Essays on International Economics

by

Sergi Basco

B.A., Universitat Pompeu Fabra (2003)
M.Sc., Universitat Pompeu Fabra (2005)

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Signature of Author .....
Department of Economics
May 10, 2010

Certified by .....
Daron Acemoglu
Charles P. Kindleberger Professor of Applied Economics
Thesis Supervisor

Certified by .....
Ricardo J. Caballero
Ford International Professor of Economics
Thesis Supervisor

Certified by .....
Pol Antràs
Professor of Economics, Harvard University
Thesis Supervisor

Accepted by .....
Esther Duflo
Abdul Latif Jameel Professor of Poverty Alleviation and Development Economics
Chairperson, Department Committee on Graduate Students

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Abstract

This dissertation analyzes different aspects of the globalization process. In recent years we witnessed an increasing role of emerging economies in world capital markets. Moreover, there has been a large reduction in trade costs which has allowed production to be offshored to less developed economies. Both elements are part of the globalization process but they have different effects within and between countries.

The first essay studies the relationship between globalization and the appearance of rational bubbles. It shows that bubbles cannot appear in a financially developed economy in autarky. In contrast, as globalization progresses, more financially underdeveloped economies have access to world capital markets and the possibility of having a bubble in the financially developed country increases. It also shows that, conditional on having a bubble, globalization raises house prices only when the bubble is attached to houses.

The second essay, co-authored with Martí Mestieri, analyzes the distributional effects of two waves of globalization. A First Globalization characterized by trade liberalizations and a Second Globalization characterized by reductions in communication costs. It shows that wage inequality always rises in the South. However, wage polarization emerges in the North during the Second Globalization. Moreover, there exists a complementarity between both globalizations. Wage polarization is delayed by the extent of trade in the First Globalization. It also shows that heterogenous participation in Second Globalization trade generates a discontinuous pattern of specialization.

The third essay studies how financial institution differences affect the offshoring choice of firms. It shows that financial institution differences affect the optimal contract offered to the supplier and are enough to generate a product cycle. Production is kept in North when the good is new and it is shifted to the South as it becomes more standardized.

Thesis Supervisor: Daron Acemoglu
Title: Charles P. Kindleberger Professor of Applied Economics

Thesis Supervisor: Ricardo J. Caballero
Title: Ford International Professor of Economics

Thesis Supervisor: Pol Antràs
Title: Professor of Economics, Harvard University

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[1] **This chapter is joint work with Martí Mestieri from MIT.**

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In the last two years I have had the pleasure to work with Martí Mestieri. The second essay is the first return on this partnership, which I hope it will continue in the future.

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Finally, I dedicate this dissertation to my family and specially to my grandfather who recently passed away.

Chapter 1

Introduction

This dissertation analyzes different aspects of the globalization process. In recent years we witnessed an increasing role of emerging economies in world capital markets. Moreover, there has been a large reduction in trade costs which has allowed production to be offshored to less developed economies. Both elements are part of the globalization process but they have different effects within and between countries. The three essays study the relationship between globalization and the appearance of rational bubbles, the distributional effects of different types of globalization and how financial institution differences affect the offshoring choice of firms.

The first essay starts with the observation that the United States experienced a large and sudden drop in both the stock market and house prices in the last decade. Consistent with a growing consensus, I assume that these drops were the burst of the Dot-Com and the Housing Bubbles, respectively. The goal of this essay is to study the effect of globalization on the emergence of rational bubbles and to analyze how the effect of globalization on house prices depends on the type of the bubble. In this essay I define globalization as an increase in the number of financially underdeveloped countries having access to world capital markets. This definition is meant to capture the increasing role of emerging economies in world capital markets. I show that bubbles cannot appear in a financially developed country in autarky. In contrast, as globalization progresses, the possibility of having bubbles in this country increases. The most salient empirical prediction of the model is that, conditional on having a bubble, an increase in globalization raises house prices only if the bubble is attached to houses. In the empirical

section, I show that this prediction is consistent with the Dot-Com and the Housing Bubble episodes using house prices at U.S. metropolitan statistical area level.

The second essay, co-authored with Martí Mestieri, develops a North-South model to study the distributional effects of two different waves of globalization. We provide suggestive empirical evidence consistent with (i) a First Globalization characterized by trade liberalizations, which raised trade in low skill intensive industries and (ii) a Second Globalization characterized by reductions in communication costs, which increased trade in more skill intensive industries. We show that wage inequality increases in both North and South during the First Globalization. In the Second Globalization, wage inequality also increases in the South but wage polarization emerges in the North. More importantly, there exists a complementarity between both globalizations. Wage polarization is delayed by the extent of trade in the First Globalization. Finally, we show how asymmetric participation in the Second Globalization may generate a discontinuous pattern of specialization.

The third essay studies how financial institution differences across countries affect the decision of Northern firms to offshore production and whether a product cycle arises when the only comparative advantage of Northern suppliers is their access to better financial institutions. A Northern final-good producer needs to buy an intermediate input from a supplier to complete production. She can find this supplier either in the low-wage but financially underdeveloped South or in the high-wage and financially developed North. I show that financial institution differences affect the optimal contract offered to the supplier and are enough to generate a product cycle. The final-good producer faces a trade-off between low wages and contracting distortions. When the good is new, she finds it optimal to keep production in the North at the cost of a higher wage but with the benefit of a less distorted contract. However, as the good becomes more standardized, the importance of the supplier increases and the cost of not shifting production to the South and take advantage of the lower wage offsets the contractual distortions that the underdeveloped Southern financial institutions create. The most salient empirical prediction is that the more R&D-intensive an industry is, the larger is the effect of financial development on offshoring. These results also hold when wages are endogenized. In the empirical section, the prediction is tested and confirmed using disaggregated trade data.

Chapter 2

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

2.1 Introduction

In the last decade the United States experienced a large and sudden drop in both the stock market and house prices. Figure 2-1 shows these drops using the S&P-500 and Case-Shiller house price indices (in real terms). Some economists relate these trends in house prices and stock market to changes in fundamentals. However, there is a growing consensus that the large drop in the stock market in 2000 was due to the burst of the Dot-Com Bubble and the sharp fall in house prices in 2006 was due to the crash of the Housing Bubble.[1] Consistent with this view, throughout the paper I will assume that there were two different bubbles.

Figures 2-2 and 2-3 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 holds for a larger set of countries, as shown in, for example, Aizenman and Jinjarak (2008) or Laibson and Mollerstrom (2009). Many

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

economists (e.g. Bernanke 2005) suggest that the *savings glut* was responsible for these *global imbalances*. Therefore, it hints to an effect of global imbalances on house price appreciations.

Some papers argue that the integration of financially underdeveloped countries into world capital markets, to which I refer as globalization, created global imbalances.[2] Nonetheless, its relationship with the emergence 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.

This paper yields two main results. The first result is that the possibility of having bubbles in a financially developed country increases with globalization. The intuition is that rational bubbles can only arise if there is a shortage of assets. Under autarky, this can only happen if a country is financially constrained. In the integrated economy, however, bubbles can arise in any country if there is excess demand for assets at the world level. As globalization progresses, more financially underdeveloped countries have access to world capital markets, which makes the world economy more financially constrained and increases the likelihood of having a rational bubble.

My second result highlights the differential effect that globalization has on house prices depending on the type of bubble. House prices are higher with a bubble because the interest rate is lower, which raises housing demand. However, conditional on having a bubble, an increase in globalization raises house prices only if the bubble is attached to houses. The reason is that an increase in globalization affects house prices through two channels. First, it reduces the interest rate, which raises housing demand. Second, it increases the size of the bubble, which raises housing demand 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 size of the bubble. Therefore, house prices increase with globalization only if the bubble is attached to houses. The empirical section shows that this prediction is consistent with the Dot-Com and the Housing Bubbles using U.S. metropolitan area 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,

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

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 financially constrained. Young agents can only borrow a fraction of the value of the house. Moreover, the quality of financial institutions determines this fraction. Therefore, in this model, all debt is collateralized by houses.[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 financially constrained, because the economy is dynamically efficient. However, bubbles can appear in the financially underdeveloped country. The intuition is that middle-aged agents want to increase their savings to consume more in the last period but there are not enough assets in the economy. Asset supply is limited by the amount of debt of young agents, who are financially constrained. Therefore, bubbles can arise in equilibrium because they increase the asset supply and solve the shortage of assets. This result is similar to those in 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. There is a current account deficit in the financially

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

developed country. This is analogous to Caballero et al. (2008a). Assets are used by middle-aged agents as a store of value. Thus, when capital flows towards the financially developed country, the value of its assets increases, they become scarcer, 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 are higher in the financially developed country 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 the financially underdeveloped economy consists of a continuum of mass one of identical countries and only a certain fraction of these countries have access to world capital markets. I define globalization as an increase in this fraction. As globalization progresses, the possibility of having bubbles in the financially developed country increases. Intuitively, as more financially underdeveloped countries gain 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, 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 rates in the United States in the last twenty years are consistent with the predictions of the model.

Section 5 derives the most salient empirical prediction of the model. House prices are higher with a bubble, either attached or detached to houses. However, the model predicts that, conditional on having a bubble, an increase in globalization raises house prices only if the bubble is attached to houses. The intuition is that as globalization progresses, more capital flows towards the financially developed country, 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. Thus, 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.

Section 6 provides empirical evidence consistent with the main prediction of the model 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 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 (and it has the opposite sign) during the Dot-Com Bubble.

Finally, I perform welfare analysis in section 4. 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 participating in the world capital market is higher without a bubble when capital markets are very integrated. The intuition is that when capital markets are very integrated, the gain for having additional assets is offset by the fall in the interest rate.

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

[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). The year 2001 is excluded from the two bubbles because I want to separate both bubbles and the current account deficit decreased between 2001 and 2000 which is inconsistent with the existence of a bubble.

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 constraints in both countries. In autarky, bubbles can only appear in the financially underdeveloped country because its agents are financially 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, there are inefficient investors who prefer a bubble over their investment opportunity and efficient investors who prefer their investment. This is similar to having a constrained and an unconstrained economy. The difference is that in my model constrained agents can invest in the unconstrained economy and bubbles cannot appear if the unconstrained economy can generate enough additional assets. In his model, the existence of inefficient investors is sufficient for the emergence of bubbles in equilibrium. This paper is also related to Caballero et al. (2006). They consider a closed

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

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 globalization for different types of bubbles.

There exist several papers which study the current account deficit in the United States. Laibson and Mollerstrom (2009), Kraay and Ventura (2007) and Ventura (2001) also link the current account deficit with the appearance of bubbles. These papers are mostly silent about the "South" and focus on the current account implications of having asset price bubbles 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 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 the Housing Bubbles.

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.

2.2 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 financially constrained. Agents can only borrow a fraction of the value of the house. The quality of financial institutions determines this fraction. Thus, agents can borrow more against their house in more financially developed countries.

2.2.1 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

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

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 δ.

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

[6] This is a simplifying assumption. If middle-aged and/or old agents had an endowment, the threshold of θ below which households are constrained should be modified but all the qualitative results would hold.

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.

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 $R_t [p_t h_{2,t+1} - w_t]$ when middle-aged. However, if a young agent spends a fraction θ of the value of the house while being young, she can avoid repayment when middle-aged. I interpret θ as an index of the quality of financial institutions. It is easier to avoid repayment in less financially developed countries. Thus, the lender will lend to the borrower only up to the point where $R_t [p_t h_{2,t+1} - w_t] \leq \theta R_t p_t h_{2,t+1}$. It follows that $w_t \geq (1-\theta)\ p_t h_{2,t+1}$. In other words, young agents need to make a down payment of, at least, a fraction $1-\theta$ of the value of the house $p_t h_{2,t+1}$ when purchasing it. This implies that the borrowing constraint is $d_t \leq \theta\ p_t h_{2,t+1}$. The important feature and the source of rational bubbles in this model is that agents may be financially constrained. Other formulations of the borrowing constraint would give qualitatively similar results.[7]

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,

[7] The qualitative results of the paper go through if the borrowing constraint is, for example, an ad-hoc constraint like $d_t \leq \theta$ or it depends on future house prices instead of current prices, like $d_t \leq \theta(1-\delta) p_{t+1} h_{2,t+1}$. The details of the model with these alternative borrowing constraints are available upon request.

[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.

$$p_t h_{2,t+1} \leq d_t + w_t, \tag{2.1}$$

$$R_t d_t + a_{t+1} \leq (1-\delta) p_{t+1} h_{2,t+1}, \tag{2.2}$$

$$c_{3,t+2} \leq R_{t+1} a_{t+1}, \tag{2.3}$$

the borrowing constraint is

$$d_t \leq \theta p_t h_{2,t+1}, \tag{2.4}$$

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

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,

$$H_{t+1}^S = g(l_t^h) + (1-\delta) H_t^S. \tag{2.5}$$

[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. The only relevant assumption is that households do not own the firm. If young agents own the firm, the threshold of θ which determines when agents are constrained is the same. Otherwise, this is equivalent to middle-aged and/or old agents receiving an endowment and, as discussed in footnote 6, the threshold should be modified but all qualitative results would hold.

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 suggests 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.

For simplicity, I assume that the production functions for houses and consumption good are $g(l^h) = (l^h)^\epsilon$ and $f(l^c) = \gamma l^c$, respectively.

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 in terms of the borrowing constraint. In particular, I consider a financially developed economy U with a level of institutions θ^U and a financially underdeveloped economy C with θ^C.

Assumption $\theta^U \geq \theta^* > \theta^C$ *where* $\theta^* \equiv \frac{2(1-\delta)}{2-\delta+\sqrt{\delta^2+8(1-\delta)}}$.

This assumption implies that agents in country C are financially constrained and agents in country U are unconstrained.

2.2.2 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.

I assume that the depreciation rate δ is small enough so that the economy is dynamically efficient in autarky. In particular, $\delta < 1/3$.

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 (2.1) to (2.3), the borrowing constraint (2.4) and non-negativity constraints.

Households living in a financially developed country are unconstrained (i.e., $\theta^U \geq \theta^*$). Therefore, the budget constraints (2.1) to (2.3) bind in equilibrium, the borrowing constraint (2.4) 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

$$\left[p_t - (1-\delta)\frac{p_{t+1}}{R_t}\right] h_{2,t+1} + \frac{1}{R_t R_{t+1}} c_{3,t+2} = w_t. \tag{2.6}$$

Each household chooses housing services h and consumption good c to maximize her lifetime utility given the budget constraint (2.6). Equation (2.6) 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 2-4. 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.

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

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 (2.1) to (2.3) 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 2-5 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 $p_t g'(l_t^h) = w_t$.

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: the capital, the housing and the labor markets. There is a zero net supply of bonds. Thus, the capital market clears when aggregate savings A equal aggregate debt D. Using the household choices, the capital market clearing condition is

$$A = \frac{w}{2}R = \frac{w}{2}\left[\frac{2\frac{(1-\delta)}{R} - 1}{1 - \frac{(1-\delta)}{R}}\right] = D. \tag{2.7}$$

Housing supply is given by (2.5) and housing demand follows from household maximization problem. Therefore, the housing market clearing condition is

$$H^S = \frac{g(l^h)}{\delta} = \frac{1}{2}\frac{w}{p - (1-\delta)\frac{p}{R}} = H^D. \tag{2.8}$$

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

$$\begin{aligned} l^c + l^h &= 1, \\ \text{with } pg'(l^h) &= w \text{ and } f'(l^c) = w. \end{aligned} \tag{2.9}$$

Finally, using the capital (2.7), the housing (2.8) and the labor market clearing conditions

(2.9), I derive all the equilibrium outcomes.

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

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 $r(\delta)$ is higher than one because I assume that the economy is dynamically efficient (i.e., $\delta < 1/3$). The interest rate decreases with the depreciation rate 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 on house price (stock) is larger (smaller), the less elastic the housing supply, ξ, is. The role of the housing supply elasticity will be emphasized in section 6, in which I use U.S. Metropolitan Statistical Area (MSA) data to provide empirical evidence consistent with the model.

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 2-6 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.

2.2.3 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 financially constrained (i.e., $\theta^C \equiv \theta < \theta^*$) . Thus, the borrowing constraint (2.4) 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

$$\begin{aligned} \left[p_t - (1-\delta)\frac{p_{t+1}}{R_t}\right] h_{2,t+1} + \frac{1}{R_t R_{t+1}} c_{3,t+2} &= w_t, \\ h_{2,t+1} &= \frac{1}{1-\theta}\frac{w_t}{p_t}. \end{aligned} \tag{2.10}$$

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 (2.10). When financial institutions improve (i.e., θ increases), this constraint is relaxed and households can afford more housing. Figure 2-4 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 θ 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 the budget constraints intersect). Then, the housing and the consumption choices are

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

Housing demand is determined by equation (2.10) and the consumption choice is determined by the budget constraint.

Figure 2-4 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 the borrowing constraints (2.1) to (2.4). 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 θ. 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 same comparative statics exercise as before.

Figure 2-5 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 the 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 θ. The reason is that asset demand A decreases with financial development and asset supply D increases. Financial development has two effects on asset demand. On 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.

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 2-6 represents the steady-state capital market in a financially

underdeveloped country. Given that the asset supply D does not depend on the interest rate and the asset demand A is decreasing with the interest rate, rational bubbles are possible as long as $\theta < \theta^b$, where θ^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.[10] In this model, rational bubbles can always appear in a financially constrained economy.[11]

If a financially underdeveloped country improves its financial institutions (increases θ), 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.

2.3 Bubbles and Trade

In this section I study the relationship between globalization and rational bubbles. First, 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. Then, I assume that the financially underdeveloped economy C consists of a continuum of mass one of identical countries and only a certain fraction of these countries is financially integrated with country U. I define globalization as an increase in this fraction. I show that as globalization progresses, the possibility of having bubbles in country U increases. The intuition is that bubbles can only appear when there is excess demand for assets. Under autarky, this can only happen in country C, which is financially constrained. As globalization progresses, by definition, the financially constrained economies represent an increasing share of world capital

[10] 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.

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

markets, which raises the likelihood of having a rational bubble in, for instance, country U.

2.3.1 Trade Equilibrium

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

I assume that the consumption good is traded and capital markets are also integrated. However, both the housing and the labor markets are not integrated. Houses are non-tradable and labor cannot migrate.[12]

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 market clearing conditions. By Walras' Law I can ignore the consumption good market clearing condition and focus on the other five. Given that the housing and the labor markets 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 α of the world, the capital market clearing condition, which equates world aggregate savings and borrowing, is

$$\alpha A^U(R^T) + (1-\alpha)A^C(R^T) = \alpha D^U(R^T) + (1-\alpha)D^C(R^T), \tag{2.11}$$

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

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

Plugging the optimal savings and borrowing choices derived in section 2 by constrained (country C) and unconstrained (country U) households into equation (2.11), 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 α and θ. The intuition is that both a reduction in α and θ increase the flow of assets from the financially constrained to the financially unconstrained economy. It makes assets in country U scarcer, which increases their value and reduces the equilibrium interest rate.[13]

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 2-7 that represents the capital market in both countries and the housing market in country U with point a and t denoting the autarky and trade equilibrium, respectively. 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.[14]

Figure 2-7 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 ξ. The more inelastic the housing supply is, the larger the rise in house prices is.

[13] 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 $\theta^C \equiv \theta$.

[14] 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.

2.3.2 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., $\alpha = 0$), 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* θ *and increasing in* δ.

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 α. Moreover, $\alpha^*(\theta, \delta) = \frac{1}{1+\Phi}$ 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 α, bubbles are less likely to arise when financial institutions in country C improve (i.e., θ 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.[15] 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. Section 6 provides empirical evidence consistent with this differential effect. It would be interesting to further investigate the conditions which make one type of bubble more likely to arise than another.

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. It would be nice to also have a theory of the location of the bubble, but I leave it for future research.

Figure 2-8 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 2-7 and 2-8). 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 2-8.

The solution represented in figure 2-8 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,

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

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

[15] 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).

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

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.[16] It follows that house prices with a housing bubble $p^{U,HB}$ are higher than with a pure asset price bubble $p^{U,DB}$,[17]

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

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.

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

[16] 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 (2003) 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.

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

2.3.3 Effect of Globalization

In this subsection I study the effect of globalization on the existence of 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.

I assume that the financially underdeveloped economy C consists of a continuum of mass one of identical countries. However, only a certain fraction τ of these countries have access to the capital market of country U. I define globalization as an increase in τ. This definition 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 is one capital market for each of the financially underdeveloped countries which cannot participate in the world capital market and the "integrated" capital market. This integrated capital market consists of country U and the fraction τ of financially underdeveloped countries with access to the world capital market. I discuss the possibility of having a bubble in the countries which are not part of the "globalized world" 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 (2.11) needs to be modified to take into account the stage of globalization τ,

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

Note that the integrated equilibrium characterized in subsection 3.2 is a particular case when $\tau = 1$ and the solution to the autarky equilibrium 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 α and θ and decreasing in δ.*

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

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 α, 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 bubbles is increasing with globalization. Bubbles are not possible if the fraction of financially constrained countries with access to world capital markets is low (i.e., $\tau < \tau^*(\alpha, \theta, \delta)$) but bubbles are possible when this fraction increases (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 θ. 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, bubbles can appear in each of the fraction $1 - \tau$ of financially underdeveloped countries which cannot participate in the world capital market. The reason is that the capital market clearing condition in these countries is the same as the one derived in subsection 2.3 where I showed that $B = A^C(R = 1) - D^C(R = 1) > 0$.

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 the United States which is financially unconstrained (country U in the model) and the Rest of the World which is a mass one of identical financially constrained countries. 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 in the "globalized world" when $t < t^* \equiv \tau^{-1}[\tau^*(\alpha, \theta, \delta)]$ and can appear afterwards. If $t^* \leq 1995$, the model could explain why emerging markets experienced several bubbles during the 1980s and early 1990s and the Dot-Com and the Housing Bubbles arose in the United States.[18]

The comparative statics on current account is consistent with figure 2. The current account deficit in country U is, by definition, $CAD(\tau) = B(\tau) + D^U[R(\tau)] - A^U[R(\tau)]$. When there is no bubble, $B(\tau) = 0$ but since $R(\tau)$ is decreasing in τ, 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 with a bubble. House prices are higher if there is a housing bubble because the bubble directly raises housing demand. Section 5 derives the main empirical prediction of the model and section 6 tests it using house prices for U.S. metropolitan areas.

2.4 Welfare Analysis

This section performs welfare analysis. First, I study whether a housing bubble is better than a pure asset price bubble. Then, I study whether welfare in country U and in a financially underdeveloped country C with access to world capital markets is higher with a bubble located in country U.

2.4.1 Welfare with a Housing and a 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

[18] See, for example, Caballero and Krishnamurthy (2006) for a discussion on bubbles in emerging economies.

production purposes, in the latter. The housing market of a financially constrained country 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.

Proposition 3 *Utility of households is higher with a Dot-Com Bubble and profits of developers are higher with a Housing Bubble.*

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 a housing bubble is

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

The lifetime utility of households is (weakly) higher with a Dot-Com Bubble. The more inelastic the housing supply is, the larger the welfare loss of having a Housing 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 both bubbles is the price appreciation (and distortion) of the Housing Bubble. 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 producers 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.[19]

2.4.2 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 τ, 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 2-7 and it coordinates to point b in figure 2-8.[20]

Proposition 4 *Welfare in country* U *is higher with a Dot-Com Bubble when the housing supply elasticity ξ is higher than a threshold $\underline{\xi}$. Otherwise, it depends on how different agents and generations are weighted. The utility of households (excluding the first generation) is lower but profits of developers and the utility of the first generation of households (they receive the bubble) are higher with a Dot-Com Bubble.*

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

$$U^U = \frac{\xi}{1+\xi} \ln \left[\frac{R^T(\tau)}{R^T(\tau) - (1-\delta)} \right] + 2 \ln R^T(\tau) + constant \tag{2.12}$$

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 (2.12). Thus, each next generation gains from being in a steady-state with a bubble if the lifetime utility (2.12) 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 returns on the savings of old agents decrease. Second, the fall in the interest rate raises housing demand and housing services. The second effect

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

[20] The same qualitative results hold when comparing welfare with and without a Housing Bubble. The only difference is that the threshold of the housing supply elasticity above which welfare is higher with a bubble is larger. This follows from Proposition 3.

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 higher with a bubble if $\xi > \underline{\xi}$.[21]

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 the quality of financial institutions in the constrained countries, θ, is very low and the level of globalization, τ, is high.

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,

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

Thus, profits increase because house prices are higher with a bubble. The first generation of households gains because they receive the bubble. Utility of next generations depends on the housing supply elasticity. Then, when utility of next generations is higher with a bubble (i.e., $\xi > \underline{\xi}$), welfare in country U is higher. Otherwise, it depends on how different generations and agents are weighted.

2.4.3 Welfare in Country C

In this subsection I do the same welfare analysis exercise as in subsection 4.2 for a financially constrained economy participating in world capital markets, 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.[22]

Proposition 5 *Welfare in country* C *is higher with a bubble located in country* U *when the*

[21] The housing supply elasticity threshold is $\underline{\xi} \equiv \frac{2R-2(1-\delta)}{3(1-\delta)-2R}$. It follows from setting the partial derivative of equation (2.12) with respect to R equal to zero.

[22] 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.

interest rate $R^T(\tau)$ *is larger than* $\frac{1-\delta}{2\theta}$

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 τ, is proportional to $R^T(\tau)\left[(1-\delta)-\theta R^T(\tau)\right]$.

Housing is determined by the borrowing 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 returns on savings increase with the interest rate. On the other hand, a higher interest rate lowers the amount of 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 capital markets are already very integrated. The intuition is that when capital markets are very integrated, the gain for having additional assets is offset by the fall in the interest rate.

2.5 Empirical Prediction

This section derives the most salient empirical prediction of the model.

The model predicts that, conditional on having a bubble, 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 τ. 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, conditional on having a bubble, house prices only increase with globalization if the bubble is attached to houses (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 towards country U, driving down the interest rate and raising housing demand and house prices. The second channel is the size of the bubble. As globalization progresses, the size of the bubble increases. 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.

2.5.1 An Extension: n Financially Developed Cities

This extension shows that the empirical prediction discussed above extends to n financially developed cities.

In this extension, I allow for labor mobility across cities. Therefore, these cities have a common labor market and different housing markets. Only capital and consumption good can be traded between countries. Each city i has the same level of financial institutions $\theta^i = \theta^U \geq \theta^*$ 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

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

where w^U_t is the wage in any city i in country U and p^i_t is house prices in city i.

The steady-state capital market clearing condition is the same as when considering one financially developed country, equation (2.11). 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.

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

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

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

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

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

$$p^{i,HB} = \left[\frac{1}{2} \frac{\gamma}{\psi^i} \frac{1}{1-(1-\delta)} + \frac{B^i(\tau)}{\alpha^i} \frac{1}{\psi^i} \right]^{\frac{1}{1+\xi^i}} \text{ and } p^{i,DB} = \left[\frac{1}{2} \frac{\gamma}{\psi^i} \frac{1}{1-(1-\delta)} \right]^{\frac{1}{1+\xi^i}}, \quad (2.13)$$

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 (i.e., $\frac{\partial p^{i,HB}}{\partial \tau} > 0$ and $\frac{\partial p^{i,DB}}{\partial \tau} = 0$). Thus, the empirical prediction I take to the data is as follows.

Prediction *Conditional on having a bubble, an increase in globalization raises house prices only if the bubble is attached to houses. Moreover, this effect is larger, the lower the housing supply elasticity is.*

2.6 Empirical Evidence

This section provides empirical evidence consistent with the main empirical prediction of the model described in section 5.

2.6.1 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 and a Housing Bubble 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.[23] 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 Bubble (1996-2000) and the Housing Bubble (2002-2006). During both bubbles 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.

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.

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

[23] 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.

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 2-9 shows the growth rate of (real) house prices (per year) during the Dot-Com and the Housing Bubbles 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 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.

2.6.2 Empirical Strategy

I use the following equation to test the empirical prediction described in section 5,

$$HP_{it} = \sum_{j \in \{HB,DB,O\}} \beta_j \cdot CAD_t \cdot Elast_i \cdot \rho_j + \phi X_{it} + \delta_i + \delta_t + \eta_{it}, \tag{2.14}$$

where ρ_{HB}, ρ_{DB}, ρ_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, δ_i and δ_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.[24]

The prediction of the model is that, conditional on having a bubble, an increase in globalization raises house prices only if the bubble is attached to houses. Moreover, this effect is larger, the lower the housing supply elasticity is, equation (2.13). Therefore, the two coefficients of interest are the triple interaction between the current account deficit, the housing supply elasticity and the Housing Bubble dummy β_{HB} and the triple interaction with the Dot-Com Bubble dummy β_{DB}. The model predicts that $\beta_{HB} < 0$ and $\beta_{DB} = 0$. The double interactions and main effects are not included in equation (2.14) because they are captured by the time and metropolitan area fixed effects.

2.6.3 Results

Table 2 reports the coefficients of regression (2.14) 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 the coefficient is negative and statistically significant (-0.171) during the Housing Bubble. It means that an increase in current account deficit only has a significant 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 prices 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 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

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

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 main 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 the bubble is attached to. The prediction is 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.

2.7 Concluding Remarks

In this paper I developed a framework 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. 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 financially constrained. Young agents can only borrow a fraction of the value of the house. Moreover, the quality of financial institutions determines this fraction.

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 financially 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 rational bubbles can appear in the integrated equilibrium and be located in the financially developed country. Then, I assumed that the financially underdeveloped economy consisted of a continuum of mass one of identical countries and only a certain fraction of these countries had access to world capital markets. I defined globalization as an increase in this fraction. I showed that as globalization progresses, the possibility of having bubbles in the financially developed country increases. The intuition is that as more financially underdeveloped countries integrate into world capital markets, it becomes more likely that there is a shortage of assets in the world economy.

I also showed that the effect of globalization on house prices depends on which asset the bubble is attached to. House prices are higher when there is a bubble, either attached or detached to houses, because the interest is lower with a bubble. However, conditional on having a bubble, an increase in globalization only affects house prices if the bubble is attached to houses. The reason is that when there is a bubble, 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. Therefore, an increase in globalization raises house prices only if there is a housing bubble. 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 the Housing Bubbles (2002-2006) using house prices from 1983 to 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.

2.8 Figures

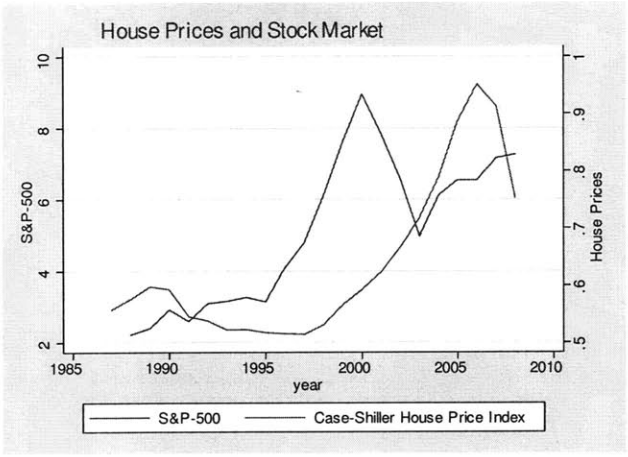

Figure 2-1: The Dot-Com and the Housing Bubbles.

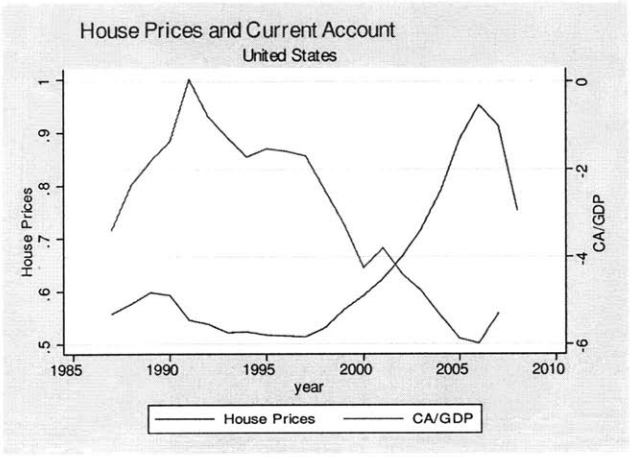

Figure 2-2: House Prices and Current Account in the United States. Source: Case-Shiller house price index and International Financial Statistics (IMF).

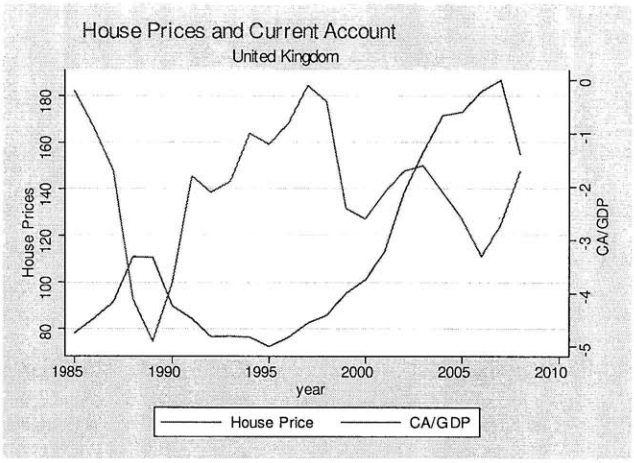

Figure 2-3: House Prices and Current Account in the United Kingdom. Source: House prices from Nationwide and current account (over GDP) from UK National Statistics.

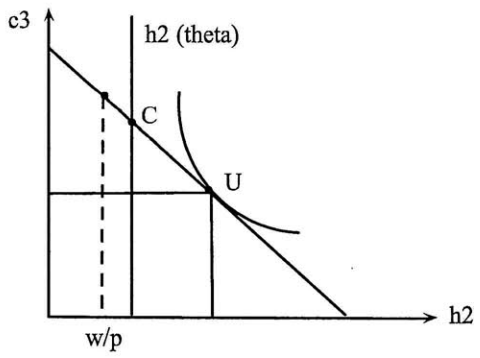

Figure 2-4: Household Maximization. Optimal choice in Financially Developed (U) and Financially Underdeveloped Country (C).

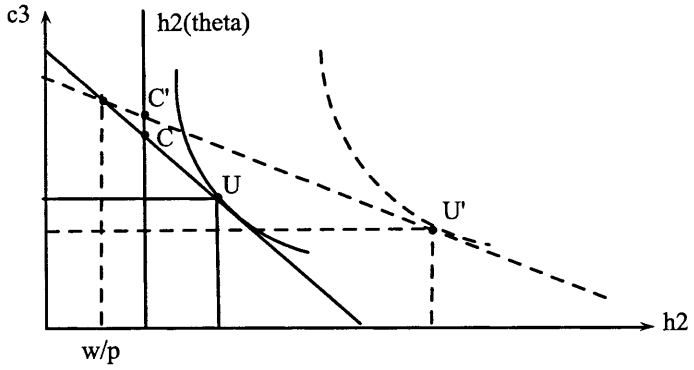

Figure 2-5: Comparative Statics: Decrease in Interest Rate.

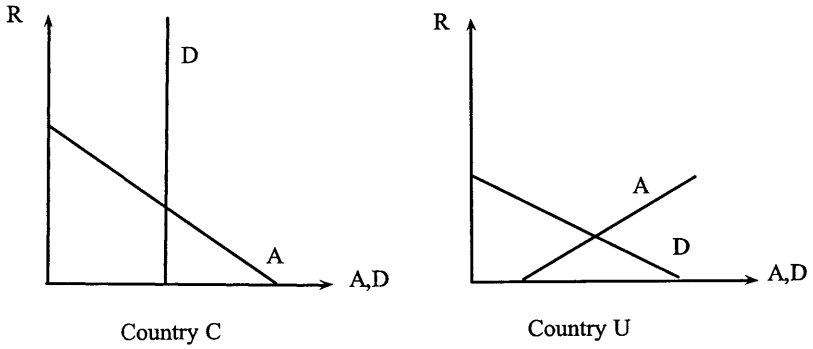

Figure 2-6: Autarky equilibrium: Capital market.

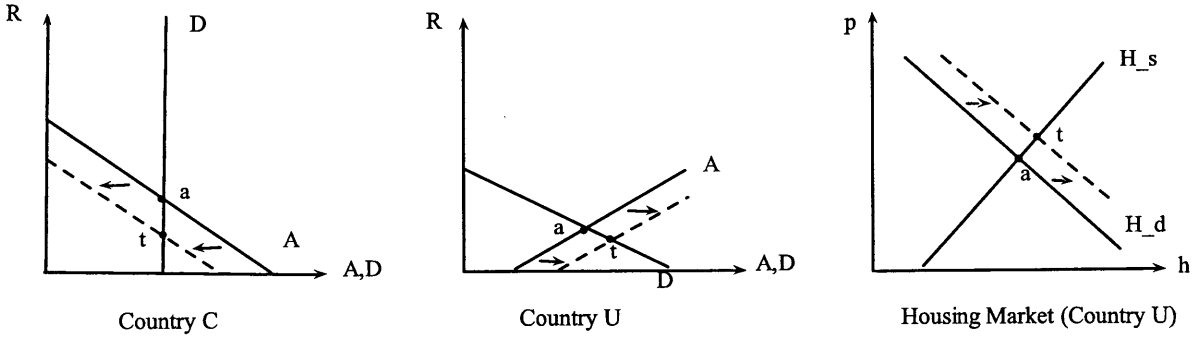

Figure 2-7: Trade equilibrium without bubbles.

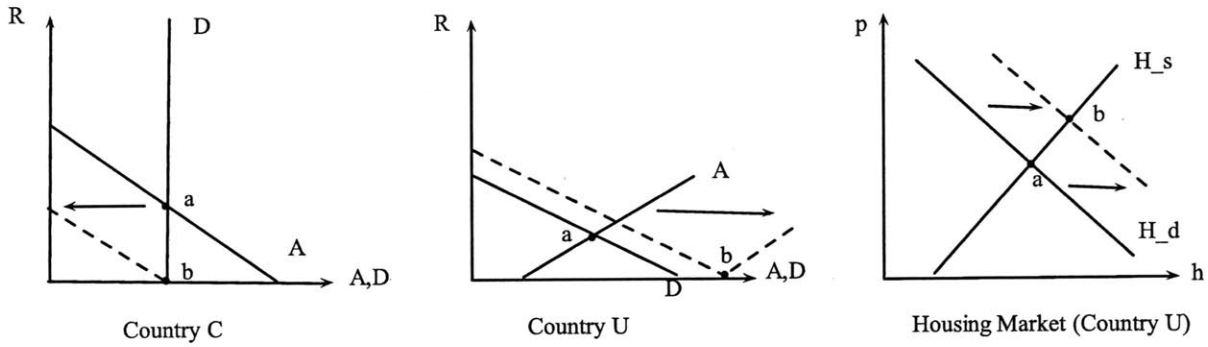

Figure 2-8: Trade equilibrium with a pure asset price bubble appearing in Country *U*.

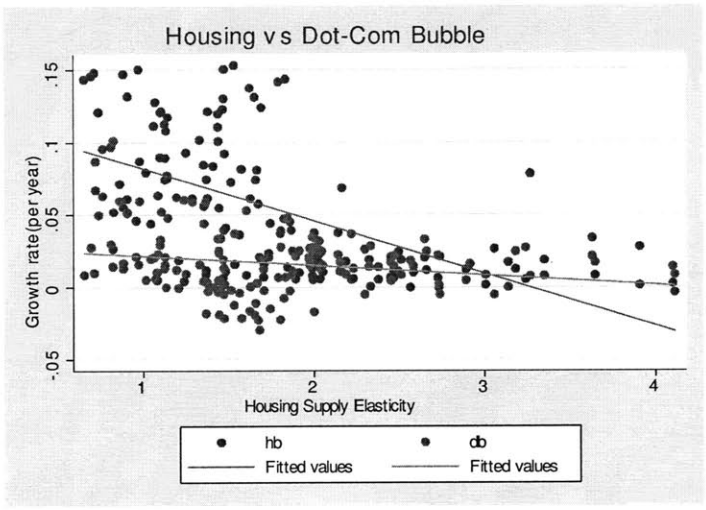

Figure 2-9: Growth Rate (per year) of House Prices during the Dot-Com (1996-2000) and the Housing Bubbles (2002-2006) in different U.S. metropolitan areas. Source: House price index from OFHEO and elasticity from Saiz (2009).

2.9 Tables

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.

2.10 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

Chapter 3

A Model of Two Globalizations: Implications for Wage Inequality and Trade Specialization[1]

3.1 Introduction

The skill content of North-South trade has changed over the last decades. Figure 3-1 documents the evolution of the share of southern exports in industries with skill intensity above the average skill intensity of U.S. industries. During the 1980s, southern exports increased relatively more in industries with skill intensity below the U.S. average. In the 1990s, this pattern was reversed and southern exports grew disproportionally more in industries above the U.S. average skill intensity.

These changes in southern exports can be exemplified by the bilateral trade of the U.S. with Chile and India. Figure 3-2 shows that in the 1980s Chilean exports increased in below average skill intensive industries. During the 1990s, Indian exports rose in above average skill intensive industries. We interpret these differential increases in North-South trade as reductions in different trade costs. Chile underwent a dramatic trade liberalization in the late 1970s and

[1] **This chapter is joint work with Martí Mestieri from MIT.**

1980s,[2] while India has benefited from offshoring of IT industries and services in the 1990s.[3]

Our empirical analysis suggests that the trade patterns described for India and Chile hold more broadly. Trade liberalizations in the 1980s increased northern imports in low skill intensive industries, whereas the IT revolution increased northern imports in middle skill intensive industries. We label the expansion of trade in low skill goods in the 1980s as *First Globalization* and the increase in trade in more skill intensive goods during the 1990s, *Second Globalization.* This will guide our comparative statics exercises.

The objective of this paper is to offer a unifying perspective of these two waves of globalization and analyze the complementarities between the two within a tractable framework. We investigate the effects of the Second Globalization on wage inequality, the pattern of specialization and how these effects change with the extent of First Globalization trade.

Our first main result highlights the complementarity between the two globalizations. Northern wage polarization in the Second Globalization is delayed by the extent of trade during the First. We find that the relative wage of high to middle skill workers increases throughout the Second Globalization. On the contrary, the relative wage of middle to low skill workers exhibits a hump shape pattern. Its peak increases and it is delayed by First Globalization trade. Thus, the equilibrium wage distribution tends to wage polarization as Second Globalization progresses and it is delayed by the extent of First Globalization trade.

Our second main result starts from the observation that some southern countries lack from the minimum stock of specific capital needed to benefit from the IT revolution. This may lead to an asymmetric participation in Second Globalization trade, as figure 3-3 suggests for India and Pakistan. To account for this asymmetric participation, we extend the model to two southern countries, with only one participating in the Second Globalization. We show that this generates a discontinuous pattern of specialization. The country participating in the Second Globalization specializes in the least skill intensive First Globalization goods, in addition to Second Globalization goods. The other southern country specializes in the relatively higher

[2]This pattern is not specific for Chile. Goldberg and Pavcnik (2007) document that trade liberalizations during the 1970s and 1980s in several emerging countries (e.g. Mexico, Colombia and Morocco) were biased towards low skill intensive industries.

[3]India is one of the countries which has benefited the most from this new wave of offshoring. Trefler (2006) documents that India hosted the highest number of new IT services projects (around 19% of the world total) and call centers (around 12% of the world total) in 2003 and 2004. Markusen (2006) and Markusen and Strand (2008) argue that these services need a skill intensity above the average skill intensity of U.S. imports.

skill intensive goods of the First Globalization. Wage inequality increases in the former and decreases in the latter.

Section 3.2 provides suggestive evidence consistent with a First Globalization characterized by tariff reductions affecting low skill industries and a Second driven by a fall in communication costs, mainly affecting middle skill industries. We show that tariffs only affected U.S. imports in the First Globalization. Then, we use a Routine Task Intensity (RTI) index as a proxy for offshorability in the Second Globalization. Figures 3-4 and 3-5 show that high levels of RTI (and, thus, offshoring) are associated with middle skill jobs.[4] We use Internet adoption as a proxy for communication costs and show its relevance for Second Globalization trade. Finally, we show that trade relatively reduced the U.S. wage bill in low skill industries during the First Globalization and relatively reduced it in middle skill industries in the Second.

Our model features a North-South trade economy. A freely traded final good is produced in the North by combining a bundle of inputs and high skill labor. This bundle is assembled using a continuum of inputs, which are produced combining middle and low skill labor in different proportions. Thus, this model can be thought as an offshoring decision of northern firms. We assume that North is skill abundant and that there are heterogeneous trade costs across different inputs. To show the main results of the paper in the most transparent way, our baseline model, section 3.3, abstracts from endogenous labor supply decisions. Subsection 3.5.1 allows for endogenous labor supply decisions and shows that all results hold.

Throughout the paper and for ease of exposition, we label the inputs traded in the First Globalization as *intermediates*, and those traded in the Second as *tasks*. We frame the First Globalization as an increase in the set of tradeable low skill *intermediates*, and the Second Globalization as an increase in the set of traded middle skill *tasks*.[5]

[4] This measure is closely related to impersonal services, which Blinder (2006) emphasizes as a distinctive element of Second Globalization trade. The use of the RTI is motivated by the observation that goods that can be electronically delivered (or monitored) are fairly standardized and follow determined procedures. The Index is taken from Autor and Dorn (2009), who also link the IT revolution with the loss of middle skill jobs in northern industries. In this paper, we focus on the role of offshoring of jobs to the South rather than the substitution of jobs by computers emphasized in Autor and Dorn.

[5] Note that these definitions do not change with the endogenous equilibrium objects. In particular, we assume that there exists a continuum of inputs indexed with $z \in [0,1]$. We label *intermediates* the inputs with skill intensity $z < \overline{z}$ and *tasks* inputs with skill intensity $z > \overline{z}$, where $\overline{z}$ is exogenous. Moreover, consistent with our empirical evidence that U.S. average southern imports have become more skill intensive, we frame both globalizations as increasing the skill content of U.S. imports.

Section 3.4 presents the main results of the model. In Subsection 3.4.1, we first analyze the comparative statics on relative wages for the First and Second Globalization. Then, we show how the distributional implications of the Second Globalization in the North depend on the extent of the First Globalization. In the First Globalization, the set of low skill intensive inputs imported from the South increases. As in Wood (1995) and Feenstra and Hanson (1996), since the intermediates imported by the North are below its mean skill intensity, the relative demand of middle skill labor increases, thereby raising their relative wage. Moreover, the wage of high skill workers relative to both middle and low skill agents increases because more intermediates can be bought at cheaper prices (thereby increasing the marginal productivity of high skill workers) and demand of northern intermediates decreases.

In the Second Globalization, as the set of traded tasks increases, the equilibrium tends to wage polarization in the North. The relative wage of high skill workers increases, because the same forces as in the First Globalization are in place. Namely, an increase in the set of traded inputs and a decline in the demand of northern inputs. The relative wage of middle to low skill workers exhibits an inverse U-shape pattern. The intuition is that the relative demand of northern middle skill workers increases if the marginal task being offshored to the South is below the skill intensity of the mean input produced in the North after the First Globalization.

We find that there is a complementarity between trade in the First and Second Globalization. Wage polarization is delayed by the extent of trade in the First Globalization. A larger set of intermediates traded during the First Globalization implies a higher skill intensity of the mean input produced in the North. Thus, more trade in the First Globalization allows a larger set of tasks to be offshored during the Second Globalization before the northern relative wage of middle skill workers starts to decline. This highlights the importance of having a unified view of the First and Second Globalization, which is one of the novelties of our framework.

In the South, relative wages increase both in the First and Second Globalization. The intuition is analogous to Wood (1995) and Feenstra and Hanson (1996). The marginal input being offshored is relatively more skill intensive. This raises the relative demand of middle skill labor and the relative wage throughout the globalization process.

Subsection 3.4.2 introduces a second southern country to study how asymmetric participation in the Second Globalization affects the pattern of specialization and wage inequality

in the South. We want to capture the notion that participation in the Second Globalization is constrained by the stock of specific capital required to benefit from the IT revolution (e.g. knowledge, institutions and infrastructure). To embody this idea in our model, we assume that only one southern country participates in the Second Globalization. In equilibrium, this country exports tasks to the North. Thus, it gains comparative advantage in the least skill intensive intermediates. This generates a discontinuous pattern of specialization. The most and least skill intensive traded inputs are produced by this southern country. As the Second Globalization progresses, the equilibrium tends to complete specialization. One South produces tasks and the other, intermediates. The distributional implications are that the relative wage of middle skill workers increases in the South participating in the Second Globalization, while it declines in the other. Figure 3-3 shows how this could have been the pattern of specialization for India and Pakistan during the Second Globalization. Indian exports grew in industries above average skill intensity, whereas Pakistani exports grew in below average skill intensive industries.

Section 3.5 presents two extensions. Subsection 3.5.1 allows for endogenous supply decisions. It shows that the comparative statics for wages derived in the baseline model hold in this extended version. Moreover, additional insights on the distribution of jobs emerge. In particular, the mass of northern agents selecting into middle skill jobs increases during the First Globalization and eventually shrinks during the Second, while the converse is true for the mass of agents selecting into low skill jobs. Finally, we have emphasized the role of the IT revolution in allowing firms to participate in the Second Globalization. However, the Second Globalization is also an outcome of the adoption of new technologies that replace middle and low skill jobs (Autor et al., 1998). Subsection 3.5.2 shows that the adoption of a new technology needed to benefit from Second Globalization trade is delayed by the extent of trade in the First Globalization.

The rest of the paper proceeds as follows. In Section 3.2, we present the motivating evidence and discuss the related literature. Section 3.3 presents the baseline model and Section 3.4 derives the main results of the paper. The two extensions of the model are presented in Section 3.5. Section 3.6 concludes. Proofs are in the appendix.

3.2 Motivating Evidence and Related Literature

3.2.1 Empirical Evidence

The premise of our analysis is that trade costs have changed differentially across sectors of different skill intensity. In particular, the First Globalization comparative statics exercise assumes that the decline in trade costs is concentrated in low skill intensive industries. The Second Globalization comparative statics exercise assumes that the fall in trade costs is concentrated in middle skill intensive industries.

In this section, we offer a variety of suggestive evidence consistent with these assumptions. We argue that the reduction in trade costs in the 1980s (First Globalization) seems to have been biased towards the least skill intensive industries due to tariff reductions. On the contrary, trade costs since the 1990s (Second Globalization) appear to have fallen mainly for industries with middle skill intensity because of reductions in communication costs (IT revolution). We then show that these differential reductions in trade costs have changed the type of goods that the U.S. trades. Finally, we provide suggestive evidence pointing to a different correlation between trade and demand for skill in the U.S. during 1980s and 1990s, which is also consistent with the model.

Evidence on Tariffs and Transportation Costs

The first piece of evidence comes from analyzing changes in U.S. tariffs by industry (3-digit NAICS) and industry mean skill intensity. Although non-tariff barriers are important, the difficulty on assessing their differential effect by skill precluded us from analyzing them. First, we provide a complementary view of the Haskel and Slaughter (2003) finding for the U.S., calculating the mean tariff change between 1978 and 1988 by industry skill intensity. Figure 3-6 shows that the decrease in the lowest skill intensive industries is the highest. In fact, it is the only skill level at which the change in tariffs is statistically greater than one percent. Second, we perform an analogous exercise for the 1990-2000 period. Figure 3-7 shows that the changes in U.S. tariffs were not significantly different from zero at any level of skill intensity. Thus, during the 1990s there was not a clear pattern of change in tariffs across different skill intensive industries, whereas in the 1980s, tariff reductions mainly affected low skill intensive

industries. Finally, we perform a similar exercise by calculating the implied transportation costs of U.S. imports. Figure 3-8 shows that the decrease in transportation costs was not statistically different from zero at any level of skill, neither in the 1980s, nor in the 1990s.[6]

The second piece of evidence comes from Goldberg and Pavcnik (2007). Goldberg and Pavcnik summarize empirical evidence for emerging countries pointing that trade liberalizations in the 1970s and 1980s were biased towards low skill intensive industries. Amongst others, they cite Hanson and Harrison (1999) and Robertson (2000, 2004) documenting this pattern for Mexico, Currie and Harrison (1997) for Morocco and Attanasio et al. (2004) for Colombia. This is also consistent with the evidence presented for Chile in figure 3-2. Therefore, the overall evidence points towards a differential effect of trade liberalization on low skill intensive industries during the 1980s, but not in the 1990s.

Evidence on Communication Costs

Blinder (2006) remarks that the offshoring of services is a distinctive feature of the recent patterns of trade. Services which seemed non-tradeable during the First Globalization are now being offshored. Blinder notes that these "...services can be delivered electronically over long distances with little or no degradation in quality...". Thus, the standard measures of transportation costs become less useful to understand these new trade patterns. We argue that communication costs may have become the relevant margin driving the Second Globalization pattern of trade.

A common characteristic of goods that can be electronically transmitted is that they are readily standardized and follow tight and determined procedures. In order to capture this intuition, we use the index of routine task intensity (RTI) from Autor and Dorn (2009) as a proxy for "offshorability". Each job is assigned a routine and a manual score, and this index is the log ratio of the two. Therefore, tasks with high RTI imply a high routine and a low manual score. We think of jobs with higher RTI index as having higher probability of being offshored.[7]

[6] This is consistent with Hummels (2007) findings for shipping costs. Hummels documents that ocean trade represents a large share of international trade and shows that the ad-valorem shipping cost has not changed much since the 1950s.

[7] Grossman and Rossi-Hansberg (2006) also relate routine indices with offshoring. The RTI index assigns a value of "routine intensity" to a representative set of 332 occupations in the U.S. census. See Autor and Dorn (2009) for further details. Note that the findings reported in Blinder and Krueger (2009) are not inconsistent

Figure 3-4 reports anecdotal evidence pointing that higher RTI jobs are performed by middle skill workers. Importantly, high RTI jobs such as telephone operators or data entry keyers are being offshored (Trefler, 2006). This figure suggests that there exists an inverse U-shape relationship between skill intensity and RTI. In fact, we find this pattern when we average the RTI of different occupations by industry skill intensity (figure 3-5).

Evidence on U.S. Imports

We now investigate the relationship between tariffs, communication costs and U.S. imports for the two globalizations.[8] To begin, we run a regression of U.S. imports on tariffs of the type

$$X_{ic} = \alpha + \beta\ \tau_i + \delta_j + \delta_c + \varepsilon_{ic}, \tag{3.1}$$

where X_{ic} are exports of product i from country c to the U.S., τ_i are U.S. tariffs for product i, δ_j and δ_c represent industry and country fixed effects, respectively. Our measure of industry is a 3-digit NAICS and of product is a 6-digit HS. Columns 1 and 2 of panel A in Table 3.2 show a negative, significant effect of tariffs on U.S. imports in 1990.[9] Moreover, this effect is larger when the sample is restricted to southern countries (columns 6 and 7). Therefore, this suggests that tariffs play a significant role in shaping U.S. imports during the First Globalization.

Columns 1, 2, 6 and 7 of panel B report the coefficients on tariffs of regression (3.1) for year 2000. The negative effect of tariffs found for the First Globalization ceases to be significant, both for the whole sample and in the South. This suggests that tariffs are not an important force driving U.S. imports during the Second Globalization. Thus, a different notion of trade cost may have become relevant to understand the Second Globalization pattern of trade. Communication costs emerge as a natural candidate.

The IT revolution has allowed electronic transmission of goods and reduced monitoring costs,

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with the use of the RTI index as proxy for offshorability. The reason is that Blinder and Krueger only consider a measure of routine that abstracts from the manual content of a job.

[8] There is a growing literature emphasizing that there are more dimensions in trade costs, e.g. Hummels (2007), Irarrazabal et al. (2010). However data along other dimensions of trade costs is difficult to come by. Specially for non-tariff barriers, data have been elusive to researchers due to the reluctance of disclosure (cf. Anderson and van Wincoop, 2004)

[9] U.S. imports are from Feenstra's data base and U.S. tariffs come from Romalis. Romalis' tariff data starts in 1989, thus we can only test for the last years of our Fist Globalization.

reshaping the notion of offshorability. Given that the intrinsic feature of these new traded goods is that they can be electronically delivered, we use Internet adoption at the country level as a proxy for communication costs. To investigate if the level of Internet adoption has a significant and differential effect on U.S. imports across different skill intensive industries, we run the following regression

$$X_{ic} = \alpha + \beta\ \tau_i + \gamma\ \text{Internet}_c \cdot \text{Skill Intensity}_j + \delta_j + \delta_c + \varepsilon_{ic}, \tag{3.2}$$

where X_{ic} are exports of product i from country c to the U.S., τ_i is U.S. tariff on product i, Internet_c is the fraction of the population with access to Internet in country c, Skill Intensity_j is the average skill of industry j and δ_j and δ_c represent industry and country fixed effects, respectively. All variables are for year 2000.

Columns 3 and 4 of panel B in Table 3.2 show that the coefficient on the interaction between Internet and Skill Intensity is positive and only significant with robust standard errors. This means that the more skill intensive an industry is, the larger the effect of Internet adoption on exports is.[10] Columns 8 and 9 show how this effect is exacerbated and becomes significant even with clustered standard errors when the sample is restricted to southern countries. This points at a differential effect of the IT revolution on southern countries. Finally, note that tariffs remain not significant in all the specifications.[11]

It is worth noting that our results abstract from trade in services, because these data are not available. Yet, as suggested by Blinder (2006), services play a sizable role in the Second Globalization. We think that the lack of data on trade in services underestimates our results because of two reasons. First, services being offshored are more RTI intensive. Second, as argued by Markusen (2006) and Markusen and Strand (2008), services require above average

[10] In this sample the highest skill intensity level is 11.4, which roughly coincides with skill level associated with the largest RTI.

[11] As robustness checks we added additional controls. One could think that our Internet adoption measure could be a proxy for other country variables such as country wealth, human capital levels and financial development and therefore their interaction with skill intensity could be relevant. Our coefficients of interest remained significant and with similar values to the baseline regression when adding these additional covariates.

A second robustness check is to control for the potential endogeneity of our measure of skill intensity. In order to address this concern, we instrument skill intensity with the RTI index. Our exclusion restriction is that RTI only affects exports through the level of skill intensity of an industry. Columns 5 and 10 report the previous regressions using this instrumental variable approach. The coefficients of interest remain significant and with the expected sign.

skills to be produced. Both facts imply that the effect we have documented would be presumably larger if data on services were available.[12]

Evidence on U.S. Wage Bill

In this subsection we show how the changes in wage bill paid by different U.S. industries is correlated with the changes in U.S. trade. The results of this exercise suggest that the relationship between trade and demand for skill has been different during the two waves of globalization.

Column 1 in Table 3.3 reports the results of regressing the change in U.S. wage bill during the 1980s on the interaction of average industry skill with change in trade openness.[13] The coefficient is positive and significant. This result states that an increase in trade openness raises relatively more the wage bill of more skill intensive industries.

Column 2 shows that the coefficient on the interaction term is not significant for the 1990s. Yet, when we add a quadratic term, the coefficients become significant, as shown in column 3. This implies a U-shape pattern for the response of wage bill to increases in trade. It means that the wage bill of middle skill intensive industries declined relative to low and high.

Therefore, Table 3.3 suggests that the relationship between trade and demand for skill has changed. During the 1980s (First Globalization) an increase in trade openness was correlated with a fall in the relative demand of low skill labor. In contrast, in the 1990s (Second Globalization), an increase in trade openness was correlated with a reduction in the relative demand of middle skill labor.

The overall evidence presented in this section paints a picture of two different waves of globalization. The First Globalization was characterized by a decline in tariffs which increased trade in industries with low skill intensity and affected the relative demand of low skill workers. The Second Globalization was shaped by a fall in communication costs which raised trade in intermediate skill intensive industries and affected the relative demand of middle skill workers.

[12] Most of the countries lack of data for access to Internet in 1990. Therefore equation 3.2 cannot be run for year 1990.

[13] We use the U.S. wage bill data for 1980-1996 constructed in Autor et al. (1998). Our trade openness measure is the share of exports plus imports over GDP from the Penn World Tables. Finally, our industry skill intensity measure is taken from the U.S. census data, see Data Appendix for more details.

3.2.2 Related Literature

The evidence presented above points towards two waves of globalization characterized by changes in trade costs affecting industries of different skill intensity. Motivated by this evidence, our paper focuses on the effects of heterogeneous changes in trade costs on wage inequality and the pattern of specialization.

This paper relates to a rich and diverse literature on international trade, wage inequality and the patterns of specialization. To the best of our knowledge, our work is the first attempt to provide a unified view of the globalization process and its effect on wage inequality, both across North-South trade and between different southern countries.

Our First Globalization comparative statics results are related to standard Heckscher-Ohlin models and the influential work of Wood (1995) and Feenstra and Hanson (1996). Feenstra and Hanson provide a rationale for increasing inequality in both North and South. They analyze the effect of capital inflows to the South in the context of a free trade equilibrium. These capital inflows reduce the unit cost of production in the South, allowing the South to produce more (relatively) skill intensive goods at the margin. The underlying mechanism of our comparative statics for the First Globalization is similar. However, their comparative statics exercise is different from ours, as we focus on changes in transportation costs. Another important difference is that our framework, by assuming heterogeneous transportation costs, allows us to study the two waves of globalization and their interdependence.

Our analysis of the Second Globalization bears upon the literature on offshoring, outsourcing and wage inequality. It includes, among others, Antràs et al. (2006a,b), Dinopoulos et al. (2009), Grossman and Rossi-Hansberg (2008), Markusen and Strand (2008) and Zhu and Trefler (2005). Our paper shares the emphasis on middle skill agents as in Antràs et al. (2006b). They focus on team problem solving. In contrast, we consider a segmented production process with firms supplying inputs. This enables us to distinguish the effects of different changes in trade costs on wage inequality. Grossman and Rossi-Hansberg (2008) consider the effect of heterogeneous transportation costs. However, they assume that tasks can be so perfectly partitioned that a fall in trade costs only affects one type of labor.

Anderson (2009), Costinot and Vogel (2009), Grossman and Maggi (2000) and Ohnsorge and Trefler (2007) among others study the role of sorting for wage inequality and the pattern

of specialization. They emphasize the difference between North-South and North-North trade, from which we abstract. However, they ignore the differential effect of heterogeneous changes in trade costs across sectors of different skill intensity.

The literature on international trade and labor market frictions has also discussed the role of trade for wage inequality. It includes among others Amiti and Davis (2008), Davidson et al. (2008), Egger and Kreickemeier (2009) and Helpman et al. (2008). They analyze the interaction of labor market frictions and trade on wage inequality, whereas our model features competitive labor markets and wage inequality arises from changes in the skill content of trade due to heterogeneous trade costs.

Our paper is also related to a broader literature on technology and wage inequality, for example, Acemoglu (2003), Blum (2008) and Yeaple (2005). We briefly discuss the incentives to adopt technologies within our two globalizations framework. Finally, labor economists have documented large changes in U.S. wage inequality, which our findings relate to. This vast literature includes Katz and Murphy (1992), Acemoglu (1999), Autor et al. (2003), Autor et al. (2008) and Autor and Dorn (2009) among others.

3.3 Model

In this section we present a simple model to study the effects of the two waves of globalization. A freely traded final good is produced in the North using high skill labor and a bundle of inputs, which are produced by middle and low skill workers. Inputs are subject to heterogeneous trade costs. This enables us to frame our two globalizations in a tractable manner. Our baseline model abstracts from endogenous labor supply decisions. It consists of three exogenous types in the North and two in the South. Subsection 3.5.1 shows that the results derived for the baseline case go through when there is a continuum of types and each type endogenously selects into one occupation.[14] This section presents and characterizes the baseline model and Section 3.4 derives the main results of the paper.

[14] In a working paper version available upon request, we analyze a similar model with three types in both North and South and derive qualitatively analogous results.

3.3.1 Baseline Model

We consider a competitive world economy consisting of two countries, North, N, and South, S. Each country is populated by a mass one of agents, which cannot migrate. Each agent is endowed with one unit of labor that inelastically supplies to the market. Northern agents can be divided between low, middle and high skill types. The fraction of each type is $1-\theta^N$, $\theta^N(1-\varphi)$ and $\theta^N\varphi$, respectively. Our interpretation is that a fraction θ^N has basic education and a fraction φ obtains further education. We assume that $\varphi = 0$ in the South. Thus, southern population can be divided between a fraction $1-\theta^S$ of low and a fraction θ^S of middle skill agents. Finally, we assume that the South is relatively abundant in low skill labor, i.e., $(1-\theta^S)/\theta^S > (1-\theta^N)/\theta^N(1-\varphi)$.

All agents have the same utility function, $u(c)$, which is defined over individual consumption of the final good c.

The final good is produced by combining a bundle of inputs B and high skill services h,

$$Y = h^{\alpha}B^{1-\alpha}. \tag{3.3}$$

This h can be thought as headquarter services, which are provided by high skill agents. The bundle is made by assembling a continuum of inputs, $I(z)$, with $z \in [0,1]$,

$$B = \int_0^1 \ln I(z)dz. \tag{3.4}$$

Each input is produced using a Cobb-Douglas production function

$$I(z) = A\left(\frac{m(z)}{z}\right)^{z}\left(\frac{l(z)}{1-z}\right)^{1-z} \quad \text{for } z \in [0,1], \tag{3.5}$$

where A denotes a productivity factor and $m(z)$ and $l(z)$ denote middle and low skill workers employed in the production of input z, respectively.[15] Note that z parametrizes the skill intensity required to produce each input. The higher is z, the more intensive the input in middle skill labor is.

[15] We assume that $A > \frac{e}{1-\alpha}\left(\theta^S(1-\theta^N)\right)^{-1}$, where e is the Neper number, to ensure that the bundle is positive. This condition is implied by (3.5) and (3.6).

The final good is assumed to be freely traded and we normalize its price to one throughout the paper. Inputs are subject to heterogeneous iceberg costs. For one unit of input z to arrive at home, $\tau(z)$ units must be purchased abroad.

Definition A *competitive equilibrium* is a set of prices $p^i(z)$ for each input z and country $i \in \{N, S\}$, a price for the final good $p_f(\equiv 1)$, a wage for low skill workers w_l^i, a wage for middle skill workers w_m^i, a wage for northern high skill workers w_h^N, an allocation of low skill $l^i(z)$ and middle skill $m^i(z)$ labor across inputs producers and a consumption choice c^i for each agent in country i such that agents maximize their utility given their income, firms maximize profits and all markets clear.

3.3.2 Trade equilibrium

We characterize the competitive equilibrium for a given trade cost function $\tau(z)$. Consider the problem of the final good producer,

$$\max_{\{h, I^i(z)\}} h^\alpha \left(\int_0^1 \ln I^i(z) dz \right)^{1-\alpha} - w_h h - \int_0^1 p^i(z) I^i(z) dz. \tag{3.6}$$

Demands for high skill services and each input z are

$$\alpha Y = w_h h, \tag{3.7}$$

$$(1-\alpha) Y = I^i(z) p^i(z) B. \tag{3.8}$$

Consider the problem of an input producer in country i,

$$\max_{\{m^i(z), h^i(z)\}} p^i(z) A \left(\frac{m^i(z)}{z} \right)^z \left(\frac{l^i(z)}{1-z} \right)^{1-z} - w_m^i m^i(z) - w_l^i l^i(z).$$

The labor demands of a producer of input z in country i are given by

$$z p^i(z) I^i(z) = w_m^i m^i(z), \tag{3.9}$$

$$(1-z) p^i(z) I^i(z) = w_l^i l^i(z). \tag{3.10}$$

Using labor market clearing, we can integrate labor demands across all input producers in

each country to obtain the following implicit expressions for wages

$$w_h = \alpha \frac{Y}{\theta^N \varphi}, \tag{3.11}$$

$$\int_0^1 m^N(z)dz = (1-\alpha)\frac{Y}{B}\int_0^1 \left(\mathbf{1}_d^N(z) + \frac{\mathbf{1}_x^N(z)}{\tau(z)}\right)\frac{z}{w_m^N}dz = \theta^N(1-\varphi), \tag{3.12}$$

$$\int_0^1 l^N(z)dz = (1-\alpha)\frac{Y}{B}\int_0^1 \left(\mathbf{1}_d^N(z) + \frac{\mathbf{1}_x^N(z)}{\tau(z)}\right)\frac{1-z}{w_l^N}dz = 1-\theta^N, \tag{3.13}$$

$$\int_0^1 m^S(z)dz = (1-\alpha)\frac{Y}{B}\int_0^1 \frac{\mathbf{1}_x^S(z)}{\tau(z)}\frac{z}{w_m^S}dz = \theta^S, \tag{3.14}$$

$$\int_0^1 l^S(z)dz = (1-\alpha)\frac{Y}{B}\int_0^1 \frac{\mathbf{1}_x^S(z)}{\tau(z)}\frac{1-z}{w_l^S}dz = 1-\theta^S, \tag{3.15}$$

where $\mathbf{1}_d^i(z)$ and $\mathbf{1}_x^i(z)$ are indicator functions for each input z being produced in country i for domestic consumption and for exporting, respectively. The rest of the equilibrium outcomes can be fully characterized as follows. A price $p^i(z)$ for each input follows from the demand function (3.8). The allocation of middle skill labor $m^i(z)$ is determined by (3.9) and the allocation of low skill labor $l^i(z)$ is given by (3.10). Using that optimality in consumers' behavior requires that all their income should be consumed, we can derive the optimal level of consumption. Finally, given that the final good is freely traded, trade balance results from the value of exports of inputs and final good being equal to the value of imports in a country.

3.4 Main Results

In this section we present the two main results of the paper. Subsection 3.4.1 derives the distributional consequences of the First and Second Globalizations and then shows our first main result, namely, the complementarity between the First and the Second Globalization. Subsection 3.4.2 extends the baseline model by dividing the original South in two different southern countries which open differently to trade in the Second Globalization. Our second main result states how the patterns of specialization and wage inequality depend on the differential participation in the Second Globalization.

3.4.1 The two Globalizations and their Complementarity

This section performs comparative statics on relative wages for the two globalizations. Then, we present our first main result which shows how the distributional effects of the Second Globalization depend on the extent of the First. We show that trade in First Globalization delays the emergence of wage polarization in the North during the Second Globalization.

Comparative Statics for the First Globalization

Section 3.2 characterized the First Globalization as a decrease in the trade costs of the least skill intensive inputs. To study its effects in a parsimonious way, we assume that trade is only possible in inputs with an index lower than z_I.[16]

Consistent with the empirical evidence provided in Section 3.2, we define First Globalization as an increase in the set of traded intermediates. Therefore, the comparative statics exercise we are interested in is an increase in z_I.[17]

Assumption 1 $z_1 < z^*(\theta_N, \theta_S) < 1$, where $z^*(\theta_N, \theta_S)$ is implicitly defined as

$$\left(\frac{1-z^{*2}}{z^{*2}}\frac{\theta_S}{\theta_N}\right)^{z^*}\left(\frac{(1-z^*)^2}{1-(1-z^*)^2}\frac{1-\theta_S}{1-\theta_N}\right)^{1-z^*}=1. \tag{3.16}$$

The threshold $z^*(\theta_N, \theta_S)$ is an implicit function of the relative skill abundance of both countries. This assumption implies that all traded inputs are produced in the South. North exports the freely traded final good to ensure balanced trade.

Proposition 6 *(First Globalization) The First Globalization equilibrium features an increase of the relative wage of middle skill workers in the North and the South. The relative wage of northern high skill workers increases.*

[16] This threshold z_I could be endogenized as an equilibrium outcome if we assumed a constant iceberg cost $\tau(z) = \tau$. The reason is that the South has comparative advantage in low skill intensive inputs. In this case, our First Globalization comparative statics exercise (i.e., an increase in z_I) could be endogenously obtained as a decrease in τ.

[17] Our qualitative results would go through if we allowed for $\tau(z) = 1$ for $0 < \underline{z} < z < z_I$. The key assumption is that an increase in the set of traded inputs in the First Globalization translates into an increase in the relative demand of middle skill labor in the South. This assumption is borne out by the data. The average skill of U.S. southern imports has increased in the 1980s and the 1990s.

The proof follows from using equations (3.11) to (3.15). The relative wages of middle to low skill workers are

$$\frac{w_m^N}{w_l^N} = \frac{1-\theta^N}{\theta^N}\,\frac{1+z_I}{1-z_I}, \qquad \frac{w_m^S}{w_l^S} = \frac{1-\theta^S}{\theta^S}\,\frac{z_I^2}{1-(1-z_I)^2}.$$

By inspection, the relative wages are increasing in z_I. The relative wage of high skill is increasing because B increases with z_I and demand of northern inputs decreases.

Note that the relative wages of middle to low skill workers consists of two parts. The term $(1-\theta^i)/\theta^i$ corresponds to the relative supply (of low skill agents), while the term containing z corresponds to the relative demand. Therefore, our First Globalization comparative statics represents a shift in the relative demand curves, while keeping the relative supply fixed.[18] This is summarized in figure 3-9.

The relative wage of middle to low skill workers in the North increases because it offshores the least skill intensive inputs. As a result, the relative demand of middle skill workers increases, thereby increasing the relative wage. The relative wage of middle to low skill workers also increases in the South. The reason is that an increase in traded intermediates (i.e., an increase in z_I) translates into a larger relative demand of middle skill jobs. This is also noticed in Wood (1995) or Feenstra and Hanson (1996).[19]

Comparative Statics for Second Globalization and Complementarity Result

Based on our results in Section 3.2, we characterize the Second Globalization as an increase in traded middle skill intensive inputs. We argued that the reduction in communication costs was the driver of the Second Globalization and it mainly affected trade in middle skill industries. Thus, we add to the set of traded intermediates a new set of tradeable tasks. Given that the nature of trade costs driving the First and Second Globalizations is different, it is natural to allow for the two sets to be possibly disjoint. We frame this observation in the following trade

[18] In subsection 3.5.1 we generalize the model to have endogenous labor supply and we show that the comparative statics on wages remain unchanged.

[19] Despite the mixed evidence presented in Goldberg and Pavcnik (2007) for inequality in the South, conventional wisdom seems to point to an increase in southern inequality as the right prediction to have. Our model is consistent with this prediction.

cost structure

$$\tau(z) = \begin{cases} 1 & \text{for } z \leq z_I \text{ and } \bar{z} \leq z \leq z_{II}, \\ \infty & \text{otherwise,} \end{cases} \tag{3.17}$$

where $0 \leq z_I \leq \bar{z} \leq z_{II} < 1$. In addition to the First Globalization trade in intermediates $z \in [0, z_I]$, we now allow for trade in more skill intensive tasks $z \in [\bar{z}, z_{II}]$.

We formally define Second Globalization as an increase in z_{II}. Thus, the comparative statics exercise that we perform is to increase the set of traded inputs with skill intensity above $\bar{z}$ by increasing z_{II}.[20]

Allowing for the sets of First and Second Globalization traded inputs to be disjoint enables us to have a natural measure of depth of the First Globalization. Other formulations that do not rely on disjoint sets are possible and deliver similar insights. The two key assumptions are *(i)* trade in the Second Globalization affects more skill intensive industries than in the First and *(ii)* an increase in the set of traded inputs in the First and Second Globalizations translates into an increase in the relative demand of middle skill labor in the South. These two assumptions are borne out by the data, as discussed above.

Assumption 2 $z_{II} < z^*(\theta_N, \theta_S)$, where $z^*(\theta_N, \theta_S)$ is implicitly defined in equation (3.16).

This assumption ensures that in equilibrium South produces all traded inputs.

Proposition 7 *(Second Globalization) In the Second Globalization equilibrium, the relative wage of middle to low skill workers in the North has an inverse U-shape pattern. It increases in z_{II} for $z_{II} < \tilde{z}_{II}(z_I, \bar{z})$ and decreases thereafter. The relative wage of high skill workers in the North and the relative wage of middle to low skill workers in the South increase in z_{II}.*

The intuition for the comparative statics of the relative wage of middle northern workers is as follows. Assume that $\bar{z} = 1/2$ and note that, to a first order approximation (for small z_I), the threshold $\tilde{z}_{II}(z_I, \bar{z} = 1/2)$ is the arithmetic mean of the skill intensity of inputs produced in the North after the First Globalization, i.e., $\tilde{z}_{II}(z_I) = \frac{1+z_I}{2}$. Therefore, when North offshores tasks below the skill requirement of the average input produced domestically, the relative demand of

[20] We increase z_{II} instead of decreasing $\bar{z}$ because, consistent with our empirical evidence, the average skill intensity of U.S. imports has increased over time.

middle skill workers increases, raising the relative wage. Conversely, the relative wage decreases when the tasks being offshored require a skill intensity higher than the skill of the average input. The relative wage of high skill workers increases because the size of the bundle of inputs increases with the set of tradeable inputs. This implies that the equilibrium tends to wage polarization. The relative wage of high to middle skill workers increases and the relative wage of middle to low skill workers decreases. The relative wage in the South increases in the Second Globalization. The intuition is that the marginal input being offshored is more skill intensive, which raises the relative demand of middle skill workers.

Our results for the wage distribution in the North are consistent with the 90/50 and 50/10 measures of U.S. wage inequality in the last three decades. Namely, the 90/50 measure has steadily increased, and the 50/10 increased during the 1980s, flattening and, eventually declining thereafter. This is consistent with our model. Figure 3-10 reports the predictions of our model and data on U.S. wage inequality used in Autor et al. (2008).

Proposition 8 *(Complementarity in the North) The threshold $\tilde{z}_{II}(z_I)$ below which the relative wage of middle skill workers in the North increases in z_{II} is increasing in z_I.*

Figure 3-11 summarizes the results in proposition 8. Consider the extreme case in which the First Globalization did not happen, i.e., $z_I = 0$. The mean skill intensity of northern inputs is $\tilde{z}_{II}(0) = 1/2$. Thus, the relative wage decreases from the onset of the Second Globalization. Consider now the case in which there has been some First Globalization, i.e., $z_I > 0$. In this case, the mean skill is larger ($\tilde{z}_{II}(z_I) > 1/2$), implying that the relative wage increases in the first stages of the Second Globalization ($z_{II} < \tilde{z}_{II}$), to decrease thereafter. This brings about the importance of taking into account the First Globalization to predict the effects of the Second. There is a complementarity between trade in First and Second Globalization. Note that this result implies that northern wage polarization is delayed by the extent of trade in the First Globalization.

Table 1 provides anecdotal evidence consistent with this result. Measuring trade openness as exports plus imports over GDP from the Penn World Tables, this index for 1991 was 17.2 percent for the U.S., 40.8 percent for the U.K. and 46.6 percent for Germany. Suppose that "the First Globalization ended" in 1990. Our prediction that the deeper the First Globalization

is, the higher the relative wage of middle skill workers (our 50/10 measure) will rise, seems to be confirmed by the independent studies of Autor et al. (2008) for the U.S., Goos and Manning (2007) for the U.K. and Dustmann et al. (2007) for Germany. The increase in relative wage was the lowest in the U.S. and the highest in Germany.

3.4.2 Two Souths and the Moving Band

In this subsection, we investigate how the existence of different southern countries which asymmetrically participate in Second Globalization trade affects their pattern of specialization and wage inequality. As pointed out before, a key difference between the First and Second Globalization is that, while the First is driven by tariff reductions, the Second is driven by the IT revolution. Arguably, a trade liberalization is a policy relatively easier to implement than building the specific capital needed to benefit from the IT revolution.[21] Thus, it is reasonable to expect that not all southern countries can equally engage in Second Globalization trade. To account for this heterogeneity within our framework, we consider an extension in which two identical Souths, Southeast and Southwest, open asymmetrically to trade during the Second Globalization. More specifically, we assume that the two Souths open to trade in the First Globalization, but only Southeast participates in the Second.[22]

The equilibrium in the First Globalization is simple. Due to the symmetry of the two southern countries, all competitive equilibria feature the same wage schedule in both Souths. Appendix 3.9 contains the formal proof. We now turn to the characterization of the equilibrium in the Second Globalization.

Proposition 9 *(Pattern of Specialization) In the Second Globalization, Southeast exports tasks* $z \in [\overline{z}, z_{II}]$ *and intermediates* $z \leq \check{z}_I(z_I, z_{II})$. *Southwest exports intermediates* $z \in [\check{z}_I(z_I, z_{II}), z_I]$, *with* $0 \leq \check{z}_I(z_I, z_{II}) < z_I$.

The intuition for the result is that when Southeast starts offshoring tasks, its relative wage of low skill workers decreases (these tasks are more skill intensive than the intermediates offshored

[21] In policy circles, trade liberalizations can be categorized as "first-generation" reforms. On the other hand, building the stock of technology and creating the institutional features needed to benefit from the IT revolution would be considered "second-generation" reforms, which take a longer time to be completed. See Buera and Shin (2008) for a similar discussion.

[22] We maintain Assumption 2.

in the First Globalization). This gives Southeast comparative advantage in the least skill intensive intermediates. As a result, in addition to tasks ($z \in [\overline{z}, z_{II}]$), Southeast also produces the least skill intensive intermediates ($z \in [0, \check{z}_I]$).

Proposition 10 *(Moving Band) The threshold $\check{z}_I(z_I, z_{II})$ is increasing in z_I and decreasing in z_{II} in the relevant range.*

An implication of proposition 10 is that the equilibrium tends to complete specialization as the second wave of globalization progresses (i.e., z_{II} increases). As the set of traded tasks increases, the labor demand in Southeast increases, raising wages. Thus, the range of intermediates in which Southwest has comparative advantage increases. Wages in Southeast rise and eventually reach a point in which Southeast is only able to produce tasks (i.e., $\check{z}_I$ goes to zero). Therefore, the band of intermediates produced in Southeast shrinks with the progress of the Second Globalization. In this sense, we have a moving band of intermediates in which Southeast has comparative advantage.

Proposition 11 *The relative wage of middle skill workers is increasing in Southeast and (weakly) decreasing in Southwest in z_{II}.*

The intuition is similar to proposition 7. Southwest increases the production of intermediates below the mean skill of its domestic production, raising the relative wage of low skill workers. The converse happens with Southeast. The set of exported tasks increases, while the band of exported intermediates decreases. As a result, the relative demand for middle skill labor rises, thereby increasing its relative wage.

Proposition 11 highlights how gains from Second Globalization may not be equally shared between different types of workers across southern countries. This is a consequence of the change in the southern division of production. Let Internet access be a proxy for the participation in the Second Globalization. In 2000, Internet access in India was twice as large as in Pakistan.[23] This suggests a different participation in the Second Globalization for India and Pakistan. Our model predicts India specializing in middle skill intensive industries and Pakistan specializing

[23] We use the number of Internet users per 100 inhabitants and the International Internet Bandwidth measured in bits per person from the World Development Indicators (World Bank).

in less skill intensive industries. This is consistent with Indian and Pakistani exports to the U.S., as documented in figure 3-3. The model then implies an increase in the relative wage of middle skill workers in India and a decline in Pakistan.

Some studies suggest that there is low labor mobility within southern countries. For example, Munshi and Rosenzweig (2009) document low labor mobility in rural India, even though inequality has risen in recent years. Paweenawat and Townsend (2009) document a similar pattern for Thailand and show that wages are not equalized across different Thai regions. Candelaria et al. (2009) document a similar fact for China: inequality in coastal regions has increased, while it has remained fairly constant in inland regions. If we assume low labor mobility within countries, our model can be applied to different regions of the same country. Then, this model could explain why inequality has increased in Bengaluru, an Indian city specialized in Second Globalization exports, and declined in Bhopa, a city which has not benefited from Second Globalization trade.

This section provided a tractable framework to study how differential access to trade generates changes in the pattern of specialization and wage inequality in otherwise identical southern countries. In our model, we assumed that the source of differential access to trade comes from the necessity of building an IT specific capital to benefit from the Second Globalization. We think of this infrastructure as being inherently more difficult to create and manage than tariff reductions. Therefore, our globalization approach provides a rationale for asymmetric participation within southern countries. This generates a discontinuous pattern of specialization for the country (or region) participating in the Second Globalization. It leads to increasing wage inequality in this country (or region), while reducing it in the one not participating.

3.5 Extensions

This section relaxes some of the assumptions of the baseline model in two directions. First, we allow for a skill distribution over agents to endogenize labor supply decisions. From this exercise we want to emphasize that all the comparative statics results for the relative wages are analogous to the ones derived in section 3.4. Moreover, additional natural insights emerge when endogenizing the labor supply. In particular, the mass of northern agents selecting into

middle skill jobs endogenously expands in the First Globalization and eventually shrinks during the Second.

Second, in our baseline model, we emphasized the role of the IT revolution in shaping the Second Globalization, as argued by Blinder (2006). However, the Second Globalization is also the result of the adoption of new technologies which, as emphasized by Autor et al. (2003), have replaced middle and low skill jobs in the U.S. In Subsection 3.5.2, we take a first step towards understanding how the incentives of adopting IT related technologies are influenced by trade. We distinguish between an Old and a New Technology. The New Technology benefits from the Second Globalization, while the Old requires relatively more middle and low skill jobs and can only benefit from First Globalization trade. We show that the adoption of the New Technology is delayed by trade in the First Globalization.

3.5.1 A Model with Endogenous Labor Supply

We extend the baseline model to allow agents to self select in any of the occupations of the economy. Let j be the index of an agent. As in the previous sections, we assume that $j \in [0,1]$.

If agent j chooses to be employed in a low, middle or high skill job, this agent can supply one, $s^i(j)$ and $s^i(j)^{1+\varepsilon}$ units of labor in country i, respectively, where ε is some small number greater than zero. Note that wages described in Section 3.3 should now be interpreted as wages per unit of effective labor. Finally, to avoid taxonomical analysis, we assume that the functions $s^i(j)$ are strictly increasing.

North and South only differ on $s^i(j)$, where $s^N(j)$ first order stochastically dominates $s^S(j)$.[24] Note that there is a single-crossing property built-in s^i. If an agent j with skill $s^i(j)$ chooses to be employed as a high skill worker, another agent j', with $j < j'$ will also work as high skill worker. Therefore, there exists a cutoff level of skill $\bar{s}^i$, such that all agents with $s^i > \bar{s}^i$ choose to work as high skill workers. A similar reasoning applies for the middle to low decision.

The agent $\bar{j}^i$ in country i who is indifferent between being employed in a middle or low skill job verifies that $s^i(\bar{j})w_m^i = w_l^i$. Similarly, the agent $\bar{J}$ who is indifferent between being

[24] Formally, this is $\frac{\int_0^J s^N(j)dj}{\int_0^1 s^N(j)dj} \leq \frac{\int_0^J s^S(j)dj}{\int_0^1 s^S(j)dj} \quad \forall J \in [0,1]$.

employed in a high or middle skill job in the North verifies $s^N(\bar{J})^{\varepsilon} w_h^N = w_m^N$. It is convenient to choose a functional form for $s^N(j)$ to obtain analytic solutions. For tractability, we specialize $s^N(j) = j$ in what follows.

Proposition 12 *(First Globalization) In the First Globalization equilibrium, the mass of agents selecting into middle and high skill jobs increases with z_I in the North. The relative wage of middle to low skill workers and the relative wage of high skill workers in the North increase with z_I. In the South, the mass of middle skill workers and its relative wage increase with z_I.*

The intuition for the results in proposition 12 is that an increase in the set of tradeable intermediates increases the relative demand of middle skill workers in both North and South. Therefore, the mass of agents selecting into middle skill jobs increases in both countries. However, these changes in the supply of skills do not offset the primary demand forces, and the comparative statics for relative wages is analogous to section 3.4. The return on high skill labor increases with trade because it increases the set of intermediates that can be purchased in the South at a cheaper price, while the demand for low and middle skill workers declines in the North.

Proposition 13 *(Second Globalization) In the Second Globalization equilibrium, the mass of northern middle skill workers increases for $z_{II} < \tilde{z}_{II}(z_I, \bar{z})$ and decreases thereafter, where $\tilde{z}_{II}(z_I, \bar{z})$ is defined in proposition 7. The mass of high skill workers increases with z_{II}. The mass of low skill workers decreases for $z_{II} < \tilde{z}_{II}(z_I, \bar{z}) + \eta(z_I, \bar{z})$, with $\eta > 0$ and increases thereafter. The relative wage of high skill workers increases with z_{II} and the relative wage of middle to low skill workers increases for $z_{II} < \tilde{z}_{II}(z_I, \bar{z}) + \eta(z_I, \bar{z})$ and decreases thereafter. In the South, the mass of middle skill workers and its relative wage increase with z_{II}.*

An implication of proposition 13 is that the Second Globalization tends to wage polarization. Compared to the exogenous labor supply case, wage polarization is delayed when agents can endogenously select into occupations. This is intuitive because in the endogenous supply case there is an extra margin of adjustment. An additional insight from this exercise is to show the endogenous responses of the masses of agents selecting into each occupation. Consistent with the labor literature (e.g. Autor and Dorn, 2009), the mass of middle skill workers in the

North eventually shrinks with Second Globalization trade. On the contrary, the mass of agents selecting low skill jobs eventually expands with Second Globalization trade.

The results in this subsection suggest that from the point of view of the North, the First Globalization gave incentives to select into middle skill jobs. In this sense, trade complemented middle skills during the First Globalization in the North. However, this complementarity effect diminishes and it is eventually overturned as Second Globalization progresses and more skill intensive tasks are offshored to the South. In addition to a reduction in the relative wage of middle skill workers, this generates a reduction in the mass of northern middle skill agents. For the South, trade complements skills in the First and Second Globalization.

To conclude, the results for the Two Souths stated in Subsection 3.4.2, and for the Technology Adoption extension presented below (Subsection 3.5.2) apply in this extension of the model. This is intuitive because the relative wage of middle to low skill workers behaves in the same manner as in the baseline model and its behavior is the main driver of the results.

3.5.2 Technology Adoption

Our baseline model assumed that the Second Globalization was entirely driven by a reduction in communication costs. However, the Second Globalization is an outcome of both the IT revolution and firms choosing to adopt new technologies, which replace low and middle skill jobs (Autor et al., 2003). It is therefore natural to investigate the effect of different types of trade on the incentives of firms to adopt new technologies.

Consider an extension of our baseline model in which agents can freely choose between two technologies. There is an Old Technology which can only benefit from trade in First Globalization intermediates. There is a New Technology which uses more skill intensive inputs (computerization) and benefits from Second Globalization trade. This New Technology only uses tasks as inputs, more precisely,

$$\text{Old Technology}: \quad h^{\alpha}\left(\int_0^1 \ln I(z)dz\right)^{1-\alpha},$$

$$\text{New Technology}: \quad h^{\alpha}\left(\int_{\overline{z}}^1 \ln[I(z)]dz\right)^{1-\alpha}.$$

We assume that high skill agents choose the production technology. Note, that the optimal

technology to use is the one that maximizes the bundle of inputs. These bundles in equilibrium are

$$B^{Old} = \int_0^{z_I} \ln(\tilde{p}^S(z))^{-1}dz + \int_{z_I}^1 \ln(\tilde{p}^N(z))^{-1}dz, \tag{3.18}$$

$$B^{New} = \int_{\bar{z}}^{z_{II}} \ln(\tilde{p}^S(z))^{-1}dz + \int_{z_{II}}^1 \ln(\tilde{p}^N(z))^{-1}dz, \tag{3.19}$$

where $\tilde{p}^i(z) = \frac{B}{(1-\alpha)Y}p^i(z)$ denotes a renormalized price in country i.

Proposition 14 *Let $\hat{z}_{II}(z_I)$ denote the threshold above which the New Technology starts to be adopted. The threshold $\hat{z}_{II}(z_I)$ is (weakly) increasing in z_I.*

There are two economic forces driving proposition 14. First, the Old Technology benefits from the First Globalization by replacing northern intermediates by cheaper southern intermediates. Second, the prices of tasks increase with First Globalization. As a result, the relative profitability of the Old Technology increases with trade in the First Globalization.

This simple technology choice model suggests that the effect of trade on technology adoption depends on the "type of trade" and the "type of technology". First Globalization complements Old Technology and Second Globalization complements New Technology. However, First Globalization delays the adoption of New Technology and thus can be seen as a substitute for adoption of New Technology. If we think of New Technology as computerization, along the lines of Autor et al. (2003), proposition 14 can be interpreted as saying that there is no dichotomy between offshoring of services and computerization.

The labor literature has proposed the computerization hypothesis to account for the differential loss of middle skill jobs and wage polarization (Autor et al., 2003). In our model, computerization is needed to take advantage of the Second Globalization. Therefore, computerization leads to offshoring and, consequently, to the loss of middle skill jobs and wage polarization in the North. The value added of this extension is to show that trade in First Globalization intermediates delays computerization. As a result, our framework provides a rationale why middling and wage polarization appear sooner in the relatively less open northern countries (e.g., the U.S.) than in relatively more open countries (e.g., the U.K.).

3.6 Concluding Remarks

In this paper, we provided a unified view of two waves of globalization and analyzed the interdependencies that arise. We distinguished between *(i)* the First Globalization, characterized by a reduction in tariffs, which mainly affected trade in low skill intensive goods, *(ii)* the Second Globalization, characterized by a reduction in communication costs, which has affected trade in middle skill intensive goods.

We considered a trade economy with two countries, North and South, which only differ on the relative supply of skills. A final good is produced in the North employing high skill agents and assembling a bundle of inputs. Inputs are produced combining middle and low skill labor in different proportions and can be purchased in the North or the South.

Our main results are that *(i)* there is a complementarity on wage inequality between the First and Second Globalization, which implies that northern wage polarization in the Second Globalization is delayed by the extent of trade in the First, and *(ii)* asymmetric participation in the Second Globalization across southern countries (or regions) generates a discontinuous pattern of specialization in which one southern country produces the most and least skill intensive traded inputs.

We found a non-monotonic effect of trade in the Second Globalization on the relative wage of middle to low skill workers in the North. We showed that the relative wage of northern middle skill workers increases if the intermediates (or tasks) being offshored are below the skill intensity of the average input produced in the North. Therefore, in our setup, the relative wage of middle skill workers rises during the First Globalization and can decrease during the Second. A complementarity between the two waves of globalization arises because the threshold below which the relative wage rises during the Second Globalization increases with the set of traded intermediates in the First. In other words, First Globalization increases the skill intensity of the average northern input, thereby increasing the set of Second Globalization tasks that can be offshored before the northern relative wage starts to decline. This prediction is consistent with anecdotal evidence for the U.S., U.K. and Germany. Moreover, the relative wage of high skill workers is increasing throughout the globalization process. Thus, as the Second Globalization progresses, the equilibrium tends to wage polarization. Due to the complementarity result, wage polarization is delayed by First Globalization trade. For the South, we show that the

relative wage increases both during the First and Second Globalization.

We divided the original South in two identical southern countries (or regions) and assumed that only one of the two southern countries could open to the Second Globalization. This was meant to capture the notion that participation in the Second Globalization requires a stock of specific capital (e.g. knowledge, institutions and infrastructure), which some southern countries may lack of. At the impact, the country that participates in the Second Globalization gains comparative advantage in the least skill intensive intermediates. This generates a discontinuous pattern of specialization. As the Second Globalization progresses, the set of First Globalization intermediates in which this country has comparative advantage shrinks. Eventually, complete specialization is reached. As a result, the relative wage of middle skill workers in the southern country that opens to the Second Globalization increases while it decreases in the other.

Finally, we considered two extensions. First, we allowed for endogenous supply choices and showed that the comparative statics for relative wages go through in this generalized set-up. Moreover, we showed that the mass of northern agents selecting into middle skill jobs increases during the First Globalization and eventually declines during the Second, while the converse is true for the mass of agents selecting into low skill jobs. In the second extension, based on the assumption that the Second Globalization requires a new final good production technology more intensive in skilled inputs, we showed that trade in the First Globalization delays trade in the Second through its effect on relative prices.

Our model has brought about several empirical implications which we would like to further investigate and take to the data. A natural next step that we leave for future research would be to test the complementarity result. This paper abstracted from endogenous technological change. Given the tractability of our framework, we could accommodate a dynamic version of our model with endogenous skill biased technology choices, which, as shown by Acemoglu (1998, 2003), can complement skilled labor supply and be affected by international trade. This would allow us to understand how the different waves of globalization complement skill bias technology choices.

3.7 Figures

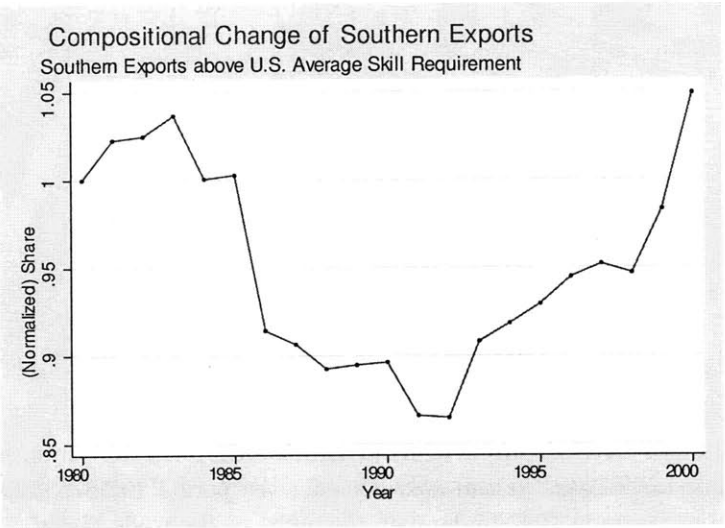

Figure 3-1: Changes in southern exports to the North in industries with above average U.S. The mean skill intensity of U.S. industries is measured using educational attainment in U.S. Census. North is defined as having more than 50 percent of U.S. GDP per capita (PPP adjusted). Source: Feenstra World Trade Database.

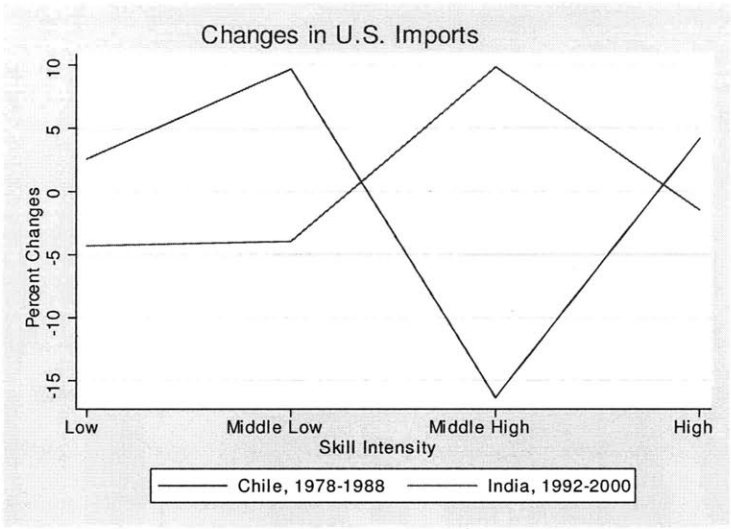

Figure 3-2: Changes in U.S. imports from India and Chile for different skill levels. For comparability with our tariff data, we can only consider the period 1978-1988 for the First Globalization. For India, the series starts in 1992 to dampen the effect of the trade liberalization in 1991, documented in Topalova (2005) among others. Source: Feenstra U.S. Imports Database, Skill Intensity constructed from U.S. Census.

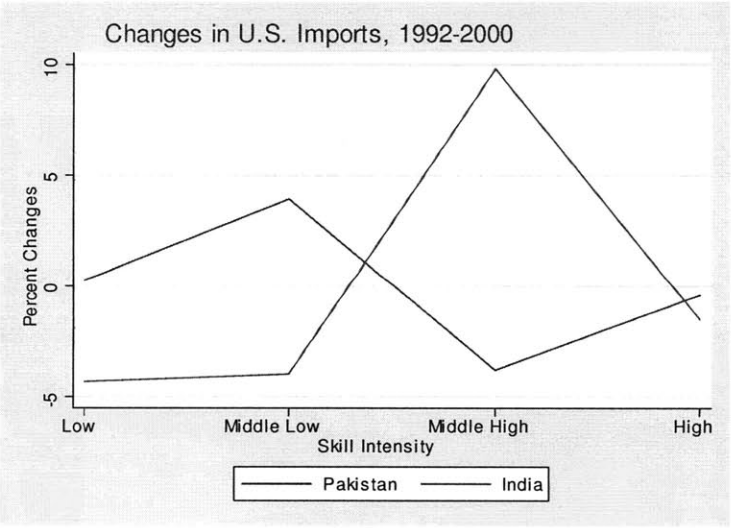

Figure 3-3: Changes in U.S. imports from India and Pakistan for different skill levels. Source: Feenstra U.S. Imports Database.

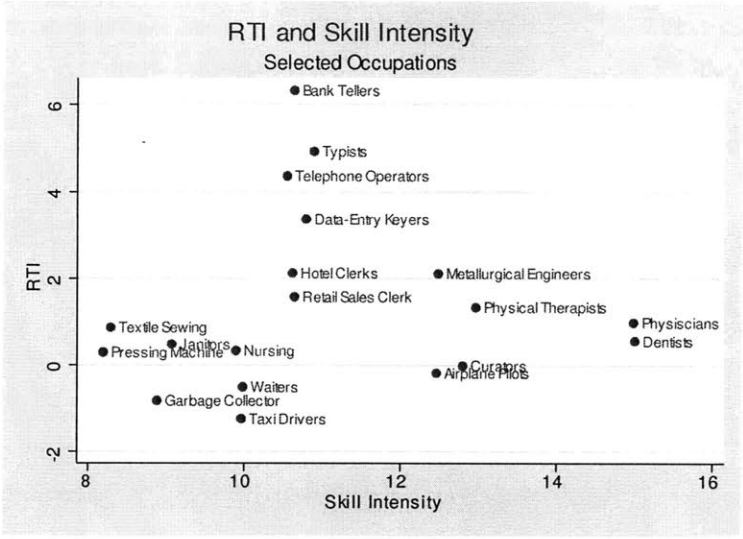

Figure 3-4: Examples of RTI for Selected Occupations. Source: Autor and Dorn (2009).

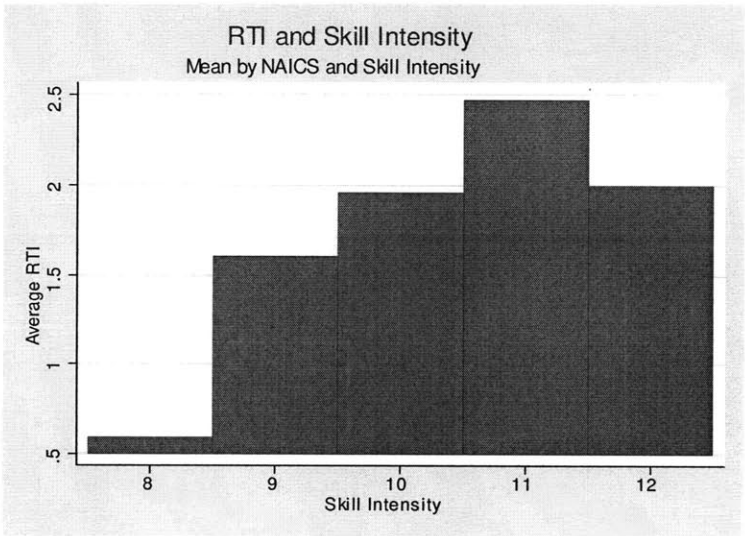

Figure 3-5: Average Skill Intensity by U.S. Industry. Source: Autor and Dorn (2009).

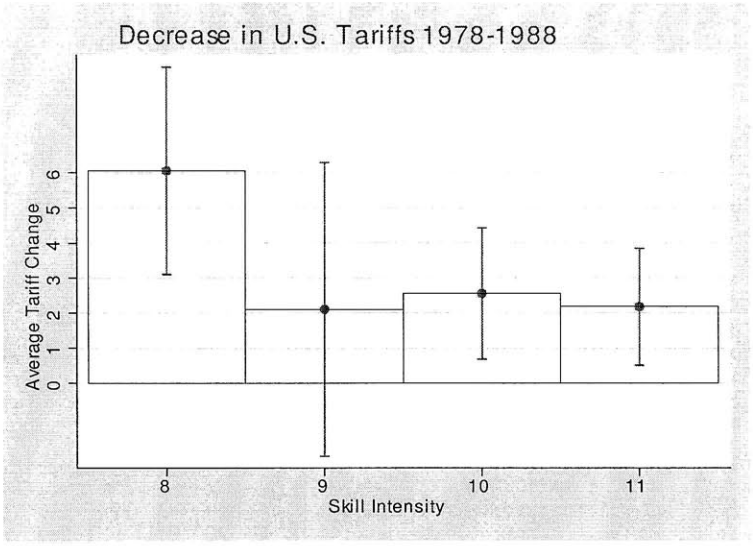

Figure 3-6: Changes in U.S. Tariffs by Skill in the First Globalization. (Two Std. Dev. bars). Source: Feenstra tariff data.

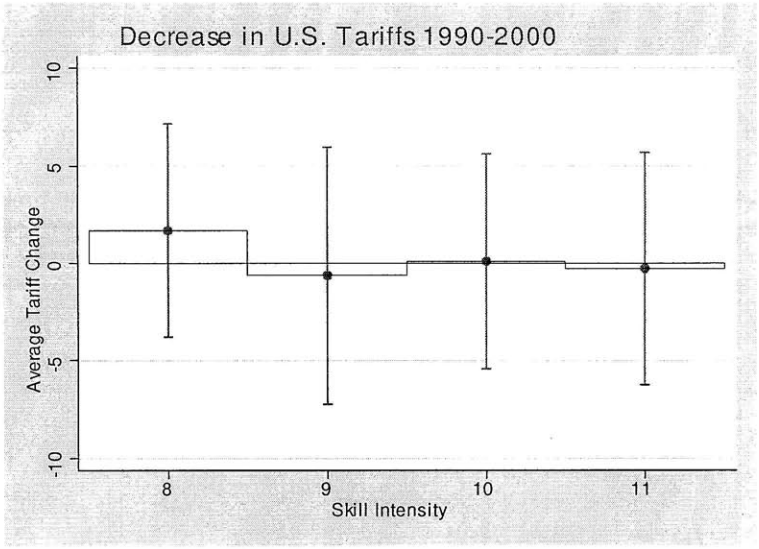

Figure 3-7: Changes in U.S. Tariffs by Skill in the Second Globalization. (One Std. Dev. bars). Source: Romalis tariff data.

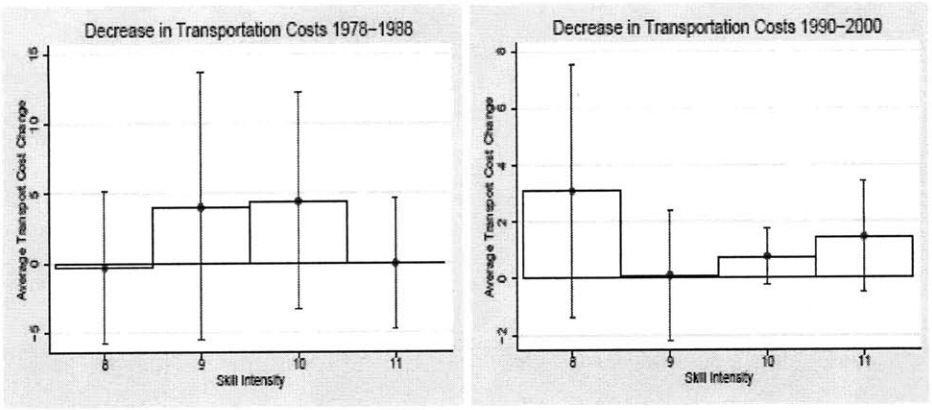

Figure 3-8: Changes in U.S. Transportation Costs (Insurance and Freight). One Std. Dev. bars are shown. Source: Feenstra database.

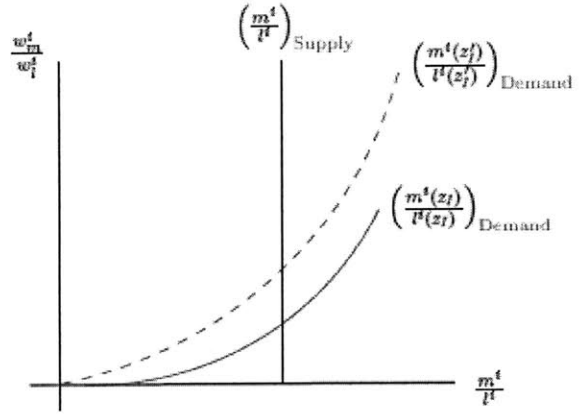

Figure 3-9: Relative Supply and Demand in the First Globalization for $z_I' > z_I$.

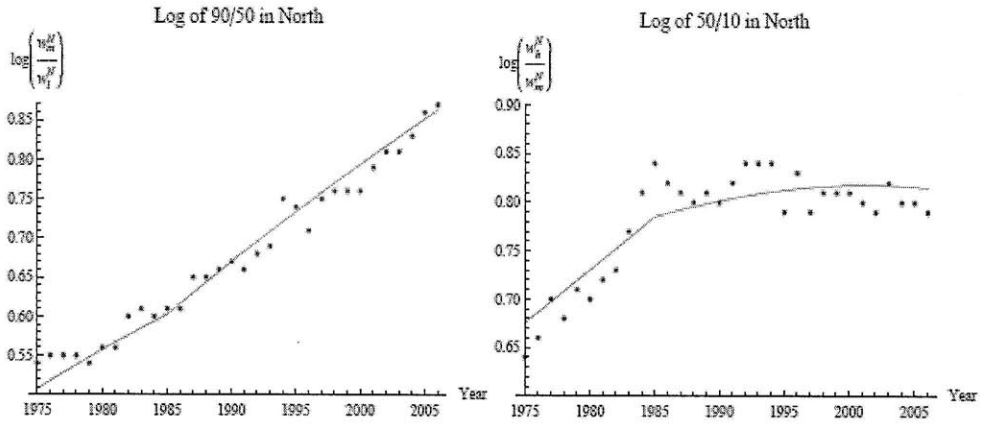

Figure 3-10: Model versus Autor et al. (2008) estimates. We take the structural change to be 1987, as in Autor et al. First Globalization is a shift from $z_{\mathrm{I}} = .15$ to $z_{\mathrm{I}} = .21$. Second Globalization is a shift from $z_{\mathrm{II}} = .5$ to $z_{\mathrm{II}} = .64$.

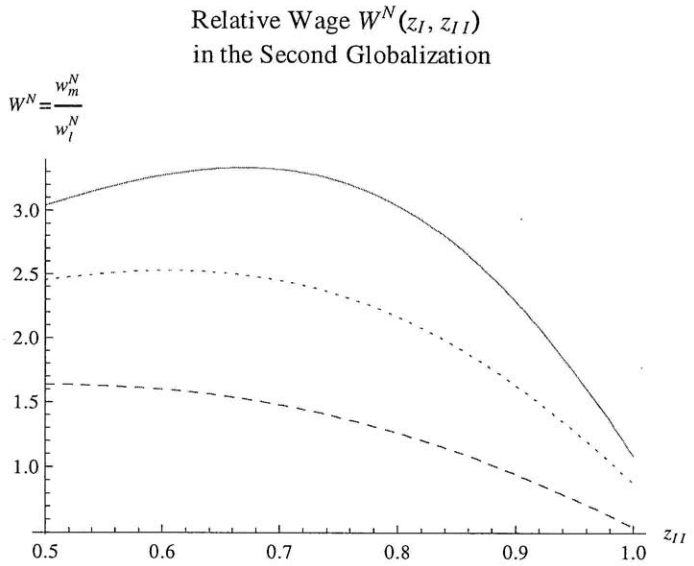

Figure 3-11: Interdependence in the North. This plot assumes $\bar{z} = 1/2$. The dashed line is for $z_I = 0$,dotted for $z_I = .2$ and regular line for $z_I = .3$.

3.8 Tables

Table 3.1: Complementarity in the North

Country	Trade Openness (1991)	Change 50/10 Relative Wage (1990-2000)
United States	17.2	-.01
United Kingdom	40.8	.04
Germany	46.6	.07

Data sources: Autor et al. (2008) for the U.S., Prasad (2002) for the U.K. and Dustmann et al. (2007) for Germany. The measure for Germany is the log of the relative wage of the 50 to 15 percentile, instead of the 50 to 10 of the other sources. Trade openness is measured as Exports plus Imports over GDP from the Penn World Tables.

Table 3.2: Trade Costs and Pattern of Specialization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Whole Sample					South				
	OLS	OLS	OLS	OLS	2SLS	OLS	OLS	OLS	OLS	2SLS
	Panel A: *Dependent Variable is U.S. Imports in 1990*									
Tariff	-6.77	-6.77				-8.2	-8.2			
	(1.35)	(2.31)				(1.99)	(2.56)			
Observations	26397	26397				12642	12642			
	Panel B: *Dependent Variable is U.S. Imports in 2000*									
Tariff	-3.46	-3.46	-4.07	-4.07	-4.05	-1.29	-1.29	-1.49	-1.49	-1.48
	(3.63)	(2.47)	(3.62)	(2.43)	(3.62)	(2.58)	(2.88)	(2.56)	(2.89)	(2.57)
Internet · Skill Intensity			6.3	6.3	6.09			9.59	9.59	8.07
			(1.65)	(5.03)	(.93)			(3.19)	(2.66)	(1.64)
Observations	262303	262303	261961	261961	261961	126891	126891	126549	126549	126549
Std. Error	Robust	Cluster	Robust	Cluster	Robust	Robust	Cluster	Robust	Cluster	Robust

Standard errors are clustered by country. A southern country is defined as having less than half of 2000 U.S. GDP per capita adjusted by PPP from the Penn World Tables. RTI index is used as instrument of Skill Intensity in the first stage regressions, which are omitted. All regressions include country and industry fixed effects. Dependent variable is U.S. Imports from Feenstra's NBER Dataset. Tariff is U.S. Tariffs at HS6 level from Romalis' Dataset. Skill intensity is mean level of education from U.S. Census for industry. Internet is the fraction of population with access to Internet in 2000. See Appendix 3.10 for detailed data definitions and sources.

Table 3.3: Change in Trade Openness and Wage Bill in the U.S.

	(1)	(2)	(3)
	Δ Wage Bill 80-90	Δ Wage Bill 90-96	
Δ Trade Openness 80-90 · Skill Int.	1.65		
	(.43)		
Δ Trade Openness 90-96 · Skill Int.		.29	-4.62
		(.17)	(2.17)
Δ Trade Openness 90-96 · Skill Int.^{2}			.23
			(.10)
Observations	118	118	118

Robust Standard Errors in parenthesis. Δ Trade Openness is the change in the share of exports and imports over GDP from the Penn World Tables. Wage bill data at industry level at 3-digit NAICS comes from Autor et al. (1998). Skill intensity is the mean level of education from U.S. Census by industry.

3.9 Proofs and Auxiliary Propositions

Proof of Proposition 7 Using equations (3.12) to (3.15) and the trade cost structure, (3.17), the relative wages of middle skill workers are

$$\frac{w_h^N}{w_m^N} = \frac{1-\varphi}{\varphi}\frac{\alpha}{1-\alpha}\frac{2B}{1-z_I^2-z_{II}^2+\bar{z}^2}, \tag{3.20}$$

$$\frac{w_m^N}{w_l^N} = \frac{1-z_I^2-z_{II}^2+\bar{z}^2}{(1-z_I)^2+(1-z_{II})^2-(1-\bar{z})^2}\frac{1-\theta^N}{\theta^N(1-\varphi)}, \tag{3.21}$$

$$\frac{w_m^S}{w_l^S} = \frac{z_I^2+z_{II}^2-\bar{z}^2}{1-(1-z_I)^2-(1-z_{II})^2+(1-\bar{z})^2}\frac{1-\theta^S}{\theta^S}. \tag{3.22}$$

The relative wage of high skill workers in the North increases with z_{II} because the bundle B increases with z_{II} and the denominator decreases with z_{II}. Note that the same reasoning applies for the relative wage of high to low skill workers. Taking the partial derivative of the relative wage of middle skill workers (3.21) in the North, we find that it is increasing in z_{II} as long as $z_{II} < \tilde{z}_{II}(z_I) \equiv 1+\bar{z}-z_I-\sqrt{2(\bar{z}-z_I)(1-z_I)}$. For the relative wage in the South, the sign of the partial derivative with respect to z_{II} is always positive. ∎

Proof of Proposition 8 Direct differentiation of $\tilde{z}_{II}(z_I)$ yields to

$$\frac{1-2z_I+\bar{z}}{\sqrt{2(\bar{z}-z_I)(1-z_I)}}-1.$$

Note that this expression is increasing in z_I and decreasing in $\bar{z}$, thus, a lower bound on it is $\frac{2}{\sqrt{2}}-1$, which is positive. ∎

Proposition 15 *In the two Souths model of Subsection 3.4.2, all competitive equilibria in the First Globalization have the same wage schedule for both Souths.*

Proof. First, note that the price function in country i is a geometric mean of the middle and low skill wages. The price schedule in a country i, $p^i(z)$, is strictly monotone in z (if the wages of middle and low skill agents are different). Thus the price functions can cross at most once.

We proof the result by contradiction. Note that in autarky, the price of intermediates were the same in both Souths (because both are identical) and that as a result of opening to trade, the prices in the South strictly increase if there is positive demand from the North in any good. Suppose that North demands the set of goods χ_1 to Southeast and χ_2 to Southwest, where we are allowing for some traded intermediates $z \notin \chi_1 \cap \chi_2$. Note that intermediate $z = 0$ has to be produced *only* by one country, because otherwise the price in both countries would be the same and by single crossing we cannot have an equilibrium. Suppose Southeast produces it. To have an equilibrium we must have the prices crossing in the relevant range. This means that $w_l^{\text{Southeast}} < w_l^{\text{Southwest}}$ and that $w_m^{\text{Southeast}} > w_m^{\text{Southwest}}$. In other words, the relative demand of middle skill workers in Southeast is higher than in Southwest. This implies that intermediates with low index z (low means below the threshold at which the two prices cross) are cheaper in Southeast and yet there is more demand of them in Southwest. This is a contradiction, unless both prices are equal, which implies that wages are equal in Southeast and Southwest. ∎■

Proof of Proposition 9 For algebraic convenience we normalize the population size of each southern country to one. Let $f(z)$ denote the fraction of each intermediate z produced by Southeast in the range $z \in [0, z_I]$. Thus, Southwest produces the remaining fraction $1 - f(z)$. Prices in both Souths will generically coincide if and only if wages of middle skill and low skill

workers are equalized in equilibrium. Denoting $E_f[z] = \int_0^{z_I} zf(z)dz$, equalization of middle skill wages implies that $E_f[z] = \frac{1}{2}\int_0^{z_I} zdz$. Equalization of low skill wages implies that $E_f[z] = 1 - \frac{1}{2}\int_0^{z_I}(1-z)dz$. This two conditions cannot be satisfied at the same time, and thus, the price schedule will be different in Southeast and Southwest.

By an analogous reasoning of proposition 15, prices can cross at most once. Thus, there is a threshold equilibrium. Denote by $\check{z}_I$ the threshold intermediate. We show the result by contradiction. Suppose that Southwest produces $z \in [0, \check{z}_I]$ and that Southeast produces $z \in [\check{z}_I, z_I] \cup [\bar{z}, z_{II}]$. This can be an equilibrium if and only if $w_l^{\text{Southwest}} < w_l^{\text{Southeast}}$ and $w_m^{\text{Southwest}} > w_m^{\text{Southeast}}$. These conditions on wages imply

$$\begin{aligned} 0 &< z_I\left(1-\frac{z_I}{2}\right) - 2\check{z}_I\left(1-\frac{\check{z}_I}{2}\right) + z_{II}\left(1-\frac{z_{II}}{2}\right) - \bar{z}_I\left(1-\frac{\bar{z}_I}{2}\right), \\ 0 &< 2\check{z}_I^2 - z_I^2 - z_{II}^2 + \bar{z}_I^2, \end{aligned}$$

which cannot be satisfied simultaneously. Thus this cannot be an equilibrium. ∎

Proof of Proposition 10 The threshold $\check{z}_I$ can expressed implicitly as the solution to the problem $p_{\text{Southeast}}(z) = p_{\text{Southwest}}(z)$ for some $z \in [0, z_I]$, where if the inequality is not satisfied, then either 0 or z_I is the solution, depending on whether the price schedule of Southeast is above or below the pricing schedule of Southwest for $z \in [0, z_I]$. Using that in order to have an equilibrium middle skill wages are higher in Southeast and low skill wages are lower in Southeast, we have that the geometric average with parameter z

$$\left(\frac{w_m^{\text{Southeast}}}{w_m^{\text{Southwest}}}\right)^z \left(\frac{w_l^{\text{Southeast}}}{w_l^{\text{Southwest}}}\right)^{1-z} \tag{3.23}$$

will be exactly one by some z between zero and one. Consider an interior solution for z. Inspection of the explicit equation (3.23) shows that both the ratios of middle skill and low skill wages in Southeast to Southwest are decreasing in z_I and increasing in z_{II} and $\check{z}_I$. As result, and using implicit derivation, it follows that in this range $\check{z}_I(z_I, z_{II})$ is increasing in z_I and decreasing in z_{II}. Letting $A \equiv \frac{w_m^{\text{Southeast}}}{w_m^{\text{Southwest}}}$ and $B \equiv \frac{w_l^{\text{Southeast}}}{w_l^{\text{Southwest}}}$, the expression for the implicit

derivatives of $\check{z}_I$ becomes, after some manipulation,

$$\frac{\partial \check{z}_I}{\partial z_i}\left[\ln A - \ln B + \frac{\check{z}_I}{A}\frac{\partial A}{\partial \check{z}_I} + \frac{(1-\check{z}_I)}{B}\frac{\partial B}{\partial \check{z}_I}\right] = -\frac{\check{z}_I}{A}\frac{\partial A}{\partial z_i} - \frac{(1-\check{z}_I)}{B}\frac{\partial B}{\partial z_i}, \tag{3.24}$$

where $i = \{I, II\}$. The sign of the term in brackets in the left hand side is positive for all i and the term on the right hand side is positive for z_I and negative for z_{II}. Thus, the sign of the derivative of the threshold $\check{z}_I$ with respect to z_i is unambiguous. ∎

Proof of Proposition 11 The relative wages in Southeast and Southwest are proportional to

$$\frac{w_m^{\text{Southeast}}}{w_l^{\text{Southeast}}} \propto \frac{\check{z}_I^2 + z_{II}^2 - \bar{z}^2}{1-(1-\check{z}_I)^2-(1-z_{II})^2+(1-\bar{z})^2}, \qquad \frac{w_m^{\text{Southwest}}}{w_l^{\text{Southwest}}} \propto \frac{z_I^2 - \check{z}_I^2}{(1-\check{z}_I)^2-(1-z_I)^2}.$$

From proposition 10, the relative wage in Southwest is decreasing in z_{II} for the range in which there is an interior solution for $\check{z}_I$ and is constant otherwise. For the relative wage in Southeast, if $\check{z}_I = 0$, it is immediate to check that the relative wage is increasing in z_{II}. If $\check{z}_I > 0$, we first show that a sufficient condition for the relative wage being increasing is that $|\partial \check{z}_I / \partial z_{II}| < 1$. If this is the case, the change induced in $\check{z}_I$ by an infinitesimal change ε in z_{II} is bounded below by $z_I - \varepsilon$. Algebraic manipulation shows that as long as $z_{II} > \check{z}_I$ (which is true by assumption), the relative wage is increasing in z_{II}.

To show that $|\partial \check{z}_I / \partial z_{II}| < 1$, we show that an upper bound of this derivative is less than one,

$$\frac{\frac{\check{z}_I}{A}\frac{\partial A}{\partial z_{II}} + \frac{(1-\check{z}_I)}{B}\frac{\partial B}{\partial z_{II}}}{\frac{\check{z}_I}{A}\frac{\partial A}{\partial \check{z}_I} + \frac{(1-\check{z}_I)}{B}\frac{\partial B}{\partial \check{z}_I}} < 1.$$

This condition reduces to

$$\frac{-2\check{z}_I z_I + z_I + \check{z}_I}{(z_I - \check{z}_I)(z_I + \check{z}_I - 2)(z_I + \check{z}_I)} + \frac{\check{z}_I(z_{II} - \check{z}_I)}{\check{z}_I^2 + z_{II}^2 - \bar{z}^2} + \frac{(\check{z}_I - 1)(\check{z}_I - z_{II})}{(\check{z}_I - 2)\check{z}_I + (z_{II} - \bar{z})(z_{II} + \bar{z} - 2)} < 0,$$

which is true given that $0 < \check{z}_I < z_I < \bar{z} \leq z_{II} < 1$. ∎

Proof of Proposition 12 The indifference conditions can be rewritten as

$$\bar{J}^{\varepsilon}\frac{\alpha}{1-\alpha}\frac{(2+\varepsilon)B}{1-\bar{J}^{2+\varepsilon}} = \frac{1-z_I^2-z_{II}^2+\bar{z}^2}{\bar{J}^2-\bar{j}^{N2}} \tag{3.25}$$

$$\bar{j}^{N}\frac{1-z_I^2-z_{II}^2+\bar{z}^2}{\bar{J}^2-\bar{j}^{N2}} = \frac{(1-z_I)^2+(1-z_{II})^2-(1-\bar{z})^2}{2\bar{j}^{N}}, \tag{3.26}$$

$$\bar{s}^{S}(\bar{j}^{S})\frac{z_I^2+z_{II}^2-\bar{z}^2}{\int_{\bar{j}^S}^1 s^S(j)dj} = \frac{1-(1-z_I)^2-(1-z_{II})^2+(1-\bar{z})^2}{\bar{j}^{S}}. \tag{3.27}$$

Consider the case for the South. Equation (3.27) can be rewritten as

$$\frac{\int_{\bar{j}^S}^1 s^S(j)dj}{2\bar{j}^S\bar{s}^S(\bar{j}^S)} = \frac{\theta^S}{(1-\theta^S)}\frac{w_m^S}{w_l^S}, \tag{3.28}$$

where the expression for the wages corresponds to section 3.4. Thus, the right hand side of equation (3.28) is increasing in z_I. The left hand side of (3.28) is decreasing in $\bar{j}^S$. Therefore, $\bar{j}^S$ is decreasing in z_I. Note that the relative wage of a middle skill agent can be written as

$$\frac{w_m^S}{w_l^S} = \frac{s^S(j)}{s^S(\bar{j}^S(z_I))}. \tag{3.29}$$

Thus, the relative wage in the South increases with z_I.

Consider the case for the North. Given that ε is a small positive number, we assume that $2+\varepsilon \approx 2$. Under this simplifying assumption, we find

$$\bar{J}^2 = \frac{(1+A)C}{1+(1+A)C}, \tag{3.30}$$

$$\bar{j}^{N2} = \frac{AC}{1+(1+A)C}, \tag{3.31}$$

where $A = \frac{(1-z_I)^2+(1-z_{II})^2-(1-\bar{z})^2}{2(1-z_I^2-z_{II}^2+\bar{z}^2)}$ and $C = \frac{(1-\alpha)}{\alpha}\frac{1-z_I^2-z_{II}^2+\bar{z}^2}{2B}$. Note that optimality on offshoring requires B being increasing in z_I. In the First Globalization $z_{II} = \bar{z}$, thus, A and C (and AC) are decreasing in z_I. Therefore, $\bar{J}$ and $\bar{j}^N$ are decreasing in z_I. Finally, note that the size of middle agents is

$$\frac{\bar{J}}{\bar{j}^N} = \sqrt{\frac{1+A}{A}}, \tag{3.32}$$

which increases in the First Globalization. Finally, relative wages are

$$\frac{w_h^N}{w_m^N} = \frac{j^{1+\epsilon}}{\bar{J}^{\epsilon}(z_I)}, \tag{3.33}$$

$$\frac{w_m^N}{w_l^N} = \frac{j}{\bar{j}^N(z_I)}, \tag{3.34}$$

which are increasing in z_I. ∎

Proof of Proposition 13 For the South, the same reasoning as in proposition 12 applies. For the North, the comparative statics is the same as in proposition 12, while A is decreasing. However, when $z_{II} > \tilde{z}_{II}(z_I)$, A increases. From equation (3.32), it follows that the mass of middle skill workers declines. The comparative statics for the mass of high skill workers does not depend on A, but on AC, which is unambiguously decreasing in z_{II}. From equation (3.30), this implies that the threshold $\bar{J}$ is decreasing in z_{II}. From equation (3.33), this implies that the relative wage of high skill agents is increasing. The threshold $\bar{j}^N$ is implicitly defined by equation (3.31). Taking the total derivative of (3.31) with respect to z_{II}, we can isolate $d\bar{j}^N/dz_{II}$. Evaluating this derivative at $z_{II} = \bar{z}$ and $z_{II} = 1$, shows that the derivative takes negative and positive values, respectively. Moreover, it is immediate to check that the derivative is continuous and monotone. Intuitively, monotonicity follows from the derivatives of A and C being monotone. Thus, by the Bolzano theorem, we know that there is a unique threshold for z_{II}, above which $d\bar{j}^N/dz_{II} > 0$. Note that this threshold is above $\tilde{z}_{II}$ (defined in proposition 7) because $\partial A/\partial z_{II}|_{z_{II}=\tilde{z}_{II}} = 0$, and from the implicit derivation of equation (3.31), it follows that $d\bar{j}^N/dz_{II}|_{z_{II}=\tilde{z}_{II}} < 0$. ∎

Proof of Proposition 14 Define $\Delta B(z_I, z_{II}) \equiv B^{New} - B^{Old}$, the difference in profits between the two technologies,

$$\Delta B(z_I, z_{II}) = \int_{\bar{z}}^{z_{II}} \ln\left(\frac{\tilde{p}^S(z)}{\tilde{p}^N(z)}\right)^{-1} dz - \left(\int_0^{z_I} \ln(\tilde{p}^S(z))^{-1} dz + \int_{z_I}^{\bar{z}} \ln(\tilde{p}^N(z))^{-1} dz\right). \tag{3.35}$$

The first term in (3.35) summarizes the relative benefit of adopting the New Technology, whereas the second captures the additional benefit of using the Old Technology. The equation $\Delta B(z_I, z_{II}) = 0$ implicitly defines the threshold $\hat{z}_{II}(z_I)$ above which the New Technology starts to be adopted. The partial derivative of equation (3.35) with respect to z_{II} is positive,

because $p^N(z) \geq p^S(z)$ in the trade region. The partial derivative of equation (3.35) with respect to z_I is negative. The first term decreases in z_I and the second term (in parenthesis) increases. The result for the first term comes directly from differentiation of prices. To obtain the sign of the second term, note that by Leibniz's rule, we have that the partial derivative is

$$\ln\left(\frac{\tilde{p}^N(z_I)}{\tilde{p}^S(z_I)}\right) + \int_0^{z_I} \frac{\partial}{\partial z_I} \ln(\tilde{p}^S(z))^{-1} dz + \int_{z_I}^{\bar{z}} \frac{\partial}{\partial z_I} \ln(\tilde{p}^N(z))^{-1} dz. \tag{3.36}$$

The first term in (3.36) is non-negative as long as $p^N/p^S \geq 1$ for traded goods, which is assumed to be true to derive the equilibrium. The second and third terms can be expressed as

$$\frac{(1-\bar{z}+2z_I)(1-\bar{z})}{1-z_I^2}, \tag{3.37}$$

which is positive. Therefore, using the implicit function theorem it follows that $\hat{z}_{II}(z_I)$ is increasing in z_I. ∎

3.10 Data Appendix

World bilateral trade flows are taken from Feenstra database. We obtain U.S. tariff data at industry level for the period 1978-1988 from Feenstra database. Feenstra's data is available from http://cid.econ.ucdavis.edu/. For the period 1990-2000, we use Romalis' database, available at http://faculty.chicagobooth.edu/john.romalis/more/. Transportation costs are cost of insurance and freight over customs import value from Feenstra database. Data on U.S. imports comes from Feenstra database.

We construct a skill intensity index by using 5 percent U.S. census data from IPUMS. The skill intensity variable is constructed assigning a score to each level of education reported in the US Census, using the variable educ99. We average across industries by same NAICS and across occupations when noted in the main text.

We take the routine-intensity index (RTI) from Autor and Dorn (2009). Roughly speaking, using the Dictionary of Tasks each task can be divided into three characteristics (abstract, routine and manual) and it is assigned a score for each of the three entries. The RTI index represents the importance of the routine part for each task. See Autor and Dorn (2009) for

further discussion.

Internet measures are obtained from the World Development Indicators (WDI), available from the World Bank. For the robustness checks, the financial development measure is domestic credit to private sector over GDP. Human capital is the fraction of the labor force with secondary education. Both measures are obtained from the World Development Indicators (WDI).

Chapter 4

Financial Development and the Product Cycle

4.1 Introduction

Goods can either be entirely produced inside a country or production can be fragmented across countries. In a seminal paper, Vernon (1966) argues that these two production strategies reflect different stages in the natural cycle of goods. In this product cycle, as described by Vernon, goods are created and initially produced in rich countries until they become more standardized and their assembly is shifted to lower-cost countries.

In practice, this product cycle could arise because of Southern imitation, technology transfer, foreign direct investment, and so on. In this paper I focus on offshoring of production. A product cycle takes place because Northern firms prefer to buy intermediate inputs from Southern suppliers to complete the production of their final good. Anecdotal evidence illustrates that this type of offshoring is indeed taking place. For example, Feenstra (1998) cites Tempest (1996) who observes that even though the design and marketing of Barbie dolls is made in the United States, assembly is made in Indonesia, Malaysia and China that obtain the raw materials from Taiwan and Japan. Feenstra also cites Tisdale (1994) who documents the outsourcing strategy of Nike. Nike also keeps the design and marketing units in the United States but the shoes and clothes are manufactured by the 75,000 workers employed in independent factories in Asia.

Financial development is a key determinant of firm behavior because it affects not only the size of the investment that financially constrained firms can undertake but also which type of contracts are written and how revenues and expenditures are shared ex-ante and ex-post.[1] Even though there exists a widespread agreement about the importance of financial institutions and it is well known that financial development is heterogeneous across countries, the idea that financial institution differences could be a driving force of the product cycle has been largely ignored in the literature. In this paper I fill this gap by developing a simple model of offshoring in which the only comparative advantage of Northern suppliers is their access to better financial institutions.

I show that financial institution differences are enough to generate a product cycle akin to the one described by Vernon. The most salient empirical prediction of the model is that the more R&D-intensive an industry is, the larger is the effect of financial development on offshoring. In the empirical section I test this prediction using the number of goods that a country exports to the United States in each industry as a proxy of offshoring and domestic credit to private sector over GDP as a measure of financial development.

The model builds on Antràs (2005). A Northern final-good producer provides headquarter services and needs an input to complete production. She can acquire this input from a supplier located either in the high-wage and financially developed North or in the low-wage and financially underdeveloped South.

One of the main contributions of this paper is to endogenize the bargaining weights, which are crucial yet unexplained in Antràs (2005). I consider a complete contracting setting where revenues are contractible. The final-good producer, after contacting with a supplier, extends her a take-it-or-leave-it offer consisting of an ex-ante transfer and an ex-post payment.

The supplier needs to pay a fixed cost (e.g., a relationship-specific plant) to enter into the relationship but she has no initial funds and has to cover this fixed cost with a loan from a local bank and the transfer from the final-good producer.[2] Financial institution differences across countries affect the size of the loan that the bank offers to the supplier and the transfer that the final-good producer provides. In more financially developed countries, the supplier receives,

[1] See, among others, Antràs et al. (2008), King and Levine (1993) and Rajan and Zingales (1998).

[2] I assume, for easiness of exposition and without loss of generality, that the fixed cost is such that it is always the case that the transfer from the final-good producer to the supplier is positive.

ceteris paribus, a larger loan from the bank and needs a lower transfer from the final-good producer. This is another departure from the related literature because it is usually assumed that both parties have deep pockets and the transfers are unconstrained.

Once this fixed cost is paid, the supplier and the final-good producer make their investment choices, which are noncontractbile, and after headquarter services and intermediate inputs are combined and the final good is sold, revenues are divided according to the optimal ex-post payment chosen by the final-good producer.

In the appendix, I consider a more general model in which the ex-post payment includes a transfer and a share of revenues. Moreover, in this generalized model I assume that after the investments are made there exists a small probability of a bad shock that drives revenues to zero and because of this uncertainty, a limited commitment constraint is also added.

However, for expositional reasons and to gain a better intuition into the main result of the paper, my baseline model abstracts from uncertainty and the ex-post payment takes the form of a simple endogenous sharing rule. In this environment, the final-good producer would like to extract all the rents of the supplier by offering her a transfer as low as possible but when the supplier is located in the South, the final-good producer needs to leave her some rents. Otherwise the supplier would not have enough funds to cover the fixed cost. Therefore, the final-good producer chooses to tilt the ex-post sharing rule in her favor to extract more surplus from the Southern supplier ex-post. Changes in the sharing rule affect investment choices, thus, one result of the paper is that financial underdevelopment leads to distorted contracts. Nonetheless, the contract is optimal and, as it is well known in the contract theory literature, taking financial institutions as given, the more important the investment of one party is, the larger the share of revenues going to that party is.

Section 2 shows that these financial institution differences across countries are enough to generate a product cycle in which the final-good producer prefers to keep production in the North when the good is new (intermediates are not very important) and it is transferred to the South when the good becomes more standardized (intermediate inputs are more relevant because the services provided by headquarters become relatively less important). The intuition is that the final-good producer faces a trade-off between low wages and contracting distortions. When the good is new, the role of the supplier is small and the final-good producer finds it

optimal to keep production in the North at the cost of a higher wage but with the benefit of a less distorted contract. However, as the good becomes more standardized, the importance of the supplier increases and the cost of not shifting production to the South and take advantage of the lower wage offsets the contractual distortions that the underdeveloped Southern financial institutions create. Moreover, I show that when Southern financial institutions improve, more production is located in the South and, more importantly, the effect of financial institutions is larger, the less standardized the good is. The intuition is that with poor financial institutions, the Southern supplier is already producing the more mature goods and when financial institutions improve and contractual distortions decrease, the final-good producer prefers to also buy from the South the relatively newer goods.

Section 3 shows, for completeness, that all the results derived in partial equilibrium go through when wages are endogenized. The main contribution of this section is to illustrate that relative Northern wage decreases when Southern financial institutions improve and it reduces the effect of financial development on offshoring.

Section 4 describes and tests the most salient empirical prediction of the model. The model predicts that the effect of financial development on offshoring is larger, the more R&D-intensive the industry is. In order to test this prediction I use the number of goods (5-digit SITC) that a country exports to the United States in each industry (3-digit NAICS) as a proxy of offshoring and domestic credit to private sector over GDP as a measure of financial development. My sample consists of all the trading partners of the United States and the 15 manufacturing industries for which data on R&D-expenditure (my proxy for R&D-intensity) are available. In all my regressions I control for country and industry fixed effects. The prediction of the model is confirmed in the data and it is robust to different specifications and definitions of financial development.

The literature that uses incomplete contracts to understand the organization of the firm and the patterns of trade heavily relies on the *exogenous* bargaining power of the parties. This is, when contracts are incomplete, revenues are shared according to an exogenous bargaining power and this sharing rule is crucial to determine the comparative statics. Section 2.4 shows that the implications of the model can be counterfactual when these sharing rules are exogenous. Moreover, it is difficult to assess the validity of the assumptions made to choose the bargaining

power of both parties because they are unobservable. My framework features complete contracts and it does not suffer from these problems. On the one hand, the sharing rule is *endogenous*. This optimal sharing rule is uniquely determined and it gives comparative statics consistent with the product cycle hypothesis. On the other hand, differences in financial development are the source of the differences in the optimal contract that the final-good producer offers to the supplier. Therefore, the predictions of the model on the optimal contract could be taken to the data. As pointed out before, the model predicts a negative correlation between the financial development in the supplier country and the share of revenues that the final-good producer keeps for herself. Even though data on contracts are not available and the direct implications of the model cannot be tested, this prediction is consistent with the findings of Antràs et al. (2008) for US multinationals.

Related literature. This paper relates to the literature on the product cycle and offshoring. It includes Krugman (1979), Antràs and Helpman (2003) and Antràs (2005). My model is similar to Antràs (2005) but I focus on a different, but potentially complementary, explanation of the product cycle. In my framework the set of available contracts is the same in both countries but they differ in financial development. Antràs (2005) considers that the set of contracts is different across countries and ignores financial institution differences. Therefore, I consider differences in financial institutions across countries as the source of the product cycle, whereas he pushes the view that differences in the contractual framework are the relevant ones. My empirical results seem to suggest that both contracting and financial institutions are important. Bernanke and Gertler (1989) and Kiyotaky and Moore (1997) provide microfoundations to the collateral constraint which I interpret as an indicator of the stage of financial development. This paper also relates to the growing literature on the impact of financial development on trade. It includes, among others, Antràs and Caballero (2007), Beck (2002), Becker and Greenberg (2005), Kletzer and Bardhan (1987), Levchenko (2007), Manova (2007) and Matsuyama (2007). My model shares with them the idea that financial development can translate into comparative advantage. The main difference is that I focus on how financial institution differences affect the offshoring decision of the firm and the optimal contract that the final-good producer offers to the supplier. Moreover, I offer a new explanation of the product cycle, which was not the goal of any of those papers.

4.2 A Model of the Product Cycle with Financial Institutions Differences

4.2.1 Setup

The world consists of two countries: North and South. Labor is the unique factor of production and it cannot move across borders. There exists a large number of identical profit-maximizing suppliers both in the North and the South with an outside option normalized to zero in both countries. I assume that all final-good producers are located in the North and there is free-entry in the production of the final good.

There is a unit measure of consumers with the following preferences

$$U = \int_0^N \log \left[\int_0^{n_j} x_{j(i)}^{\alpha} di \right]^{\frac{1}{\alpha}} dj, 0 < \alpha < 1,$$

where $x_{j(i)}$ is total consumption of variety i in industry j, N is the number of industries in the economy and n_j is the number of varieties in industry j which is endogenously determined in Section 3. The elasticity of substitution between varieties is 1/(1-α) and it is one between industries.

The final-good producer needs headquarter services (h) and intermediate inputs (m) to produce each unit of the final good. The production function is

$$x_{j(i)} = \left(\frac{h_{j(i)}}{1 - z_j} \right)^{1-z_j} \left(\frac{m_{j(i)}}{z_j} \right)^{z_j},$$

where z_j represents the relative intensity of intermediate inputs in the production of the final good in industry j. I interpret z_j as an indicator of standardization and R&D-intensity of the good. The higher is z_j, the less important headquarter services (design, marketing,...) are and therefore the more standardized the good is.

Headquarter services, which are provided by the final-good producer, must be produced in the North and a worker is needed to produce one unit of headquarter services. Intermediate inputs, which are produced by the supplier, can also be produced in the South and the unit cost is one worker, the same in both countries.

The final-good producer needs to pay a fixed cost (e.g., patent) and then she contacts with a supplier located either in the North or the South. This supplier must also pay a fixed cost to enter into the relationship and she funds it with a loan from a local bank and a transfer from the final-good producer. After these fixed costs have been paid, each party makes, non-cooperatively, its investment decision. Finally, the final-good is produced and revenues are shared.

Financial institution differences affect the size of the loan that the supplier obtains from the bank through the fraction of pledgeable income. Since Southern financial institutions are less developed, the Southern supplier can pledge a lower fraction of their future profits and she has to rely more on the ex-ante transfer of the final-good producer to cover the fixed cost.

Banks can be interpreted as a third-party that observes all the game but they recognize that enforcing the contract is very expensive when financial institutions are poorly developed. For example, although revenues are contractible, it can be more difficult and costly to assess the net worth of the supplier in less financially developed countries. Therefore, banks lend to the supplier only a fraction of their pledgeable income.[3]

There is no uncertainty and the setting is one of complete contracting. I assume that investment choices are not contractible, but revenues are contractible. We can think that there is moral hazard in the investment phase, but once the inputs are produced, both parties observe revenues and, therefore, contracts can be written contingent on them.

The timeline of events is represented in figure 1 and summarized as follows.

- The final-good producer (F) of variety i in industry j chooses to locate production in country $c \in \{N, S\}$ and pays the fixed cost (f_F).
- After deciding where to buy the intermediate input, the final-good producer offers a contract to the supplier consisting of an ex-ante transfer (T) and an ex-post share of revenues (β). [4,5]

[3] An interpretation similar to Bernanke and Gertler (1989) as I explain below.

[4] I only consider linear contracts but this assumption could be rationalized by citing Holmstrom and Milgrom (1987) who show that in a dynamic moral-hazard problem linear contracts are indeed the optimal contracts.

[5] In Appendix E, I show that the main results of the paper go through when I consider a more general setup with a larger set of feasible contracts.

- If the supplier (S) accepts the contract, she uses the ex-ante transfer (T) and the loan (D) from the bank to cover the fixed cost (f_S).

- At t=1 both parties make their investment choices. The final-good producer invests in headquarter services ($h_{j(i)}$) and the supplier in intermediate inputs ($m_{j(i)}$). The final good ($x_{j(i)}$) is produced and revenues are shared according to the sharing rule chosen at t=0 (i.e., a fraction β for the final-good producer and 1-β for the supplier).

4.2.2 Partial equilibrium

This section considers the choice of the final-good producer of variety i in industry j who needs to buy an input from an independent supplier. This supplier can be found either in the North where wages are w^N or in the South where wages are w^S but financial institutions are less developed.

Definition

The subgame perfect equilibrium (SPE) can be described by a tuple $\left\{c^*, T^*, D^*, \beta^*, h^*_{j(i)}, m^*_{j(i)}, x^*_{j(i)}\right\}$ in which c^* is the location of production, $\{T^*, \beta^*\}$ is the contract offered to the supplier, D^* is the loan from the bank, $x^*_{j(i)}$ is the consumer demand by variety i of industry j and $\left\{h^*_{j(i)}, m^*_{j(i)}\right\}$ are the equilibrium investment choices.

The equilibrium can be solved backwards. The investments $\left\{h^*_{j(i)}, m^*_{j(i)}\right\}$ are the Nash equilibrium of the game in the stage in which both parties make their decisions non-cooperatively taking wages as given.

Given that $\left\{h^*_{j(i)}, m^*_{j(i)}\right\}$ are the equilibrium investments and demand, $x^*_{j(i)}$, is chosen by the consumers who maximize their utility given prices and income, the final-good producer chooses the terms of the contract $\{T^*, \beta^*\}$ and, indirectly, the loan, D^*, that the bank offers to the supplier in order to maximize her own profits when the supplier is located in country c.

Finally, the final-good producer compares profits in the different locations $c \in \{N, S\}$ and chooses to locate production where profits are larger.

Consumers

Each consumer chooses $x_{j(i)}$ subject to prices $p_{j(i)}$ and income to maximize the utility function defined above. It follows that the demand faced by the producer of variety i in industry j is given by

$$x_{j(i)} = \Delta p_{j(i)}^{-\frac{1}{1-\alpha}} \text{ where } \Delta = \frac{1}{N} \frac{E}{\int_0^{n_j} p_{j(i')}^{-\frac{\alpha}{1-\alpha}} di'},$$

where E is world income and each firm takes Δ as given.

Thus, revenues generated by variety i in industry j are $R = \Delta^{1-\alpha} x_{j(i)}^{\alpha}$

Equilibrium

I solve backwards the SPE of the game between the final-good producer and the supplier described above. First, I consider the stage in which both parties make their investment decisions.

The supplier chooses intermediate inputs (m) to maximize her profits which are her share of revenues minus the cost of producing these inputs. She takes into account consumer demand and acknowledges that revenues also depend on headquarter services (h) which are chosen, simultaneously, by the final-good producer. Therefore, if the supplier is located in country c, she solves the following problem

$$\begin{aligned} & \max_{\{m\}} \ (1-\beta)R - w^C m \\ s.t.\ R &= \Delta^{1-\alpha} x^{\alpha} \\ x &= \left(\frac{h}{1-z}\right)^{1-z} \left(\frac{m}{z}\right)^{z} \end{aligned}$$

Similarly, the final-good producer makes her investment in headquarter services (h) to maximize her own profits.

$$\begin{aligned} & \max_{\{h\}} \ \beta R - w^N h \\ s.t.\ R &= \Delta^{1-\alpha} \left(\frac{h}{1-z}\right)^{\alpha(1-z)} \left(\frac{m}{z}\right)^{\alpha z} \end{aligned}$$

It is straightforward to solve the equilibrium investment choices by combining the first-order conditions of both problems and check that revenues are given by

$$R = \Delta \left[\alpha \left(\frac{\beta}{w^N} \right)^{1-z} \left(\frac{1-\beta}{w^C} \right)^{z} \right]^{\frac{\alpha}{1-\alpha}}.$$

Now consider the stage in which the final-good producer has already decided to locate production in country c and extends a take-it-or-leave-it offer to that supplier. The final-good producer solves the following program where h and m are the equilibrium investments derived above [6,7]

$$\begin{aligned}
& \max_{\{\beta,T,D\}} \ \pi^c = \beta R - w^N h - T - f_F \\
s.t.\ T + D &\geq f_S && (4.1) \\
PS &\equiv T - f_S + (1-\beta)R - w^c m \geq 0 && (4.2) \\
D &\leq \theta^c \left[(1-\beta)R - w^c m \right] && (4.3) \\
R &= \Delta \left[\alpha \left(\frac{\beta}{w^N} \right)^{1-z} \left(\frac{1-\beta}{w^C} \right)^{z} \right]^{\frac{\alpha}{1-\alpha}} && (4.4)
\end{aligned}$$

She chooses the terms of the contract $\{\beta, T, \}$ and, indirectly, the loan (D) that the supplier receives in order to maximize her own profits which are given by her share of revenues (βR) minus the investment costs $(w^N h)$, the transfer provided to the supplier (T) and the fixed cost (f_F).

The first constraint is the budget constraint of the supplier. The supplier enters into the relationship only if she obtains enough funds to cover the fixed cost (f_S) which I assume, for simplicity, to be the same in both countries. The supplier obtains a loan from the bank (D) and the transfer from the final-good producer (T).

Equation (4.2) is the participation constraint of the supplier where the outside option is normalized to zero. The supplier prefers not to sign the contract with the final-good producer when her net profits are lower than her outside option. This happens when her share of

[6] For simplicity, the gross interest rate is normalized to one.

[7] The FOC of the supplier is $w^C m = \alpha z(1-\beta)R$ and the FOC of the final-good producer is $w^N h = \alpha(1-z)\beta R$.

revenues ((1-β)R) plus the ex-ante transfer (T) fall short of the fixed cost (f_S) and investment costs ($w^c m$).

Equation (4.4) is the equilibrium outcome in the final stage of the game that the final-good producer takes into account when choosing the terms of contract. She internalizes that changes in the ex-post sharing rule (β) affect the equilibrium investment choices and revenues in the next period.

Lastly, equation (4.3) is the collateral constraint and the main departure from the related literature. It says that the bank lends to the supplier, at most, a fraction θ^c of her future profits. The lower is θ^c, the weaker financial institutions are. This constraint could be rationalized, along the lines of Bernanke and Gertler (1989), by saying that banks in less financially developed countries have worse information about the balance sheets of their clients and they require more collateral (future profits) to lend money to the supplier. Therefore, this collateral constraint can be interpreted as a reduced-form solution to this asymmetric information problem.

To solve this problem note that the final-good producer would like to extract all the profits of the supplier (i.e., make $PS = 0$) but she cannot do it when $\theta^c < 1$ because it would violate the budget constraint of the supplier (i.e., $T + D < f_S$ if $PS = 0$).[8] It implies that, *ceteris paribus*, the final-good producer needs to leave more rents to the supplier when financial institutions are less developed (i.e., θ^c lower). It follows that the budget and the collateral constraint bind in equilibrium, $PS > 0$ and the problem simplifies to

$$\max_{\{\beta\}} \pi^c = \Delta \frac{\beta\left[1-\alpha(1-z)\right] + \theta^c(1-\beta)\left[1-\alpha z\right]}{\left[\alpha\left(\frac{\beta}{w^N}\right)^{1-z}\left(\frac{1-\beta}{w^C}\right)^{z}\right]^{-\frac{\alpha}{1-\alpha}}} - f_F - f_S \tag{4.5}$$

Finally, after solving for the optimal sharing rule, the final-good producer chooses to locate production where profits are higher.

I next compute the profits of the final-good producer when she contracts with a Southern supplier, then with a Northern supplier and I compare them to see when offshoring takes place.

For simplicity and without loss of generality I set $\theta = \theta^S < \theta^N \equiv 1$. Northern financial institutions are perfect in the sense that the supplier can fully pledge her future profits and are

[8] Note that the final-good producer is able to extract all the rents of the supplier when $\theta^c = 1$.

imperfect in the South where the supplier can only a pledge a fraction of these profits.

Southern supplier

If the supplier is located in the South, equation (4.5) becomes

$$\max_{\{\beta\}} \pi^S = \Delta \frac{\beta\left[1-\alpha(1-z)\right]+\theta(1-\beta)\left[1-\alpha z\right]}{\left[\alpha\left(\frac{\beta}{w^N}\right)^{1-z}\left(\frac{1-\beta}{w^S}\right)^{z}\right]^{-\frac{\alpha}{1-\alpha}}} - f_F - f_S \tag{4.6}$$

Lemma 1 *$\beta^S(\theta,z)$ is the unique solution to (4.6) and $\beta^S(\theta,z)$ is weakly (strictly if $z>0$) decreasing in θ and strictly decreasing in z.*[9]

Northern supplier

If the final-good producer prefers to contact with a Northern supplier, equation (4.5) becomes

$$\max_{\{\beta\}} \pi^N = \Delta \frac{\beta\left[1-\alpha(1-z)\right]+(1-\beta)\left[1-\alpha z\right]}{\left[\alpha\left(\frac{\beta}{w^N}\right)^{1-z}\left(\frac{1-\beta}{w^N}\right)^{z}\right]^{-\frac{\alpha}{1-\alpha}}} - f_F - f_S \tag{4.7}$$

The optimal sharing rule is[10] $\beta^N(z) = \frac{(1-\alpha z)(1-z)-\sqrt{(1-\alpha+\alpha z)z(1-\alpha z)(1-z)}}{1-2z}$.

Lemma 2 *$\beta^N(z)$ is decreasing in z, $\beta^N(z)=\beta^S(\theta=1,z)$ and $\beta^N(z)\leq\beta^S(\theta,z)$ (with inequality if $z>0$).*

Proof It follows from the fact that the optimal β is independent of wages and $\frac{\partial\beta^S(\theta)}{\partial\theta} < 0$ if $z>0$.

Figure 2 represents the optimal sharing rules (β) for different levels of financial development (θ). We can see that β is decreasing in z. This is a well known result in the contract theory literature and it means that it is optimal to give more incentives to the party whose investment is relatively more important. As z increases, intermediate inputs become more important and

[9] $\beta^S(\theta) = \frac{(1-\alpha z)[1-\theta-\alpha(1-z)(1+\theta)]+\sqrt{(1-\alpha z)\{(1-\theta)^2(1-2\alpha+\alpha z)+\alpha^2(1-z)[[(1+\theta)^2(1+z(1-\alpha+\alpha z))]-4\theta]\}}}{2[1-\theta-\alpha+(1+\theta)\alpha z]}$

[10] This expression is the same as the one derived in Antràs and Helpman (2004) with the only difference that I define z as their 1-η.

the final-good producer gives a higher share of the ex-post revenues (low β) to the supplier who produces these intermediate inputs.

A more interesting result is that β is decreasing in θ. It means that when financial institutions are underdeveloped, the ex-post share of revenues that the final-good producer keeps for herself is too high. The intuition is that when Southern financial institutions worsen (i.e., θ declines), the ex-ante transfer that the final-good producer has to make to the supplier increases and it translates into a lower ex-post share of revenues for the supplier (i.e., higher β). In other words, the final-good producer would always prefer to give a higher share of revenues to the Southern supplier but she cannot do it because she has to give her a higher ex-ante transfer to cover the fixed costs. Note that the negative correlation between Southern financial institutions and the optimal sharing rule is consistent with the findings of Antràs et al. (2008) for US multinationals.

4.2.3 Optimal location

The final-good producer compares equations (4.6) and (4.7) and chooses to locate production in the South if and only if $\omega \equiv \frac{w^N}{w^S} \geq A(.,\theta,z)$, where

$$A(.,\theta,z) \equiv \frac{1-\beta^N}{1-\beta^S}\left(\frac{\beta^N}{\beta^S}\right)^{\frac{1-z}{z}}\left[\frac{\left(1-\beta^N\right)(1-\alpha z)+\beta^N\left[1-\alpha(1-z)\right]}{\theta\left(1-\beta^S\right)(1-\alpha z)+\beta^S\left[1-\alpha(1-z)\right]}\right]^{\frac{1-\alpha}{\alpha z}}$$

Note that as long as $\theta < 1$, $A(.,\theta,z)$ is decreasing in z if $z < \widehat{z}$, $A(.,\theta,z)$ is increasing in z if $z > \widehat{z}$, $\lim_{z\to 0} A(.,\theta,z) = +\infty$ and $\lim_{z\to 1} A(.,\theta,z) = \frac{1-(1-\alpha)\theta}{\alpha} > 1$.[11]

The fact that $A(.,\theta,z) > 1$ means that since contracts are distorted in the South due to the weaker financial institutions, the final-good producer requires strictly lower wages in the South to offshore production. If wages were the same in the North and South, production would always take place in the North.

I need to assume the relative Northern wage to solve the partial equilibrium and Proposition 1 shows that assumption A1 is sufficient for having a unique threshold which gives raise to a product cycle.

Assumption A1

[11] See Appendix B for the derivation of $\widehat{z}$.

$$\omega > \frac{1-(1-\alpha)\theta}{\alpha}$$

This assumption implies that a larger wage differential is required, the worse Southern financial institutions are (i.e., the right-hand side decreases with θ). It means that when Southern financial development declines, the Northern final-good producer demands a lower relative Southern wage to locate production in the South, otherwise she prefers not to offshore production and no product cycle takes place. Note that when Southern financial institutions converge to Northern ones (i.e., $\theta \to 1$), assumption A1 approaches to the standard assumption $\omega > 1$.

In the next section where I close the model in general equilibrium I show that this assumption is part of the equilibrium outcome.

Proposition 1

i) Existence of product cycle: If A1 holds, there exists a unique $z^* \equiv A^{-1}(\omega)$ *such that* $\omega < A(.,\theta,z)$ *when* $z < z^*$ *and* $\omega > A(.,\theta,z)$ *when* $z > z^*$.

ii) Effect of financial development: If A1 holds, z^* *is decreasing in* θ.

Proof See Appendix B.

The first part of Proposition 1 says that there exists a unique $z^* \equiv A^{-1}(\omega)$ such that the final-good producer decides to buy the intermediate inputs from a Northern supplier when $z \in (0, z^*)$ and from a Southern supplier when $z \in (z^*, 1)$. The intuition is that the final-good producer faces a trade-off between high wages and distorted contracts when choosing where to locate production. A product cycle emerges because the final-good producer prefers to keep production in the high-wage but financially developed North when the good is new and headquarter services are very important and she prefers to distort the optimal contract and take advantage of the low-wage South when the good matures and the contribution of intermediate inputs in the final good increases. To better understand this product cycle result and capture the time dimension, let me formalize my assumption that headquarter services become less important as the good matures and say that $z(t) = h(t)$ with $h'(t) > 0$, $h(0) > 0$ and $\lim_{t\to\infty} h(t) = 1$.[12] Proposition 1 directly implies that production remains in the North

[12] This assumption is also made in Antràs (2005).

when the good is new (i.e., $t < h^{-1}(z^*)$) and it is offshored to the South when becomes more standardized (i.e., $t > h^{-1}(z^*)$).

The second part means that the effect of financial development on offshoring is positive and, more importantly, this effect is larger, the more R&D-intensive (i.e., the lower z) the good is. This result can be seen in figure 3 which represents how the optimal location of production changes with Southern financial development. Graphically, when Southern financial institutions improve (i.e., θ increases), $A(.,\theta,z)$ shifts down and, given relative wages, z^* decreases. The intuition is that the Northern final-good producer requires a lower wage differential to offshore production because the improvement in Southern financial institutions allows the Northern final-good producer to offer a less-distorted contract to the Southern supplier and it decreases the comparative advantage of the Northern supplier. Since wages are given, it implies that more production is located in the South. Moreover, the effect of financial development on offshoring is in the relatively less standardized (lower z) goods. The Southern supplier was already producing the more mature goods and as a result of the improvement in financial institutions she can also start producing more R&D-intensive goods. In the empirical part, section 5, I formalize this insight to take this prediction of the model to the data.

Finally, note that if Southern financial institutions were as developed as Northern ones (i.e., $\theta = 1$), all production would be located in the South if we maintain assumption A1 because $\omega > 1 (= A(.,\theta = 1, z))$.

The next proposition shows that the time-series results in Proposition 1 go through if I consider a cross-section of countries which differ in their financial institutions.

Proposition 2 *If we have three countries: North (N), Developing Country (DC) and South (S) which differ in financial development ($\theta^N > \theta^{DC} > \theta^S$) and the final-good producer is located in the North, it must be the case that production is located in the North when $z < z_N$, is located in DC when $z \in (z_N, z_{DC})$ and it is located in S when $z > z_{DC}$. Therefore, there is no reversal of comparative advantage.*

Proof See Appendix C.

Proposition 2 says that it is not possible that the good is first produced in a developing country, then in the South and then it comes back to the developing country when it is more

standardized. In other words, there cannot be a reversal of comparative advantage as the good matures. It implies that the less standardized a good is, the more likely it is to be produced by (and exported to the North from) a financially developed country.

This proposition could be generalized to n countries allowing me to use a cross-section of countries in the empirical section.

4.2.4 Discussion of the model

A critical element of the model is how revenues are shared because it determines the investment choices that both parties make and the comparative advantage of the Northern supplier. The baseline model restricts the ex-post payment to a simple sharing rule. This restriction is not important and I show, in the appendix, that the results go through when the final-good producer is allowed to extract rents from the supplier ex-post through a non-distortionary transfer.

This subsection emphasizes the importance of considering a complete contracting setting and shows that very different results are obtained if contracts were incomplete (revenues were not contractible) and the sharing rule was exogenously given.

The model says that production is shifted to the South whenever $w^N/w^S \geq A(.,\theta,z)$, where

$$A(.,\theta,z) \equiv \frac{1-\beta^N}{1-\beta^S}\left(\frac{\beta^N}{\beta^S}\right)^{\frac{1-z}{z}}\left[\frac{\left(1-\beta^N\right)(1-\alpha z)+\beta^N\left[1-\alpha(1-z)\right]}{\theta\left(1-\beta^S\right)(1-\alpha z)+\beta^S\left[1-\alpha(1-z)\right]}\right]^{\frac{1-\alpha}{\alpha z}}$$

This equation follows from comparing equations (4.6) and (4.7) and it is valid independently of how these sharing rules are chosen. Proposition 1 shows that a product cycle arises when these ex-post sharing rules are optimally chosen by the final-good producer.

Now, consider that contracts are incomplete (revenues are not contractible) and the final-good producer cannot choose the ex-post sharing rule but it is *exogenously* determined by the bargaining power of each party. In this case, β represents the bargaining power of the final-good producer. First, let us assume that the bargaining power of the final-good producer is the same when contracting with the Northern and Southern supplier (i.e., $\beta^N = \beta^S = \beta$). $A(.,\theta,z) \equiv \left[\frac{(1-\beta)(1-\alpha z)+\beta[1-\alpha(1-z)]}{\theta(1-\beta)(1-\alpha z)+\beta[1-\alpha(1-z)]}\right]^{\frac{1-\alpha}{\alpha z}}$. The properties of $A(.,\theta,z)$ are qualitatively the same and all the results of the model would go through.

However, consider a more extreme case in which the bargaining power of the final-good

producer is very high when contacting with a Southern supplier but very low when contacting with a Northern supplier (i.e., $\beta^N = \varepsilon$, $\beta^S = 1 - \varepsilon$ where $\varepsilon > 0$ and small). In this case, $A(.,\theta,z) \equiv \left(\frac{1-\varepsilon}{\varepsilon}\right)^{\frac{2z-1}{z}} \left[\frac{(1-\varepsilon)(1-\alpha z)+\varepsilon[1-\alpha(1-z)]}{\theta\varepsilon(1-\alpha z)+(1-\varepsilon)[1-\alpha(1-z)]}\right]^{\frac{1-\alpha}{\alpha z}}$. $A(.,\theta,z)$ is now increasing in z instead of being decreasing and if we assume that $\omega < A(.,\theta,z=1)$, then there exists $z^* \equiv A^{-1}(\omega)$ such that production is kept in the North for the most standardized goods ($z > z^*$) and it is shifted to the South when they are new ($z < z^*$). This model counterfactually generates a reversed product cycle.

These examples illustrate the importance of considering a complete contracts setting. The cross-section and product cycle implications of the model could be dramatically different if the sharing rule was exogenously given. Therefore, it is important to derive the optimal contract to understand what determines theses sharing rules.

4.3 General equilibrium effects

I show that the results derived in partial equilibrium go through and assumption A1 is confirmed in general equilibrium. The main difference is that the effect of financial development on off-shoring is reduced because relative Southern wage also increases in response to an improvement in Southern financial institutions.

4.3.1 Closing the model

I close the model by finding the equilibrium number of varieties in each industry and the equilibrium wages in the economy.

There is free-entry in each industry and therefore new firms enter until the profits of this marginal firm are equal to zero. It follows from equations (4.6), (4.7), prices and the optimal location of production that

$$n_j = \begin{cases} \left[\beta^N\left[1-\alpha(1-z)\right] + (1-\beta^N)(1-\alpha z)\right]\frac{E}{N(f_S+f_F)} & \text{when } z \in (0,z^*) \\ \left[\beta^S\left[1-\alpha(1-z)\right] + \theta(1-\beta^S)(1-\alpha z)\right]\frac{E}{N(f_S+f_F)} & \text{when } z \in (z^*,1) \end{cases}$$

As discussed above, the final-good producer has to let rents to the Southern supplier because

of the collateral constraint (i.e., $PS > 0$). The rents of the Southern supplier of variety i in industry j can be expressed as $PS_{j(i)} = (1-\theta)(1-\beta^S)(1-\alpha z)\frac{E}{Nn_j}$.

If we denote $F(z)$ as the fraction of industries with $z < z^*$ and $f(z)$ as its density function, then, using the expression for Southern rents derived above and recognizing that the Southern supplier produces only those intermediate inputs with $z > z^*$, it follows that total Southern profits are

$$\int_{z^*}^{1} (1-\theta)(1-\alpha z)\left[1-\beta^S(.,\theta,z)\right] Ef(z)dz.$$

Noting that Northern suppliers obtain no rents ($PS_{j(i)} = 0$ if $\theta = 1$) and the final-good producer has zero profits in equilibrium because of the free-entry condition, the goods market clearing condition becomes

$$(1-\theta)\varphi(z^*,1)E + w^S L^S + w^N L^N = E \tag{4.8}$$

where $\varphi(a,b) \equiv \int_a^b (1-\alpha z)\left[1-\beta^S(.,\theta,z)\right] f(z)dz$, L^c is the supply of workers in country c and E is world income.

After deriving the goods market clearing condition, I only need, by Walras' law, to clear one of the two labor markets and I choose to focus on the Southern labor market. The labor demand of any Southern supplier of variety i in industry j is $m^S_{j(i)} w^S = \alpha z(1-\beta^S)\frac{E}{Nn_j}$, then, the Southern labor market condition is given by

$$\int_{z^*}^{1} \alpha z\left[1-\beta^S(.,\theta,z)\right] Ef(z)dz = w^S L^S \tag{4.9}$$

If we define $\xi(a,b) \equiv \int_a^b \left[1-\beta^S(.,\theta,z)\right] zf(z)dz$, then, by plugging the labor market condition (4.9) into the goods market condition (4.8), we obtain

$$\frac{w^N}{w^S} = B(.,\theta,z^*) \equiv \frac{1-(1-\theta)\varphi(z^*,1)-\alpha\xi(z^*,1)}{\alpha\xi(z^*,1)}\frac{L^S}{L^N}$$

Note that $B(.,\theta,z^*)$ is increasing in z^*, $\lim_{z^*\to 1} B(.,\theta,z^*) = +\infty$, $\lim_{z^*\to 0} B(.,\theta,z^*) > 0$

and $\frac{\partial B(.,\theta,z^*)}{\partial \theta} < 0$.

To close the model I need another equation that combines relative wages with the optimal threshold. In the partial equilibrium section I already obtained this equation ($\omega = A(.,\theta,z^*)$) from the final-good producer optimal location problem which I use next to find the equilibrium outcomes.

4.3.2 Effect of financial development

Summing up, we have two equations that determine the equilibrium values of z^* and $\frac{w^N}{w^S}$.

$$\begin{aligned}
\frac{w^N}{w^S} &= A(.,\theta,z^*) \equiv \frac{1-\beta^N}{1-\beta^S}\left(\frac{\beta^N}{\beta^S}\right)^{\frac{1-z^*}{z^*}}\left[\frac{\left(1-\beta^N\right)(1-\alpha z^*)+\beta^N\left[1-\alpha(1-z^*)\right]}{\theta\left(1-\beta^S\right)(1-\alpha z^*)+\beta^S\left[1-\alpha(1-z^*)\right]}\right]^{\frac{1-\alpha}{\alpha z^*}} \\
\frac{w^N}{w^S} &= B(.,\theta,z^*) \equiv \frac{1-(1-\theta)\varphi(z^*,1)-\alpha\xi(z^*,1)}{\alpha\xi(z^*,1)}\frac{L^S}{L^N}
\end{aligned}$$

Given reasonable parameter values and density function, $f(z)$, assumption A1 holds in general equilibrium.[13]

Proposition 3 *w^N/w^S and z^* are decreasing in θ.*

Proof See Appendix D.

This result can be seen in figure 4. Intuitively, an improvement in Southern financial institutions has two effects. First, it increases Southern labor demand (i.e., $B(.,\theta,z)$ shifts down). Second, the comparative advantage of Northern supplier decreases because contractual distortions associated to the underdeveloped Southern financial institutions decline and the final-good producer requires a lower wage differential to offshore production (i.e., $A(.,\theta,z)$ shifts down). The total effect is that relative Southern wage rises but it does not increase enough to offset the gain in contractual efficiency and more production is shifted to the South.

[13] However, it is theoretically possible to find a combination of relative labor supplies and density function, $f(z)$, such that both curves cross at $z^* > \widehat{z}$ and assumption A1 is violated. Even if A1 is violated, all results go through if $z^* < \widehat{z}$ (i.e., $\frac{\partial A(.,\theta,z)}{\partial z}\,|_{z=z^*} < 0$). To ensure that it is indeed the case one could either restrict the values that z can take (i.e., $z \in (0,\widehat{z}]$) or assume that $\frac{L^S}{L^N} \geq \frac{\overline{L}^S}{\overline{L}^N}$ where $\frac{\overline{L}^S}{\overline{L}^N}$ is such that $B\left(.,\frac{\overline{L}^S}{\overline{L}^N},\theta,0\right) = A(.,\theta,\widehat{z})$.

4.4 Empirical Evidence

4.4.1 Prediction of the model

In this subsection, I describe the main empirical prediction of the model.

Prediction *The effect of financial development on offshoring is larger in industries with less standardized (more R&D-intensive) goods.*

To see that, remember that the model predicts that production takes places in the South whenever $z > z^*$. Let us define an indicator function, $M(z)$, that equals one if the good is offshored and zero otherwise. If goods in industry i are represented by the distribution function $G_i(z)$, then $M_i = \int_0^1 M(z)dG_i(z)$ is a measure of offshoring in industry i.

Let us now assume that there are two industries (A and B) with industry A having more standardized (higher z) goods than industry B. To be more precise, $G_A(z)$ first-order stochastically dominates $G_B(z)$.

It follows from the definition of first-order stochastic dominance and the second part of Proposition 1 that $\frac{\partial M_B}{\partial \theta} \geq \frac{\partial M_A}{\partial \theta}$ and the prediction is verified.

To provide a better intuition, let us take a look at figure 5. This figure represents two arbitrary distributions of goods in industries A and B with the assumption that industry B is a more R&D-intensive industry (i.e., $G_A(z)$ first-order stochastically dominates $G_B(z)$). Assume that the initial equilibrium is z^*. When Southern financial institutions improve (i.e., θ increases), the new equilibrium is, as predicted by the model, shifted to the left, let us say z^{**}. Therefore, this improvement in financial institutions affects the Southern production of those goods in the range (z^{**}, z^*) which were previously produced in the North and are now produced in the South. Given our distribution assumptions, the effect of financial development is larger in industry B which has more goods in this range. Graphically, the shaded region reflects how much larger the effect in industry B is $\left(\text{i.e., } \frac{\partial M_B}{\partial \theta} - \frac{\partial M_A}{\partial \theta}\right)$.[14]

[14] Even though my model has also time-series predictions, I do not test these predictions because of the lack of time-variation in the measures of financial development for the period in which disaggregated trade data are available. Moreover, there exists a growing literature (e.g., Antràs et al. (2008) and Carluccio and Fally (2008)) on the effect of financial development on the integration decision of the firms but my model abstracts from this integration decision and I therefore focus on the effect on offshoring.

4.4.2 Data

I use the number of goods per industry that a given country exports to the North as proxy for offshoring because the prediction of the model is more related to the extensive margin. My definition of a good is a 5-digit SITC and I assume that these goods are used as intermediate inputs.[15] United States is treated as the North because of data availability and because it is sensible to assume that goods are created in the United States and then they are produced abroad. My sample includes all the trading partners of the United States (145 countries). These trade data come from NBER.

As robustness check I also use the intensive margin as proxy for offshoring. In this case I use the value of exports to US by industry instead of the number of goods. These trade data also come from NBER. Finally, US foreign direct investment is used as a potential proxy for offshoring and these data are obtained from BEA.

The proxy for standardization is R&D-expenditure at the industry level in the United States. I am assuming that the more R&D-intensive an industry is, the less standardized its goods are. This definition of standardization is very closely related to the model and it is also akin to the description of the product cycle in Vernon (1966). Vernon notes that when the good is new, it requires a high expenditure on product development (which is related to R&D-expenditure), but its importance decreases as the good becomes more standardized. The definition of an industry is a 3-digit NAICS and data from R&D-expenditure at industry level in the United States are obtained from NSF.

When doing robustness checks I add additional industry control variables. I use dependence on external finance, asset tangibility, capital intensity and industry share in total value added. Later on I argue why these variables can be useful. Dependence on external finance is defined as the share of investment that cannot be financed through the cash flows generated by the firm and asset tangibility is the share of plant, property and equipment in total assets. I obtain both measures from Braun (2003). Capital intensity which measures the use of capital in each industry is obtained from Manova (2007). Industry share is value added in industry i in country c over value added in country c. This variable is constructed by using data from UNIDO.

[15] I also ran the same regressions when a good is defined as a 10-digit HS. I do not report these results because the coefficients are very similar due to the use of logs.

My preferred definition of financial development is the share of domestic credit to private sector over GDP (*D Credit*) which I obtain from World Development Indicators (World Bank). Different definitions of financial development are used as robustness checks. *D Credit (2)* stands for private credit by deposit money banks and other financial institutions (% GDP), *Stock Mkt* is stock market capitalization (% GDP), *Repud* is risk of contract repudiation, *Exprop* is risk of expropriation and *Account* is accounting standards. The first two measures are obtained from Beck et al. (2000) and the last three measures come from La Porta et al. (1998). Although the exact definitions and sources can be found in those papers, I just want to remark that lower values in *Rep* and *Exprop* mean higher risks of contract repudiation and expropriation and higher values in *Account* mean better accounting practices. Thus, for all definitions, higher values mean better financial institutions.

Appendix A reports average US R&D-expenditure at industry level for 1999-2001 and the measures of dependence on external finance, asset tangibility and capital intensity for the 15 industries for which R&D-expenditure is available. Unsurprisingly, the "computer and electronic products" industry is the most R&D-intensive and "wood products" and "beverage and tobacco products" are the least R&D-intensive ones and the different measures are correlated.

4.4.3 Empirical strategy

The baseline equation that I use to test the prediction of the model is

$$G_{ic} = \delta_i + \delta_c + \gamma FD_c RD_i + \epsilon_{ic}, \tag{4.10}$$

G_{ic} is the number of goods in industry i that country c exports to the US, FD_c is financial development of country c, RD_i is US-R&D expenditure in industry i and δ_i and δ_c are a set of industry and country fixed effects, respectively. All variables are in logs and are the average for 1999-2001.[16]

The variable of interest is the interaction between financial development and R&D-intensity and the model predicts a positive coefficient on this variable (i.e., $\gamma > 0$).

As a first informal check of the model, figures 6 and 7 show the relationship between financial

[16] Except for risk of contract repudiation, risk of expropriation, accounting standards, dependence on external finance and asset tangibility which are not available for this period.

development and the number of goods exported to the United States in the "computer and electronic products" and "textile, apparel and leather" industries, respectively. At first sight we can note that these figures are consistent with the model because the slope of the regression fit line is steeper in the "computer and electronic products" industry. It implies that the effect of financial development is larger in the "computer and electronic products" industry which is more R&D-intensive than the "textile, apparel and leather" industry.

4.4.4 Results

Table 1 reports the results of running equation (4.10) by using country-fixed effects with robust standard errors in parentheses.[17] In the different columns, I run the same regression but using different definitions of financial development. As it can be seen, the coefficient on the interaction term is positive and statistically significant for all the different definitions. It means that the effect of financial development on offshoring is larger, the more R&D-intensive the industry is. This effect is also economically significant, take for example the coefficient in the first column (0.098). Imagine that the financial development of one country goes from the 25th percentile of the distribution to the 75th percentile. That country would see that the number of goods in an industry in the 25th percentile of the R&D-intensity distribution that exports to the US increases by 0.91% whereas the number of goods in an industry in the 75th percentile of the distribution increases by 1.40%.[18]

In Table 2, I check whether my results are being driven by the most R&D-intensive industries. I eliminate from the sample the three most R&D-intensive industries.[19] The top panel of Table 2 reports the coefficients for the whole sample (Table 1) and the bottom one the coefficients for the constrained sample. Note that the coefficients are larger and remain positive and statistically significant for the six different definitions of financial development. For example, in column one the coefficient increases from 0.098 to 0.132.

[17] Similar results are obtained if equation (10) is estimated by using a Probit model.

[18] To get these numbers note that the 25th and 75th percentiles of the R&D-expenditure distribution are 295 and 6347 and the percentiles in the domestic credit distribution are 11.83% and 60.69%, respectively. Given that the coefficient is 0.098, if domestic credit goes from 11.83% to 60.69%, the increase in the number of goods in the industry in the 25th percentile of the R&D distribution is 0.098*log(295)*[log(60.69)-log(11.83)] = 0.91 percentage points.

[19] As can be seen in Appendix A, the industries with highest R&D-expenditure are computer and electronic products, transportation equipment and chemicals.

In Table 3, I study whether my results are robust to including other industry controls. It could be argued (see for example Manova 2007) that the omission of other industry variables such as dependence on external finance and asset tangibility is driving my results and that R&D-intensity is just a proxy of these omitted variables. Moreover, it could be that my measure of R&D-intensity is a proxy of capital intensity (see Romalis 2004). The top panel of Table 3 repeats the previous results and the bottom panel includes the interaction of financial development with these three additional industry controls. There are two interesting things to remark. First, the coefficient on the variable of interest is almost unchanged and it is positive and statistically significant in the different definitions of financial development (for example, in the first column it slightly decreases to 0.083). Second, the interaction of financial development with these three additional variables is statistically insignificant for all the definitions except for the interaction between accounting standards and dependence on external finance which has the expected positive sign. Therefore, R&D-intensity is not only still significant when other industry variables are included but it seems to be the relevant one.

Table 4 includes a new variable to try to disentangle offshoring from Hecksher-Ohlin effects. Standard trade theory predicts that countries relatively abundant in one input (in this case, financial institutions) tend to export goods that intensively use this input. In order to partially address this concern, I add a new variable that I label industry share. This variable is the share (in value added terms) of industry i in country c over all the manufacturing industries in country c. The top panel repeats again Table 1 and the bottom panel includes this industry share variable. The sample size falls a lot after including this new variable and for that reason the coefficients in the last three columns, where the sample size is very small, should be taken with a grain of salt. In the three first columns it can be seen that the coefficient on the interaction between financial development and R&D-intensity is almost unchanged (for example, it goes from 0.098 to 0.092 in column one) and it remains positive and significant. Therefore, even though industry share is statistically significant, the coefficient on the variable of interest remains large and significant.

Table 5 considers the effects of ignoring the zeros (my left-hand side variable is the (log) number of goods exported to United States by country and industry). Helpman et al. (2007) illustrate that there are a lot of zeros in the bilateral trade relationships and show that ignoring

these zeros can generate significant biases in the coefficients of interest. To see whether ignoring these zeros affects my results, Table 5 runs two versions of equation (4.10) by using country-fixed effects in a Poisson specification with bootstrap standard errors in parentheses. Private credit is used as measure of financial development. The first column reports the coefficients when I ignore the zeros and the second column reports the results when the zeros are taken into account. In the top panel, I have the interaction between financial development and R&D-intensity, dependence on external finance and asset tangibility. By comparing both columns we can see that including the zeros has almost no effect on the coefficients (the coefficient on the variable of interest changes from 0.117 when zeros are ignored to 0.115 when zeros are included). In the bottom panel the interaction term and the industry share are the explanatory variables. Once again the coefficients are almost the same. The explanation for this negligible effect of the zeros is that a lot of countries trade with the United States and therefore the number of zeros in the sample is small.

4.4.5 Additional Robustness Checks

I perform additional robustness checks that confirm the empirical prediction of the model.

Table 6 investigates whether the effect of financial development on offshoring also applies to the intensive margin. The dependent variable is the value of exports to the United States for industry and country. The top panel only includes the interaction variable, the middle one adds the industry controls and the bottom one only considers the interaction variable and the industry share.[20] All the coefficients on the variable of interest are positive and statistically significant. One interpretation of this result is that when financial development increases, not only the industries that are more R&D-intensive export more goods to the US but the share of these industries in the export sector also increases.

Table 7 studies the effect of financial development abroad when foreign direct investment (FDI) is used as proxy of offshoring. One would expect that when a country improves its financial institutions, it receives more direct investment from the North and it is biased towards the more R&D-intensive industries. To test this hypothesis, FDI data for all the available manu-

[20] From now on, when I add industry controls I omit the interaction with capital intensity because it is not statistically significant. My coefficient of interest does not change if the interaction is included.

facturing industries are obtained from BEA. The dependent variable is US direct investment abroad measured as capital outflows. The top panel only includes the interaction variable, the middle one adds the industry variables and the bottom one uses the interaction variable and the industry share as explanatory variables. The first thing to note is that the sample is much smaller. The reason is that BEA only disaggregates data for seven manufacturing industries and the number of countries is also smaller. Having this in mind, we can see that the sign of the coefficient on the variable of interest goes always in the direction predicted by the model and it is also statistically significant in all the panels except in the bottom one where the sample size is very small.

Following the theoretical work of Antràs (2003) a growing empirical literature including Bernard et al. (2008) and Nunn (2007) has attempted to test the role of contracting institutions in intra-firm trade. Moreover, Acemoglu and Johnson (2005) emphasize that different institutions play a different role in the economic outcomes. Table 9 checks whether the effect of financial development is still significant when other type of institutions are added. The top panel repeats Table 1, the middle panel adds constraint on the executive (*XConst*) from Polity IV which measures, in scale from 1 to 7, how the rules constrain the state and the bottom panel includes rule of law (*RoL*) from Kaufmann et al. (2008). By using the terminology introduced by Acemoglu and Johnson, the middle panel studies the complementarity between financial and "property rights" institutions and the bottom one the complementarity between financial and "contracting" institutions. In the middle panel we see that the variable of interest remains positive, significant and the size of the coefficient is almost unchanged (for example, in the first column it decreases only from 0.098 to 0.086) and the interaction between constraint on the executive and R&D is positive and significant (except in the last three columns where the definition of financial development is very similar to constraint on the executive). The bottom panel shows that when the interaction between rule of law and R&D is included, the coefficient on rule of law is positive and significant and the coefficient on the variable of interest sharply falls. This reduction is specially large in the first column where the coefficient drops to 0.029. This result is not surprising given the high correlation (0.77) between domestic credit and rule of law. However, the coefficient still remains statistically significant. To conclude, these results suggest that property rights, contracting and financial institutions all matter and their effect

on offshoring is larger, the more R&D-intensive the industry is. It would be interesting to see the different mechanisms at work but this exercise is outside the scope of the paper.

Finally, one could be concerned because I do not weigh the number of goods that a country exports to the United States by the importance of that industry in the country. I check this in Table 9. The dependent variable in the bottom panel is $G_{ic}\frac{VA_{ic}}{VA_c}$ where G_{ic} is the number of goods in industry i that country c exports to US and VA_{ic} is the value added of industry i in country c. By comparing the top (unweighted) and the bottom (weighted) panel, it can be seen that the coefficient on the variable of interest is positive, bigger and significant but with larger standard deviations (for example, in column one, the coefficient goes from 0.098 to 0.199 with standard deviation increasing from 0.009 to 0.037). Thus, the prediction of the model is also confirmed when the number of goods is weighted by the importance of the industry in the country.

Summing up, this empirical section has shown that the more R&D-intensive the industry is, the larger the effect of financial development on offshoring is. Therefore, the main prediction of the model is consistent with the data and it is robust to different specifications and definitions of financial development.

4.5 Concluding remarks

The trade literature has provided us with several explanations of the product cycle but the role of financial institutions has been largely ignored. In this paper I fill this gap by considering the problem faced by a Northern final-good producer that needs to buy intermediate inputs from a supplier to complete production. This supplier can be found either in the high-wage but financially developed North or in the low-wage and financially underdeveloped South.

I show that these financial institution differences are enough to generate a product cycle in which the production of new goods is kept in the North and it is shifted to the South when the goods become more standardized. The intuition is that the final-good producer faces a trade-off between low wages and contractual distortions. When the good is new, intermediate inputs are not very important and the final-good producer finds it optimal to keep production in the North at the cost of a higher wage but with the benefit of a less distorted contract. However,

when the good becomes more standardized and the importance of intermediate inputs increases, the low Southern wage compensates the contractual distortions that less developed financial institutions create and production is shifted to the South.

The empirical section shows, consistent with the model, that the more R&D-intensive the industry is, the larger the effect of financial development on offshoring is. This result is robust to different specifications and definitions of financial development.

The model derived in the paper has abstracted from dynamic considerations. An interesting extension would be to consider a dynamic version of the model in which the Southern supplier can also accumulate past rents and the Northern final-good producer when making her contracting choice takes into account the fact that the importance of the intermediate input will be growing over time.

4.6 Figures

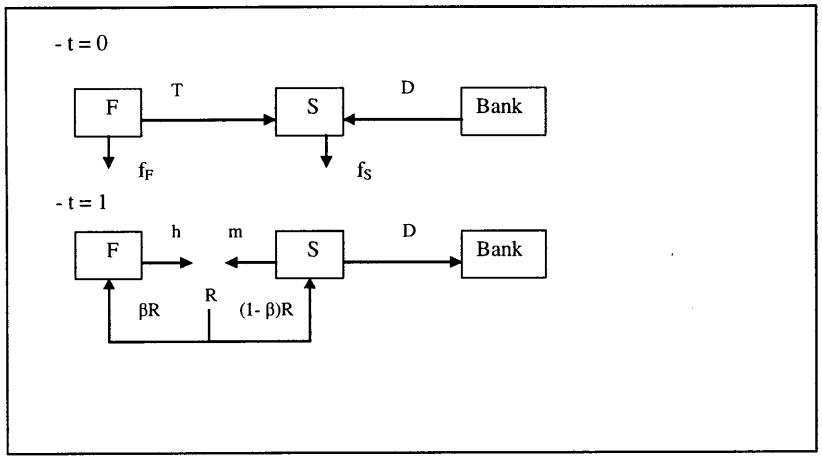

Figure 4-1: Timing of actions

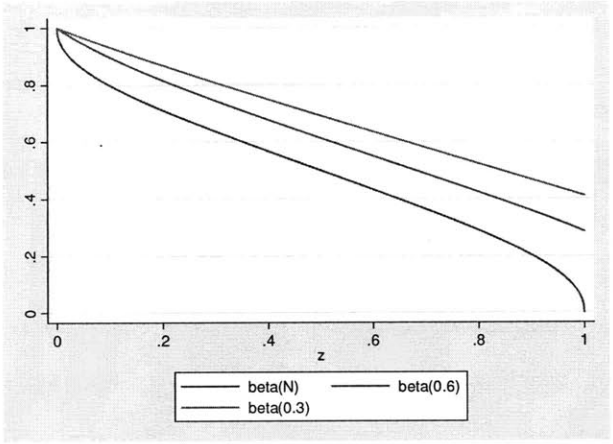

Figure 4-2: Optimal sharing rules (β) for the North and different financial development in the South ($\theta = 0.3$ and $\theta = 0.6$).

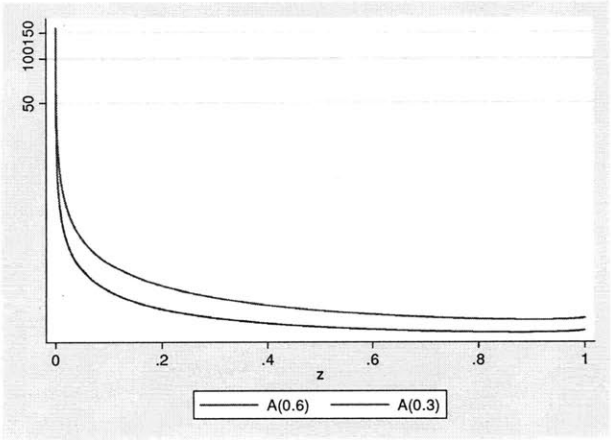

Figure 4-3: Optimal location of production for different Southern financial institutions ($\theta = 0.3$ and $\theta = 0.6$). Partial equilibrium.

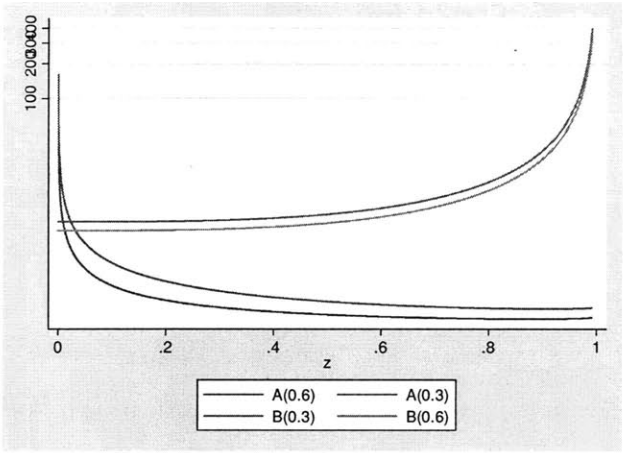

Figure 4-4: Optimal location of production for different Southern financial institutions ($\theta = 0.3$ and $\theta = 0.6$). General equilibrium.

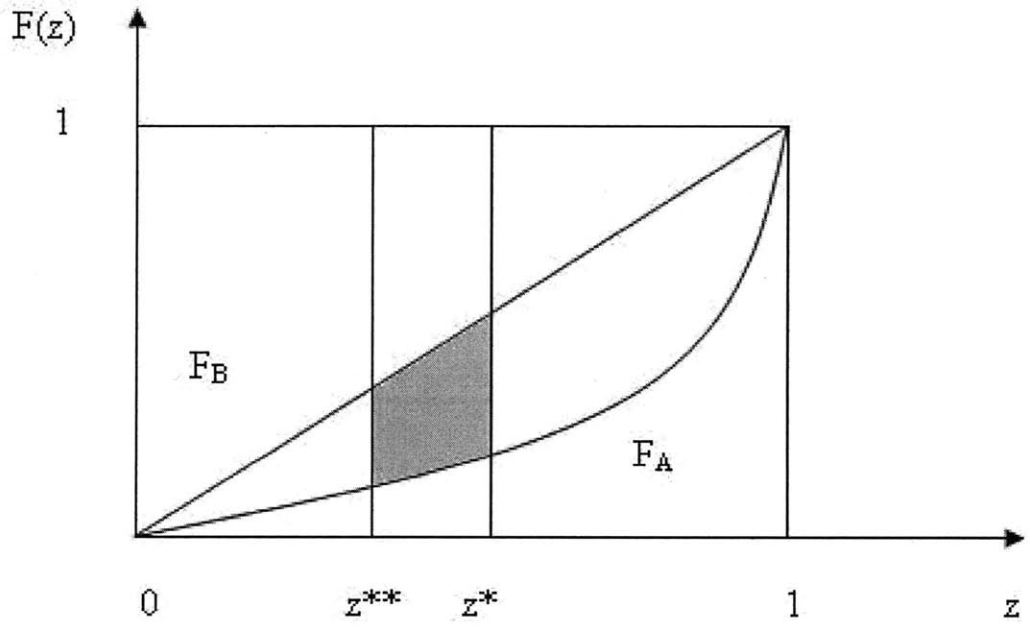

Figure 4-5: Prediction of the model. The shaded region represents the increase in offshoring in Industry B (more R&D-intensive) respect to Industry A when Southern financial institutions improve.

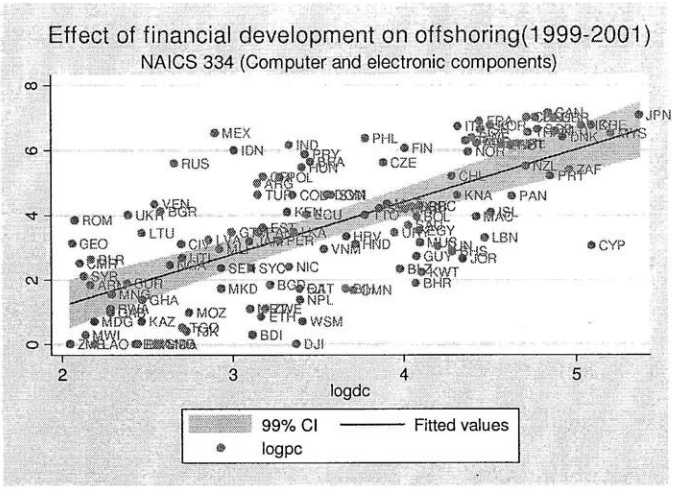

Figure 4-6: Effect of financial development on offshoring in the "computer and electronic components" industry. Logpc is (log) number of goods each country exports to US. Logdc is (log) domestic credit to private sector over GDP.

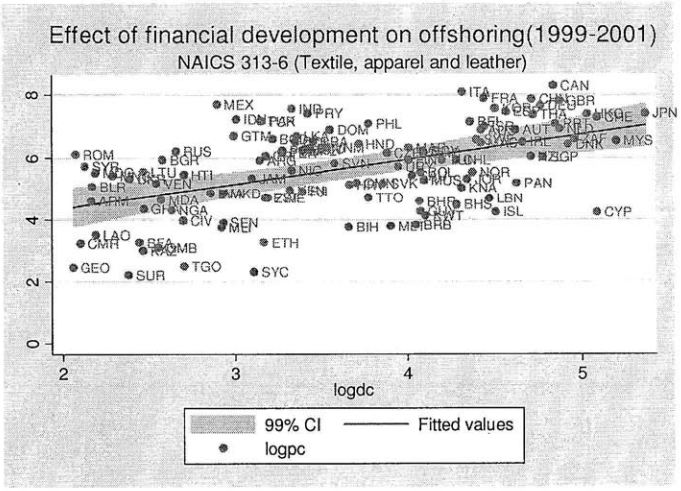

Figure 4-7: Effect of financial development on offshoring in the "textile, apparel and leather" industry. Logpc is (log) number of goods each country exports to US. Logdc is (log) domestic credit to private sector over GDP.

4.7 Tables

Table 1: Effect of financial development on offshoring (1999-2001)

Dependent variable: Number of Goods Exported to US

	D Credit	D Credit(2)	Stock Mkt	Repud	Exprop	Account
Fin.Dev*R&D	0.098	0.104	0.063	0.490	0.633	0.342
	(0.009)	(0.009)	(0.007)	(0.051)	(0.063)	(0.043)
No. Observations	1690	1580	1275	656	656	551
R^2	0.47	0.48	0.47	0.77	0.78	0.77

Notes: The dependent variable is the average number of goods exported to the US for country and industry (1999-2001). D Credit is domestic credit to private sector (% GDP) from WDI. D Credit (2) is private credit by deposit money banks and other financial institutions (% GDP), Stock Mkt is stock market capitalization (% GDP) from Beck et al. (2000). Repud is risk of contract repudiation, Exprop is risk of expropriation and Account is accounting standards from La Porta et al. (1998). Each specification is a country-fixed effect regression with industry fixed effects. Heteroskedasticity consistent standard errors appear in parenthesis.

Table 2: Robustness check: dropping NAICS 325, 334 and 336

Dependent variable: Number of Goods Exported to US

	D Credit	D Credit(2)	Stock Mkt	Repud	Exprop	Account
Whole sample						
Fin.Dev*R&D	0.098	0.104	0.063	0.490	0.633	0.342
	(0.009)	(0.009)	(0.007)	(0.051)	(0.063)	(0.043)
No. Observations	1690	1580	1275	656	656	551
R^2	0.47	0.48	0.47	0.77	0.78	0.77
Dropping NAICS						
Fin.Dev*R&D	0.132	0.140	0.083	0.622	0.797	0.393
	(0.014)	(0.016)	(0.011)	(0.081)	(0.102)	(0.074)
No. Observations	1279	1200	981	512	512	413
R^2	0.51	0.51	0.52	0.78	0.78	0.79

Notes: The dependent variable is the average number of goods exported to the US for country and industry (1999-2001). Each specification is a country-fixed effect regression with industry fixed effects. Heteroskedasticity consistent standard errors appear in parenthesis.

Table 3: Robustness check: Adding more industry variables

Dependent variable: Number of goods exported to US by industry

	D Credit	D Credit(2)	Stock Mkt	Repud	Exprop	Account
Fin.Dev*R&D	0.098	0.104	0.063	0.490	0.633	0.342
	(0.009)	(0.009)	(0.007)	(0.051)	(0.063)	(0.043)
No. Observations	1690	1580	1275	656	656	551
R^2	0.47	0.48	0.47	0.77	0.78	0.77
Fin.Dev*R&D	0.083	0.087	0.049	0.419	0.532	0.210
	(0.017)	(0.019)	(0.011)	(0.066)	(0.066)	(0.039)
Fin. Dev*Ext. fin.	-0.034	-0.055	0.090	0.189	0.009	0.832
	(0.076)	(0.084)	(0.619)	(0.535)	(0.639)	(0.362
Fin. Dev*Tang.	-0.583	-0.724	-0.173	-1.45	-2.84	-2.103
	(0.385)	(0.424)	(0.249)	(1.61)	(1.97)	(0.771)
Fin. Dev*K_int	1.646	2.118	0.644	15.74	22.94	4.95
	(1.805)	(1.996)	(0.912)	(8.43)	(10.82)	(6.37)
No. Observations	1690	1580	1275	656	656	551
R^2	0.42	0.43	0.46	0.77	0.78	0.77

Notes: The dependent variable is the average number of goods exported to the US for country and industry (1999-2001). Ext. fin. is dependence on external finance, Tang is asset tangibility both from Braun (2003) and K_int is capital intensity from Manova (2007). Each specification is a country-fixed effect regression with industry fixed effects. Heteroskedasticity consistent standard errors appear in parenthesis.

Table 4: Offshoring vs Heckscher-Ohlin

Dependent variable: Number of goods exported to US by industry (1999-2001)

	D Credit	D Credit(2)	Stock Mkt	Repud	Exprop	Account
Fin.Dev*R&D	0.098	0.104	0.063	0.490	0.633	0.342
	(0.009)	(0.009)	(0.007)	(0.051)	(0.063)	(0.043)
No. Observations	1690	1580	1275	656	656	551
R^2	0.47	0.48	0.47	0.77	0.78	0.77
Fin.Dev*R&D	0.092	0.103	0.069	0.256	0.352	0.161
	(0.015)	(0.015)	(0.013)	(0.067)	(0.088)	(0.080)
Industry share	0.177	0.192	0.175	0.213	0.212	0.185
	(0.026)	(0.027)	(0.027)	(0.029)	(0.029)	(0.034)
No. Observations	656	653	606	382	382	308
R^2	0.53	0.52	0.55	0.80	0.81	0.87

Notes: The dependent variable is the average number of goods exported to the US for country and industry (1999-2001). Industry share (Value added in industry i divided by value added in the manufacturing sector) comes from UNIDO. Each specification is a country-fixed effect regression with industry fixed effects. Heteroskedasticity consistent standard errors appear in parenthesis.

Table 5: Are zeros important?

Dependent variable: Number of goods exported to US by industry

	Without zeros	With zeros
Fin.Dev*R&D	0.117	0.115
	(0.028)	(0.023)
Fin.Dev*Ext. fin.	-0.004	-0.001
	(0.129)	(0.112)
Fin. Dev*Tang	0.506	0.554
	(0.310)	(0.283)
No. Observations	1690	2175
Fin. Dev*R&D	0.032	0.032
	(0.014)	(0.009)
Industry share	0.262	0.261
	(0.033)	(0.028)
No. Observations	655	761

Notes: The dependent variable is the average number of goods exported to the US for country and industry (1999-2001). Fin. Dev is domestic credit to private sector (% GDP) from WDI. Ext. fin. is dependence on external finance and Tang is asset tangibility both from Braun (2003). Industry share comes from UNIDO. Each specification is a Poisson regression with industry and country fixed effects. Bootstrap (50 replications) standard errors appear in parenthesis.

Table 6: Robustness check: The Intensive Margin

Dependent variable: Value of Exports to US (1999-2001)

	D Credit	D Credit(2)	Stock Mkt	Repud	Exprop	Account
Fin.Dev*R&D	0.203	0.227	0.138	1.20	1.55	0.945
	(0.023)	(0.025)	(0.020)	(0.139)	(0.178)	(0.151)
No. Observations	1690	1580	1275	656	656	551
R^2	0.36	0.36	.032	0.54	0.55	0.48
Fin.Dev*R&D	0.187	0.217	0.122	1.16	1.52	0.532
	(0.029)	(0.032)	(0.025)	(0.155)	(0.186)	(0.159)
Fin. Dev*Ext. fin.	0.128	0.044	0.278	3.13	4.14	4.65
	(0.234)	(0.255)	(0.205)	(1.36)	(1.79)	(1.33)
Fin. Dev*Tang.	-0.183	-0.215	0.326	8.08	12.08	-0.628
	(0.757)	(0.816)	(0.589)	(4.28)	(5.20)	(4.25)
No. Observations	1690	1580	1275	656	656	551
R^2	0.35	0.36	0.32	0.50	0.51	0.52
Fin.Dev*R&D	0.248	0.277	0.185	0.665	0.887	0.507
	(0.041)	(0.042)	(0.034)	(0.177)	(0.232)	(0.223)
Industry share	0.449	0.488	0.485	0.718	0.721	0.828
	(0.078)	(0.082)	(0.088)	(0.100)	(0.099)	(0.102)
No. Observations	656	633	606	382	382	308
R^2	0.39	0.37	0.39	0.60	0.62	0.61

Notes: The dependent variable is Value of Exports (1999-2001) for industry and country. Each specification is country-fixed effect regression with sector fixed effects. Heteroskedasticity consistent standard errors appear in parenthesis.

Table 7: Robustness check: US Direct Investment Abroad

Dependent variable: Capital Outflows (2001)

	D Credit	D Credit(2)	Stock Mkt	Repud	Exprop	Account
Fin.Dev*R&D	43.22	45.08	33.11	147.45	199.06	150.16
	(21.78)	(22.20)	(16.57)	(71.49)	(92.81)	(74.37)
No. Observations	283	276	280	234	234	219
R^2	0.04	0.04	0.03	0.05	0.05	0.03
Fin.Dev*R&D	86.58	89.42	56.59	345.81	472.31	198.26
	(34.96)	(35.62)	(19.74)	(142.33)	(179.93)	(82.30)
Fin. Dev*Ext. fin.	-10.59	-31.43	-12.28	-24.15	17.65	4.16
	(91.82)	(89.57)	(62.98)	(269.66)	(332.60)	(341.01)
Fin. Dev*Tang.	251.18	221.62	120.92	1072.60	1580.45	316.01
	(209.02)	(213.87)	(150.15)	(783.02)	(967.43)	(769.64)
No. Observations	283	276	280	234	234	219
R^2	0.05	0.04	0.03	0.05	0.06	0.03
Fin.Dev*R&D	28.51	29.25	17.60	78.92	132.85	209.85
	(25.59)	(25.61)	(20.91)	(85.79)	(119.24)	(131.05)
Industry share	31.31	28.02	31.24	32.04	29.44	59.14
	(32.39)	(32.68)	(31.54)	(39.21)	(37.85)	(55.19)
No. Observations	172	166	172	146	146	132
R^2	0.04	0.04	0.04	0.04	0.04	0.05

Notes: The dependent variable is US Direct Investment Abroad (Capital Outflows) for industry and country. Each specification is country-fixed effect regression with sector fixed effects. Heteroskedasticity consistent standard errors appear in parenthesis.

Table 8: Robustness Check: Financial vs Other Institutions

Dependent variable: Number of goods exported to US by industry

	D Credit	D Credit(2)	Stock Mkt	Repud	Exprop	Account
Fin.Dev*R&D	0.098	0.104	0.063	0.490	0.633	0.342
	(0.009)	(0.009)	(0.007)	(0.051)	(0.063)	(0.043)
No. Observations	1690	1580	1275	656	656	551
R^2	0.47	0.48	0.47	0.77	0.78	0.77
Fin.Dev*R&D	0.086	0.089	0.053	0.426	0.569	0.324
	(0.010)	(0.011)	(0.008)	(0.058)	(0.073)	(0.047)
XConst*R&D	0.025	0.032	0.026	0.019	0.015	0.016
	(0.006)	(0.006)	(0.007)	(0.011)	(0.011)	(0.013)
No. Observations	1517	1418	1188	643	643	538
R^2	0.58	0.59	0.56	0.78	0.79	0.78
Fin.Dev*R&D	0.029	0.032	0.020	0.237	0.441	0.238
	(0.013)	(0.014)	(0.009)	(0.098)	(0.133)	(0.052)
RoL*R&D	0.098	0.104	0.100	0.068	0.040	0.060
	(0.013)	(0.014)	(0.014)	(0.024)	(0.026)	(0.017)
No. Observations	1665	1542	1237	643	643	551
R^2	0.46	0.47	0.47	0.75	0.77	0.79

Notes: The dependent variable is the number of goods exported to the US for country and industry. XConst is Constraint on the Executive from Polity IV Project (2006). RoL is rule of law from Kaufmann et al. (2008). Each specification is a country-fixed effect regression with industry fixed effects. Heteroskedasticity consistent standard errors appear in parenthesis.

Table 9: Robustness Check: Weighting the number of goods

Dependent variable: Number of goods exported to US by industry

	D Credit	D Credit(2)	Stock Mkt	Repud	Exprop	Account
Unweighted						
Fin.Dev*R&D	0.098	0.104	0.063	0.490	0.633	0.342
	(0.009)	(0.009)	(0.007)	(0.051)	(0.063)	(0.043)
No. Observations	1690	1580	1275	656	656	551
R^2	0.47	0.48	0.47	0.77	0.78	0.77
Weighted						
Fin.Dev*R&D	0.199	0.200	0.199	0.964	1.23	0.764
	(0.037)	(0.038)	(0.029)	(0.165)	(0.200)	(0.174)
No. Observations	656	633	606	382	382	308
R^2	0.35	0.33	0.35	0.60	0.61	0.60

Notes: The dependent variable in the top panel is the average number of goods exported to the US for country and industry between 1999-2001 and in the bottom panel this average number of goods is weighted by the share of the industry in that country $\left(i.e.\ G_{ic}\frac{VA_{ic}}{VA_c}\right)$. D Credit is domestic credit to private sector (% GDP) from WDI. D Credit (2) is private credit by deposit money banks and other financial institutions (% GDP), Stock Mkt is stock market capitalization (% GDP) from Beck et al. (2000). Repud is risk of contract repudiation, Exprop is risk of expropriation and Account is accounting standards from La Porta et al. (1998). Each specification is a country-fixed effect regression with industry fixed effects. Heteroskedasticity consistent standard errors appear in parenthesis.

4.8 Appendix

Appendix A: Data

List of Industries

NAICS	Name	R&D	Ext. fin.	Tang.	K_int
311	Food	1475	0.136	0.377	0.062
312	Beverage and tobacco products	284	-0.187	0.250	0.040
313-316	Textile, apparel and leather	295	0.096	0.196	0.041
321	Wood products	119	0.284	0.379	0.065
324	Petroleum	837	0.188	0.487	0.135
325	Chemicals	19685	0.211	0.304	0.092
327	Nonmetallic mineral products	919	0.062	0.420	0.068
331	Primary metals	526	0.087	0.458	0.102
332	Fabricated metal products	1642	0.237	0.281	0.053
333	Machinery	6346	0.445	0.182	0.058
334	Computer and electronic products	42703	0.961	0.151	0.052
335	Electrical equipment. Appliances	4980	0.767	0.213	0.076
336	Transportation equipment	30005	0.306	0.254	0.071
337	Furniture and related products	278	0.235	0.263	0.039
339	Miscellaneous manufacturing	4887	0.470	0.188	0.039

Source: R&D data come from National Science Foundation/Division of Science Resources Statistics, Survey of Industrial Research and Development (1999, 2000 and 2001), Ext. fin. dep is dependence on external finance and Tang is asset tangibility both from Braun (2003) and K_int is capital intensity from Manova (2007).

List of Countries

The baseline specification consists of 145 countries. Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bangladesh, Barbados, Belarus, Belize, Belgium, Benin, Bolivia, Bosnia, Brazil, Bulgaria, Burkina-Faso, Burundi, Cambodia, Cameroon, Canada, Chad, Chile, China, Colombia, Congo, Costa Rica, Croatia, Cyprus, Czech Republic, Djibouti, Dominican Republic, Ecuador, Egypt, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guyana, Guinea-Bissau, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea, Kuwait, Kyrgyzstan, Lao, Latvia, Lebanon, Liberia, Lithuania, Macao, Macedonia, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mexico, Moldova, Morocco, Mozambique, Mauritius, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Samoa, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Saint Kits and Nevis, Sudan, Surinam, Sweden, Switzerland, Syria, Tajikistan, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, United Kingdom, Ukraine, Uruguay, Venezuela, Vietnam, Yemen, Zambia and Zimbawe.

Appendix B: Derivation of $\widehat{z}$ and proof of Proposition 1

In this appendix, I derive $\widehat{z}$ and show why assumption A1 is a sufficient condition to have uniqueness and z^* decreasing in θ.

First, it is straightforward to check that $\frac{\partial A(z,\theta)}{\partial z} < 0$ if and only if $r(z,\theta,\alpha) > 0$ where $r(z,\theta,\alpha) \equiv \ln\left[\kappa\left(\frac{\beta^N}{\beta^S}\right)^{\frac{\alpha}{1-\alpha}}\right] - \alpha z\left[\frac{(2\beta^N-1)}{(1-\beta^N)(1-\alpha z)+\beta^N[1-\alpha(1-z)]} - \frac{(1+\theta)\beta^S-\theta}{\theta(1-\beta^S)(1-\alpha z)+\beta^S[1-\alpha(1-z)]}\right]$

where $\kappa \equiv \frac{(1-\beta^N)(1-\alpha z)+\beta^N[1-\alpha(1-z)]}{\theta(1-\beta^S)(1-\alpha z)+\beta^S[1-\alpha(1-z)]}$

Remember that β^N goes to zero as z goes to one, therefore, $\lim_{z\to 1} r(z,\theta,\alpha) < 0$. However, it can be shown that there exists $\widehat{z} \in (0,1)$ such that $r(\widehat{z},\theta,\alpha) = 0$ and $r(\widehat{z},\theta,\alpha) > 0$ if $z < \widehat{z}$ and $r(\widehat{z},\theta,\alpha) < 0$ if $z > \widehat{z}$. Thus, $\frac{\partial A(z,\theta)}{\partial z} < 0$ if $z < \widehat{z}$. It can also be derived that $\frac{\partial \widehat{z}}{\partial \theta} < 0$ and $\frac{\partial \widehat{z}}{\partial \alpha} > 0$.

Given the properties of $r(z,\theta,\alpha)$, it is clear that if A1 holds, there exists a unique $z^* \equiv A^{-1}(\omega) < \widehat{z}$.

Moreover, $z^* < \widehat{z}$ implies that $\frac{\partial A(.)}{\partial z}|_{z=z^*} < 0$. Then, $\frac{\partial z^*}{\partial \theta} = -\frac{\frac{\partial A(.)}{\partial \theta}|_{z=z^*}}{\frac{\partial A(.)}{\partial z}|_{z=z^*}} < 0$ because $\frac{\partial A(.)}{\partial \theta} < 0$ for all z.

Appendix C: Proof of Proposition 2

It is proved by contradiction. Let us assume that S also produces the good when $z = z_0 \in (z_N, z_{DC})$. It follows that $\pi^S(\theta^S, z_0) > \pi^{DC}(\theta^{DC}, z_0)$.

The above inequality implies that $\frac{w^{DC}}{w^S} > A(.,\theta^{DC},\theta^S,z_0)$ where

$$A(.,\theta^{DC},\theta^S,z_0) \equiv \frac{1-\beta^{DC}}{1-\beta^S}\left(\frac{\beta^{DC}}{\beta^S}\right)^{\frac{1-z_0}{z_0}}\left[\frac{\theta^{DC}\left(1-\beta^{DC}\right)(1-\alpha z_0)+\beta^{DC}\left[1-\alpha(1-z_0)\right]}{\theta^S\left(1-\beta^S\right)(1-\alpha z_0)+\beta^S\left[1-\alpha(1-z_0)\right]}\right]^{\frac{1-\alpha}{\alpha z_0}}.$$

Similarly to Appendix B, it can be shown that $A(.,\theta^{DC},\theta^S,z)$ is decreasing in z if and only if $\widetilde{r}(z,\theta^{DC},\theta^S,\alpha) > 0$.

For simplicity, I assume that θ^{DC} and θ^S are such that $\widetilde{r}(z,\theta^{DC},\theta^S,\alpha) > 0$ for all z. Therefore, $A(.,\theta^{DC},\theta^S,z)$ is decreasing and S must produce the good for all $z > z_0$, contradicting that DC produces the good for $z \in (z_N, z_{DC})$.

An analogous argument applies when comparing DC and N.

Thus, it confirms Proposition 2.

Appendix D: Proof of Proposition 3

The first part of the proposition simply follows from the fact that $\frac{\partial A(,\theta,z)}{\partial \theta} < 0$ and $\frac{\partial B(.,\theta,z)}{\partial \theta} < 0$.

To prove the second part let us define $F(\theta, z^*) \equiv A(., \theta, z^*) - B(., \theta, z^*)$. Then, we must show that $\frac{\partial z^*}{\partial \theta} = -\frac{\frac{\partial F(\theta,z^*)}{\partial \theta}}{\frac{\partial F(\theta,z^*)}{\partial z^*}} < 0$. Given that $\frac{\partial A(,\theta,z^*)}{\partial z^*} < 0$ and $\frac{\partial B(.,\theta,z^*)}{\partial z^*} > 0$, $\frac{\partial z^*}{\partial \theta} < 0$ because $\left|\frac{\partial A(,\theta,z^*)}{\partial \theta}\right| > \left|\frac{\partial B(.,\theta,z^*)}{\partial \theta}\right|$.

Appendix E: A more general model

This appendix shows that the main results of the model go through in a more general environment. In particular, it shows that a modified version of Proposition 1 holds when a larger set of feasible contracts is allowed.

The first difference that I introduce is uncertainty after the investment choices are made. I assume that revenues are represented by the following equation where p is the (small) probability of a bad shock that drives revenues to zero.

$$\widetilde{R} = \begin{cases} R = \Delta^{1-\alpha} \left(\frac{h}{1-z}\right)^{\alpha(1-z)} \left(\frac{m}{z}\right)^{\alpha z} & \text{with prob. 1-}p \\ 0 & \text{with prob. } p \end{cases}$$

I keep assuming that revenues are observable and therefore contracts can be written contingent on them but the shock is not observable. It implies that when revenues are zero, both parties observe those revenues but they do not know whether it was a bad shock or the other party did not make the investment.

Finally, I also introduce limited liability and limited commitment.

The timeline of events is the same as described in the text. I next derive the optimal contract in this modified model. The problem of the Northern final-good producer when she chooses to locate production in country c can be represented as follows

$$\max_{\{h,m,G(\widetilde{R}),T,D\}} \widetilde{\pi}^c = E\left[\widetilde{R} - G(\widetilde{R})\right] - w^N h - T - f_F$$

$$st. T + D \geq f_S \quad \text{(BC)}$$

$$D \leq \theta^c \left[E\left[G(\widetilde{R})\right] - w^C m\right] \quad \text{(CC)}$$

$$PS \equiv T + E\left[G(\widetilde{R})\right] - w^C m - f_S \geq 0 \quad \text{(PC)}$$

$$PS \geq V_{default} \quad \text{(LC)}$$

$$G(\widetilde{R}) \geq w^C m \ \ \forall \widetilde{R} \quad \text{(LL)}$$

$$h \in \arg\max_{\widehat{h}} \left\{E\left[\widehat{R} - G(\widehat{R})\right] - w^N \widehat{h}\right\} \quad \text{(ICC-F)}$$

$$m \in \arg\max_{\widehat{m}} \left\{E\left[G(\widehat{R})\right] - w^C \widehat{m}\right\} \quad \text{(ICC-S)}$$

$$R = \Delta^{1-\alpha} \left(\frac{h}{1-z}\right)^{\alpha(1-z)} \left(\frac{m}{z}\right)^{\alpha z}$$

The final-good producer chooses the terms of the contract, which are an ex-ante transfer (T) and an ex-post payment contingent on revenues $G(\widetilde{R})$, and, indirectly, the loan (D) that supplier receives from the bank and the investment choices (h, m) in order to maximize her own (expected) profits. The profits of the final-good producer are given by total revenues minus what she gives to supplier ex-ante (T) and ex-post ($G(\widetilde{R})$), the investment costs ($w^N h$) and the fixed cost (f_F).

The first constraint is the budget constraint which says that the supplier can enter into the relationship only if the funds she obtains, the ex-ante transfer (T) and the loan from the bank (D), are enough to cover the fixed cost (f_S).

The next two equations are the collateral constraint (CC) and the participation constraint (PC) that are the same as the ones derived in the main text with the only difference that revenues are now stochastic and both must hold in expectation.

Equation (LC) is the limited commitment constraint. It means that the supplier has now the option to default and not making any investment after receiving the ex-ante transfer. Note that she could do it because revenues are stochastic and when the final-good producer observes no revenues she cannot be certain whether it was a bad shock or the supplier did not make any investment. Therefore, the final-good producer must make sure that what the supplier obtains

if she does the right investments (PS) is larger than what she obtains if she does not make them and keeps the ex-ante transfer (i.e., $V_{default} = T + G(\widetilde{R} = 0)$).

Equation (LL) is the limited liability constraint. It says that the supplier cannot have negative profits in any state of nature because if she were asked to make a payment that would drive her net income below zero she would refuse to do it. This constraint was not necessary in the main text because of the set of contracts that was considered. In this more general setup the final-good producer is constrained to give to the supplier enough revenues ($G(\widetilde{R})$) to pay her investment costs ($w^C m$). In other words, $G(\widetilde{R}) < w^C m$ cannot be an equilibrium for any given $\widetilde{R}$ because the supplier would stop paying to the final-good producer when $G(\widetilde{R}) = w^C m$.

Equations (ICC-F) and (ICC-S) are the incentive compatibility constraints of the final-good producer and the supplier, respectively. They mean that the final-good producer is constrained to choose the investment choices that both parties make in the next period. The final-good producer knows that each party makes her investment choice in order to maximize its own profits.

Finally, the last equation is the revenues function that follows from the consumer demand and production function of the final-good.

To solve the model I assume that the contract that the final-good producer offers to the supplier to divide revenues ex-post is contingent on revenues and consists of a transfer and a share of revenues. To be more specific, it takes the following functional form

$$G(\widetilde{R}) = \begin{cases} \mu_R + (1-\beta)R & \text{if } \widetilde{R} = R \\ \mu_0 & \text{if } \widetilde{R} = 0 \end{cases}$$

Given these contracts, the value of the supplier to default and not make any investment is $V_{default} = T + \mu_0$.

After noting that (ICC-F) and (ICC-S) reduce to $w^N h = \alpha(1-z)(1-p)\beta R$ and $w^C m = \alpha z(1-\beta)(1-p)R$, respectively, it is easy to see that the problem of the final-good producer becomes

$$\max_{\{\mu_R,\mu_0,\beta,T\}} \widetilde{\pi}^c = (1-p)(1-\alpha(1-z))\beta R - (1-p)\mu_R - p\mu_0 - T - f_F$$

$$st.0 \quad \leq \quad T + \theta^c\left[(1-p)\mu_R + p\mu_0 + (1-\alpha z)(1-\beta)R\right] - fs \qquad \text{(BC')}$$

$$\mu_R \quad \geq \quad -(1-(1-p)\alpha z)(1-\beta)R \qquad \text{(LL-R)}$$

$$\mu_0 \quad \geq \quad \alpha z(1-p)(1-\beta)R \qquad \text{(LL-0)}$$

$$\mu_R + (1-\alpha z)(1-\beta)R \quad \geq \quad \mu_0 + \frac{f_s}{1-p} \qquad \text{(LC)}$$

The final-good producer chooses the ex-ante transfer (T), the ex-post transfer when revenues are R (μ_R), the ex-post transfer when revenues are zero (μ_0) and the ex-post sharing rule (β) to maximize her own profits. In this equation the investment choices are already included and the probability of having a bad shock also taken into account.

(BC') is the modified budget constraint when the investment choice of the supplier and the fact that the collateral constraint binds in equilibrium are taken into account. Note that the participation constraint (PC) is irrelevant because if (BC') holds, (PC) also holds given $\theta^c \leq 1$.

(LL-R) and (LL-0) are the limited liability constraints when revenues are R and zero, respectively, when the equilibrium investment choice of the supplier is included.

Finally, (LC) is the limited commitment constraint given the contract and investment choices.

It is straightforward to check that in equilibrium (LL-0), (LC) and (BC') bind and (LL-R) holds with inequality.[21] The intuition is that the final-good producer wants to offer an, as low as possible, ex-post transfer to the supplier and it translates into an ex-post transfer when revenues are zero (μ_0) determined by the limited liability constraint (LL-0) and an ex-post transfer when revenues are R (μ_R) determined by the limited commitment constraint (LC). In other words, the final-good producer must leave rents to the supplier when revenues are obtained to avoid default (i.e. (LL-R) holds with inequality in equilibrium). (BC') binds in equilibrium because the final-good supplier offers an ex-ante transfer (T) as low as possible. Therefore, it follows that the ex-post fixed payments are

[21] One could easily setup the Lagrangean of this program and verify that it is indeed the case.

$$\begin{aligned}\mu_0 &= \alpha z(1-p)(1-\beta)R \\ \mu_R &= \frac{f_s}{1-p} - (1-(2-p)\alpha z)(1-\beta)R\end{aligned}$$

and noting that $R = \Delta(1-p)^{\frac{\alpha}{1-\alpha}}\left[\alpha\left(\frac{\beta}{w^N}\right)^{1-z}\left(\frac{1-\beta}{w^C}\right)^{z}\right]^{\frac{\alpha}{1-\alpha}}$, the problem of the final-good producer reduces to

$$\max_{\{\beta\}} \widetilde{\pi}^c(\theta^c) = \Delta(1-p)^{\frac{1}{1-\alpha}} \frac{[1-\alpha(1-z)]\beta + [1-(2-\theta^c)\alpha z](1-\beta)}{\left[\alpha\left(\frac{\beta}{w^N}\right)^{1-z}\left(\frac{1-\beta}{w^C}\right)^{z}\right]^{\frac{\alpha}{1-\alpha}}} - (2-\theta^c)f_s - f_F$$

It can be shown that $\beta^C(\theta^c, z)$ is the unique solution to this maximization problem and it is decreasing in θ^c for all z and it is decreasing in z if $z < \widetilde{z}(\theta^c, \alpha)$.

I set, as in the text, $\theta = \theta^S < \theta^N \equiv 1$. Note that the profits that the final-good producer obtains when contracting with a Northern supplier in this model are the same as the ones she obtained in the version in the text (where $p \equiv 0$).

Finally, the final-good producer compares profits when contacting with a Southern supplier (i.e., $\widetilde{\pi}^S(\theta)$) and a Northern supplier (i.e., $\widetilde{\pi}^N(\theta = 1)$) and chooses to locate production in the South if and only if $\omega \geq \widetilde{A}(., z, \theta)$, where

$$\widetilde{A}(., z, \theta) \equiv \frac{1-\beta^N}{1-\beta^S}\left(\frac{\beta^N}{\beta^S}\right)^{\frac{1-z}{z}} \kappa^{\frac{1-\alpha}{\alpha z}},$$

where $\kappa \equiv \frac{[1-\alpha(1-z)]\beta^N + [1-\alpha z](1-\beta^N) + (1-\theta)f_s\varphi\left[\beta^{N(1-z)}(1-\beta^N)^z\right]^{-\frac{\alpha}{1-\alpha}}}{[1-\alpha(1-z)]\beta^S + [1-(2-\theta)\alpha z](1-\beta^S)}$ and $\varphi \equiv \left(\frac{w^N}{\alpha}\right)^{\frac{\alpha}{1-\alpha}} \frac{1}{\Delta(1-p)^{\frac{1}{1-\alpha}}}$.

If $f_s > 0$, $\lim_{z\to 0} \widetilde{A}(., z, \theta) = +\infty$, $\lim_{z\to 1} \widetilde{A}(., z, \theta) = (2-\theta)\left[1 + \frac{(1-\theta)f_s\varphi}{1-\alpha}\right]^{\frac{1-\alpha}{\alpha}} > 1$, $\widetilde{A}(., z, \theta)$ is strictly decreasing in θ for all z and it is strictly decreasing in z if $z < \overline{z}$.[22]

Assumption A1'

$$\omega > (2-\theta)\left[1 + \frac{(1-\theta)f_s\varphi}{1-\alpha}\right]^{\frac{1-\alpha}{\alpha}}$$

[22] The derivation of $\overline{z}$ is similar to the derivation of $\widehat{z}$.

This assumption is the counterpart of assumption A1 in the text. Similarly, the required relative wage decreases with the development of Southern financial institutions (i.e., the right-hand side is decreasing in θ) and A1' approaches to the standard assumption $\omega > 1$ when Southern financial institutions converge to Northern ones (i.e., $\theta \to 1$).

Proposition 1'

i) Existence of product cycle: If $f_s > 0$ *and A1' holds, there exists a unique* $z^{**} \equiv \widetilde{A}^{-1}(\omega)$ *such that* $\omega < \widetilde{A}(.,\theta,z)$ *when* $z < z^{**}$ *and* $\omega > \widetilde{A}(.,\theta,z)$ *when* $z > z^{**}$.

ii) Effect of financial development: If $f_s > 0$ *and A1' holds,* z^{**} *is decreasing in* θ.

The proof of this proposition is analogous to the proof of Proposition 1.

Therefore, I have shown that the main results of the model in the text go through when a more general version of the model with a larger set of feasible contracts is considered.

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