg costs (as in case (b)), so that the American investors will not invest in China (so all Chinese assets are owned by Chinese investors, who may invest in the United States). Note that $r_t^H = r_t^F$ is a special case of (b). If both (a) and (b) are true, we effectively have financial autarky.[12]

Clearing conditions in other markets are the same in both equilibria given that labor is not mobile across countries and housing is a nontradable good. Thus, market clearing conditions are:

(a) Housing market:

$$\sum_{j>1}^{J-1} L_{j,t}^{i} h_{j+1,t+1}^{i} + H_{t+1}^{f,i} = N_{t+1}^{i}.$$

(b) Rental market:

$$L_{1,t}^{i} f_{1,t}^{i} = H_t^{f,i}.$$

(c) Labor market:

$$\sum_{j=1}^{J_R} \varepsilon_{j,t}^{i} L_{j,t}^{i} = L_t^{i},$$

where J_R is the last period of work before retirement.

[12] To solve the resulting system of equilibrium equations and inequalities, we use the complementarity methods from Miranda and Fackler (2002).

(d) Goods market:

$$Y_t^i - T_t^i = C_t^i + I_t^i + G_t^i + TB_t^i,$$

where TB_t^i is the trade balance at time t in country i. Note that, $\sum_i (TB_t^i) = 0$ in the integrated equilibrium; and $TB_t^i = 0$, $\forall i$, in the autarkic equilibrium. T_t^i is the total amount of iceberg costs paid by investors from country i who decide to invest in another country. Since we assume that after the financial integration, $\tau_t^H = 0$ while $\tau_t^F \geq 0$, we have $T_t^F = 0$ and

$$T_t^H = r_t^F \tau_t^F \max\left(K_{t+1}^F + q_t^F H_{t+1}^{f,F} - \sum_{j=1}^{J-1} L_{j,t}^F a_{j,t+1}^F, 0\right).$$

We further assume that the bequests are distributed across generations according to:

$$B_{j,t}^i = \zeta^j \frac{L_{J,t}^i}{L_{j,t}^i} b_{J,t}^i,$$

where ζ^j represents the fraction of bequests received by generation j.

To close the model, we derive an expression for the real exchange rate. In our model economy, the nontradable good is housing and we assume that the law of one price holds for the tradable/consumption good.[13] Given the functional form of the utility function, the relevant expression for the real exchange rate in country i relative to country j at time t, $RER_t^{j/i}$, becomes:

$$RER_t^{j/i} = \left(\frac{r_t^{f,i}}{r_t^{f,j}}\right)^{1-\gamma}, \tag{7}$$

where $1-\gamma$ is the share of housing services in the utility function.

In the quantitative experiments in this article, we solve for the equilibrium in which the economy in the long run follows a balanced growth path. This requires transforming our nonstationary environment into a stationary one, by detrending a number of key variables (such as nondurable consumption, the housing rental rate, wages, household savings, and the house prices) using the labor productivity growth in each economy. The details are provided in Appendix A.2.

3. CALIBRATION

We assume that households' economic life consists of 11 periods ($J = 11$), with each period corresponding to five years. Each period of life in the model corresponds to the following age brackets: younger than 25, 25–29, ..., 65–69, older than 70. We assume that households younger than 25 years of age are renters, whereas all households above that age are home owners. We use the same life-cycle earnings profiles, demographic growth and productivity growth rates as in Coeurdacier et al. (2015) for the United States and China, which we report in Tables A.1, A.2, and A.3 in Appendix A.1. As in Coeurdacier et al. (2015), the choice of the initial productivity levels together with the assumed subsequent productivity growth rates match the output of China relative to the United States over the period 1988–2008 and a

[13] To compute the real exchange rate of our economy, we follow the procedure by the National Bureaus of Statistics (for the United States, see the Bureau of Economic Analysis, BEA; and, for China, see the National Bureau of Statistics of China, NBS) to compute the CPI. In particular, we use our rental price as the rent of primary residence and owners' equivalent rent. This is to say that the price of nontradable goods and services in our economy is the rental price.

capital-effective-labor ratio of 70% in China relative to the United States in 1988. We choose the initial capital in China to match the output in China relative to the United States at the time of integration, which in the model happens in 1988.[14] We also assume that after 2013 the productivity growth rates in the two countries become the same, equal to 1.5%.[15] Demographic growth matches the evolution of population structure over time in each country.[16] Coeurdacier et al. (2015) take the data for the age profile of labor income over the life cycle in China from the Urban Household Survey (UHS) conducted by the National Bureau of Statistics. For the United States, they use the data from the Consumer Expenditures Survey (CEX). As can be seen in Table A.1 in Appendix A.1, there are two main differences between life-cycle wage profiles across the two countries: first, Chinese wage income profile peaks at an earlier age compared to the United States; and, second, the peak of the wage profile in China shifts to an earlier age over time unlike in the United States.

Several parameters are common to both economies and calibrated to match-specific U.S. ratios in 1983.[17] The discount factor β is set to 0.9683 (on an annual basis) and is calibrated to match a capital-to-output ratio of 1.37 in the initial steady state, which is the value of this ratio in the U.S. economy in 1983.[18] The rate of depreciation δ is set at 0.1 on an annual basis. The intertemporal rate of substitution parameter, σ, is equal to 2, which is standard in the literature[19] and the capital share in the production function α is set to 0.28. The nonhousing preference parameter is $\gamma = 0.8683$ and is calibrated to match a residential capital-to-output ratio of 1.19 in the initial steady state which is the value of this ratio in the U.S. economy in 1983.[20] We calibrate the strength of the bequest motive for saving, ϕ, to match the ratio of bequest to GDP of 2.65% in the data ($\phi = 0.1133$).[21]

With regards to financial development, we assume that $\theta^H = 0.8$, which is equivalent to an LTV ratio of 80%.[22] For China, the LTV ratio on new mortgages was capped at 0.8 starting in 2001. According to Bingxi and Lijuan (2007), residential mortgage loans increased almost 150-fold between 1997 and 2007 and mortgage loans to GDP rose from 0.2% to 10.9% of GDP over the same period; the average downpayment on active mortgages in large Chinese cities was 37.4% in 2007. Although we have no direct data before 1997, the evidence suggests that LTV ratios were extremely low until the mid-1990s and grew rapidly after that.[23] We interpret this evidence as suggesting that market financing of housing purchases was very limited in China in 1990 and then it gradually improved. For this reason, we set θ^F equal to 0.02, such that the θ^F/θ^H ratio is the same as in Coeurdacier et al. (2015).[24]

Finally, we assume that the iceberg costs in China decline linearly over time. Under this assumption, we need to choose two parameters: first, an initial value of the iceberg costs at the time of the opening, that is, τ_0^F; and, second, the slope for the linear path. We set τ_0^F such that one period after the opening (i.e., model period $t = 1$), the current account deficit in China

[14] According to the data from FRED, real GDP in China (using market prices) in 1988 was equal to 32.9% of that in the U.S. economy.

[15] We make this assumption because the focus of our analysis is on the period before 2008. However, we have carried out an alternative experiment in which the Chinese economy keeps growing faster than the United States until 2023 and found exactly the same qualitative results.

[16] See table 3 in Coeurdacier et al. (2015).

[17] We assume that the financial integration of China starts in 1988.

[18] Capital is defined as business capital and nonresidential structures. Data from EUKLEMS and the BEA.

[19] The intertemporal elasticity of substitution (IES) in our model economy equals $1/\sigma$, thus a value of $\sigma = 2$ implies an IES = 0.5. Guvenen (2006) estimates the IES to be between 0 and 1. We performed sensitivity analysis, recalibrating our model for different values of σ. We obtained similar results.

[20] Data from EUKLEMS and the BEA.

[21] This is the value used in Coeurdacier et al. (2015) and taken from Gale and Scholz (1994) and De Nardi (2004).

[22] We borrow this value from Chambers et al. (2009) which compute it using the 1995 American Housing Survey.

[23] For further evidence that housing financing options did not exist until the early 2000s, see Yang and Chen (2014).

[24] Our sensitivity analysis suggests that, as long as $\theta^F < \theta^H$, a higher value for θ^F does not substantially change our results. In particular, we solve a model in which θ^F is such that the ratio θ^F/θ^H has increased at the same rate as the ratio of the financial indices for China and the United States computed by Abiad et al. (2008) from 1988 to 2005. See Subsection 4.2.

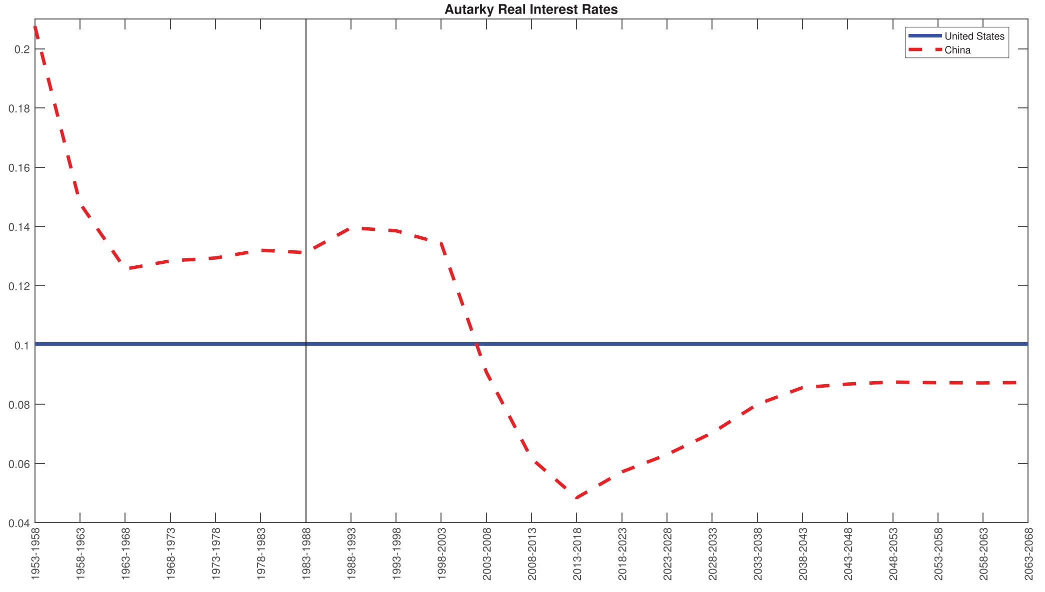


FIGURE 4

AUTARKY REAL INTEREST RATES

equals the one observed in the data in 1993 (2.6% of GDP). Regarding the calibration of the slope for the linear path, we choose a value such that the ratio τ_4^F/τ_0^F in the model is the same as the ratio of the values of the capital control index in China in 1995 and in 2010 as reported in Fernández et al. (2016).[25]

4. RESULTS

4.1. *Benchmark Model.* In this section, we use our model to study what happens when the United States and China open to trade. To develop the intuition for the results in the integrated equilibrium, we start by inspecting what would happen in a counterfactual scenario where both countries remain in autarky. Figure 4 shows the path for the real interest rate in the two countries in this case. As a point of reference, the vertical line at t = 1983–88 shows the period when the two economies become integrated in our full model. Period t = 1983–88 in the model corresponds to the period between 1983 and 1988 in the data.[26] We assume that the United States starts in the autarky steady state, so its autarky real interest rate in Figure 4 remains unchanged over time (the blue solid line is flat). On the other hand, China is initially capital scarce, and as a result, its initial autarky real interest rate is significantly higher than its steady-state value, and also higher than the interest rate in the United States. However, even if China remained in autarky, its real interest rate would fall over time as it builds up its capital stock. In fact, the steady-state autarky interest rate in China is lower than that in the United States. This is because we assume that the differences in financial development between the two countries, captured in our model by tighter borrowing limit in China, persist in the long run. This leads to higher savings and lower interest rate in the autarky steady state in

[25] We carried out sensitivity analysis with respect to the path followed by the iceberg costs in China over time and this assumption does not have a substantial effect on the results. The reason for this is that we are mainly interested in the model predictions for the periods when China runs current account surpluses, and the iceberg costs in China do not play any role.

[26] We set 1983–88 to be the period in which China started the process of financial integration into the world economy. The first set of reforms started in 1978 but many important market-oriented reforms took place all along the 1980s. See, for example, Chow (2004) and Song et al. (2011).

China. However, the differences in the autarky steady-state interest rates between the United States and China caused by long-run differences in their financial development are not very large, and as we will argue below, are not the main driver of our results.

At the same time, the figure shows that the decline in the autarky interest rate in China in our model is nonmonotonic. A temporary increase in productivity growth in China that in our model starts in period $t = 1973$–78 slows down the decline in the autarky interest rate. As a result, the autarky interest rate in China remains above that in the United States for several periods after $t = 1983$–88. In the integrated equilibrium, this corresponds to China running current account deficits during these periods.

As documented in Coeurdacier et al. (2015), China has also been experiencing a demographic transition and changes in the life-cycle profile of earnings. Because the population in China is becoming older, and the peak of the earnings life-cycle profile moves to a younger age, there is an increased incentive to save, which leads to a sharp drop in the autarky interest rate in China in periods $t = 2003$–8 and $t = 2008$–13. As a result, the autarky interest rate in China drops below its steady-state value during these periods. This generates a large difference between the autarky interest rates in the United States and China and leads to the current account deficits in the United States and surpluses in China in the integrated equilibrium.

Before we study the results from our benchmark model, it is instructive to look at what happens in the model without the iceberg costs.[27] With no iceberg costs, our model predicts that the real interest rates in both countries would become equalized immediately after integration, in period $t = 1983$–88. Since the initial interest rate in China is higher than in the United States, the equilibrium interest rate in the integrated equilibrium without iceberg costs is in between these two autarky interest rates, and our model without iceberg costs predicts that China would run much larger current account deficits in periods $t = 1983$–88, $t = 1988$–93, and $t = 1993$–98 than in the data. However, this would reverse and, starting with period $t = 2003$–8, China would be running large current account surpluses (with the current account deficits in the United States). As we explained above, this corresponds to a large drop in the autarky interest rate in China in the same period in Figure 4.

With the iceberg costs, Figure 5 shows that the interest rates in the two countries do not become equalized immediately after the integration. Initially, American investors who would like to invest in the Chinese assets have to pay the iceberg costs which create a wedge between the two interest rates. As a result, the drop in the interest rate in China and the increase in the interest rate in the United States are smaller than in the model without the iceberg costs, with smaller corresponding current account deficits in China and surpluses in the United States. The interest rates in the two countries become equalized in period $t = 2003$–8, when China starts running current account surpluses versus the United States, since we assume that Chinese investors do not have to pay iceberg costs on the returns from their investments in the United States. The results predicted by our model during this period are similar in model with and without the iceberg costs. Note again that this period corresponds to the period of the large drop in the autarky interest rates in China in Figure 4.

Period $t = 2003$–8 in our model corresponds to the five-year period that precedes the Great Recession. We mainly focus on the model predictions from the end of the 1990s ($t = 1993$–98) to the end of the 2000s ($t = 2003$–8) since this is the time period in which China progressively became a more important trade partner of the U.S. economy.

The model predicts the negative correlation between current account balances and real house prices in the U.S. economy, and a positive correlation between these two variables in China from the end of the 1990s to the end of the 2000s. The model is able to generate increasing house prices in both economies. Intuitively, in the U.S. economy, a decrease of the interest rate prompts a portfolio reallocation from financial assets toward housing which increases housing prices. In China, however, it is the wealth effect on middle-aged generations

[27] The results from the model with no iceberg costs are shown in Figure A.1 in the Appendix.

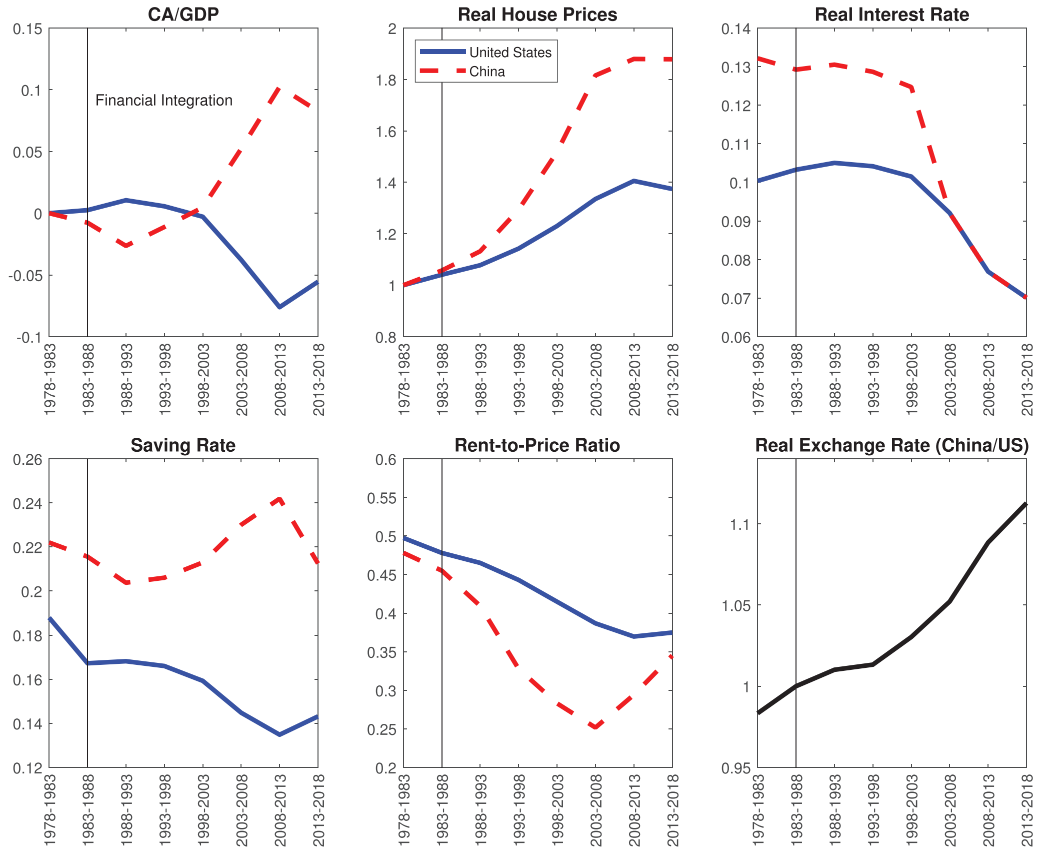


FIGURE 5

THE UNITED STATES AND CHINA: FINANCIAL INTEGRATION

from a rapid productivity growth that drives the dynamics.[28] This wealth effect leads to the increase in savings/asset accumulation by the middle-aged in both housing and financial assets, which then leads to increasing house prices and current account surpluses in China. We will explore in detail the main mechanism behind this result in Subsection 4.2. In the rest of this section, we focus on the quantitative responses of our full model and compare those predictions to the data.

Current account imbalances in the model are in line with the observed ones in the data. In the model, China reaches a 5.2% current account surplus by 2008, whereas in the data the Chinese economy was running a 10% surplus in 2007. For the United States, the model predicts a 3.8% current account deficit by the end of the 2000s whereas in the data the U.S. economy reached a 4.9% current account deficit by 2007. Note that, after financial integration, in model period $t = 1988$–93, the Chinese economy runs a current account deficit equal to the one observed in the data in 1993 (2.6%), since we target this number to calibrate the iceberg costs in the model.[29]

In our model, the divergence in saving rates of both economies is the main driving force behind global imbalances. For the United States, the model generates a drop of 2.1% in the

[28] This wealth effect has been already described in Coeurdacier et al. (2015) in a two-country overlapping generations model with financial frictions and faster productivity growth in one of the economies. By including housing in the analysis, we complement and extend the literature by studying to which extent this wealth effect and housing relate to each other.

[29] See Appendix A.4 for the results of the model without iceberg costs.

saving rate between the end of the 1990s and the end of the 2000s, which represents two-thirds of the observed decrease (3.2%) in the data over the same time period.[30] For China, the model predicts an increase in the household saving rate of 2.4%, which means that the model accounts for around 33% of the increase in the saving rate in China observed in the data between 1998 and 2007.[31] Between 1998 and 2008, when house price growth accelerated and China became a more important trade partner of the U.S. economy, our model accounts for 43.1% of the divergence in the saving rates observed in the data between the United States and China. This finding suggests that housing may have played an important role in explaining the divergence in saving rates between the two economies.

At the same time, and in line with the evidence, the model predicts a decrease of the international interest rate, starting at the end of the 1990s together with an appreciation of the real exchange rate (3.8% appreciation in the model between periods t = 1993–98 and t = 2003–8 vs. 3.4% appreciation in the data between 1998 and 2007).[32]

Regarding house prices, the model predicts a 16.9% increase of real house prices in the U.S. economy from the end of the 1990s to 2008, which implies that our model accounts for 47.9% of the increase observed in the data during the same time period.[33] For the same time period in China, the model predicts a 40.3% increase in real house prices, which represents 45.8% of the increase in residential land prices observed in the data.[34] As can be seen in Figure 5, our model predicts, consistently with the evidence presented above, a larger (detrended) real house prices increase in China than in the U.S. economy.

Finally, the model predicts a decrease of the rent-to-price ratio in both countries from the end of the 1990s to 2008 in line with the decrease observed in the data. Because of the decrease in the interest rate, financial institutions reallocate resources from financial assets toward rental units, which pushes house prices up and, at the same time, tends to decrease the rental price through an increasing supply. Hence the rent-to-price ratio goes down in both countries. For the U.S. economy, a 12.7% drop in the model between periods t = 1993–98 and t = 2003–8 accounts for the 48.6% of the decrease observed in the data from 1998 to 2007; and for China the model predicts a 23.2% decrease of the rent-to-price ratio between 1998 and 2008, while in the data a 13.1% drop was observed during the same time period.

4.2. *Inspecting the Mechanism.* The two countries in our benchmark model differ along several dimensions: (i) differences in the life-cycle profiles of wage income; (ii) differences in the productivity growth rates between the United States and China; and (3) differences in financial development between the two countries, which we capture in the model through differences in LTV ratios. To better understand what drives the results in our benchmark economy, we inspect how important each of these differences are. In particular, we study the behavior of our model when we eliminate one of these features at a time.[35]

[30] Coeurdacier et al. (2015), from National Income and Product Accounts (NIPA) tables, report a personal saving rate in the United States of 6.2% in 1998 and 3% in 2007.

[31] Coeurdacier et al. (2015) report a household saving rate in China of 20.1% in 1998 and 27.4% in 2007.

[32] In the 1990s, China introduced a control system in order to intervene in the foreign exchange market by buying dollars to keep its nominal exchange rate artificially depreciated (see, e.g., Goldstein and Lardy, 2006). Since we abstract from the foreign exchange market in our model, we construct a measure of the real exchange rate for China in the data by plugging the rental price data for the United States and China into Equation (7) and then compare the resulting rate with the model prediction. The model implied real exchange rate is plotted in Figure A.4 in the Appendix. Both the constructed real exchange rate in the data and in the model appreciated (by 3.4% and 3.8%, respectively) over the entire period.

[33] Since real house prices in our model are detrended by the productivity growth rate of each economy, we also apply the same detrending to residential land prices in the data in order to compute our data counterparts. Residential land price data from Knoll et al. (2017), constructed as an index with the value 100 in 2000, reports a value of 150 in 2007.

[34] Combined residential land price data from the NBS and Wu et al. (2012), and constructed as an index with the value 100 in 2000, reports a value of 245.21 in 2007. We thank Yu Wu for providing us with this data.

[35] We have also checked the importance of differences in the population structure across countries and the assumption of initial capital scarcity in China. None of these features change the qualitative predictions of the model, but slightly amplify the results of the benchmark model quantitatively.

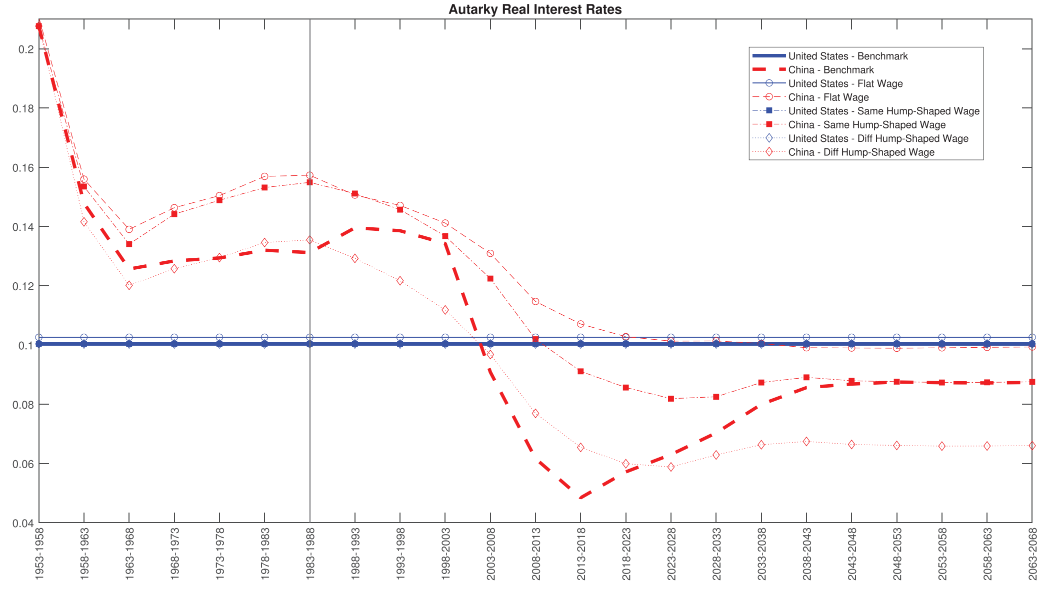


FIGURE 6

AUTARKY REAL INTEREST RATES WITH THE WAGE PROFILE SET EQUAL TO 1 OVER THE LIFE CYCLE AND OVER TIME IN BOTH COUNTRIES

Life-cycle profiles of wage income

In our first experiment, we analyze the importance of different age profiles of labor income across countries. To do this, we perform the following three exercises: first, we compare the results with the hump-shaped versus flat life-cycle wage income profiles in the two countries; second, we inspect the importance of the fact that the peak of the life-cycle wage income profile is reached at an earlier age in China compared to the United States; finally, we analyze the importance of the further shift of the peak of the wage profile in China to an earlier age over time.[36] Figure 6 shows the behavior of the autarky interest rates in both countries under these different scenarios and compares it to our benchmark results, whereas Figure 7 does the same for the current account and housing prices.

The dashed red line with circles in Figure 6 shows the autarky interest rate in China in a model without a hump-shaped wage income profile (whereas the blue solid line with circles shows it for the United States).[37] In this scenario, the higher productivity growth and initial capital scarcity in China would generate a somewhat higher autarky interest rate in China in period $t = 1983–88$ compared to our benchmark model. As one can see in Figure 7, this leads to a larger current account deficit in China at the time when the two countries become financially integrated. Contrary to what happens in our benchmark model, with constant and flat wage profile over the life cycle the autarky interest rate in China does not drop below the autarky interest rate in the United States in periods $t = 2003–8$, $t = 2008–13$, and $t = 2013–18$. Intuitively, without a hump-shaped profile in efficient units of labor, agents do not have the incentive to accumulate wealth over the life cycle. This makes the Chinese households behave similarly to how they would behave in a frictionless neoclassical growth model: instead of increasing their savings, they optimally choose to borrow against the increasing future labor income implied by the higher productivity growth rate. In the integrated equilibrium, as can be

[36] For evidence on the evolution of the wage profile over the life cycle in China, see Guo and Perri (2012) or Coeurdacier et al. (2015).

[37] In this experiment, labeled "Flat Wage" in Figures 6 and 7, we assume that wage income is constant, equal to 1 both over the life cycle and over time in both countries.

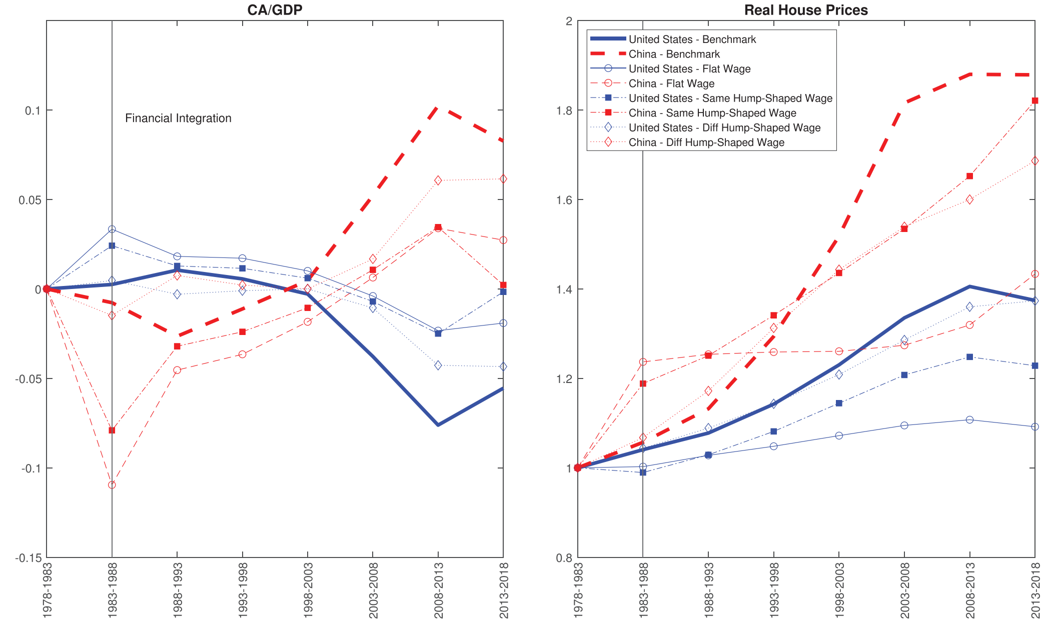


FIGURE 7

THE UNITED STATES AND CHINA: FINANCIAL INTEGRATION NOTE: WAGE PROFILE SET EQUAL TO 1 OVER THE LIFE CYCLE AND OVER TIME IN BOTH COUNTRIES.

seen in Figure 7, this implies current account deficits in China along almost the whole transition path together with a reduced downward pressure on the international interest rate and a smaller increase in the house prices. Therefore, China and the United States do not experience either the current account imbalances or the housing boom observed in the data. In particular, housing prices in China are almost flat from integration at $t = 1983$–88 to $t = 2003$–8 under this specification of the model with a flat wage profile over the life cycle.

In the next experiment, we allow the wage profile to be hump-shaped, but we restrict it to be the same in both economies.[38] With the hump-shaped profile of earnings in China (even though we assume that it is the same as in the United States), the higher productivity growth in China generates the wealth effect on the middle-aged in that country, who want to optimally save because of the life-cycle considerations. The results are shown with the dashed red line with squares in Figures 6 and 7. As one can see in Figure 6, the autarky interest rate starts at the same level as in the case with a flat wage profile, but then drops in later periods below the one in the U.S. economy, similarly to what happens in our benchmark economy. Middle-aged individuals in China increase their demand for both the internationally traded bond and housing, which leads to the current account surpluses, decreasing world interest rates and increasing house prices (see Figures 6 and 7). As a result, in this experiment we obtain a pattern of current account imbalances which are closer to the one observed in the data, together with increasing house prices in both economies.

In the last experiment in this section, we set the wage structure in China to the one observed in the data (as estimated by Coeurdacier et al., 2015) but keep it constant over time at its initial level.[39] Since the actual wage profile in China peaks at an earlier age than in the United States, the incentive for the Chinese middle-aged to accumulate wealth becomes

[38] In particular, we use the wage profile of the United States for both countries and label this experiment as "Same Hump-Shaped Wage."

[39] We set the hump-shaped age-income profile in China at its pre-1988 level (see Table A.1) and label this counterfactual as "Diff Hump-Shaped Wage" in the figures.

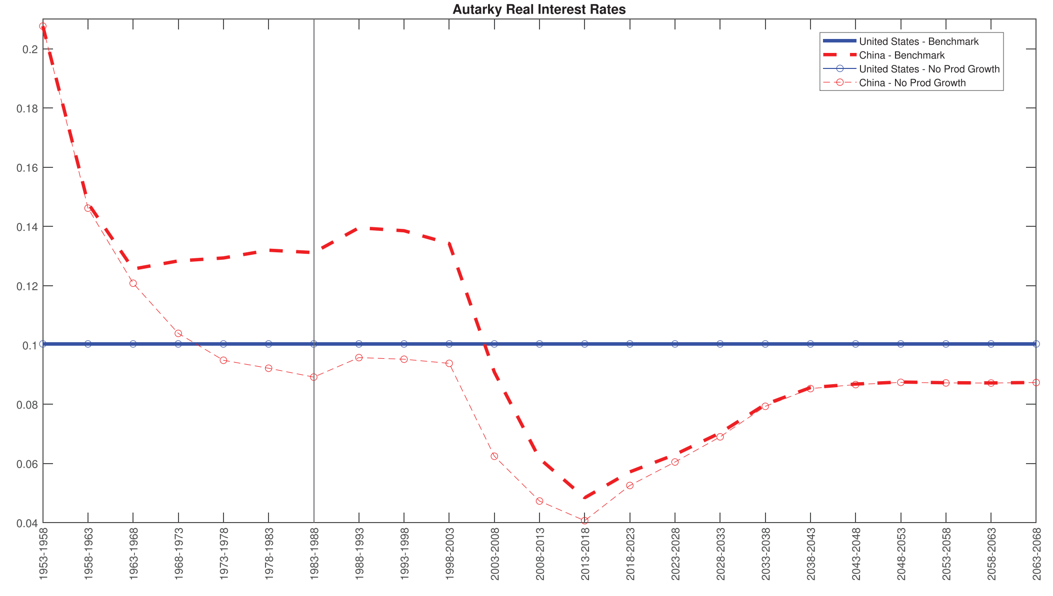


FIGURE 8

AUTARKY REAL INTEREST RATES WITHOUT PRODUCTIVITY GROWTH DIFFERENTIALS

stronger, thus amplifying the results. In our benchmark model, which we include in Figures 6 and 7 for comparison, the wage profile in China changes over time, with the peak moving to an earlier age. This further reinforces the effect of the hump-shaped earnings profile on savings and quantitatively boosts the results in the benchmark economy.[40]

We conclude that the hump-shaped profile of wages is key to allow the main mechanism to drive the results in the benchmark economy.

Growth-rate differences

In our next exercise, we assume that there are no differences in the productivity growth rates in the two countries: we set the growth rates in China to be the same as those in the United States Figure 8 shows the resulting behavior of the autarky interest rates, whereas Figure 9 shows the integrated equilibrium results. Without faster Total Factor Productivity (TFP) growth in China, the autarky real interest rate drops below that in the United States already in period t = 1983–88. As a result, unlike in our benchmark model, there are no current account deficits in China immediately after the integration in this version of the model. Instead, China runs a small current account surplus. Similar to our benchmark model, there is a further drop in the autarky interest rate in China in periods t = 2003–8, t = 2008–13, and t = 2013–18 that corresponds to larger current account surpluses in those periods. Two main differences arise from this experiment compared to the benchmark. First, the wealth effect on the Chinese middle-aged individuals disappears, which leads to an almost flat saving rate over time and a milder increase in housing prices compared to the benchmark. And second, without higher productivity growth, capital investment in China falls compared to the benchmark. This explains the absence of investment-driven current account deficits immediately after the integration. Investment in China falls further as it builds up capital along the transition from the capital

[40] In the benchmark model, we assume that the age profile of wage income in China converges to the one in the United States in the long run, whereas in the last experiment in this section, we assume that it remains constant, and continues to be different from the United States in the long-run steady state. This explains why the autarky real interest rate in this experiment is lower in the long run that in our benchmark experiment.

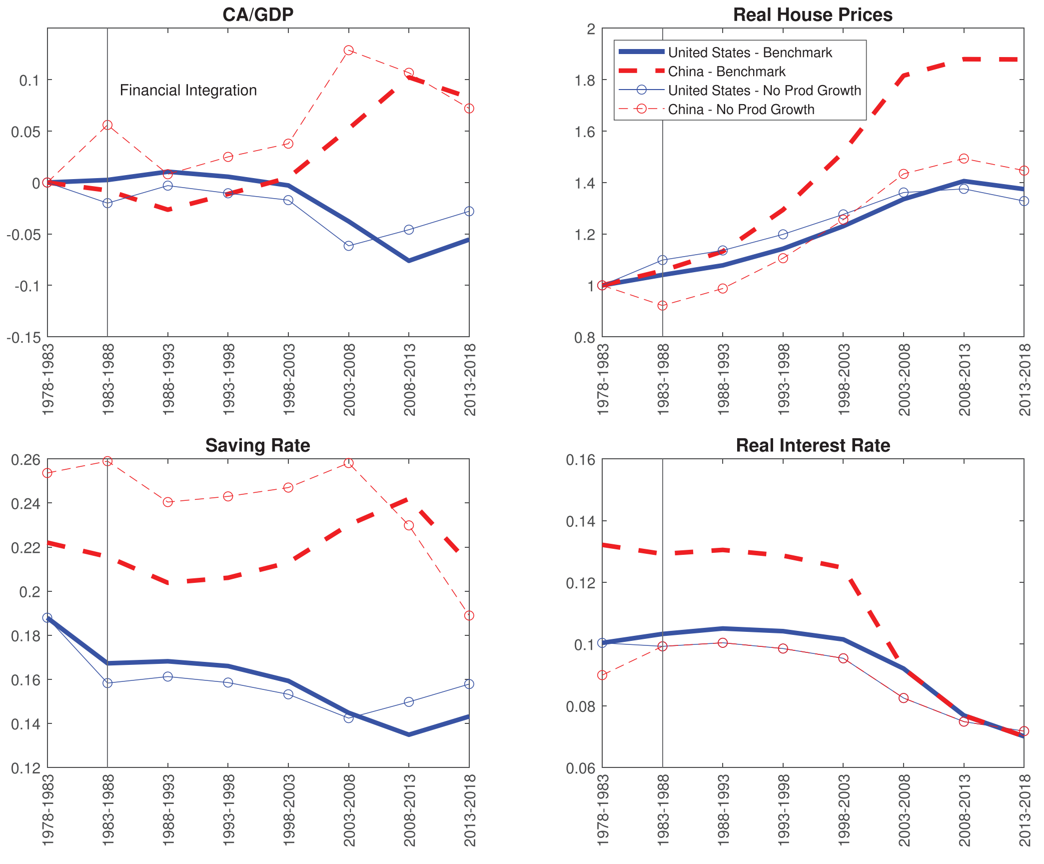


FIGURE 9

THE UNITED STATES AND CHINA: FINANCIAL INTEGRATION—NO PRODUCTIVITY GROWTH DIFFERENTIALS NOTE: NO PRODUCTIVITY GROWTH DIFFERENTIALS.

scarce initial point toward the long-run steady state. As a result, the current account dynamics in this experiment is more heavily investment-driven.[41]

Differences in financial development

In our last exercise, we address the role of the differences in the level of financial development across countries. There has been a rapid development in the financial sector both in the United States and China during the period before the Great Recession.[42] In this section, we run two experiments: (i) we increase θ^F, the parameter that captures the financial development in China, to a higher value than in our benchmark model; and (ii) we increase θ^H, the parameter that captures financial development in the United States, to a higher value than in our benchmark model.

In the first experiment in this section, we increase the value of θ^F to 0.23, which can be motivated by making use of the financial index in Abiad et al. (2008).[43] In our second experiment, we study the model dynamics when the LTV ratio in the United States, θ^H, is

[41] Note, however, that we still have different wage income wage profiles in this experiment, which generates notable differences in the saving behavior in the two countries.

[42] For evidence on the United States, see, for example, Favilukis et al. (2017). For China, see, for example, Podpiera (2006) or Song et al. (2011).

[43] In particular, we compute the ratio of the financial development indices in China and the United States during the period from 1988 to 2005. The financial development index in China has increased faster than in the United States during this period. We compute the growth rate of the ratio of these two indices, and apply it to the θ^F/θ^H ratio from our benchmark economy. Assuming that θ^H has remained constant over time at the value from our

TABLE 1
CURRENT-ACCOUNT-TO-GDP IS THE LEVEL REACHED AT $t = 4$

	The United States			China		
	Benchmark	$\uparrow \theta^F$	$\uparrow \theta^H$	Benchmark	$\uparrow \theta^F$	$\uparrow \theta^H$
CA-to-GDP	−3.78%	−3.53%	−4.45%	5.22%	4.88%	6.13%
Δ Saving Rate	−2.12%	−2.12%	−2.28%	2.40%	2.47%	2.56%
Δ Real House Prices	16.88%	16.94%	17.06%	40.33%	39.03%	41.01%

NOTE: Δ Saving Rate is the change in the saving rate between $t = 1993$–98 and $t = 2003$–8; and, Δ real house prices, is the change in Real House Prices between $t = 1993$–98 and $t = 2003$–8. $\uparrow \theta^F$ is the counterfactual economy with $\theta^F = 0.23$; and, $\uparrow \theta^H$ with $\theta^H = 1$.

larger than in the benchmark. As it has been documented in the literature, see, for example, Favilukis et al. (2017), the LTV ratio in the U.S. economy substantially increased during the housing boom prior to the Great Recession of 2007–8. In particular, we study the model predictions after financial integration assuming that $\theta^H = 1$.[44] Table 1 shows the outcomes for a set of main variables in the integrated equilibrium for both experiments and compares them to the results from our benchmark model.

As one can see from Table 1, the outcomes in both of these experiments are similar to those in our benchmark model calibration. This suggests that the tightness of the borrowing limit plays only a minor role for our results, and the outcomes are fairly robust to the precise calibration of the LTV ratio that one chooses. In fact, in our first experiment in this section where we increase θ^F, the model produces a smaller current account to GDP both in China and in the United States. Intuitively, given that the age profile of the earnings in China peaks at a much earlier age than in the United States, the young individuals in China have a very strong incentive to save and are not borrowing constrained, and the increase in θ^F does not significantly affect the outcomes. In this counterfactual economy with larger θ^F, global imbalances decrease their size and house prices increase in China by less than in the benchmark economy.

In our second experiment in this section, where we assume a larger θ^H, our model produces a slightly larger size of the current account to GDP both in China and in the United States than in our benchmark model calibration, and slightly larger increase in house prices in both countries. Intuitively, given the wage income profile in the United States, the young individuals there are likely to be borrowing constrained. As a result, the increase in θ^H increases borrowing in the United States and generates a higher demand for housing. In equilibrium, this must correspond to larger savings in China. This suggests that further financial development in the United States may have played a more important role in generating global imbalances and housing booms than the financial development in China during the period before the financial crisis. However, the difference with our benchmark results are small.

4.3. *House Prices and Global Imbalances.* In this section, we study to which extent housing contributed to the rise of global imbalances in the world economy. To this end, we run a counterfactual experiment in which we set the weight of housing consumption in the utility function to be almost zero (i.e., we fix $\gamma \approx 1$). By doing so, we shut down an important channel that differentiates housing from any other asset in the economy, which is the flow of housing services obtained from the housing stock owned by an individual. In this counterfactual economy, we increase γ, the parameter that controls the weight of nonhousing consumption goods in the utility function, from its benchmark ($\gamma = 0.8683$) to 0.99, which implies a housing-to-output ratio of 0.11 (compared to 1.19 in the benchmark) in country H in the initial steady state. As a result, houses make up a much smaller share of households' wealth, and

benchmark model, $\theta^H = 0.8$, we compute the implied value for θ^F at the end of this period. We take the resulting value of $\theta^F = 0.23$ and assume that it is constant over time in this experiment.

[44] Which implies an LTV of 100% in line with the evidence presented in Favilukis et al. (2017).

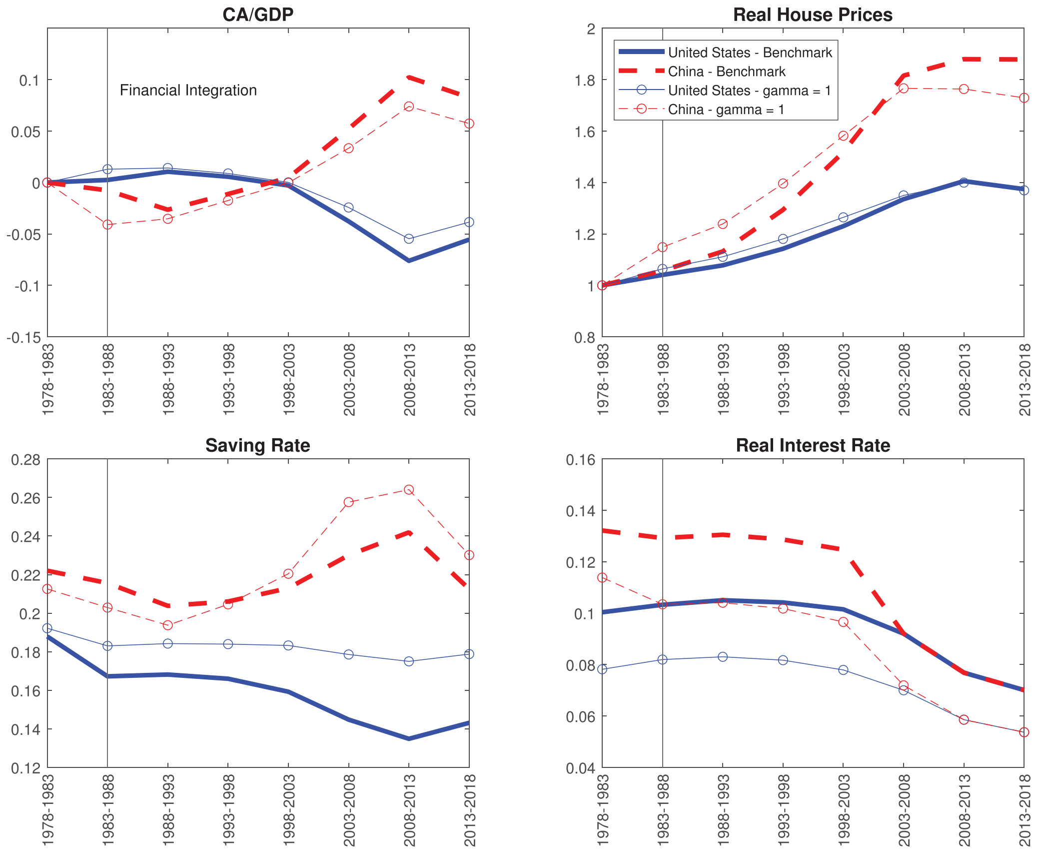


FIGURE 10

NONHOUSING CONSUMPTION SHARE IN THE UTILITY FUNCTION ALMOST EQUAL TO ONE, THAT IS, γ=0.99

changes in house prices become much less important for optimal decisions of consumers in both countries.

As can be seen in Figure 10, the qualitative responses in the counterfactual economy are similar to the ones in our benchmark model, but are smaller in magnitude. In particular, we find an amplification effect of house prices on global imbalances when comparing both economies. With a substantially smaller weight on housing services in the utility function, a decreasing interest rate does not increase housing demand through a higher consumption bundle today of both types: housing and nonhousing. Because of the absence of this channel, house prices increase by less in both countries which leads to two countervailing effects. On the one hand, a smaller increase in house prices in the United States implies a smaller decrease in the U.S. saving rate since houses are cheaper, all households can save more in general and, moreover, young agents borrow less against housing. This leads the U.S. economy to run a smaller current account deficit. On the other hand, a smaller house price increase in China also implies less borrowing which tends to generate larger current account surpluses. At the end, which effect dominates over the other depends on the particular quantitative experiment since a current account deficit run by a country must be matched with the surplus of the same size in the trade partner of our two-country model. In our model, we find housing to have an amplification effect on global imbalances (56.25%) (see Table 2).

4.4. *Autarky versus Integrated Equilibrium.* As we show in Section 4, our benchmark model produces a negative correlation between current account balances and real house

TABLE 2

CURRENT-ACCOUNT-TO-GDP AT $t = 4$ IN FIGURES 5 AND 10

	Benchmark	$\gamma \approx 1$	Amplification (%)
The United States	−3.78%	−2.43%	55.56%
China	5.22%	3.33%	56.76%

NOTE: Amplification (in % terms) is computed as the ratio of CA-to-GDP from both experiments, in absolute terms, minus one and multiplied by 100.

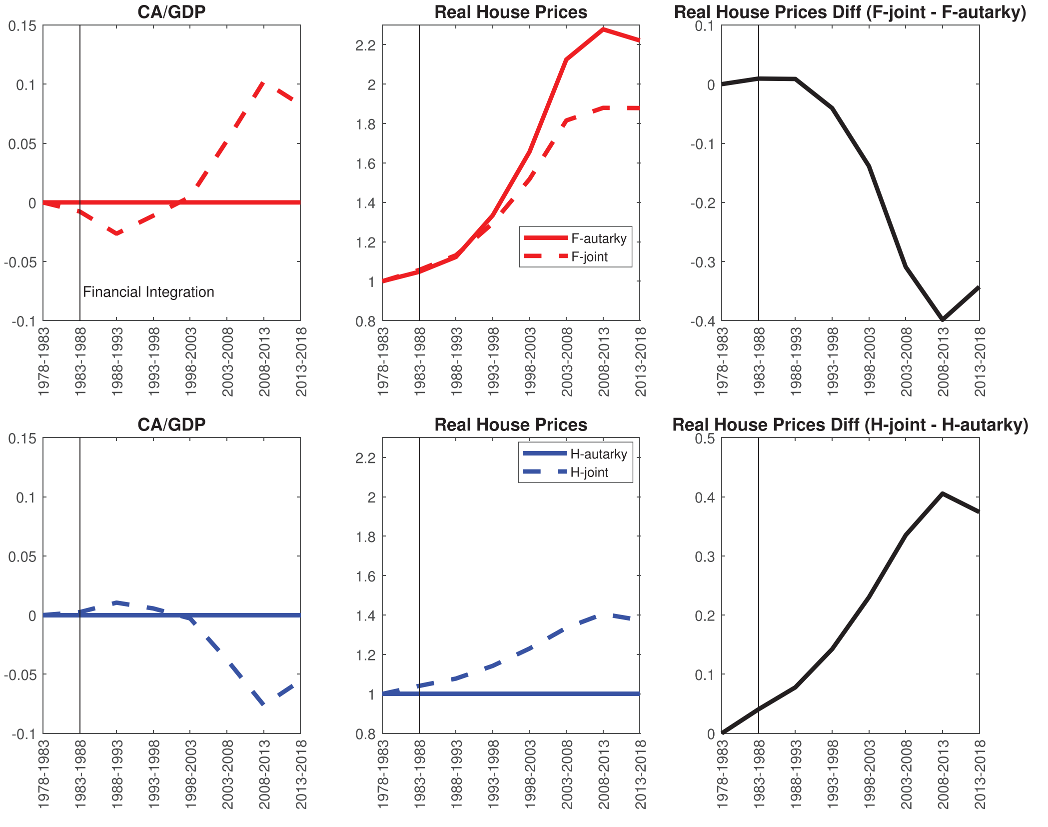


FIGURE 11

THE UNITED STATES AND CHINA: AUTARKY VERSUS FINANCIAL INTEGRATION

prices in the U.S. economy, but a positive correlation between these two variables in China. The latter prediction goes against the finding of the negative correlation between the current account balances and real house prices in empirical literature, mainly based on the data from the developed countries.

In this section, we show that our model delivers a negative correlation between the current account and the *difference* in the house prices in equilibrium and in autarky, both in the United States and in China. The top row in Figure 11 shows the results for China. The left subplot shows the current account in the integrated equilibrium in our model (dashed line) and in autarky (the solid zero line). The middle subplot shows the house prices in China in our integrated equilibrium (dashed line) and in autarky. Finally, the right subplot shows the difference between the house prices in the integrated equilibrium and in autarky in China. As one can see, there is a negative correlation between the current account in the left subplot and the difference between the equilibrium and autarky house prices in the right subplot. This is in line with the intuition: capital outflows lower the house prices compared to the counterfactual scenario of autarky. Unfortunately, we cannot observe the hypothetical autarky house prices, and, as our model demonstrates, in a fast-growing economy like China, they may grow faster than the ones we observe in equilibrium. This may explain the *positive* correlation between the current account and house prices that we found in the fast-growing Asian economies.

The bottom row of Figure 11 shows the current account, integrated equilibrium, and autarky house prices in the United States. Since the United States starts on its balanced growth path, the autarky house prices (appropriately adjusted for the economic growth rate) would remain unchanged. Therefore, the difference between integrated and autarky house prices is equal to the integrated-economy house prices. As a result, we observe the negative correlation between the current account and the equilibrium house prices. This may explain why we are more likely to find the negative correlation between the current account and equilibrium house prices in developed economies.

5. CONCLUSIONS

In this article, we document a positive correlation between current account balances and house prices among a set of fast-growing Asian economies. China, one of the main trade partners of the U.S. economy, is included among those countries. We then develop a life-cycle two-country model with housing and endogenous borrowing constraints where the foreign economy is a fast-growing economy that finds itself in a transition to its autarky steady state and calibrate our model to the United States and China. We allow for asymmetries across countries in terms of productivity growth, the LTV ratio, the wage profile over the life cycle, and the population structure. We show that, after China becomes financially integrated with the United States, our model is able to account for the joint determination of current account balances and house prices in both economies as observed in the data. After financial integration, China experiences a wealth effect on middle-aged generations from a rapid productivity growth which allows for an increase in savings/asset accumulation by the middle-aged, because of life-cycle reasons, in both housing and financial assets. This leads to increasing house prices in China while running current account surpluses. Increasing savings in China translates into capital flows to the U.S. economy as well as into a decrease in the international interest rate. In the United States, a decrease in the interest rate prompts a portfolio reallocation from financial assets toward housing which increases housing prices and, at the same time, increases borrowing leading to current account deficits.

We then use our model to run two exercises. In the first one, we reduce the importance of housing in the economy by removing the flow of services into the utility function and find an amplification effect of housing on global imbalances. In the second experiment, we compare our benchmark financially integrated economy with a conuterfactual economy in which both countries operate in financial autarky and find a negative correlation between current account balances and the *difference* between house prices in the benchmark and in autarky in both economies. This is the case because house prices in China would have grown by more in financial autarky.

APPENDIX A

A.1 *Calibration.*

TABLE A.1
AGE–INCOME PROFILE

	<25	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	>70
The United States	0.34	0.69	0.82	0.93	0.99	0.98	1.00	0.85	0.70	0.31	0.18
China (pre-1988)	0.80	1.00	1.17	1.19	1.27	1.32	1.00	0.77	0.17	0.11	0.09
China (1993)	0.85	0.99	1.20	1.23	1.29	1.23	1.00	0.67	0.15	0.10	0.03
China (1998)	0.95	1.05	1.29	1.41	1.41	1.35	1.00	0.65	0.09	0.09	0.05
China (2003)	0.87	1.19	1.46	1.49	1.49	1.41	1.00	0.68	0.08	0.07	0.03
China (2008)	0.79	1.34	1.64	1.59	1.58	1.48	1.00	0.71	0.06	0.03	0.01
China (steady state)	0.34	0.69	0.82	0.93	0.99	0.98	1.00	0.85	0.70	0.31	0.18

SOURCE: Coeurdacier et al. (2015).

TABLE A.2
POPULATION GROWTH (ANNUAL)

	Pre-1968	1968–73	1973–78	1978–83	1983–88	1988–93	1993–98	1998–2003	2003–08	post-2008
The United States	1.5	6.0	2.5	0.0	−2.0	−1.5	0.5	1.5	0.5	1.0
China	3.0	7.0	0.0	3.0	5.5	−0.5	−5.0	1.5	0.0	1.0

SOURCE: Coeurdacier et al. (2015).

TABLE A.3
PRODUCTIVITY GROWTH RATES (ANNUAL)

	Pre-1973	1973–2003	2003–08	2008–13
The United States	1.5	1.5	1.5	1.5
China	1.5	4.0	3.75	3.0

SOURCE: Coeurdacier et al. (2015).

A.2 *Mathematical Appendix.*

A.2.1 *Detrending.* Assume that $Z_{t+1} = (1 + g_{Z,t+1})Z_t$, and $L_{1,t+1} = (1 + g_{L,t+1})L_{1,t}$, where g_Z and g_L are the technology and population growth rates.

To derive the population growth rate, define $\varphi_{1,t}$:

$$\varphi_{1,t} \equiv \frac{L_{1,t}}{L_t} = \frac{1}{(1 + g_{L,t+1}) \sum_{j=1}^{J_R} \frac{\varepsilon_j}{\prod_{i=1}^{j}(1+g_{L,t-i+2})}}$$

Thus, for any j, $\varphi_{j,t}$ is the fraction of the j generation on the labor supply:

$$\varphi_{j,t} \equiv \frac{L_{j,t}}{L_t} = \frac{(1 + g_{L,t+1})\varphi_{1,t}}{\prod_{i=1}^{j}(1 + g_{L,t-i+2})}.$$

Let us also derive:

$$\frac{L_{j,t}}{L_{t+1}} = \frac{\varphi_{1,t+1}}{\prod_{i=1}^{j}(1 + g_{L,t-i+2})} = \frac{L_{j+1,t+1}}{L_{t+1}} = \varphi_{j+1,t+1}.$$

This means that

$$\frac{L_{t+1}}{L_t} = \frac{\frac{L_{t+1}}{L_{1,t}}}{\frac{L_t}{L_{1,t}}} = (1 + g_{L,t+1})\frac{\varphi_{1,t}}{\varphi_{1,t+1}} = \frac{\varphi_{1,t}}{\varphi_{2,t+1}}.$$

In addition, assume that the supply of land grows at the same rate as labor: $N_{t+1} = (1 + g_{L,t})N_t$. This means that the land-to-total labor ratio, $\frac{N_t}{L_t}$, remains constant. Let $\bar{n} = \frac{N_t}{L_t}$ denote this ratio.

We conjecture that on a balanced-growth path, individual savings grow at the same rate as productivity, so that $a_{y,t+1} = a_{y,t}(1 + g_Z)$ and $a_{m,t+1} = a_{m,t}(1 + g_Z)$. This implies that, in the balanced-growth path, $\frac{K_{t+1}}{Z_{t+1}L_{t+1}}$, so that this ratio remains constant. This means that r_t^k remains constant, whereas w_t grows at the same rate as Z_t.

Let $\hat{x}_t = \frac{x_t}{Z_t}$ denote the "detrended" variable for any x_t (e.g., $\hat{w}_t = \frac{w_t}{Z_t}$). Also, let $\tilde{\beta}_{[t,t+1]} = \beta(1 + g_{Z,t+1})^{\gamma(1-\sigma)}$, and $\tilde{\beta}_{[t,t+2]} = \beta^2((1 + g_{Z,t+1})(1 + g_{Z,t+2}))^{\gamma(1-\sigma)}$, and in general, $\tilde{\beta}_{[t,t+j]} = \beta^j(\prod_{i=1}^{j}(1 + g_{Z,t+i}))^{\gamma(1-\sigma)}$ and $\tilde{\beta}_{[t,t]} = 1$.

A.2.2 *Reformulation of the household problem.* We can rewrite household optimization problem as:

$$\max \quad \sum_{j=1}^{J} \tilde{\beta}_{[t,t+j-1]} \frac{\left(\hat{C}^{a,j}_{t+j-1}\right)^{1-\sigma}}{1-\sigma} + \phi\tilde{\beta}_{[t,t+J-1]} u(\hat{b}^J_{t+J-1})$$

$$\text{s.t. for } j = 1, \ldots, J:$$

$$\hat{C}^{a,j}_{t+j-1} = \left(\hat{c}^j_{t+j-1}\right)^{\gamma}\left(x^j_{t+j-1}\right)^{1-\gamma},$$

$$\hat{c}^j_{t+j-1} + \hat{r}^f_{t+j-1} f^j_{t+j-1} + \hat{q}_{t+j-1} h^{j+1}_{t+j} + \hat{a}^j_{t+j}(1 + g_{Z,t+j}) + \mathbb{1}(j = J)\hat{b}^J_{t+J-1}$$
$$= \varepsilon^j \hat{w}_{t+j-1} + \hat{q}_{t+j-1} h^j_{t+j-1} + \hat{a}^{j-1}_{t+j-1}(1 + r_{t+j-1}) + \hat{b}^{j<J}_{t+j-1}(\hat{b}^J_{t+J-1}),$$

$$x^j_{t+j-1} = f^j_{t+j-1} + h^j_{t+j-1},$$

$$h^j_{t+j-1} = 0 \text{ for } j \leq J_1,$$

$$f^j_{t+j-1} = 0 \text{ for } j > J_1 \text{ for some } 0 < J_1 < J,$$

$$\hat{a}^j_{t+j} \geq -\frac{\theta\hat{q}_{t+j-1}h^{j+1}_{t+1}}{1+g_{Z,t+j}},$$

$$\hat{a}^0_t = 0, \quad \hat{a}^J_{t+J} = 0, \quad h^{J+1}_{t+J} = 0,$$

The no-arbitrage condition for the financial intermediaries becomes:

$$1 + r^k_{t+1} = \frac{(\hat{r}^f_{t+1} + \hat{q}_{t+1})(1 + g_{Z,t+1})}{\hat{q}_t} \tag{A.1}$$

First-order and market clearing conditions. Let $k_t = \frac{K_t}{Z_tL_t}$. Equilibrium is described by the following system of optimality and market clearing conditions:

$$[\hat{c}^j_{t+j-1}]: \quad \gamma\tilde{\beta}_{[t,t+j-1]}\left(\frac{x^j_{t+j-1}}{\hat{c}^j_{t+j-1}}\right)^{1-\gamma}\left(\hat{C}^{a,j}_{t+j-1}\right)^{-\sigma} = \tilde{\beta}_{[t,t+j-1]}\lambda^j_{t+j-1},$$

$$[f^j_{t+j-1}]: \quad (1-\gamma)\tilde{\beta}_{[t,t+j-1]}\left(\frac{x^j_{t+j-1}}{\hat{c}^j_{t+j-1}}\right)^{-\gamma}\left(\hat{C}^{a,j}_{t+j-1}\right)^{-\sigma} = \tilde{\beta}_{[t,t+j-1]}\lambda^j_{t+j-1}\hat{r}^f_{t+j-1}, \quad j \leq J_1,$$

$$[\hat{a}^j_{t+j}]: \quad \tilde{\beta}_{[t,t+j]}\lambda^{j+1}_{t+j}(1+r_{t+j}) = \tilde{\beta}_{[t,t+j-1]}\Big(\lambda^j_{t+j-1}(1+g_{Z,t+j}) - \mu^j_{t+j-1}\Big),$$

$$[h^{j+1}_{t+j}]: \quad \tilde{\beta}_{[t,t+j]}\lambda^{j+1}_{t+j}\left(\tfrac{1-\gamma}{\gamma}\tfrac{\hat{c}^{j+1}_{t+j}}{h^{j+1}_{t+j}} + \hat{q}_{t+j}\right) = \tilde{\beta}_{[t,t+j-1]}\Big(\lambda^j_{t+j-1}\hat{q}_{t+j-1} - \mu^j_{t+j-1}\tfrac{\theta\hat{q}_{t+j-1}}{1+g_{Z,t+j}}\Big),$$

$$[b^J_{t+J-1}]: \quad \phi\gamma\tilde{\beta}_{[t,t+J-1]}\Big(\hat{b}^J_{t+J-1}\Big)^{\gamma(1-\sigma)-1} = \tilde{\beta}_{[t,t+J-1]}\lambda^J_{t+J-1},$$

$$[BC^j_{t+j-1}]: \quad \hat{c}^j_{t+j-1} + \hat{r}^f_{t+j-1}f^j_{t+j-1} + \hat{q}_{t+j-1}h^{j+1}_{t+j} + \hat{a}^j_{t+j}(1+g_{Z,t+j}) + \mathbb{1}(j=J)\hat{b}^J_{t+J-1}$$
$$= \varepsilon^j\hat{w}_{t+j-1} + \hat{q}_{t+j-1}h^j_{t+j-1} + \hat{a}^{j-1}_{t+j-1}(1+r_{t+j-1}) + \hat{b}^{j<J}_{t+j-1}(\hat{b}^J_{t+J-1}),$$

$$[BL^j_{t+j-1}]: \quad \mu^j_{t+j-1} \geq 0, \quad \hat{a}^j_{t+j} + \tfrac{\theta\hat{q}_{t+j-1}h^{j+1}_{t+j}}{1+g_{Z,t+j}} \geq 0, \quad \mu^j_{t+j-1}\left(\hat{a}^j_{t+j} + \tfrac{\theta\hat{q}_{t+j-1}h^{j+1}_{t+j}}{1+g_{Z,t+j}}\right) = 0,$$

$$[MC_{K,t}]: \quad \textstyle\sum_{j=1}^{J-1}\varphi_{j+1,t+1}\hat{a}^j_{t+1} = k_{t+1} + \frac{\hat{q}_t}{1+g_{Z,t+1}}\sum_{j=1}^{J_1}\varphi_{j,t+1}f^j_{t+1},$$

$$[MC_{H,t}]: \quad \textstyle\sum_{j=1}^{J_1}\varphi_{j,t+1}f^j_{t+1} + \sum_{j=J_1+1}^{J}\varphi_{j,t+1}h^j_{t+1} = \bar{n},$$

$$[FOC_{L,t}]: \quad \hat{w}_t = (1-\alpha)k^\alpha_t,$$

$$[FOC_{K,t}]: \quad r^k_t = \alpha k^{\alpha-1}_t - \delta,$$

$$[NoArb_t]: \quad (1+r^k_{t+1}) = \tfrac{(\hat{r}^f_{t+1}+\hat{q}_{t+1})(1+g_{Z,t+1})}{\hat{q}_t}.$$

A.2.3 *Integrated (open trade) equilibrium.* Market clearing condition for capital (savings) changes to:

$$\sum_{j=1}^{J-1}L^H_{j,t}a^{j,H}_{t+1} + \sum_{j=1}^{J-1}L^F_{j,t}a^{j,F}_{t+1} = K^H_{t+1} + K^F_{t+1} + q^H_t H^{H,f}_{t+1} + q^F_t H^{F,f}_{t+1}.$$

A.2.4 *Definitions.* The *net foreign asset position* at the end of period t is defined as

$$NFA_{t+1} = \sum_{j=1}^{J-1}L_{j,t}a_{j,t+1} - K_{t+1} - q_t H^f_{t+1},$$

or in terms of GDP:

$$\frac{NFA_{t+1}}{Y_{t+1}} = \frac{\sum_{j=1}^{J-1}L_{j,t}a_{j,t+1}}{Z_{t+1}L_{t+1}k^\alpha_{t+1}} - \frac{K_{t+1}}{Z_{t+1}L_{t+1}k^\alpha_{t+1}} - \frac{q_t H^f_{t+1}}{Z_{t+1}L_{t+1}k^\alpha_{t+1}} =$$

$$= \frac{1}{k^\alpha_{t+1}}\left(\sum_{j=1}^{J-1}\frac{L_{j,t}}{L_{t+1}}\frac{a_{y,t+1}}{Z_{t+1}} - \frac{K_{t+1}}{Z_{t+1}L_{t+1}} - \frac{q_t Z_t}{Z_t Z_{t+1}}\sum_{j=1}^{J_1}\frac{L_{j,t+1}}{L_{t+1}}f_{j,t+1}\right) =$$

$$= \frac{1}{k^\alpha_{t+1}}\left(\sum_{j=1}^{J-1}\frac{\varphi_{1,t+1}}{\prod_{i=1}^{j}(1+g_{L,t-i+2})}\hat{a}_{j,t+1} - k_{t+1} - \frac{\hat{q}_t}{(1+g_{Z,t+1})}\sum_{j=1}^{J_1}\varphi_{j,t+1}f_{j,t+1}\right) =$$

$$= \frac{1}{k^\alpha_{t+1}}(\sum_{j=1}^{J-1}\varphi_{j+1,t+1}\hat{a}^j_{t+1} - \left(k_{t+1} + \frac{\hat{q}_t}{(1+g_{Z,t+1})}\sum_{j=1}^{J_1}\varphi_{j,t+1}f_{j,t+1}\right)) \tag{A.2}$$

The *current account position* in period t is defined as:

$$CA_t = NFA_{t+1} - NFA_t,$$

or in terms of GDP:

$$\frac{CA_t}{Y_t} = \frac{NFA_{t+1}}{Y_t} - \frac{NFA_t}{Y_t} = \frac{NFA_{t+1}Y_{t+1}}{Y_{t+1}Y_t} - \frac{NFA_t}{Y_t} =$$

$$= \frac{Z_{t+1}L_{t+1}k_{t+1}^{\alpha}}{Z_t L_t k_t^{\alpha}} \frac{NFA_{t+1}}{Y_{t+1}} - \frac{NFA_t}{Y_t} =$$

$$= (1+g_{Z,t+1}) \frac{(1+g_{L,t+1})\varphi_{1,t}}{\varphi_{1,t+1}} \left(\frac{k_{t+1}}{k_t}\right)^{\alpha} \frac{NFA_{t+1}}{Y_{t+1}} - \frac{NFA_t}{Y_t}. \tag{A.3}$$

Investment in period t is given by:

$$I_t^k \equiv K_{t+1} - (1-\delta)K_t,$$

or in terms of GDP:

$$\frac{I_t^k}{Y_t} = \frac{Y_{t+1}}{Y_t}\frac{K_{t+1}}{Y_{t+1}} - (1-\delta)\frac{K_t}{Y_t} = \frac{Z_{t+1}L_{t+1}k_{t+1}^{\alpha}}{Z_t L_t k_t^{\alpha}} k_{t+1}^{1-\alpha} - (1-\delta)k_t^{1-\alpha} =$$

$$= (1+g_{Z,t+1}) \frac{(1+g_{L,t+1})\varphi_{1,t}}{\varphi_{1,t+1}} \left(\frac{k_{t+1}}{k_t}\right)^{\alpha} k_{t+1}^{1-\alpha} - (1-\delta)k_t^{1-\alpha}. \tag{A.4}$$

Consumption in period t is given by:

$$C_t = \sum_{j=1}^{J} L_{j,t} c_{j,t},$$

or in terms of GDP:

$$\frac{C_t}{Y_t} = \sum_{j=1}^{J} \frac{L_{j,t}}{L_t} \frac{c_{j,t}}{Z_t} \frac{1}{k_t^{\alpha}} =$$

$$= \frac{1}{k_t^{\alpha}} \left(\sum_{j=1}^{J} \varphi_{j,t} \hat{c}_{j,t} \right). \tag{A.5}$$

Aggregate savings in period t is given by:

$$S_t = Y_t + r_t NFA_t - C_t,$$

or in terms of GDP:

$$\frac{S_t}{Y_t} = 1 + r_t \frac{NFA_t}{Y_t} - \frac{C_t}{Y_t}. \tag{A.6}$$

A.3 *No Iceberg Costs.* In this section, we solve a version of our benchmark economy with no iceberg costs and study what happens when the United States and China open to trade. The results of our experiment can be seen in Figure A.1. We keep the same timing conventions and the experiment is the same as the one described for the benchmark economy. The only difference stands in the iceberg costs which, in this version of the model, are set equal to zero all along the transition.

As it can be seen in Figure A.1, with no iceberg costs, the Chinese economy runs a very large current account deficit at opening (model period $t = 1983$–88). However, the model predictions between periods $t = 1993$–98 and $t = 2003$–8 are qualitatively the same as in our

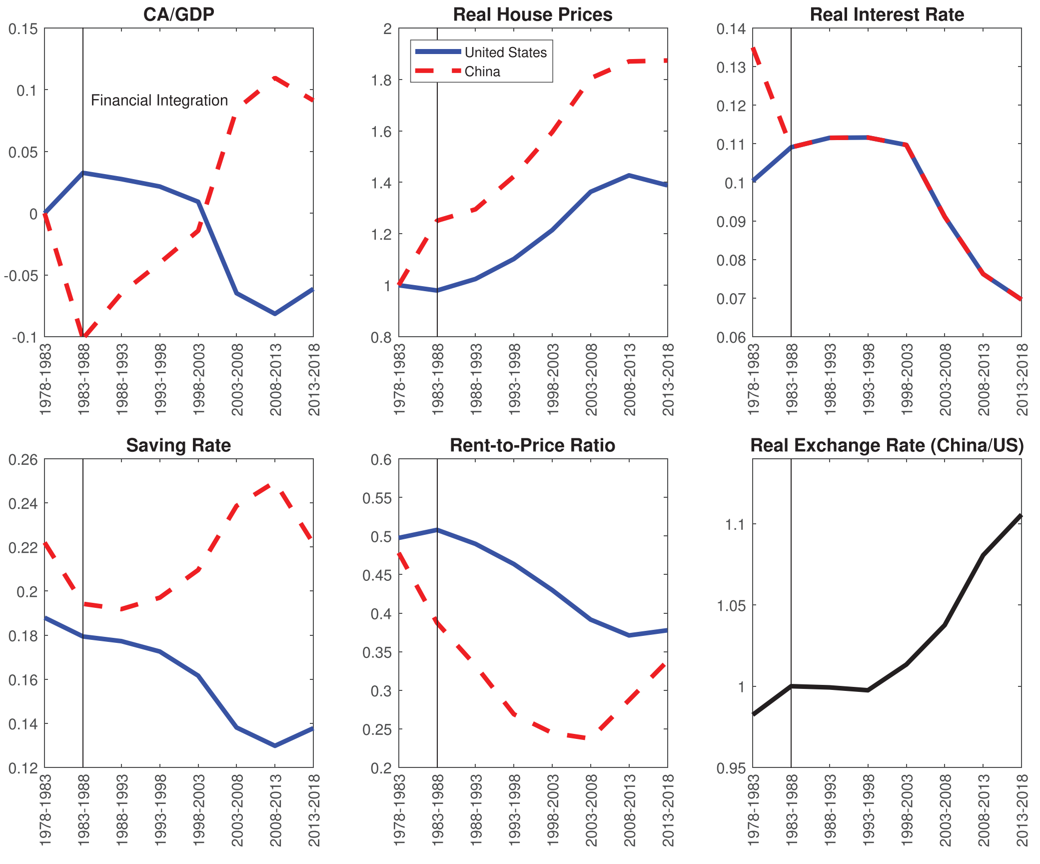


FIGURE A.1

THE UNITED STATES AND CHINA: FINANCIAL INTEGRATION

benchmark model economy with iceberg costs and the only difference stands in the quantitative response after financial integration. In this version of the model, China reaches a larger current account surplus by 2008 (8.4% vs. a 5.2% in the benchmark economy). Also, for the United States, this version of the model predicts a larger current account deficit by the end of the 2000s when compared to the benchmark (6.5% vs. 3.8%). For the United States, the model without iceberg costs generates a drop of 3.5% in the saving rate (2.1% in the benchmark) between the end of the 1990s and the end of the 2000s which is close to the observed decrease of 3.2% in the data over the same time period. For China, the model predicts an increase in the household saving rate of 4.2% (2.4% in the benchmark) which means that this version of the model accounts for 57% of the increase in the saving rate of China observed in the data between 1998 and 2007. Between 1998 and 2008, when house price growth accelerated and China became a more important trade partner of the U.S. economy, our model with no iceberg costs accounts for 72.6% of the divergence in the saving rates observed in the data between the United States and China. This version of the model with no iceberg costs explains about 40% of the divergence in the saving rates between the United States and China observed in the data since the Chinese financial integration (1988), compared to the 30% in Coeurdacier et al. (2015) over the same time period. This finding suggests that housing may have played an important role in explaining the divergence in saving rates between the two economies.

With respect to house prices, the model with no iceberg costs accounts for 66.2% (47.9% in the benchmark) of the increase in house prices in the U.S. economy from the end of the 1990s to 2008. For the same time period in China, this version of the model accounts for 30.4% (45.8% in the benchmark) of the increase in residential land prices observed in the data. As it can be seen in Figure A.1, the model with no iceberg costs still predicts a larger (detrended) real house prices increase in China than in the U.S. economy.

In summary, either the benchmark model economy or the model with no iceberg costs predict the same joint dynamics of the current account balances and house prices in both economies after financial integration.

A.4 *Additional Figures.*

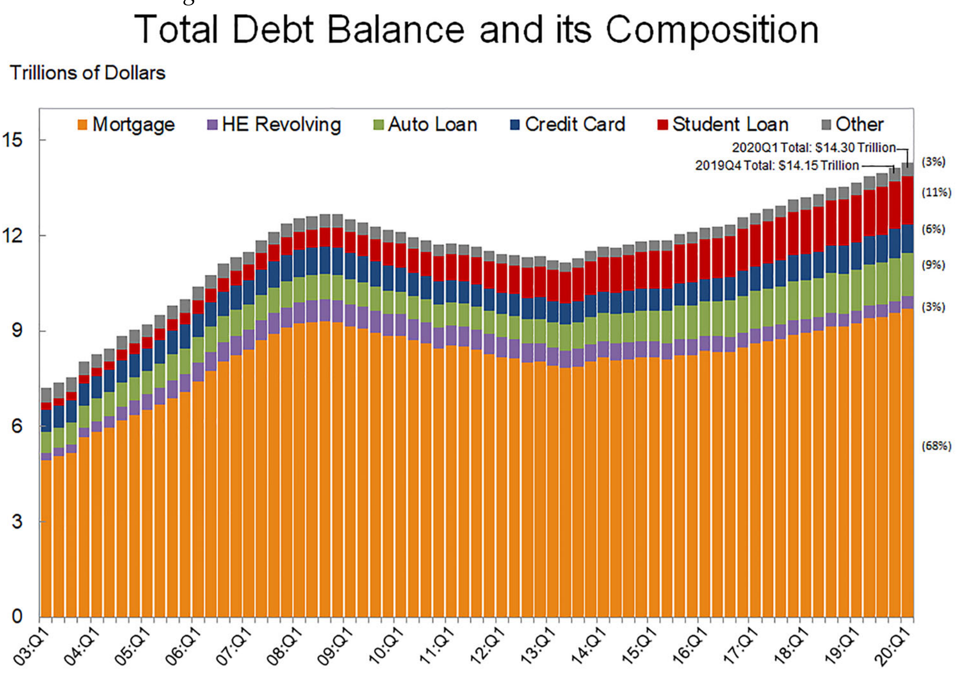
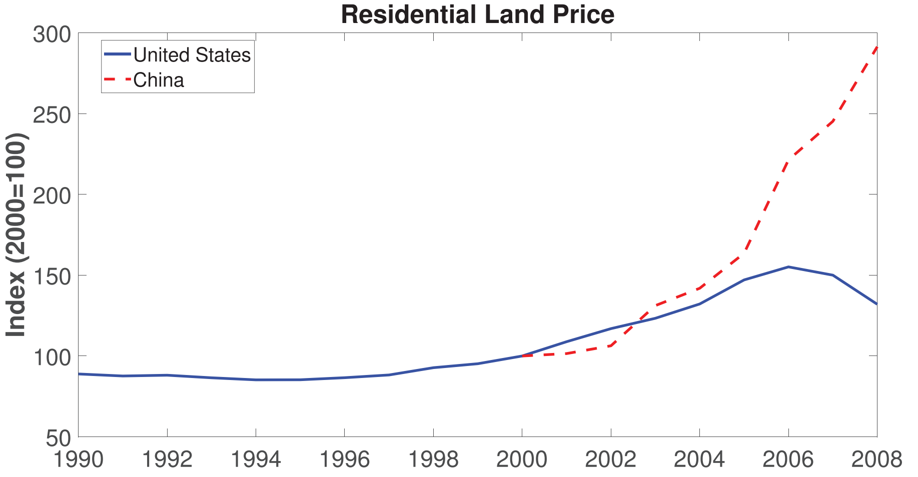


FIGURE A.2

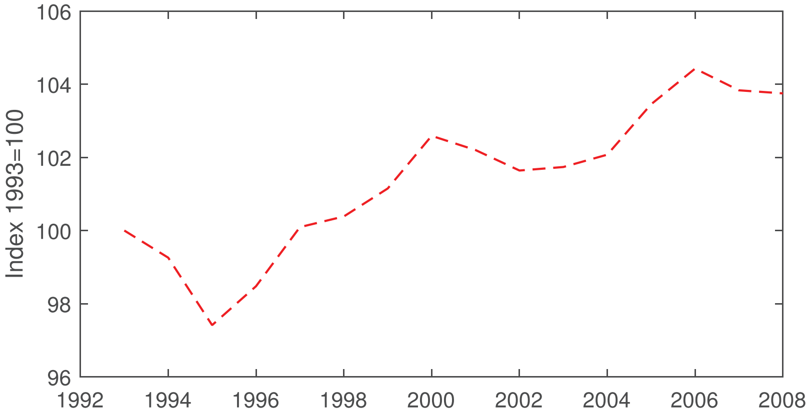
HOUSEHOLD DEBT COMPOSITION IN THE UNITED STATES



SOURCE: Residential land price data for the United States from Knoll et al. (2017), and, for China, data from the National Bureau of Statistics of China and Wu et al. (2012).

FIGURE A.3

RESIDENTIAL LAND PRICES



SOURCE: Model Implied Real Exchange Rate (China/the United States) computed from the ratio of rental prices in both economies according to Equation (7). Rental price data from the OECD and the National Bureau of Statistics of China.

FIGURE A.4

MODEL IMPLIED REAL EXCHANGE RATE

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