# Globalization and Financial Development: A Model of the Dot-Com and Housing Bubble

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**Abstract**

The United States has recently experienced a large sudden drop in both the stock market and house prices. These two episodes have been referred as the burst of the Dot-Com and Housing Bubble. In this paper I develop a model to study the relationship between international trade and the emergence of rational bubbles and analyze how the effect of globalization on house prices depends on the type of bubble. The model is a three-period OLG economy in which young agents borrow to purchase a house and middle-aged agents save to consume when they are old. Agents can only borrow a fraction of the value of the house. This fraction depends on the financial institutions of each country. I show that a financially developed country cannot have bubbles if it remains in autarky but pure asset price and/or housing bubbles can appear in the financially developed country when it opens up to trade with a financially underdeveloped country. As globalization progresses, the possibility of having a bubble in the financially developed country increases. I also show that an increase in globalization raises house prices when there is a housing bubble but it has no effect if the bubble is not attached to houses. This prediction is consistent with empirical evidence on house prices for U.S. metropolitan areas. An increase in U.S. current account deficit (over GDP) has a significant effect on real house price appreciation during the Housing Bubble. This effect is larger, the lower the housing supply elasticity is. However, the effect is not significant during the Dot-Com Bubble.

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# 1 Introduction

The United States has recently experienced a large sudden drop in both the stock market and house prices. Figure (1) reports them by representing the S&P-500 and Case-Shiller house price indices (in real terms). These two episodes have been referred as the burst of the Dot-Com and Housing Bubble.[1] Throughout the paper I will assume that there were indeed two different bubbles. The first was a pure asset price bubble, whereas the second bubble was attached to houses. It matters in which asset the bubble is attached to. Houses are very different from stocks. Agents derive utility from houses and real resources are used to build them. Moreover, as exemplified by the recent subprime crisis, houses are also used as collateral to borrow.

Figures (2) and (3) show the relationship between house prices and current account (over GDP) for the United States and the United Kingdom, respectively. There exists a strong and negative correlation between both series. This relationship is not specific to these countries but, as Aizenman and Jinjarak (2008) show, it holds for a larger set of countries. Many economists (e.g. Bernanke 2005) suggest that the *savings glut* was responsible of these *global imbalances*. Therefore, it hints to an effect of global imbalances on house price appreciations.

Some papers argue that the integration of financial underdeveloped countries into the world economy created global imbalances.[2] However, its relationship with the appearance of rational bubbles has been largely ignored. This paper provides a framework to understand the effect of globalization on the existence of bubbles. It also distinguishes the effect of globalization on house prices depending on the type of bubble.

The first result shows that, in autarky, rational bubbles can appear in financially underdeveloped countries but they cannot appear in financially developed countries. Nonetheless, if both countries open up to trade, bubbles can appear in the integrated economy. Therefore, the possibility of having a bubble in a financially developed country increases with globalization.

My second result highlights the differential effect that an increase in globalization has on house prices depending on which asset the bubble is attached to. I show that an increase in globalization raises house prices if there is a housing bubble and this effect is larger, the lower the housing supply elasticity is. However, if there is a pure asset price bubble, an increase in globalization has no effect on house prices. In the empirical section I show that this prediction is consistent with the data.

The model is a three-period OLG economy. In the first period, young agents earn a wage and borrow to purchase a house. In the second period, middle-aged agents enjoy housing services, repay the debt, sell the house and save to consume when they are old. In the last period, old agents consume the return on their savings. These assumptions are meant to capture two aspects of the life-cycle. First, the net asset position is negative when agents are young and it increases over time. Second, young agents borrow to purchase a house and enjoy housing services when middle-aged.

An important feature of the model and the source of rational bubbles is that agents may be

[1] See, among others, Case and Shiller (2003), Krugman (2005) and Shiller (2005) for a discussion on the existence of the Dot-Com and Housing Bubble.

[2] See, for example, Caballero et al. (2008a) for a model of global imbalances and financial development without bubbles.

borrowing constrained. The amount that young agents can borrow is limited by the value of the house. Therefore, all debt is collateralized by houses. Moreover, the share of the value of the house that can be borrowed depends on the financial institutions of the country.[3]

There are also developers and consumption good producers. They live one period and hire workers in a competitive labor market to produce houses and consumption goods, respectively. The consumption good is perishable. Houses are durable and depreciate at a constant rate.

Section 2 computes the steady-state equilibrium for a financially developed and a financially underdeveloped country when both countries are in autarky. I show that rational bubbles cannot appear in a financially developed country, which is not borrowing constrained, because the economy is dynamically efficient. However, bubbles can appear in the financially underdeveloped country. The intuition is that the borrowing constraint is binding and, since the supply of assets is determined by the value of houses, it creates a shortage of assets in the economy. Middle-aged agents want to increase their savings to consume more in the last period but there is not enough assets in the economy. Asset supply is limited by the amount of debt of young agents who are borrowing constrained. Therefore, bubbles can arise in equilibrium because they increase the asset supply and solve the shortage of assets. This result is similar to Arce and López-Salido (2008) and Farhi and Tirole (2008).

In section 3 I assume that the world consists of two countries, a financially developed and a financially underdeveloped country. The consumption good and capital are tradable but houses are non-tradable and labor cannot migrate. In the trade equilibrium without bubbles, capital flows from the financially underdeveloped to the financially developed country because agents in the former country invest a fraction of their savings in the latter, which has better financial institutions and can generate more assets. Thus, there is a current account deficit in the financially developed country. This is analogous to Caballero et al. (2008a). Assets are used by middle-aged agents as a store of value. Therefore, when capital flows towards the financially developed country, the value of its assets increases (they become more scarce), which reduces the interest rate. A novelty of this paper is to emphasize the effect that these capital inflows have on house prices. House prices in the financially developed country are higher in the trade equilibrium because housing demand decreases with the interest rate.

Another contribution of the paper is to study, in subsections 3.2 and 3.3, the effect of globalization on the existence of bubbles. First, I show that bubbles, either attached or detached to houses, can arise in the integrated equilibrium. Then, I assume that access of the financially underdeveloped country to the world capital market is limited and study the effect of an increase in financial integration, to which I refer as globalization. I show that as globalization progresses, the possibility of having bubbles in the world economy and, in particular, in the financially developed country increases. The intuition is that as the financially underdeveloped country gains access to the assets of the financially developed country, it becomes more likely that there exists a shortage of assets in the world economy. If a pure asset price bubble arises in the financially developed country,

[3] I interpret this borrowing constraint as financial development but it could also be interpreted as liquidity as in, for example, Farhi and Tirole (2008) and, in an extreme version, Woodford (1990).

house prices are higher because the interest rate with the bubble is lower. If the bubble is attached to houses, house prices are even higher because, in addition to the low interest rate, the bubble raises, directly, housing demand. Finally, I show that the trends in house prices, current account and interest rate in the United States in the last twenty years are consistent with the predictions of the model.

Section 4 performs welfare analysis. I show that welfare of households is higher with a pure asset price bubble. The reason is that the only difference between both types of bubbles is the price distortion of the housing bubble. However, profits of developers are higher with a housing bubble. When I study whether welfare in the financially developed country is higher in the trade equilibrium with bubbles, the same intragenerational problems arise. The interest rate is lower in the steady-state with bubbles which favors middle-aged agents who enjoy higher housing services and developers who earn more profits, but old agents lose because the return on their savings is lower. Welfare in a financially underdeveloped country is higher without a bubble when both countries are very integrated. In this case, agents in the financially underdeveloped country already have a large fraction of their savings invested in the financially developed country and the gain from having additional assets is offset by the fall in the return on their savings.

Finally, section 5 presents new empirical evidence consistent with the model. The prediction of the model is that an increase in globalization raises house prices during a housing bubble but it has no effect on house prices if there is a pure asset price bubble. The intuition is that as globalization progresses, capital flows from the financially underdeveloped to the financially developed country increase, which affects house prices through two channels. First, the interest rate falls which raises housing demand and house prices. Second, the size of the bubble increases. The size of the bubble affects housing demand only if the bubble is attached to houses. When there is a bubble, the interest rate is constant and globalization affects house prices only through the second channel. Therefore, only when the bubble is attached to houses, an increase in globalization raises house prices. Moreover, the effect on house prices is larger, the lower the housing supply elasticity is. This prediction is tested by using house prices at the metropolitan statistical area level in the United States from OFHEO, current account deficit (over GDP) from the IMF and housing supply elasticities estimated in Saiz (2009). The sample consists of 138 metropolitan areas from 1983 to 2007. I define the Dot-Com Bubble period from 1996 to 2000 and the Housing Bubble from 2002 to 2006.[4] I find, consistent with the model, that an increase in current account deficit (over GDP) has a significant effect on (real) house price appreciation during the Housing Bubble and this effect is larger, the lower the housing supply elasticity is. However, the effect is not significant during the Dot-Com Bubble.

*Related literature.* This paper relates to different strands of the literature on rational bubbles,

[4]I divide the 1996-2006 housing boom episode documented in Glaeser et al. (2008) in two subperiods, 1996-2000 and 2002-2006. There is a consensus that the Dot-Com Bubble burst in 2000. The assumption on the start of the Dot-Com Bubble is conservative with respect to Kraay and Ventura (2005) who assume that it started in 1995. The choice on the Housing Bubble is consistent with Shiller (2003). I exclude 2001 because the current account deficit decreased.

financial development, global imbalances and housing. There exists a large literature on the efficiency of the market equilibrium and the role of assets without fundamental value. It includes, among others, the seminal paper of Samuelson (1958), Cass (1972), Diamond (1965) and Shell (1971). As discussed in these papers, under certain conditions, the market equilibrium may be inefficient and assets without fundamental value, bubbles, may improve the market allocation. In my autarky constrained equilibrium, bubbles complete the market by adding assets to the economy.

The literature on rational bubbles is rich and diverse. This list includes the seminal paper of Tirole (1985) and, among others, Allen and Gale (2000), Arce and López-Salido (2008), Caballero et al. (2006), Caballero and Krishnamurthy (2006), Farhi and Tirole (2008), Hellwig and Lorenzoni (2008), Santos and Woodford (1997), Tirole (1982), Ventura (2003) and Ventura (2004). The discussion on the existence of bubbles in a closed economy is related to Tirole (1985) and Santos and Woodford (1997). I consider an overlapping generation economy as in Tirole. However, as emphasized in Santos and Woodford, the distinction between an infinitely lived agent and an overlapping generation is not crucial for the existence of rational bubbles. My results only hinge on the different borrowing constraint in both countries. In autarky, bubbles can only appear in the financially underdeveloped country because their agents are borrowing constrained and the economy does not generate enough assets.[5] The role of the borrowing constraint was also emphasized in, for example, Farhi and Tirole (2008) and Arce and López-Salido (2008). Farhi and Tirole build a closed economy model and also show that rational bubbles can appear when liquidity is scarce. My housing model and discussion on the existence of bubbles in autarky are similar to Arce and López-Salido. However, their model is a closed economy and they only consider partial equilibrium.

Ventura (2004) is the first to study the relationship between bubbles and trade. However, the intuition why bubbles arise in the integrated equilibrium is more related to Ventura (2003). He considers a closed economy with a segmented financial market. In his model, bubbles can arise in equilibrium because the rate of return is different across agents. This is akin to having a constrained and an unconstrained economy. This paper is also related to Caballero et al. (2006). They consider a closed economy and show that if there is a jump in the savings rate, the economy can transit from a steady state in which bubbles are not possible to one in which bubbles are possible. They construct an example to show that this jump could be given by capital flows. Nonetheless, they do not study why these countries are different nor the effect of trade for different types of bubbles.

There exist several papers which study the current account deficit in the United States. Ventura (2001) and Kraay and Ventura (2007) also link the current account deficit with the appearance of bubbles. Both papers are mostly silent about the "South" and focus on the current account implications of having a pure asset price bubble in the United States. Blanchard et al. (2005), Caballero et al. (2008a, 2008b), Dooley and Garber (2007) and Obstfeld and Rogoff (2005), among others, study the current account deficit without relying on bubbles. The closest papers are Caballero et al. (2008a, 2008b). They show that shocks that reduce the aggregate asset supply, generate (permanent) current account deficit in the region with "better" assets. A financially developed country

[5] I assume that the unconstrained economy is productive enough. In the model, it will translate into assuming that the depreciation rate is small.

opening up to trade with a financially underdeveloped country is analogous to a reduction in the aggregate supply of assets. However, they do not study the relationship between globalization and bubbles and their model does not include housing.

My empirical analysis is related to different papers on house price appreciations, for example, Aizenman and Jinjarak (2008), Case and Shiller (2003), Glaeser et al. (2008) and Saiz (2009). Aizenman and Jinjarak (2008) study a cross-section of 43 countries for the period 1990-2005 and find that the level of current account deficit is correlated with house price appreciation. Glaeser et al. (2008) find that during house price booms, prices react more in U.S. cities where the housing supply is less elastic. The two main differences is that I am interested in the effect of an increase in the current account deficit and that I divide, consistent with my model, their 1996-2006 housing boom period in two sub-periods, the Dot-Com and Housing Bubble.

The main contribution of the paper is to provide a tractable framework to understand the effect of globalization on the emergence of bubbles and analyze the effect of globalization on house prices for different types of bubbles. In the model, the bubble can be attached or detached to houses. Agents derive utility from housing services and real resources are used to build houses. Moreover, houses are used as collateral to borrow.

# 2 A Model of Housing with Bubbles: Autarky

This section develops a housing model with borrowing constraints and shows that, in autarky, rational bubbles cannot appear in a country with developed financial institutions but bubbles can arise in financially underdeveloped countries.

My framework is a three-period OLG economy which is meant to capture two elements of the life-cycle. First, the net asset position of agents is negative when they are young and it becomes positive as they grow older. Second, one of the reasons why young agents borrow is to purchase a house and enjoy housing services when middle-aged.

An important feature of the model is that households may be borrowing constrained. Agents can only borrowing a fraction of the value of the house. This fraction depends on the financial institutions of each country. Households can borrow more against their house in more financially developed countries.

## 2.1 Setup

I consider an OLG economy with three generations: young, middle-aged and old. Each generation consists of a continuum of agents of mass one. Young agents are endowed with one unit of labor that they inelastically supply to the labor market. Middle-aged and old agents do not have any endowment.[6] Both the endowment and the population are constant over time.

Households consume housing services when they are middle-aged and consumption good when they are old. The lifetime utility of a household born at time $t$ is

[6] This is a simplifying assumption. All the results go through if agents receive an endowment each period.

$$U_t = \log(h_{2,t+1}) + \log(c_{3,t+2}),$$

where $h$ and $c$ are housing services and consumption good, respectively, and 2 and 3 stand for middle-aged and old period. The consumption good is perishable. Houses are durable goods, which depreciate at a constant rate $\delta$.

The timing of events for a household born at time $t$ is as follows.

1. At time $t$, the agent is young. She works and receives a wage $w_t$. After receiving the wage, she chooses how much housing $h_{2,t+1}$ she wants to enjoy when middle-aged. Houses must be purchased to enjoy housing services.[7]

2. If the value of the house $p_t h_{2,t+1}$ exceeds her wage, the young agent can borrow an amount $d_t$. I assume that loan repayment is imperfectly enforceable. A young agent with wage $w_t$ needs to borrow $p_t h_{2,t+1} - w_t$. She is supposed to repay $R_t \left[p_t h_{2,t+1} - w_t\right]$ when middle-aged. However, the young agent by spending a fraction $\theta$ of the value of the house while being young, she can avoid repayment when middle-aged. Therefore, the lender will lend to the borrower only up to the point where $R_t \left[p_t h_{2,t+1} - w_t\right] \leq \theta R_t p_t h_{2,t+1}$. This implies that $d_t \leq \theta\ p_t h_{2,t+1}$.

3. At time $t+1$, the agent is middle-aged. She repays the debt $R_t d_t$ and sells the house at the end of the period.[8] Houses depreciate, therefore, she obtains $(1-\delta) p_{t+1} h_{2,t+1}$. She chooses an amount of savings $a_{t+1}$ to consume when she is old.

4. At time $t+2$, the agent is old. She consumes the returns on her savings $R_{t+1} a_{t+1}$ and dies.

Therefore, the budget constraint for young, middle-aged and old agents are, respectively,

$$\begin{aligned} p_t h_{2,t+1} &\leq d_t + w_t, && (1)\\ R_t d_t + a_{t+1} &\leq (1-\delta) p_{t+1} h_{2,t+1}, && (2)\\ c_{3,t+2} &\leq R_{t+1} a_{t+1}, && (3) \end{aligned}$$

the borrowing constraint is

$$d_t \leq \theta p_t h_{2t+1}, \tag{4}$$

and the non-negativity constraints are $d_t \geq 0, a_{t+1} \geq 0, h_{2,t+1} \geq 0, c_{3,t+2} \geq 0$.

[7] In this model there is no renting market. However, this assumption could be rationalized in a framework where both options are available. If agents do not own the house, they cannot sell it in the next period and cannot borrow against it. Assume that housing services are $\log(h^b + \chi h^r)$, where $b$ and $r$ denote buying and renting the house, respectively. If $\chi$ is small enough, agents prefer to purchase the house.

[8] Middle-aged agents could keep the house and sell it when they are old. However, in this model it is always better to sell the house when you are middle-aged. This is true because, in equilibrium, the return on savings is higher than the house price appreciation (i.e., $R_t > \frac{(1-\delta)p_{t+1}}{p_t}$).

The important feature and the source of rational bubbles in this model is that agents may be borrowing constrained. Other formulations of the borrowing constraint would give qualitatively similar results. Throughout the paper, I interpret $\theta$ as an indicator of financial development. Agents can receive a larger loan in more financially developed countries.

The production side of the economy is described by the consumption good and housing production functions. The production function of the consumption good is $f(l^c)$ with $f' > 0$ and $f'' \leq 0$, where $l^c$ denotes workers employed in the consumption good sector. Similarly, the production function of houses is $g(l^h)$ with $g' > 0$ and $g'' < 0$, where $l^h$ denotes workers employed in the housing sector.

I assume that there are developers who run the housing production function and consumption good producers. Both live one period and consist of a mass of one. They choose the number of workers to maximize their profits taking wages and prices as given.[9] They use their profits to consume the consumption good, which is the numéraire.

Labor market clearing requires that the labor demand in the consumption $l_t^c$ and the construction sector $l_t^h$ equals the supply. Thus, $l_t^c + l_t^h = 1$ at each date $t$.

Housing market clearing requires that the demand equals the supply of houses. The supply of houses in period $t+1$ is the new houses $g(l_t^h)$ plus the remaining stock of undepreciated houses of period $t$,

$$H_{t+1}^S = g(l_t^h) + (1-\delta)H_t^S. \tag{5}$$

I explicitly derive the housing demand in the next subsection. However, it is worth noting that housing demand is a function of both current and future prices. An increase in the current price, reduces housing demand. However, houses are also an asset. Therefore, an increase in future house prices raises the capital gains of middle-aged agents and increases housing demand. This implies that the equilibrium house prices will be defined in a recursive form.

The only financial instrument in this economy are bonds, which are in zero net supply. Thus, the capital market clears when savings of middle-aged agents equal borrowing of young agents.

### 2.1.1 Equilibrium

**Definition** A *competitive equilibrium* is a sequence of house prices $p_t$, wages $w_t$, interest rate $R_t$, choices of consumption $c_t$, housing services $h_t$, savings $a_t$ and debt $d_t$, an allocation of labor in the construction $l_t^h$ and consumption good sector $l_t^c$ for all $t \geq 0$ with initial condition $H_{-1}$ such that households maximize their utility given their income, firms maximize profits and all markets clear.

In the next subsections, I compute the autarky steady-state equilibrium for two countries which only differ on the borrowing constraint. In particular, I consider a financially developed economy

[9] The assumption that developers only live one period is without loss of generality. Given the technological assumptions, an infinitely-lived developer would solve the same problem, even though houses are durable goods and their demand depends on future prices. The only relevant assumption is that households do not own the firm. If they owned the firm, the threshold of $\theta$ below which households are constrained should be modified.

$U$ with a level of institutions $\theta^U$ and a financially underdeveloped economy $C$ with $\theta^C$. I assume that agents in country $C$ are borrowing constrained and agents in country $U$ are unconstrained. Thus, I assume that $\theta^U > \theta^* > \theta^C$, where $\theta^*$ is the level of financial institutions that makes the (steady-state) allocation of a constrained economy equal to an unconstrained economy.[10]

## 2.2 Financially Developed Country

In this subsection I compute the steady-state equilibrium for a financially developed country $U$ and show that rational bubbles cannot arise if this country is in autarky.[11]

The problem of a household born at time $t$ in country $U$ is

$$\max_{\{h_{2t+1}, c_{3t+2}, d_t, a_{t+1}\}} U_t = \log(h_{2,t+1}) + \log(c_{3,t+2})$$

subject to the budget constraints (1) to (3), the borrowing constraint (4) and non-negativity constraints.

Households living in a financially developed country are unconstrained (i.e., $\theta^U > \theta^*$). Therefore, the budget constraints (1) to (3) bind in equilibrium, the borrowing constraint (4) holds with inequality and the optimization problem can be rewritten as

$$\max_{\{h_{2t+1}, c_{3t+2}\}} U_t = \log(h_{2,t+1}) + \log(c_{3,t+2})$$

subject to

$$\left[p_t - (1-\delta)\frac{p_{t+1}}{R_t}\right] h_{2,t+1} + \frac{1}{R_t R_{t+1}} c_{3,t+2} = w_t. \tag{6}$$

Each household chooses housing services $h$ and consumption good $c$ to maximize her lifetime utility given the budget constraint (6). Equation (6) says that the present value of consumption equals the present value of income. The user cost of a house is the purchasing minus the (discounted) selling price.

This maximization problem can be graphically seen in figure (4). Utility is maximized when the marginal rate of substitution between housing services and consumption good equals their relative price, point $U$. Given the lifetime utility, each household optimally chooses to spend half of her wealth in housing services and half in consumption good.

$$\begin{aligned} h_{2t+1} &= \frac{1}{2}\frac{w_t}{p_t - (1-\delta)\frac{p_{t+1}}{R_t}}, \\ c_{3.t+2} &= \frac{1}{2} w_t R_t R_{t+1}. \end{aligned}$$

[10] To be more specific, $\theta^* \equiv \frac{2(1-\delta)}{2-\delta+\sqrt{\delta^2+8(1-\delta)}}$.

[11] I assume that the depreciation rate is small so that the economy is dynamically efficient. In particular, $\delta < 1/3$.

Housing expenditure $\left[p_t - (1-\delta)\frac{p_{t+1}}{R_t}\right] h_{2,t+1}$ represents half of total income $w_t$ and consumption expenditure $\frac{1}{R_t R_{t+1}} c_{3,t+2}$ the other half. Housing demand decreases with the purchasing price and increases with the future selling price.

Finally, after solving for the housing and consumption choices, I use the budget constraints (1) to (3) to find the savings and borrowing choices which will determine the equilibrium interest rate.

$$\begin{aligned} a_{t+1} &= \frac{w_t}{2} R_t, \\ d_t &= \frac{w_t}{2}\left[\frac{2\frac{(1-\delta)p_{t+1}}{R_t} - p_t}{p_t - \frac{(1-\delta)p_{t+1}}{R_t}}\right]. \end{aligned}$$

Savings (or asset demand) $a$ are increasing with the interest rate and borrowing (or asset supply) $d$ is decreasing with the interest rate. Moreover, since borrowing is directly related to housing demand, it increases with the discounted selling price and decreases with the purchasing price. Finally, the asset supply decreases with the depreciation rate. The reason is that all debt is collateralized by houses.

Before computing the rest of the equilibrium, it is useful to do a comparative statics exercise with the interest rate. A decrease in the interest rate $R_t$ represents a fall in the price of a house (it decreases the user cost) and it increases the "price" of delaying consumption. Graphically, figure (5) represents a decrease in the interest rate and the new optimal choice, point $U'$. Consumption good decreases and housing services increase. Savings are proportional to consumption, therefore, savings and the interest rate are positively related.

To find the housing supply and labor demand in the construction sector, I need to consider the problem of a developer. A developer takes house prices and wages as given and chooses the number of workers she wants to employ, in order to maximize her profits,

$$\max_{\{l_t^h\}} \pi_t^h = p_t g(l_t^h) - w_t l_t^h.$$

Then, the labor demand in the housing sector is $p_t g'(l_t^h) = w$.

Similarly, the problem of a producer of consumption good is to choose the number of workers $l_t^c$ to maximize her profits,

$$\max_{\{l_t^c\}} f(l_t^c) - w_t l_t^c.$$

It follows that labor demand in the consumption good sector is $f'(l_t^c) = w_t$.

By Walras' Law I can focus on three markets to compute the steady-state equilibrium: capital, housing and labor market. There is a zero net supply of bonds. Thus, capital market clears when aggregate savings $A$ equal aggregate debt $D$. Using the household choices, the capital market clearing condition is

$$A = \frac{w}{2}R = \frac{w}{2}\left[\frac{2\frac{(1-\delta)}{R} - 1}{1 - \frac{(1-\delta)}{R}}\right] = D. \tag{7}$$

Housing supply is given by (5) and housing demand follows from household maximization problem. Therefore, the housing market clearing condition is

$$H^S = \frac{g(l^h)}{\delta} = \frac{1}{2}\frac{w}{p - (1-\delta)\frac{p}{R}} = H^D. \tag{8}$$

Aggregate labor supply is one and labor demand comes from the developer and consumption good producer problem. Then, the labor market clearing condition is

$$\begin{aligned} l^c + l^h &= 1, \\ \text{with } pg'(l^h) &= w \text{ and } f'(l^c) = w. \end{aligned} \tag{9}$$

Finally, using the capital (7), housing (8) and labor market clearing condition (9), I derive all the equilibrium outcomes. For simplicity, I assume $g(l^h) = (l^h)^\epsilon$ and $f(l^c) = \gamma l^c$.

$$\begin{aligned} l^h &= \left[\frac{p}{\gamma}\epsilon\right]^{1+\xi}, \; l^c = 1 - \left[\frac{p}{\gamma}\epsilon\right]^{1+\xi}, \\ A &= D = \frac{\gamma}{2}r(\delta), \\ p &= \left[\frac{1}{2}\frac{\gamma}{\psi}\frac{r(\delta)}{r(\delta) - (1-\delta)}\right]^{\frac{1}{1+\xi}}, \; H = \left[\frac{\gamma}{2}\frac{r(\delta)}{r(\delta) - (1-\delta)}\right]^{\frac{\xi}{1+\xi}} \psi^{\frac{1}{1+\xi}}, \\ R &= r(\delta) \equiv \frac{-\delta + \sqrt{\delta^2 + 8(1-\delta)}}{2} > 1, \end{aligned}$$

where $\psi \equiv \frac{1}{\delta}\left[\frac{\epsilon}{\gamma}\right]^{\frac{\epsilon}{1-\epsilon}}$ and $\xi \equiv \frac{\partial H^S}{\partial p}\frac{p}{H^S} = \frac{\epsilon}{1-\epsilon} > 0$. The equilibrium interest rate $r(\delta)$ decreases with the depreciation rate. This is because an increase in the depreciation rate reduces the housing stock and, thus, the asset supply $D$. The proportion of the labor force working in the construction sector increases with house prices because it raises profits of developers. Moreover, both the equilibrium house price and housing stock decrease with the interest rate. The intuition is that when the interest rate falls, the user cost of housing decreases and it raises housing demand. This comparative statics result will be important in the trade equilibrium. Finally, the effect of a change in the interest rate in house price (stock) is larger (smaller), the less elastic the housing supply, $\xi$, is. The role of the housing supply elasticity will be emphasized in section 5, in which I use U.S. Metropolitan Statistical Area (MSA) data to provide empirical evidence consistent with the model.

### 2.2.1 Existence of Rational Bubbles

As shown in Tirole (1985), rational bubbles can appear in equilibrium if *i)* they grow at the same rate as the interest rate (i.e., $\frac{B_{t+1}}{B_t} = R_t$), *ii)* there are enough funds in the economy to sustain them (i.e., $A_t(R_t) - D(R_t) = B_t > 0$).

In this model, without growth, a (deterministic) rational bubble is possible if there exists a steady-state with interest rate equal to one and shortage of assets at this interest rate. Thus, rational bubbles are possible whenever $A(R = 1) - D(R = 1) \equiv B > 0$.

Given that $r(\delta) > 1$, $A(R = 1) < D(R = 1)$ and rational bubbles cannot appear in equilibrium. This result can be seen in the right-hand side of figure (6) that represents the capital market for a financially developed country and shows that asset demand $A$ is smaller than asset supply $D$ when the interest rate is one. There is no shortage of assets.

Therefore, this subsection has shown that rational bubbles cannot appear in financially developed countries if they remain in autarky.

## 2.3 Financially Underdeveloped Country

In this section I compute the steady-state equilibrium for a financially underdeveloped country $C$ and show that rational bubbles can arise in equilibrium.

Households living in a financially underdeveloped country are borrowing constrained (i.e., $\theta^C \equiv \theta < \theta^*$) . Thus, the borrowing constraint (4) binds in equilibrium and the problem of households can be rewritten as follows.

$$\max_{\{h_{2t+1}, c_{3t+2}\}} U_t = \log(h_{2,t+1}) + \log(c_{3,t+2})$$

subject to

$$\begin{aligned} \left[p_t - (1-\delta)\frac{p_{t+1}}{R_t}\right] h_{2,t+1} + \frac{1}{R_t R_{t+1}} c_{3,t+2} &= w_t, \\ h_{2t+1} &= \frac{1}{1-\theta}\frac{w_t}{p_t}. \end{aligned} \tag{10}$$

In addition to the budget constraint which equates the net present value of consumption with the net present value of income, the housing choice is constrained (10). When financial institutions improve (i.e., $\theta$ increases), this constraint is relaxed and households can afford more housing. Figure (4) represents this maximization problem. The dotted line represents the amount of housing that can be purchased without borrowing (or when financial institutions are so weak that $\theta$ goes to 0). The vertical line to the right of the dotted line represents the housing constraint and point $C$ is the optimal choice (where the housing and budget constraints intersect). Then, the housing and consumption choices are

$$
\begin{aligned}
h_{2t+1} &= \frac{1}{1-\theta}\frac{w_t}{p_t}, \\
c_{3,t+2} &= \frac{R_{t+1}}{1-\theta}\left[(1-\delta)\frac{p_{t+1}}{p_t} - \theta R_t\right] w_t.
\end{aligned}
$$

Housing demand is determined by equation (10) and consumption choice is determined by the budget constraint.

Figure (4) shows that households in financially underdeveloped countries, point $C$, enjoy less housing services and more consumption than households in financially developed countries, point $U$. This implies that, *ceteris paribus*, savings are higher in financially underdeveloped countries.

In order to find the expressions for savings and borrowing, I need to plug the consumption and housing services choices into the budget and borrowing constraints (1) to (4). It follows that

$$
\begin{aligned}
a_{t+1} &= \frac{1}{1-\theta}\left[(1-\delta)\frac{p_{t+1}}{p_t} - \theta R_t\right] w_t, \\
d_t &= \frac{\theta}{1-\theta} w_t.
\end{aligned}
$$

Housing services are determined by the borrowing constraint, therefore, borrowing $d$ is independent of the interest rate. Moreover, borrowing is increasing with financial development $\theta$. Savings $a$ are decreasing with the interest rate. This result is important to understand the existence of bubbles in this model. I provide an intuition of this result by doing the the same comparative statics exercise as before.

Figure (5) represents a decrease in the interest rate $R_t$. The intersection of the dotted line and the budget constraint represents the allocation when agents choose not to borrow in the first period. This allocation does not depend on the interest rate and it is also in the new budget constraint (dotted). The slope of the new budget constraint is flatter because the relative price of housing decreases. The housing constraint is represented by the vertical line to the right of the dotted vertical line and the new optimal allocation, point $C'$, is the intersection between the housing and budget constraints. Agents are borrowing, therefore, this fall in the interest rate represents a wealth increase. Households would like to increase their housing services but they are unable to do that because they are hitting the borrowing constraint. As a result, they spend this additional wealth by increasing the amount of consumption good. This brings about the negative relationship between interest rate and savings discussed above, unlike the positive relationship when households are unconstrained derived in subsection 2.2.

Following the same steps as in the last subsection, I find the steady-state equilibrium outcomes.

$$
\begin{aligned}
l^h &= \left[\frac{p}{\gamma}\epsilon\right]^{\frac{1}{1-\epsilon}},\ l^c = 1 - \left[\frac{p}{\gamma}\epsilon\right]^{\frac{1}{1-\epsilon}}, \\
A &= D = \frac{\theta}{1-\theta}\gamma, \\
p &= \left[\frac{\gamma}{\psi}\frac{1}{1-\theta}\right]^{\frac{1}{1+\xi}},\ H = \left[\frac{\gamma}{1-\theta}\right]^{\frac{\xi}{1+\xi}} \psi^{\frac{1}{1+\xi}}, \\
R &= r^c(\theta) = \frac{1-\delta-\theta}{\theta},
\end{aligned}
$$

where $\psi \equiv \frac{1}{\delta}\left[\frac{\epsilon}{\gamma}\right]^{\frac{\epsilon}{1-\epsilon}}$and $\xi \equiv \frac{\partial H^S}{\partial p}\frac{p}{H^S} > 0$. The interest rate $r^c(\theta)$ is decreasing with financial development $\theta$. The reason is that asset demand $A$ decreases with financial development and asset supply $D$ increases. Financial development has two effects on asset demand. One the one hand, savings increase with financial development because middle-aged agents have a larger house. On the other hand, savings decrease because the debt is larger. The second effect dominates and asset demand decreases with financial development. Asset supply $D$ increases with financial development because young agents can borrow more. Finally, since the borrowing constraint does not depend on the interest rate, neither house prices nor housing stock change with the interest rate.

### 2.3.1 Existence of Rational Bubbles

As discussed in subsection 2.2, in this model (deterministic) rational bubbles are possible if there is a shortage of assets when the interest rate equals one (i.e., $B = A(R=1) - D(R=1) > 0$).

The left-hand side of figure (6) represents the steady-state capital market in a financially underdeveloped country. Given that asset supply $D$ does not depend on the interest rate and asset demand $A$ is decreasing with the interest rate, rational bubbles are possible as long as $\theta < \theta^b$, where $\theta^b$ is defined as $r^c(\theta^b) = 1$. If a bubble arises, its size is $B = A(R=1) - D(R=1) = \frac{1-\delta-2\theta}{1-\theta}$.

The intuition why bubbles can appear in the constrained economy is that middle-aged agents want to save for consuming when they are old but young agents do not have enough assets to pledge against these desired savings. The bubble adds assets to the economy and solves this shortage of assets.[12] In this model, rational bubbles can always appear in a financially constrained economy.[13]

If a financially underdeveloped country improves its financial institutions (increases $\theta$), it generates more assets and it reduces the size of the bubble. If the improvement is large enough (i.e., $\theta > \theta^*$), the country becomes immune to rational bubbles as shown in subsection 2.2.

[12] Arce and López-Salido (2008) also find a negative savings slope for a range of parameter values and notice that bubbles are possible in this case. This result is also related to Farhi and Tirole (2008) who show that rational bubbles are possible when liquidity is scarce. Caballero (2006) also argues that rational bubbles can be the natural market response in economies with a shortage of assets.

[13] The reason is that a country is financially constrained if $\theta < \theta^*$, where $\theta^*$ is defined as $r^c(\theta^*) = r(\delta) > 1$. Moreover, rational bubbles can arise in a financially constrained economy if $\theta < \theta^b$,where $\theta^b$ is defined as $r^c(\theta^b) = 1$. Given that $\frac{\partial r^c(\theta)}{\partial \theta} < 0$, it follows that $\theta^* < \theta^b$.

# 3 Bubbles and Trade

In this section I study the relationship between globalization and rational bubbles. I consider a world that consists of two countries, a financially developed $U$ and a financially underdeveloped country $C$. I show that bubbles can arise in the integrated economy and, in particular, they can appear in the financially developed country which was immune to bubbles in autarky. Moreover, I study the effect of an increase in globalization on house prices when there is a pure asset price and a housing bubble.

## 3.1 Trade Equilibrium

The world consists of two countries, $U$ and $C$. Financial institutions in country $U$ are $\theta^U > \theta^*$ and they are $\theta^C \equiv \theta < \theta^*$ in country $C$. Then, households in country $U$ are borrowing unconstrained and households in country $C$ are constrained. Moreover, country $U$ has a proportion $\alpha$ of the world endowments. Thus, countries differ on scale and financial institutions.

I assume that the consumption good is traded and capital markets are also integrated. However, both the housing and labor markets are not integrated. Houses are non-tradable and labor cannot migrate.[14]

**Definition** A *competitive trade equilibrium* is a sequence of house prices $p_t^i$, wages $w_t^i$, choices of consumption $c_t^i$, housing services $h_t^i$, savings $a_t^i$ and debt $d_t^i$, an allocation of labor in the construction $l_t^{i,h}$ and consumption good sector $l_t^{i,c}$ for all $t \geq 0$ with initial condition $H_{-1}^i$ for each country $i \in \{U, C\}$ and an interest rate $R_t$ for all $t \geq 0$ such that households maximize their utility given their income, firms maximize profits and all markets clear. Housing and labor market clearing conditions are for each country $i \in \{U, C\}$ and capital and consumption good markets are integrated.

There are six markets clearing conditions. By Walras' Law I can ignore the consumption good market clearing condition and focus on the other five. Given that housing and labor market clear for each country, the only additional clearing condition is the capital market. Letting $A^i$ and $D^i$ denote aggregate savings and borrowing in country $i \in \{U, C\}$, respectively, and noting that country $U$ represents a proportion $\alpha$ of the world, the capital market clearing condition, which equates (world) aggregate savings and borrowing, is

$$\alpha A^U(R^T) + (1-\alpha)A^C(R^T) = \alpha D^U(R^T) + (1-\alpha)D^C(R^T), \tag{11}$$

where $R^T$ is the interest rate in the trade equilibrium.

Plugging the optimal savings and borrowing choices derived in section 2 by constrained (country $R$) and unconstrained (country $C$) households into equation (11), it is straightforward to show that $R^C > R^U > R^T\left(\alpha, \theta^C = \theta\right)$ with $R^T(\alpha, \theta)$ increasing with $\alpha$ and $\theta$. The intuition is that both a reduction in $\alpha$ and $\theta$ increase the flow of assets from the financially constrained to the financially

[14] Physical houses are non-tradable but they are indirectly traded because all debt is collateralized by houses.

unconstrained economy. It makes assets in country $U$ more scarce, which increases its value and reduces the equilibrium interest rate.[15]

Given the interest rate, the rest of equilibrium allocations can be easily derived. I focus on the housing market in country $U$. The expression for house prices derived in section 2 only needs to be modified by plugging the new interest rate. Thus, house prices in the trade equilibrium $p^{U,T}$ are

$$p^{U,T} = \left[\frac{1}{2}\frac{\gamma}{\psi}\frac{R^T}{R^T-(1-\delta)}\right]^{\frac{1}{1+\xi}} > \left[\frac{1}{2}\frac{\gamma}{\psi}\frac{R^U}{R^U-(1-\delta)}\right]^{\frac{1}{1+\xi}} = p^{U,A}.$$

These results can be graphically seen in figure (7) that represents the capital market in both countries and the housing market in country $U$ with point $a$ ($t$) denoting the autarky (trade) equilibrium. In autarky, as described in section 2, households in country $C$ are financially constrained and cannot borrow as much as they want because of the lack of collateralized debt. There is a shortage of assets in country $C$. When both countries integrate, savings of middle-aged agents in country $C$ are not constrained by the amount of debt that young agents can obtain at home but they can be invested in country $U$ which has better financial institutions. These capital flows create a current account deficit in country $U$.[16]

Figure (7) also shows that house prices are higher in country $U$ in the trade equilibrium with respect to autarky. The reason is that a fall in the interest rate raises housing demand. Thus, both house prices and stock are larger in the trade equilibrium. The housing market does not change in country $C$ because the borrowing constraint does not depend on the interest rate. Finally, the increase in house prices in country $U$ depends on the housing supply elasticity $\xi$. The more inelastic the housing supply is, the larger the rise in house prices is.

### 3.2 Existence of Rational Bubbles

In this subsection I show that asset price and/or housing bubbles can appear in the integrated equilibrium and, in particular, they can arise in the financially developed country.

As discussed in section 2, bubbles are possible if there is a shortage of assets when the interest rate is one. Capital markets are integrated, therefore, the shortage of assets needs to be at the world level. Then, bubbles are possible if the world supply of assets falls short of the asset demand,

$$A(\alpha, R=1) - D(\alpha, R=1) = B(\alpha) > 0,$$

where $A(\alpha, R=1) = \alpha A^U(R=1) + (1-\alpha)A^C(R=1)$ and an analogous expression for $D(\alpha, R=1)$.

Subsection 2.2 shows that if the world is financially unconstrained (i.e., $\alpha = 1$), bubbles are not possible. Similarly, subsection 2.3 shows that if the world is financially constrained (i.e., $\alpha = 0$),

[15] More explicitly, $R^T(\alpha, \theta)$ is the solution to $\alpha\frac{1}{2}\left[\frac{(R^T)^2+(1-\Lambda)R^T-2\Lambda}{R^T-\Lambda}\right] + (1-\alpha)\left[\frac{\Lambda-\theta-\theta R^T}{1-\theta}\right] = 0$
where $\Lambda \equiv 1-\delta$. Note that the equilibrium interest rate only depends on the level of financial institutions in the financially underdeveloped country $\theta^C = \theta$.

[16] Caballero (2006) and Caballero et al (2008a, 2008b) also link the shortage of assets in emerging economies to the current account deficit in financially developed countries.

bubbles can appear in equilibrium. The next proposition shows that if the world is "financially constrained enough", bubbles are possible in equilibrium.

**Proposition 1** *(Existence of Rational Bubbles in Trade Equilibrium) Bubbles attached to houses and/or pure asset price bubbles are possible if* $\alpha < \alpha^*(\theta, \delta)$ *where* $\alpha^*(\theta, \delta)$ *is decreasing in* $\theta$ *and increasing in* $\delta$.

**Proof.** Define $\alpha^*(\theta, \delta)$ as $A(\alpha^*(\theta, \delta), R = 1) - D(\alpha^*(\theta, \delta), R = 1) = B(\alpha^*(\theta, \delta)) = 0$ and note that $B(\alpha)$ is decreasing in $\alpha$. Moreover, $\alpha^*(\theta, \gamma) = \frac{1}{1+\Phi}$ with $\Phi \equiv \frac{\frac{1}{2}\frac{3(1-\delta)-2}{\delta}}{\frac{(1-\delta)-2\theta}{1-\theta}}$. ■

Proposition 1 says that for a given allocation of the world endowment $\alpha$, bubbles are less likely to arise when financial institutions in country $C$ improve (i.e., $\theta$ increases). The reason is that when financial institutions improve, the amount of assets that country $C$ generates increases. Moreover, a higher depreciation rate of houses increases the possibility of having bubbles. The intuition is that even though country $U$ is not financially constrained, the amount of assets (i.e., houses) it can generate depends on the depreciation rate. A larger depreciation rate implies a lower supply of assets and makes bubbles more likely to arise in the integrated economy.

The condition for existence of bubbles does not depend on whether the bubble is attached or detached to houses. However, as I show below, the distinction between housing and pure asset price bubbles is important to understand the effect of globalization on house prices.[17] In section 5 I provide empirical evidence consistent with this differential effect.

The location of the bubble is not determined by Proposition 1, it only shows when bubbles can appear in the integrated equilibrium. In the rest of the paper and consistent with the empirical section I assume that when bubbles are possible, they arise in the financially developed country.

Figure (8) represents the capital market in both countries and the housing market in country $U$ when a pure asset price bubble appears in country $U$. The effects are exacerbated with the bubble (see figures 7 and 8). Capital flows from country $C$ to country $U$ are larger, which increase the current account deficit. Moreover, the interest rate is lower, which makes the housing demand and, consequently, house prices higher. Graphically, the size of the bubble is the horizontal distance between the new (dotted) and old $D$ lines in figure (8).

The solution represented in figure (8) corresponds to the case in which there is a pure asset price bubble. In this case, the only effect that the bubble has on house prices in country $U$ is through the fall in the interest rate. Therefore, house prices are higher when there is an asset price bubble $p^{U,DB}$ than without a bubble $p^{U,T}$ because the interest rate is lower,

$$p^{U,DB} = \left[\frac{1}{2}\frac{\gamma}{\psi}\frac{1}{1-(1-\delta)}\right]^{\frac{1}{1+\xi}} > \left[\frac{1}{2}\frac{\gamma}{\psi}\frac{R^T}{R^T-(1-\delta)}\right]^{\frac{1}{1+\xi}} = p^{U,T}.$$

[17] There exists an indeterminacy of different types of bubbles. I assume that the bubble is either attached or detached to houses but any combination of both types of bubbles is possible. The model only determines the aggregate size of the bubble. For a further discussion, see, for example, the equilibrium with "bubble substitution" in Tirole (1985) or Example 4.1 in Santos and Woodford (1997).

However, the bubble can be attached to houses. If this is the case, all these extra savings instead of being allocated to a "useless" asset are directed to purchase houses. Therefore, when the bubble is attached to houses, the housing market clearing condition in country $U$ is

$$H^S = \alpha \frac{g(l^h)}{\delta} = \alpha \frac{1}{2} \frac{\gamma}{p} \frac{1}{\delta} + \frac{B}{p} = H^D,$$

where the difference with a pure asset price bubble is the term $B/p$. It represents the additional number of houses that are purchased only as an investment.[18] It follows that house prices with a housing bubble $p^{U,HB}$ are higher than with a pure asset price bubble $p^{U,DB}$,[19]

$$p^{U,HB} = \left[ \frac{1}{2} \frac{\gamma}{\psi} \frac{1}{1-(1-\delta)} + \frac{B}{\alpha} \frac{1}{\psi} \right]^{\frac{1}{1+\xi}} > \left[ \frac{1}{2} \frac{\gamma}{\psi} \frac{1}{1-(1-\delta)} \right]^{\frac{1}{1+\xi}} = p^{U,DB}.$$

This section underscores the importance of two strong assumptions made in Glaeser et al. (2008) to show that rational housing bubbles cannot appear in equilibrium in a frictionless economy. First, they assume that houses do not depreciate and therefore the stock of houses (and value of assets) goes to infinity. More importantly, they consider a closed economy. In section 2 I also showed that bubbles cannot appear in financially developed countries if they remain in autarky. However, this section has shown that when international capital flows are allowed (and houses depreciate), rational housing bubbles can appear in a financially developed country when it integrates with a financially underdeveloped economy.

In this subsection I have assumed that the bubble is located in the unconstrained economy but this is only one of the possible equilibria. For instance, there could be $I$ countries which differ only on $\theta^i$ and the size of the bubble in country $i$ could be inversely proportional to its level of financial development. Thus, the bubble would be larger in countries where the need for assets is higher. This is the equilibrium outcome when countries are in autarky. It would imply a negative relationship between financial development and the housing bubble. Figure (9) provides suggestive evidence pointing to this direction. It represents domestic credit (over GDP) for 1996 and (real) house price appreciation for the period 2002-2006 for all OECD countries with available data.[20] The negative slope of the fitted regression line is consistent with this prediction. For example, Spain is less financially developed than the United States and the house price appreciation was much larger in Spain.

The recent years were characterized by an increase in globalization and financial development.

[18] In this model a pure asset price bubble only reduces the interest rate and it does not have any extra effect in the economy. However, there exist papers in which a pure asset price bubble has additional effects. For example, in Ventura (2004) a pure asset price bubble increases the capital stock because inefficient investors stop investing and it reduces the cost of capital for entrepreneurs. Similarly, Olivier (2000) assumes that an asset price bubble encourages R&D investment and it increases growth.

[19] The notion of bubble is similar to the one used in Allen and Gale (2000). I consider that there is a housing bubble if the equilibrium house prices are higher than their fundamental value (i.e., $B > 0$).

[20] I choose 1996 because in my empirical exercise I assume that the Dot-Com bubble started in 1996. The pattern would not change if I choose another year because the ranking of countries and the trend is stable. In this exercise I am also assuming that the housing bubble appeared in all the countries and in the same period which does not seem to hold in the data.

I briefly discuss the predictions of the model for an increase in financial development and I will focus on globalization in the rest of the paper. The model predicts that an increase in financial development of financially constrained countries decreases the probability of having bubbles and the size of the bubble when it appears. Although this model abstracts from several aspects which exacerbated the recent subprime crisis, it is worth mentioning that financial development has also positive effects. Indeed, if the reason for the appearance of bubbles is the shortage of assets in the economy, financial development is a good policy to reduce the emergence and size of bubbles.

### 3.3 Effect of Globalization

In this subsection I study the effect of globalization (or financial integration) on the existence of rational bubbles in the integrated economy. I also interpret the current account, house prices and interest rate trends in the United States in the last twenty years through the lens of the model.

Let $\tau(< 1)$ represent the fraction of agents in country $C$ with access to the capital market of country $U$. I interpret an increase in globalization (increase in $\tau$) as country $C$ having better access to the capital market in country $U$. This definition of globalization is meant to capture the increasing role of emerging economies in world capital markets witnessed in recent years. Therefore, in this exercise, capital markets are not fully integrated. There are two capital markets. One market is for the fraction $1-\tau$ of agents in country $C$ who must remain in their country. The "integrated" capital market is for all agents in country $U$ and the fraction $\tau$ of agents in county $C$ who can invest in country $U$.[21] I discuss the possibility of having a bubble in the capital market for the fraction $1-\tau$ of agents in country $C$ at the end of this subsection. However, I first derive which is level of financial integration that makes bubbles possible in the financially developed country.

The capital market clearing condition derived in the trade equilibrium (11) needs to be modified to take into account the stage of globalization $\tau$,

$$\alpha A^U(R^T) + (1-\alpha)\tau A^C(R^T) = \alpha D^U(R^T) + (1-\alpha)\tau D^C(R^T).$$

Note that the equilibrium characterized in subsection 3.2 is a particular case when $\tau = 1$ and the solution in subsection 2.2 is a particular case when $\tau = 0$.

The next proposition shows that the possibility of having bubbles in the financially developed country is increasing with globalization.

**Proposition 2** *(Existence of Rational Bubbles and Globalization) Bubbles attached to houses and/or pure asset price bubbles are possible if $\tau > \tau^*(\alpha, \theta, \delta)$ where $\tau^*(\alpha, \theta, \delta)$ is increasing in $\alpha$ and $\theta$ and decreasing in $\delta$.*

**Proof.** Define $\tau^*(\alpha, \theta, \delta)$ as $A(\tau^*(\alpha, \theta, \delta), R = 1) - D(\tau^*(\alpha, \theta, \delta), R = 1) = B(\tau^*(\alpha, \theta, \delta)) = 0$ and

[21] Remember that when capital markets are fully integrated, $\tau = 1$, agents in country $C$ optimally choose to invest in country $U$, which can generate more assets. Thus, all agents in country $C$ allowed to invest in country $U$ will do so. Given that all agents are the same, $\tau$ could also be interpreted as the fraction that each agent in country $C$ can invest in country $U$.

note that $B(\tau)$ is increasing in $\tau$. Moreover, $\tau^*(\alpha, \theta, \gamma) = \frac{\alpha}{1-\alpha}\Phi$. ■

When $\alpha = \alpha^*(\theta, \delta)$, $\tau^*(\alpha^*, \theta, \delta) = 1$ where $\alpha^*(\theta, \delta)$ is defined in Proposition 1 as the "minimum" share that the financially developed country needs to represent of the world economy for not having rational bubbles in the integrated equilibrium. Therefore, given that $\tau^*(\alpha, \theta, \delta)$ is increasing with $\alpha$, if $\alpha > \alpha^*(\theta, \delta)$, bubbles are never possible. However, when $\alpha < \alpha^*(\theta, \delta)$, there exists $\tau^*(\alpha, \theta, \delta) < 1$ such that bubbles are possible if globalization has sufficiently advanced (i.e., $\tau > \tau^*(\alpha, \theta, \delta)$).

In other words, if the world economy is financially constrained enough (i.e., $\alpha < \alpha^*(\theta, \delta)$), the possibility of having rational bubbles is increasing with globalization. Bubbles are not possible if the access of country $C$ to world markets is limited (i.e., $\tau < \tau^*(\alpha, \theta, \delta)$) but bubbles are possible when it further integrates (i.e., $\tau > \tau^*(\alpha, \theta, \delta)$).

The level of globalization above which bubbles can appear in equilibrium $\tau^*(\alpha, \theta, \delta)$ is increasing with the financial development of the constrained economy $\theta$. Assume that the United States is an unconstrained economy and China and Europe are constrained economies with equal size but Europe has better financial institutions. Proposition 2 implies that the United States can integrate more with Europe than with China while remaining immune to rational bubbles.

In subsection 2.3 I showed that bubbles are possible in a financially developed country if it remains in autarky. Then, the fraction $1 - \tau$ of agents in country $C$ who must remain in their country can also create a bubble by themselves. Note that the condition for the bubble to arise is $B = (1 - \tau)A^C(R = 1) - (1 - \tau)D^C(R = 1) > 0$, where $A^C$ and $D^C$ are the aggregate savings and borrowing in a constrained economy in autarky derived in subsection 2.3, respectively. Thus, given that $A^C(R = 1) > D^C(R = 1)$, a bubble can appear and its size is $(1 - \tau)\frac{1-\delta-2\theta}{1-\theta}$ which is a fraction $1 - \tau$ of the bubble in autarky.

### 3.3.1 A Tale of Two Bubbles

In this subsection I interpret the trends of house prices and current account in the United States, shown in figure (2), through the lens of the model.

Assume that the world consists of two countries, the United States is financially unconstrained (country $U$ in the model) and the Rest of the World is financially constrained (country $C$). The United States represents a constant share $\alpha < \alpha^*(\theta, \delta)$ of the world and the initial level of globalization is $0 < \tau(t_0) < \tau^*(\alpha, \theta, \delta)$.

If globalization increases over time (i.e., $\tau(t)$ is exogenously increasing with $t$), Proposition 2 says that bubbles cannot happen when $t < t^* \equiv \tau^{-1}[\tau^*(\alpha, \theta, \delta)]$ and can appear afterwards. If $t^* \leq 1995$, the model could explain why the Dot-Com and Housing Bubble arose in the United States.

The comparative statics on current account and house prices with globalization are consistent with figure (2). The current account deficit in country $U$ is, by definition, $CAD(\tau) = B(\tau) + A^U[R(\tau)] - D^U[R(\tau)]$. When there is no bubble, $B(\tau) = 0$ but since $R(\tau)$ is decreasing in $\tau$, the current account deficit increases with globalization. Moreover, when there is a bubble, $B(\tau) > 0$ and the size of the bubble is increasing with globalization. Therefore, a deeper globalization increases

the possibility of having a bubble and its effect on current account deficit is exacerbated when a bubble arises.

House prices in country $U$ increase with globalization when there is no bubble. The interest rate decreases with globalization which raises housing demand. House prices are higher if there is a bubble (either attached or detached to houses) because the interest rate is lower than when there is no bubble. Moreover, the increase in house prices is larger if there is a housing bubble because an increase in globalization, increases the size of the bubble and it, directly, raises housing demand. Finally, the effect of globalization on house prices depends on the housing supply elasticity, which I will use in the empirical section.

# 4 Welfare Analysis

In this section I perform welfare analysis. First, I study whether a housing bubble is better than a pure asset price bubble (Dot-Com Bubble). Then, I study whether country $U$ and country $C$ gain from having a bubble located in country $U$.

## 4.1 Welfare with a Housing and Dot-Com Bubble

The difference between a housing and a pure asset price bubble is that in the first case the extra assets that the bubble generates are used to buy houses whereas they are not used, for production purposes, in the latter. In both cases, the interest rate is equal to one. The housing market of country $C$ is not affected by whether the bubble in country $U$ is attached or detached to houses. Therefore, I can focus on the welfare effects in country $U$.

From the point of view of a household, the only difference between both types of bubbles is house prices. If there is a housing bubble, house prices are $p^{U,HB}$ and when the bubble is detached, house prices are $p^{U,DB}(< p^{U,HB})$. From the equilibrium allocations derived in Section 3, it is straightforward to show that the difference in the lifetime utility of households in country $U$ between having a pure asset price and housing bubble is

$$U^{DB} - U^{HB} = \frac{1}{1+\xi} \ln \left[ \frac{\frac{1}{2}\frac{\gamma}{\psi}\frac{1}{1-(1-\delta)} + \frac{B}{\alpha}\frac{1}{\psi}}{\frac{1}{2}\frac{\gamma}{\psi}\frac{1}{1-(1-\delta)}} \right] \geq 0.$$

Lifetime utility of households is (weakly) larger with a Dot-Com Bubble. The more inelastic the housing supply is, the larger the welfare loss of having a Housing Bubble instead of a Dot-Com Bubble is (i.e., $\frac{\partial U^{DB} - U^{HB}}{\partial \xi} < 0$). The intuition is that the only difference between the Dot-Com and Housing Bubble is the price appreciation (and distortion) associated to the latter. Thus, the welfare loss of having a housing bubble is larger in countries with a low housing supply elasticity. Both bubbles deliver the same lifetime utility when the housing supply elasticity goes to infinity (i.e., $\lim_{\xi \to \infty} U^{DB} - U^{HB} = 0$).

Profits of consumption good producer are zero with both bubbles. However, profits of developers are higher with a Housing Bubble. From the problem of the developer it follows that, in equilibrium,

the profits with a housing bubble $\pi^{h,HB}$ relative to a pure asset price bubble $\pi^{h,DB}$ are

$$\frac{\pi^{h,HB}}{\pi^{h,DB}} = \left[\frac{p^{U,HB}}{p^{U,DB}}\right]^{1+\xi} > 1.$$

Therefore, a Housing Bubble can be better than a Dot-Com Bubble depending on the weight that a Social Planner gives to developers. The reason is that the increase in profits of developers can offset the reduction on the utility of households. For example, if developers have the same utility function as households and receive the same weight, housing bubbles are better.[22]

### 4.2 Welfare in Country U

In this section I study whether welfare in country $U$ increases if a bubble arises in country $U$.

I assume that the economy starts in a steady state with trade without bubbles, characterized by a level of globalization $\tau$, and it coordinates to a steady-state with a pure asset price bubble located in country $U$. Graphically, I assume that the economy starts in point $t$ in figure (7) and it coordinates to point $b$ in figure (8).

From the utility function and equilibrium allocations, the lifetime utility of households in country $U$ when the level of globalization is $\tau$ can be written as

$$U^U = \frac{\xi}{1+\xi} \ln\left[\frac{R^T(\tau)}{R^T(\tau)-(1-\delta)}\right] + 2\ln R^T(\tau) + constant \tag{12}$$

If we forget about the initial generation (they receive the bubble), the lifetime utility of next generations in the steady-state with bubbles is given by setting $R^T(\tau) = 1$ in equation (12). Thus, each next generation gains from being in a steady-state with a bubble if the lifetime utility (12) is decreasing with the interest rate.

A fall in the interest rate has two effects in the utility of households. First, the amount of consumption good decreases because the return on savings of old agents decrease. Second, the fall in the interest rate raises housing demand and housing services. The second effect dominates when the housing supply is very elastic. If the housing supply is infinitely inelastic (i.e., $\xi = 0$), utility of households in country $U$ decreases with a bubble. On the contrary, if the housing supply is infinitely elastic (i.e., $\xi \to \infty$), utility increases with a bubble. It can be shown that the utility of households (after the first generation) is larger with a bubble if $\xi > \underline{\xi}$.[23]

The first generation receives the bubble. Therefore, if the size of the bubble is large enough, the aggregate welfare of households is higher with a bubble. This is more likely to happen when financial institutions of country $R$ are very underdeveloped (low $\theta$) and the level of globalization is high (large $\tau$).

[22] From the equilibrium allocations derived in section 3.2, it follows that $U^{HB} + \ln \pi^{h,HB} - (U^{DB} + \ln \pi^{h,DB}) = \frac{\xi}{1+\xi} \ln\left[\frac{\frac{1}{2}\frac{\gamma}{\psi}\frac{1}{1-(1-\delta)} + \frac{B}{\alpha}\frac{1}{\psi}}{\frac{1}{2}\frac{\gamma}{\psi}\frac{1}{1-(1-\delta)}}\right] > 0$.

[23] The housing supply threshold is $\underline{\xi} \equiv \frac{2R-2(1-\delta)}{3(1-\delta)-2R}$. It follows from setting the partial derivative of equation (12) with respect to $R$ equal to zero.

Consumption good producers make zero profits and are indifferent. However, profits of developers are higher if there is a bubble because housing demand and, thus, house prices increase when the interest rate falls,

$$\frac{\pi^{h,DB}}{\pi^{h,T}} = \left[\frac{p^{U,DB}}{p^{U,T}}\right]^{1+\xi} > 1.$$

To sum up, profits of developers increase with a bubble because house prices are higher. The first generation of households gains because they receive the bubble. The next generations can gain or lose depending on the housing supply elasticity. Therefore, depending on how the different generations and agents are weighted, welfare in country $U$ may be higher with or without bubbles.

### 4.3 Welfare in Country C

In this subsection I do the same welfare analysis exercise as in subsection 4.2 for country $C$. I study how welfare in country $C$ changes when the world economy is in a steady state with trade without bubbles and it coordinates to a steady-state with an asset price bubble in country $U$.[24]

Profits of both developers and consumption good producers in country $C$ are not affected by a bubble located in country $U$. Moreover, since the bubble is created in country $U$ there is no additional gain for the first generation. Thus, it suffices to study how the (steady-state) lifetime utility of households changes when a bubble arises in country $U$.

It is easy to check that utility of households in country $C$, with a level of globalization $\tau$, is proportional to $R^T(\tau)\left[(1-\delta) - \theta R^T(\tau)\right]$.

Housing is determined by the pledgeability constraint which is not directly affected by the interest rate. The interest rate affects utility only through the consumption good. There are two effects. On the one hand, the return on savings increase with the interest rate. On the other hand, a higher interest rate lowers savings because middle-aged agents have to pay more for the money they borrowed. The second effect dominates when $R^T(\tau) > \frac{1-\delta}{2\theta}$.

Therefore, welfare of households in country $C$ is higher without a bubble than with a bubble located in country $U$ when the interest rate is below $\frac{1-\delta}{2\theta}$. Since the interest rate is decreasing with globalization, this is more likely to happen when both countries are already very integrated. The intuition is that when country $C$ has gained enough access to the better capital market of country $U$, its need for storage of assets decreases and they prefer not to have a bubble because the return for their investments is higher without bubbles.

## 5 Empirical Evidence

In this section I describe the empirical prediction of the model and I present evidence consistent with this prediction.

[24] House prices in country $C$ are not affected by the type of bubble located in country $U$. Then, welfare in country $C$ does not depend on whether the bubble in country $U$ is attached or detached to houses.

### 5.1 Empirical Prediction

The model predicts that the effect of globalization on house prices is different depending on whether the bubble is attached or detached to houses.

Section 3 shows that house prices in a financially developed country when there is a housing bubble are

$$p^{U,HB} = \left[\frac{1}{2}\frac{\gamma}{\psi}\frac{1}{1-(1-\delta)} + \frac{B(\tau)}{\alpha}\frac{1}{\psi}\right]^{\frac{1}{1+\xi}},$$

where $B(\tau)$ is the size of the bubble for a given level of globalization $\tau$. If there is a pure asset price bubble, houses prices are

$$p^{U,DB} = \left[\frac{1}{2}\frac{\gamma}{\psi}\frac{1}{1-(1-\delta)}\right]^{\frac{1}{1+\xi}}.$$

From these equations, it follows that house prices only increase with globalization if there is a housing bubble (i.e., $\frac{\partial p^{U,HB}}{\partial \tau} > 0$ and $\frac{\partial p^{U,DB}}{\partial \tau} = 0$). The intuition is that globalization affects house prices through two channels. The first channel is the interest rate. When globalization increases, more capital flows from country $C$ to country $U$, driving down the interest rate and raising housing demand and house prices. The second channel is the size of the bubble. An increase in globalization, translates into an increase in the size of the bubble. The size of the bubble only affects house prices if the bubble is attached to houses. When there is a bubble, the interest rate is constant and the only effect of globalization on house prices is the second one. Therefore, an increase in globalization raises house prices only if the bubble is attached to houses. Moreover, the more inelastic the housing supply is, the larger the effect of globalization on house prices is.

#### 5.1.1 An Extension: n Financially Developed Cities

This extension shows that the empirical prediction discussed above extends to one financially underdeveloped country and $n$ financially developed cities.

I assume that these cities have a common labor market but different housing markets. Only capital and consumption good can be traded between countries. Each city $i$ has the same level of financial institutions $\theta^i = \theta^N > \theta^*$ and the same size $\alpha^i = \alpha/n$. The only difference is the elasticity of the housing supply. In particular, I assume that $g^i(l^{h,i}) = (l^{h,i})^{\epsilon^i}$ with $\epsilon^i > 0$ for $i \in \{1, ..., n\}$.

Using the results in subsection 2.3, savings $a^i$ and borrowing $d^i$ in each city $i$ are

$$\begin{aligned} a^i_{t+1} &= \frac{w^i_t}{2} R_t, \\ d^i_t &= \frac{w^i_t}{2}\left[\frac{2\frac{(1-\delta)p^i_{t+1}}{R_t} - p^i_t}{p^i_t - \frac{(1-\delta)p^i_{t+1}}{R_t}}\right]. \end{aligned}$$

The steady-state capital market clearing condition is the same as when considering one financially developed country, equation (11). This is, $\sum_{i=1}^{n} \alpha^i a^i = \alpha A^U$ and $\sum_{i=1}^{n} \alpha^i d^i = \alpha D^U$ where $A^U$ and $D^U$ is the aggregate savings and borrowing derived in subsection 2.3, respectively. The reason is that borrowing $d^i$ does not depend on house prices and the production function of the consumption good is linear.

There is a housing market in each city $i$, thus, using the equations in subsection 2.3, it follows that the housing market clearing condition in city $i$ is

$$H^{S,i} = \frac{g^i(l^{h.i})}{\delta} = \frac{1}{2}\frac{w^i}{p^i - (1-\delta)\frac{p^i}{R}} = H^{D,i},\ \forall i \in \{1, ..., n\}.$$

Labor market is integrated for all cities, therefore, there is a unique market clearing condition

$$\begin{aligned} \sum_{i=1}^{n} l^{c,i} + \sum_{i=1}^{n} l^{h,i} &= \alpha, \\ \text{with } p^i g'(l^{h,i}) &= w^i \text{ and } f'(l^{c,i}) = w^i,\ \forall i \in \{1, ..., n\} \end{aligned}$$

Given the assumption on the production function of the consumption good, only the allocation of labor in the construction sector is uniquely determined for each city $i$. Nonetheless, it suffices to derive house prices. It follows that house prices in city $i$ are

$$p^i = \left[\frac{1}{2}\frac{\gamma}{\psi^i}\frac{R}{R-(1-\delta)}\right]^{\frac{1}{1+\xi^i}}$$

where $\psi^i \equiv \frac{1}{\delta}\left[\frac{\epsilon_i}{\gamma}\right]^{\frac{\epsilon_i}{1-\epsilon_i}}$ and $\xi^i \equiv \frac{\partial H^S}{\partial p}\frac{p}{H^S} = \frac{\epsilon_i}{1-\epsilon_i} > 0$.

Therefore, house prices in city $i$ with a housing and a pure asset price bubble are

$$p^{i,HB} = \left[\frac{1}{2}\frac{\gamma}{\psi^i}\frac{1}{1-(1-\delta)} + \frac{B^i(\tau)}{\alpha}\frac{1}{\psi^i}\right]^{\frac{1}{1+\xi^i}} \text{ and } p^{i,DB} = \left[\frac{1}{2}\frac{\gamma}{\psi^i}\frac{1}{1-(1-\delta)}\right]^{\frac{1}{1+\xi^i}},$$

respectively, where the housing bubble in each city $i$ is $B^i(\tau) > 0$ with $\sum_{i=1}^{n} B^i(\tau) = B(\tau)$. The effect of globalization on house prices is qualitatively the same. Thus, the empirical prediction I take to the data is as follows.

**Prediction** *An increase in globalization (capital inflows) raises house prices if there is a Housing Bubble. This effect is larger, the lower the housing supply elasticity is. However, an increase in globalization has no significant effect on houses prices if there is a pure asset price bubble (Dot-Com Bubble).*

### 5.2 Data and Descriptive Statistics

To test the prediction of the model I consider that the $n$ financially developed cities are Metropolitan Statistical Areas (MSAs) of the United States and that the financially underdeveloped country is the Rest of the World. The reason for choosing metropolitan areas of the United States is for data availability and because the United States experienced a Dot-Com (1996-2000) and a Housing Bubble (2002-2006) which allows me to test the prediction of the model.

I use the house price index at the Metropolitan Statistical Area (MSA) level from Office of Federal Housing Enterprise Oversight (OFHEO) and the CPI index from Bureau of Labor Statistics to obtain real prices.[25] The first row of Table 1 presents the average and standard deviation of house prices growth for the period I consider (1983-2007) and the two sub-periods I am interested in, the Dot-Com (1996-2000) and Housing Bubble (2002-2006). During both bubble episodes the average house prices growth was higher than the whole period but it was much higher during the housing bubble. The choice of the housing bubble period is consistent with Glaeser et al. (2008) who consider that the housing boom was between 1996 and 2006.[26]

My proxy for an increase in globalization is the current account deficit of the United States (over GDP) from International Financial Statistics (IMF). The current account deficit is very similar to the definition of globalization used in the model. In the model an increase in globalization is akin to an increase in (net) capital flows from country $C$ to country $U$.

The housing supply elasticity at MSA level is obtained from Saiz (2009). These elasticities are a function of both physical (e.g. the share of land with a slope above 15 degrees) and regulatory constraints. Data appendix shows some descriptive statistics of these elasticities and a list of the metropolitan areas with the least and most elastic housing supplies. For example, Miami (FL) and Los Angeles (CA) have the least elastic housing supplies and Wichita (KS) and Fort Wayne (IN) have the most elastic housing supplies. See Saiz (2009) for more details.

Figure (10) shows the growth rate of (real) house prices (per year) during the Dot-Com and Housing Bubble for different metropolitan areas represented by the housing supply elasticity. The two lines are the fitted values of a linear regression of house prices on the housing supply elasticity for both sub-periods. Two things are worth mentioning. First, the level is higher during the Housing Bubble. Second, the slope is negative and it is significantly larger during the Housing Bubble. Both facts are consistent with the model. The level is higher when the bubble is attached to houses because houses, in addition to the consumption value, have an extra asset value. The slope being negative and larger during the Housing Bubble means that house prices rise more in areas where the housing supply elasticity is lower and they are more sensitive to the housing supply elasticity when the bubble is attached to houses.

Finally, I use population and personal income at the metropolitan area level from Bureau of Economic Analysis as control variables. The second row of Table 1 reports the average and standard

[25] I choose the OFHEO price index over the Case-Shiller because this index only covers ten metropolitan areas from 1987 to 2000 and 20 from 2000 onwards.

[26] The year 2001 is excluded from the two bubbles because it is the year when the Dot-Com Bubble burst and the current account deficit decreased.

deviation of population growth for the whole period and the two sub-periods. Notice that they are very similar in both periods. The last row reports the average and standard deviation of personal income share growth. Personal income share is the personal income of each metropolitan area divided by the personal income of the United States. These number are also similar in the two sub-periods.

### 5.3 Empirical Strategy

I use the following equation to test the empirical prediction described in subsection 5.1.,

$$HP_{it} = \sum_{j \in \{HB,DB,O\}} \beta_j \cdot CAD_t \cdot Elast_i \cdot \rho_j + \phi X_{it} + \delta_i + \delta_t + \eta_{it}, \tag{13}$$

where $\rho_{HB}$, $\rho_{DB}$, $\rho_O$ are dummies for the Housing Bubble, the Dot-Com Bubble, and the rest of the sample, respectively. $HP_{it}$ is (real) house price in metropolitan area $i$ in year $t$, $CAD_t$ is current account deficit (over GDP) in the United States in year $t$, $Elast_i$ is the housing supply elasticity in metropolitan area $i$, $X_{it}$ are control variables and, $\delta_i$ and $\delta_t$ are a set of area and time fixed effects, respectively. All variables are growth rates. The sample consists of 138 metropolitan statistical areas (MSAs) and covers the period between 1983 and 2007.[27]

The two coefficients of interest are the interaction between current account deficit and housing supply during the Housing Bubble $\beta_{HB}$ and the Dot-Com Bubble $\beta_{DB}$. The model predicts that an increase in the current account deficit (capital inflows) has an effect on the growth rate of house prices only during the Housing Bubble. Moreover, this effect should be larger, the less elastic the housing supply is (i.e., $\beta_{HB} < 0$ and $\beta_{DB} = 0$).

### 5.4 Results

Table 2 reports the coefficients of running equation (13) by using metropolitan area fixed effects with robust standard errors clustered by metropolitan area in parentheses. Column (1) reports the coefficients when population is included as control variable. As expected, the coefficient on population is positive. More importantly, consistent with the model, the coefficient on the interaction term is not significant during the Dot-Com Bubble and it is negative and statistically significant (-0.171) during the Housing Bubble. It means that an increase in current account deficit only has an effect on the growth of house prices if there is a Housing Bubble. Moreover, the less elastic the housing supply is, the larger the rise in house price is.

The regression reported in column (1) is ignoring the fact that some metropolitan areas may have a larger house price appreciation because they are growing above the mean. In order to take this into account, column (2) adds the income share as control variable. The coefficient on the income share is positive. Indeed, house prices increase more in metropolitan areas whose income grows more than the national income. However, the two coefficients of interest remain almost unchanged. The

[27] The sample is chosen to maximize the number of observations while keeping a balanced panel.

coefficient on the interaction term during the Housing Bubble is negative and significant (-0.199), whereas it is not significant during the Dot-Com Bubble.

These results are also economically significant. To give an example, Santa Barbara (CA) is in the 10th percentile of the housing supply elasticity (0.91) and Richmond (VA) in the 75th percentile (2.16). If Santa Barbara and Richmond only differ on the housing supply elasticity, the coefficients on column (2) imply that one percent increase in the current account deficit translates into an increase in house prices 0.25 percentual points higher in Santa Barbara than in Richmond during the Housing Bubble. In contrast, during the Dot-Com Bubble, an increase in the current account deficit has no differential effect.

This section has provided empirical evidence consistent with the prediction of the model. The model predicts that the effect of an increase in current account deficit on house prices is different depending on which asset a bubble is attached to. The model predicts that when there is a bubble, an increase in capital inflows, raises house prices only when the bubble is attached to houses. The coefficients reported on Table 2 are consistent with this prediction. I find that an increase in current account deficit (over GDP) has a significant (and positive) effect on (real) house price appreciation during the Housing Bubble, 2002-2006, but it has no significant effect during the Dot-Com Bubble, 1996-2000.

# 6 Concluding Remarks

In this paper I developed a framework to study the relationship between international trade and the existence of rational bubbles and analyze how the effect of globalization on house prices depends on the type of bubble.

The model is a three-period OLG economy. Young agents earn a wage and borrow to purchase a house. Middle-aged agents consume housing services, repay the debt and sell the house to save and consume when they are old. An important feature of the model is that households may be borrowing constrained. Young agents can only borrow a fraction of the value of the house. Moreover, this share depends on the financial institutions of the country.

I showed that, in autarky, rational bubbles can only appear in financially underdeveloped countries. The reason is that middle-aged agents want to save more to consume when they are old, but the economy does not generate enough assets because young agents are borrowing constrained. Bubbles are possible because there is a shortage of assets, which bubbles solve by adding assets to the economy

In the trade equilibrium I assumed that the world consisted of two countries, a financially developed and a financially underdeveloped country. I showed that as globalization progresses the possibility of having rational bubbles in the integrated equilibrium and be located in the financially developed country increases. The intuition is that as the financially underdeveloped country integrates into the world economy, it becomes more likely that there is a shortage of assets at the world level.

I also showed that the effect of globalization on house prices depends on which asset the bubble is attached to. When there is a bubble, either attached or detached to houses, the interest rate is constant and globalization affects house prices only through increasing the size of the bubble. The size of the bubble affects housing demand only if the bubble is attached to houses. Thus, only if there is a housing bubble, an increase in globalization raises house prices. The less elastic the housing supply is, the larger the rise in house prices is. In the empirical section I showed that this prediction is consistent with the Dot-Com (1996-2000) and Housing Bubble (2002-2006) episodes by using house price data from 1983-2007 for U.S. metropolitan statistical areas (MSAs). An increase in U.S. current account deficit (over GDP) has a positive effect on house prices during the Housing Bubble. The effect is larger, the lower the housing supply elasticity is. However, an increase in current account deficit has no significant effect on house prices during the Dot-Com Bubble.

To conclude, one cause of the severity of the recent subprime crisis is that banks were holding the bubble whereas the Dot-Com bubble was held by households. It matters who holds the bubble when it bursts. In my model there is no financial sector and bubbles do not burst. Therefore, an interesting extension would be to include these two features into the model to provide a better welfare analysis of having different types of bubbles.

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# 8 Figures and Tables

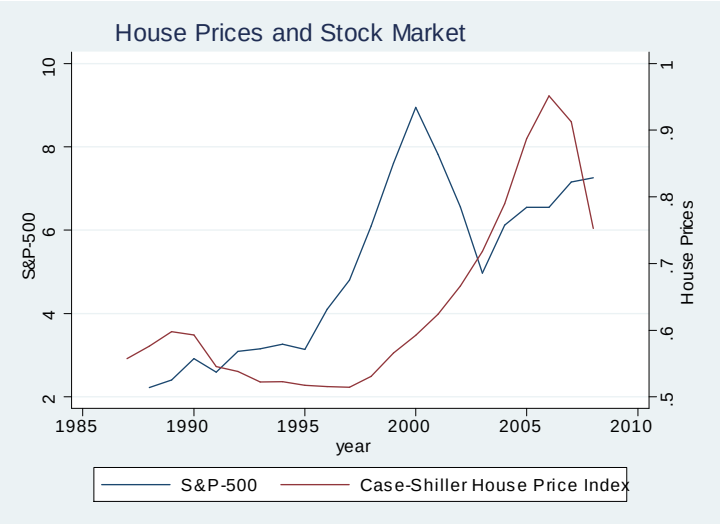


Figure 1: The Dot-Com and Housing Bubble.

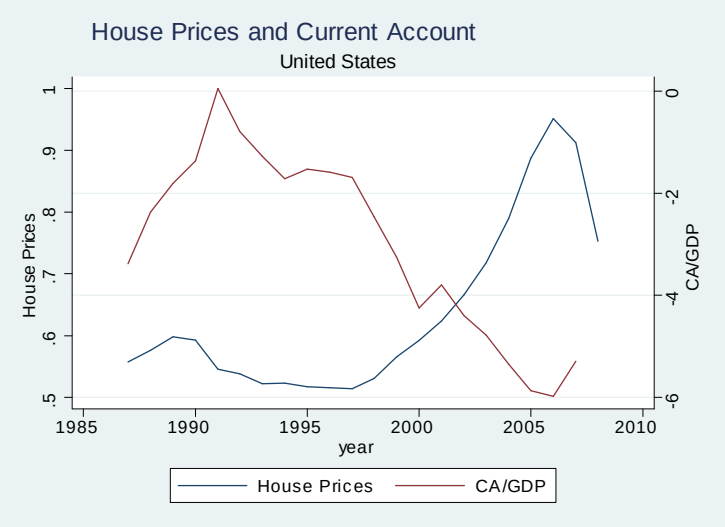


Figure 2: House Prices and Current Account in the United States. Source: Case-Shiller house price index and International Financial Statistics (IMF).

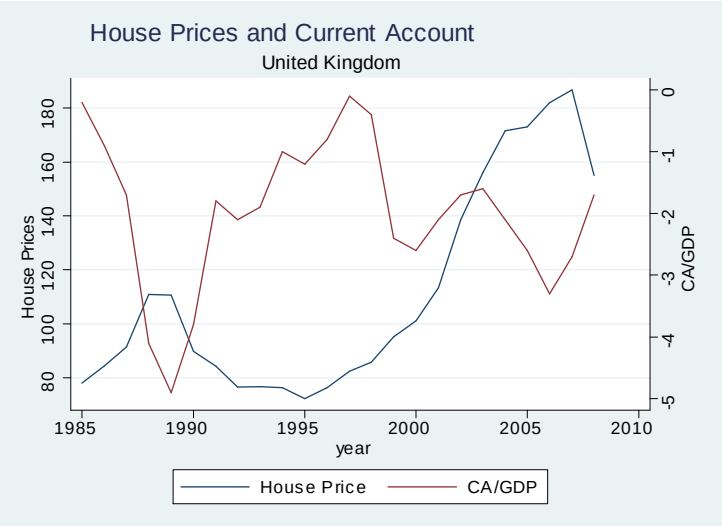


Figure 3: House Price and the Current Account in the United Kingdom. Source: House prices from Nationwide and current account (over GDP) from UK National Statistics.

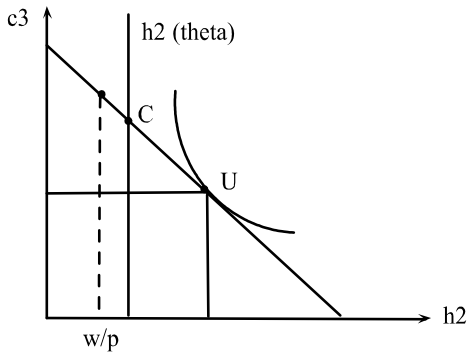


Figure 4: Household Maximization. Optimal choice in Financially Developed ($U$) and Financially Underdeveloped Country ($C$).

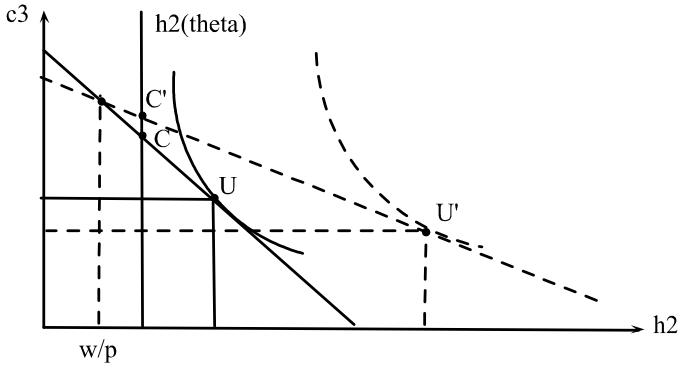


Figure 5: Comparative Statics: Decrese in Interest Rate.

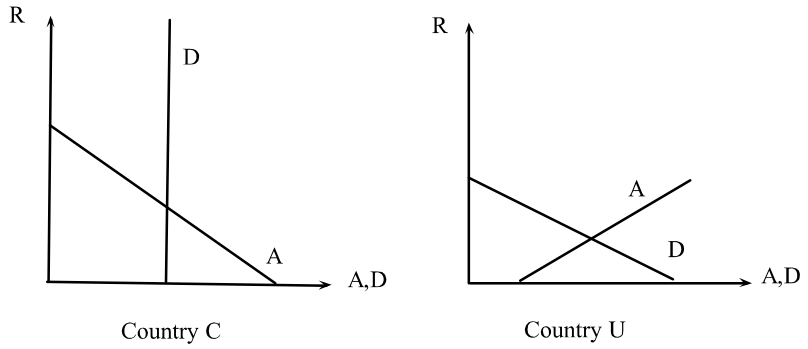


Figure 6: Autarky equilibrium: Capital market.

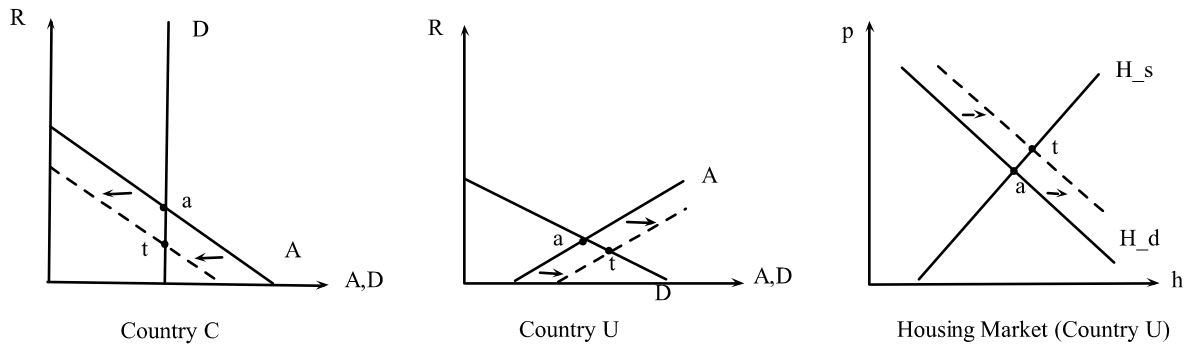


Figure 7: Trade equilibrium without bubbles.

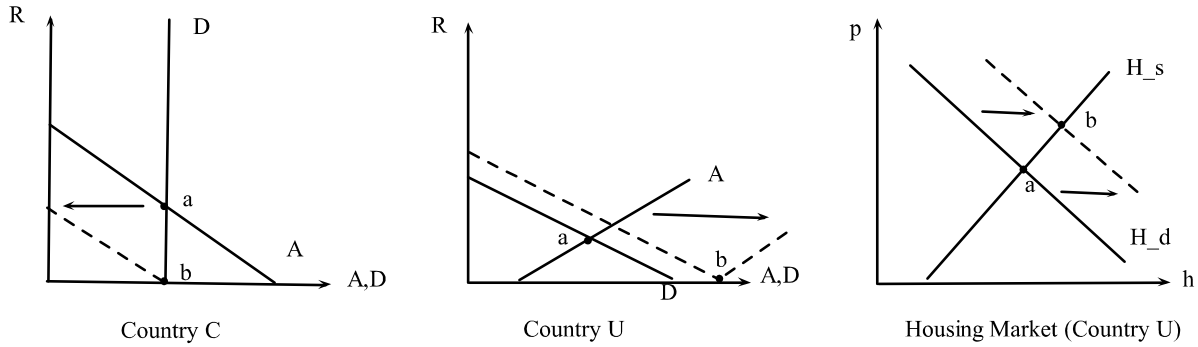


Figure 8: Trade equilibrium with a pure asset price bubble appearing in Country $U$.

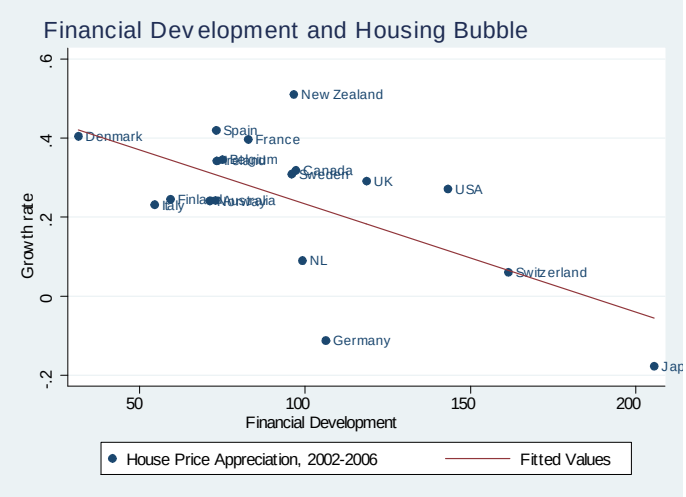


Figure 9: Financial Development and Housing Bubble. Source: House Prices from Bank for International Settlements. Financial Development is domestic credit to private sector over GDP in 1996 from WDI (World Bank).

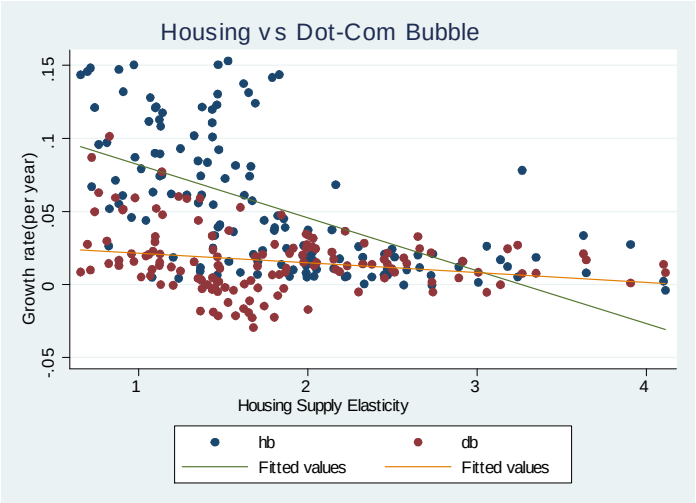


Figure 10: Growth Rate (per year) of House Prices during the Dot-Com (1996-2000) and Housing Bubble (2002-2006) in different U.S. metropolitan areas. Source: House price index from OFHEO and elasticity from Saiz (2009).

Table 1: Descriptive Statistics

| | All sample | Housing Bubble | Dot-Com Bubble |
|---|---|---|---|
| | (1) | (2) | (3) |
| House Prices | 1.49 | 5.34 | 1.73 |
| | (5.63) | (5.76) | (3.07) |
| Observations | 3450 | 690 | 690 |
| Population | 1.24 | 1.02 | 1.26 |
| | (1.34) | (1.05) | (1.07) |
| Income Share | 0.07 | 0.02 | -0.07 |
| | (2.54) | (3.05) | (1.91) |
| Observations | 3225 | 645 | 645 |

Values are averages of the (annual) growth rate during sample period, with standard deviations in parentheses. House price index is from Office of Federal Housing Enterprise Oversight (OFHEO). CPI index, used to compute real prices, is from Bureau of Labor Statistics. Population and Income data at metropolitan area level is from Bureau of Economic Analysis. Dot-Com Bubble period is between 1996 and 2000 and Housing Bubble period is between 2002 and 2006. The sample consists of 138 U.S. metropolitan statistical areas (MSAs) and the period is between 1983 and 2007.

Table 2: Current Account Deficit and House Prices for different Bubbles

| | (1) | (2) |
|---|---|---|
| | Dependent Variable: | House Prices |
| CAD·Elast·HB | -0.171 | -0.199 |
| | (0.039) | (0.034) |
| CAD·Elast·DB | 0.010 | 0.007 |
| | (0.008) | (0.007) |
| CAD·Elast·Other | 0.023 | 0.023 |
| | (0.007) | (0.006) |
| Population | 1.441 | 1.327 |
| | (0.556) | (0.129) |
| Income Share | | 0.681 |
| | | (0.107) |
| Observations | 2838 | 2838 |
| R-squared | 0.36 | 0.45 |

Fixed effect OLS regressions with robust standard errors clustered by metropolitan area in parentheses. House price index is from Office of Federal Housing Enterprise Oversight (OFHEO). CPI index, used to compute real prices, is from Bureau of Labor Statistics. Elasticity data is from Saiz (2009). Current Account and GDP data is from International Financial Statistics (IMF). Population and Income data at metropolitan area level is from Bureau of Economic Analysis. Dot-Com Bubble period is from 1996 to 2000 and Housing Bubble period is from 2002 to 2006. All variables are growth rates. The sample consists of 138 U.S. metropolitan statistical areas (MSAs) and the period is between 1983 and 2007.

# 9 Data Appendix

The housing supply elasticities for different Metropolitan Statistical Areas (MSAs) are estimated in Saiz (2009). These housing supply elasticities are a function of physical (geography) and regulatory constraints. I just show some descriptive statistics and the list of metropolitan areas with the least and most elastic housing supplies included in the sample. See Saiz (2009) for more details on the estimation of these elasticities.

| | Mean | St. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Elasticity | 1.79 | 0.75 | 0.66 | 4.11 |

Top 10 Least Elastic Housing Supply MSAs

| | |
|---|---|
| Miami, FL | 0.66 |
| Los Angeles, CA | 0.70 |
| Ft. Lauderdale, FL | 0.72 |
| San Francisco, CA | 0.72 |
| San Diego, CA | 0.74 |
| Oakland. CA | 0.76 |
| New York, NY | 0.81 |
| Salt Lake City, UT | 0.82 |
| San Jose, CA | 0.83 |
| Boston, MA | 0.86 |

Top 10 Most Elastic Housing Supply MSAs

| | |
|---|---|
| Lubbock, TX | 3.14 |
| Davenport, IA-IL | 3.18 |
| Evansville, IN-KY | 3.24 |
| Casper, WY | 3.27 |
| Topeka, KS | 3.35 |
| Lafayette, LA | 3.62 |
| South Bend-Mishawaka, IN | 3.64 |
| Longview, TX | 3.90 |
| Wichita, KS | 4.10 |
| Fort Wayne, IN | 4.11 |