A Model of Two Globalizations:

Implications for Wage Inequality and Trade Specialization.*

Sergi Basco
MIT

Martí Mestieri
MIT

July 2009

Abstract

We develop a model to analyze the distributional effects of two waves of globalization and their interdependencies. Guided by our empirical evidence, we distinguish between *(i)* a First Globalization, characterized by trade liberalizations which mainly affected trade in low skill intensive goods, *(ii)* a Second Globalization, characterized by a reduction in communication costs, which has affected trade in more skill intensive goods. We consider a North-South trade economy, in which countries only differ on the relative supply of skills. A freely traded final good is assembled using a bundle of inputs, which differ on the skill intensity required to be produced. We find that wage inequality increases in North and South during the First Globalization. In the Second Globalization, northern wage inequality exhibits a hump shape pattern. We find a complementarity between the two globalizations. Northern wage inequality in the Second Globalization increases with the extent of trade in the First. Finally, we show how asymmetries in participation in the Second Globalization of two southern countries can generate a discontinuous pattern of specialization. The southern country participating in the Second Globalization specializes in the least and most skill intensive traded inputs and wage inequality rises in this country.

Keywords: Globalization,wage inequality, pattern of specialization.
JEL Classification: F14, F16, F11.

*We thank Daron Acemoglu, Pol Antràs and Arnaud Costinot for their guidance. We also thank James Anderson, David Autor, Abhijit Banerjee, Ricardo Caballero, Gene Grossman, Pablo Kurlat, Kiminori Matsuyama, Sahar Parsa, Mar Reguant, Robert Townsend and seminar participants at MIT and Banco de España for useful comments and suggestions. David Autor and David Dorn generously shared their code and data with us. Basco acknowledges financial support from Fundación Ramón Areces. Mestieri acknowledges financial support from Banco de España. Following Dixit and Grossman (1982), we blame each other for all remaining errors. E-mail addresses: basco@mit.edu and mestieri@mit.edu.

1 Introduction

The skill content of North-South trade has changed over the last decades. Figure 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 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 1980s,[1] while India has benefited from offshoring of IT industries and services in the 1990s.[2]

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 inequality in the Second Globalization increases with the extent of trade during the First. More specifically, northern wage inequality exhibits a hump shape pattern and its peak increases and it is delayed by 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 4 suggests for India and Pakistan. To account for this asymmetric participation, we extend the model to

[1] 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 Morrocco) were biased towards low skill intensive industries.

[2] 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.

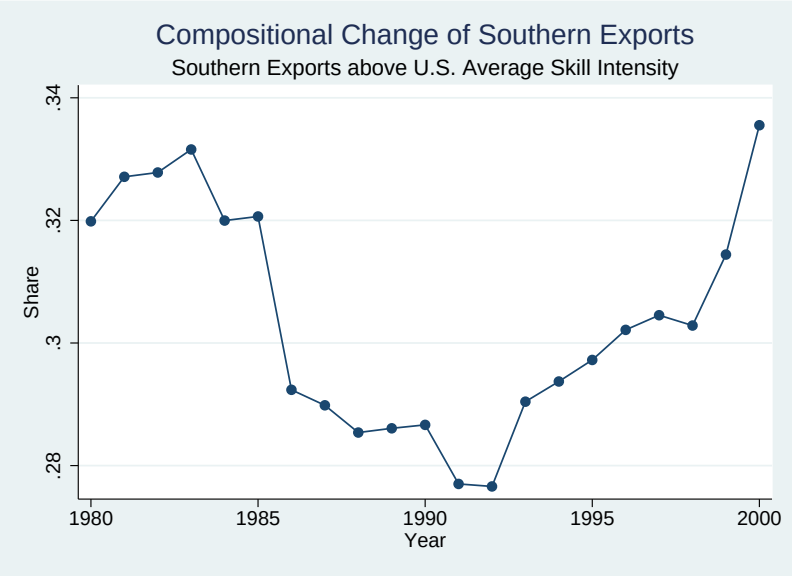

Figure 1: Changes in southern exports to the North in industries with above average U.S. skill intensity. The mean skill intensity of U.S. industries is measured using educational attainment in U.S. Census. North is defined as having more than 50 percent of U.S. GDP per capita (PPP adjusted). Source: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

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

Section 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 5 and 6 show that high levels of RTI (and, thus, offshoring) are associated with middle skill jobs.[3] 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. The only difference between both is

[3]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 (2008), 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.

the relative supply of skills. A freely traded final good is produced by assembling a continuum of inputs, which have heterogeneous trade costs. These inputs combine middle and low skill labor, which differ in skill intensity requirements. High skill agents run the final good technology. Appendix E shows that our results hold when we allow for a continuum of types endogenously selecting into these occupations.

To show the main results of the paper in the most transparent way, our baseline model abstracts from high skill agents. Section 3 characterizes the equilibrium for two types of agents, low and middle skill. It assumes that South is relatively abundant in low skill labor and that all agents can run the final good technology. The trade pattern that emerges is that North offshores input production to the South during the First and the Second Globalization and exports final good.

Throughout the paper and for ease of exposition, we refer to the inputs below average skill intensity as *intermediates*, and to inputs above, as *tasks*. Therefore, the inputs traded in the First Globalization are *intermediates*, and those traded in the Second are *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*.[4]

Section 4 presents the main results of the model. In Subsection 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 Feenstra and Hanson (1996), since the intermediates imported by the North are below its mean skill intensity, the relative wage of northern middle skill workers rises because the relative demand of middle skill labor increases.

In the Second Globalization, as the set of traded tasks increases, the relative wage exhibits an inverse U-shape pattern in the North. 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. 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 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. This result is consistent with the suggestive evidence presented in Table 1 for the U.S., U.K. and Germany.

[4]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.

Their ranking in trade openness at the end of the First Globalization (1991) coincides with the ranking in the increase of the relative wage of middle skill workers in the 1990s.

In the South, relative wages have a U-shape pattern in the First Globalization. Two economic forces play a role. First, there is a demand effect, by which the relative abundant factor of the South (low skill labor) gains from trade. This is analogous to a Heckscher-Ohlin model. Second, the marginal intermediate being offshored is relatively more skill intensive, pushing up the relative demand of middle skill labor. This is analogous to Wood (1995) and Feenstra and Hanson (1996). In the beginning of the First Globalization the demand effect dominates and, as globalization progresses, the second effect eventually overcomes the first. In the Second Globalization, both effects go in the same direction and the relative wage of southern middle skill workers increases.

Subsection 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 and exports them to both the North and the other southern country. 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 4 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 5 presents two extensions. Subsection 5.1 introduces high skill agents to have a more complete view of the distributional effects of the globalization process. This allows us to have a mapping to the 90-50-10 measures of wage inequality and obtain additional insights. Both the exogenous and endogenous labor supply versions of our model paint a picture of wage inequality consistent with the 90-50-10 measures for the U.S. in the last 30 years, featuring wage polarization during the Second Globalization. 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 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 2, we present the motivating evidence and discuss the related literature. Section 3 presents the baseline model and Section 4 derives the main results of the paper. The two extensions of the model are presented in Section 5. Section 6 concludes. Proofs and further extensions of the model are in the appendix.

2 Motivating Evidence and Related Literature

2.1 Empirical Evidence

The premise of analysis of our model 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.

2.1.1 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.[5] 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 7 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 8 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

[5] Although non-tariff barriers are important, the difficulty on assessing their differential effect by skill precluded us from analyzing them.

exercise by calculating the implied transportation costs of U.S. imports. Figure 9 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. 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.

2.1.2 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 (2008) as a proxy for "offshorability". We think of jobs with higher RTI index as having higher probability of being offshored.[7] Figure 5 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 6).

[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 (2008) for further details.

2.1.3 Evidence on U.S. Imports

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

$$X_{ic} = \alpha + \beta\ \tau_i + \delta_j + \delta_c + \varepsilon_{ic}, \tag{1}$$

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 2 show a negative, significant effect of tariffs on U.S. imports in 1990.[8] 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 (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, 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

$$X_{ic} = \alpha + \beta\ \tau_i + \gamma\ \text{Internet}_c \cdot \text{Skill Intensity}_j + \delta_j + \delta_c + \varepsilon_{ic}, \tag{2}$$

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 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.[9] Columns 8 and 9 show how this effect is exacerbated and becomes significant

[8] 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.

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

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.[10]

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 are more RTI intensive. Second, as argued by Markusen (2006) and Markusen and Strand (2008), services require above average skills to be produced. Both facts imply that the effect we have documented would be presumably larger if data on services were available.[11]

2.1.4 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 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.[12] 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 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

[10] 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.

[11] Most of the countries lack of data for access to Internet in 1990. Therefore equation 2 cannot be run for year 1990.

[12] 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.

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 the dramatic fall in communication costs which raised trade in intermediate skill intensive industries and affected the relative demand of middle skill workers.

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. 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 upons 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 (2008) among others.

3 Model

In this section we present a simple model to study the effects of the two waves of globalization. Our fully-fledged model features three occupations and agents differing in their skill endowment (summarized by a distribution of skills over the set of agents). However, to present the main results in the most transparent way, our baseline model abstracts from high skill agents. It consists of only middle and low skill agents. Appendices D and E show 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. This section presents and characterizes the baseline model and Section 4 derives the main results of the paper.

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. Agents can be divided between low and middle skill types. The fraction of middle skill types in the North, θ^N, is greater than in the South, θ^S. The only difference between North and South is that South is relatively abundant in low skill labor.

All agents have the same utility function, $u(c)$, which is defined over individual consump-

tion of the final good c.

In each country, the final good is produced by assembling a continuum of inputs, $I(z)$, with $z \in [0,1]$. Each input is produced using a Cobb-Douglas production function

$$I(z) = A\left(\frac{m(z)}{z}\right)^{z}\left(\frac{l(z)}{1-z}\right)^{1-z} \quad \text{for } z \in [0,1], \tag{3}$$

where A is a Hicks-neutral productivity factor and $m(z)$ and $l(z)$ denote middle and low skill workers employed in the production of input z, respectively. 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. The final good production aggregates inputs according to $y = \int_0^1 \ln I(z)dz$.[13] In this section, we assume that all agents have access to the final good production technology.

The final good is assumed to be freely traded and we normalize its price to one throughout the paper. Inputs are subject to iceberg transportation 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, 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.

3.2 Trade equilibrium

We characterize the competitive equilibrium defined in Section 3.1 for a given trade cost function $\tau(z)$. Consider the problem of a firm producing final good in country i,

$$\max_{\{I^i(z)\}} \int_0^1 \ln I^i(z)dz - \int_0^1 p^i(z)I^i(z)dz. \tag{4}$$

The demand of inputs of each firm is

$$I^i(z) = p^i(z)^{-1}, \tag{5}$$

[13] To simplify expressions we assume a decreasing returns to scale technology. The same expression for relative prices is obtained for the North and qualitatively similar relative prices are found for the South with a constant returns to scale technology of the type $\log y = \int_0^1 \ln I^i(z)dz$.

which is equivalent to aggregate demand. Consider the problem of an input producer in country i,[14]

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

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

$$zp^i(z)I^i(z) = w_m^i m^i(z), \tag{6}$$
$$(1-z)p^i(z)I^i(z) = w_l^i l^i(z). \tag{7}$$

Using market clearing in the middle and low skill labor markets, we pin down wages by integrating labor demands across all input producers in each country

$$\int_0^1 m^N(z)dz = \int_0^1 \left(\mathbb{1}_d^N + \frac{\mathbb{1}_x^N}{\tau(z)}\right)\frac{z}{w_m^N}dz = \theta^N, \tag{8}$$
$$\int_0^1 l^N(z)dz = \int_0^1 \left(\mathbb{1}_d^N + \frac{\mathbb{1}_x^N}{\tau(z)}\right)\frac{(1-z)}{w_l^N}dz = 1-\theta^N, \tag{9}$$
$$\int_0^1 m^S(z)dz = \int_0^1 \left(\mathbb{1}_d^S + \frac{\mathbb{1}_x^S}{\tau(z)}\right)\frac{z}{w_m^S}dz = \theta^S, \tag{10}$$
$$\int_0^1 l^S(z)dz = \int_0^1 \left(\mathbb{1}_d^S + \frac{\mathbb{1}_x^S}{\tau(z)}\right)\frac{(1-z)}{w_l^S}dz = 1-\theta^S, \tag{11}$$

where $\mathbb{1}_d^i$ and $\mathbb{1}_x^i$ are indicator functions for each input z being produced for domestic consumption and for exporting in country i, 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 (5). The allocation of middle skill labor $m^i(z)$ is determined by (6) and the allocation of low skill labor $l^i(z)$ is given by (7). 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.

4 Main Results

In this section we present the two main results of the paper. Subsection 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 4.2 extends the baseline model by dividing the original South in two different

[14] We assume that $A > e\left(\theta^S(1-\theta^N)\right)^{-1}$, where e is the Neper number, to ensure positive profits in the final good production. This condition is implied by (3) and (4).

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.

4.1 The two Globalizations and their Interdependence

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.

4.1.1 Comparative Statics for the First Globalization

Section 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. In other words, trade costs are $\tau(z) = 1$ for $z \leq z_I$ and $\tau(z) = \infty$ otherwise.

Consistent with the empirical evidence provided in Section 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.[15]

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

$$\left(\frac{1-z^{*2}}{1+z^{*2}}\frac{\theta_S}{\theta_N}\right)^{z^*}\left(\frac{(1-z^*)^2}{2-(1-z^*)^2}\frac{1-\theta_S}{1-\theta_N}\right)^{1-z^*} = 1. \tag{12}$$

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.[16]

Proposition 1 *(First Globalization) The First Globalization equilibrium features an increase of the relative wage of middle skill workers in the North and a U-shape pattern in the South.*

The proof follows from using equations (8) to (11) and the trade costs schedule. The relative wages are

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

[15] 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.

[16] If the set of traded inputs is very large, South buys the most skill intensive inputs from the North. We label this as Third Globalization and analyze it in Appendix C.

By inspection, the relative wage in the North is increasing in z_I. The relative wage in the South is decreasing for $z_I < \tilde{z}_I \equiv \sqrt{2} - 1$ and increasing thereafter.[17]

Note that the relative wage 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]

The relative wage of middle 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 skill workers in the South exhibits a U-shape pattern. Two economic forces are playing a role. First, the relative wage of low skill workers rises when the demand of low skill intermediates increases. This is analogous to a standard Heckscher-Ohlin force. Second, an increase in traded intermediates (i.e., an increase in z_I) translates into a larger relative demand of middle skill jobs at the margin. This is also noticed in Wood (1995) or Feenstra and Hanson (1996). Therefore, the first force decreases the relative demand of middle skill workers and the second increases it. As First Globalization progresses (i.e., z_I increases), the second force becomes more important because the relative content of middle skill of the marginal intermediate is higher and it eventually overcomes the first.[19]

In Section 5, we show that the magnitude of this second force (and, therefore, $\tilde{z}_I$) crucially depends on the relative size of the northern demand (which here it is in its lower bound). Note that our model has the same predictions as Feenstra and Hanson (1996) for the southern relative wage if we assume that the initial $z_I \geq \tilde{z}_I$. The same economic force is at play. The difference is that our comparative statics exercise starts in autarky, while theirs in free trade.

4.1.2 Comparative Statics for Second Globalization and Interdependence Result

Based on our results in Section 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

[17] We assume that $\theta^N < 1/2$ and $\theta^S < \sqrt{2} - 1$. It guarantees that the relative wage of middle skill workers is greater than one.

[18] In Appendix D we generalize the model to have endogenous labor supply and we show that the qualitative results 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 fits this prediction when the set of initial traded intermediates is large enough (i.e., the initial $z_I \geq \tilde{z}_I$).

cost structure

$$\tau(z) = \begin{cases} 1 & \text{for } z \leq z_I \text{ and } \bar{z} \leq z \leq z_{II}, \\ \infty & \text{otherwise,} \end{cases} \tag{13}$$

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] For simplicity and consistent with our finding in Section 2 that the skill intensity of these new traded goods is higher, we set $\bar{z} = 1/2$ in this subsection.

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* (12)*.*

Assumption 2 ensures that in equilibrium South produces all traded inputs.

Proposition 2 *(Second Globalization) In the Second Globalization equilibrium, the relative wage of middle skill workers in the North has an inverse U-shape pattern. It increases in z_{II} for $z_{II} < \tilde{z}_{II}(z_I)$ and decreases thereafter. The relative wage of middle skill workers in the South increases in z_{II}.*[21]

The intuition for this result is as follows. Start noting that, to a first order approximation (for small z_I), the threshold $\tilde{z}_{II}(z_I)$ 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 of the average input produced domestically, the relative demand of 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.

Proposition 3 *(Interdependence 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. The rate of change in z_{II} of the relative wage of middle skill workers in the North is increasing in z_I.*

[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.

[21] All the remaining proofs can be found in Appendix A.

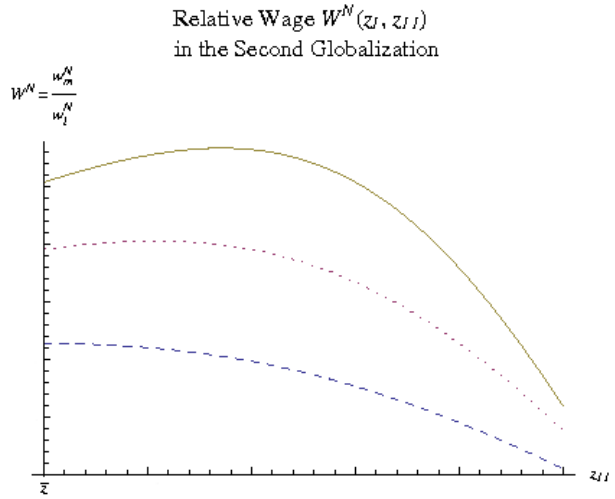

Figure 2: Interdependence in the North. The dashed line is for $z_I = 0$, dotted for $z_I = .2$ and regular line for $z_I = .3$.

Figure 2 summarizes the results in proposition 3. 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.

Table 1 provides anecdotal evidence consistent with this first main result of the paper, Interdependence in the North. 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.

The counterpart of proposition 3 for the South is stated below.

Proposition 4 *(Interdependence in the South) The southern relative wage in the Second Globalization exhibits a non-monotone pattern with respect to z_I. It decreases for $z_I < \tilde{\tilde{z}}_I(z_{II})$, and increases thereafter. The threshold $\tilde{\tilde{z}}_I(z_{II})$ is increasing in z_{II} and $\tilde{\tilde{z}}_I(z_{II} = 1/2) = \tilde{z}_I$.*

To understand the intuition behind proposition 4, start considering the case $z_{II} = 1/2$. In

this case, we recover the result in proposition 1 of a U-shape pattern in the southern relative wage. The relative wage decreases until the set of traded intermediates is $\tilde{z}_I$. However, as z_{II} increases, the higher the relative demand of middle skill workers is. Therefore, a larger set of intermediates (relatively intensive in low skill workers) can be produced without reducing the total relative demand of middle skill workers. This implies that in this case more intermediates can be traded until the relative wage starts to increase. This is, $\tilde{\tilde{z}}_I(z_{II}) > \tilde{z}_I$ for $z_{II} > 1/2$.[22]

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.[23] 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 a reduced form multicounty 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.[24]

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 A contains the formal proof. We now turn to the characterization of the equilibrium in the Second Globalization.

Proposition 5 *In the Second Globalization, the pattern of specialization is as follows. 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 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 ($z \in [0, \check{z}_I]$).

[22] To check predictions of our model for the South is harder because the empirical evidence does not seem to point into a clear direction, see for example Goldberg and Pavcnik (2007) and Verhoogen (2008).

[23] 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.

[24] We maintain Assumption 2 and $\bar{z} = 1/2$ in this section.

Proposition 6 *(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 6 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 7 *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 2. 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 7 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.[25] 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 in less skill intensive industries. This is consistent with Indian and Pakistani exports to the U.S., as documented in figure 4. 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

[25] 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).

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.

5 Extensions

This section relaxes some of the assumptions of the baseline model in two directions. First, we introduce high skill agents in subsection 5.1. This enables us to better understand the distributional implications of the two waves of globalization and gain additional insights. We show that the pattern that emerges in the North is consistent with the evolution of U.S. wage distribution in the last thirty years.

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 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.

5.1 A model with three types

This subsection presents a modified version of our baseline model with three different skill levels. We assume that a fraction φ^i of middle skill agents obtains further education, becoming high skill agents. Thus, country i is populated by a fraction $\varphi^i\theta^i$ of high skill agents, $(1-\varphi^i)\theta^i$ of middle agents, and $1-\theta^i$ of low skill agents. We assume that $\varphi^N \geq \varphi^S$. That is, North is relatively abundant in high skill agents.

We assume that the production function of inputs to be exported, which we denote by I^X,

differs from the domestic, I^H. We want to take into account the fact that translation expertise, knowledge of international requirements, compliance with international standards, etc., which we label as exporting knowledge, are needed to export. Along the lines of Matsuyama (2007), we assume that exporting knowledge is provided by high skill agents. To capture this notion we consider the following production functions

$$I^H(z) = A\left(\frac{m^H(z)}{z}\right)^z\left(\frac{l^H(z)}{1-z}\right)^{1-z}, \tag{14}$$

$$I^X(z) = \frac{A}{\beta^\beta(1-\beta)^{1-\beta}}\left[\left(\frac{m^X(z)}{z}\right)^z\left(\frac{l^X(z)}{1-z}\right)^{1-z}\right]^\beta h(z)^{1-\beta}, \tag{15}$$

where $\beta \in (0,1)$, A is a Hicks-neutral productivity factor, $m^s(z)$ and $l^s(z)$ are middle and low skill agents working in sector $s \in \{H, X\}$, respectively, and $h(z)$ is exporting knowledge.

We assume that only high skill agents have access to the final good production technology. As in the baseline model, each agent has one unit of labor. Low and middle skill agents supply this unit to low and middle skill jobs, respectively. High skill agents need a fraction $1-\gamma$ of their labor endowment to run the final good technology. The reminder γ is devoted to supply exporting knowledge.

We characterize the equilibrium for the First and Second Globalization under the assumption that all traded inputs are produced in the South.[26] The derivation of wages for low and middle skill workers is analogous to that in Section 3. The return of exporting knowledge for southern high skill agents is $(z_I + z_{II} - \bar{z})(1-\beta)\frac{\varphi^N}{\gamma\varphi^S}\frac{\theta^N}{\theta^S}$.[27]

Given the factor prices, we can use equations (14) and (15) to derive prices of inputs and equation (4) to obtain the profits of final good production. Earnings of high skill agents in country i, w_h^i, are the profits in the final good sector plus the return on their exporting knowledge.[28]

For ease of exposition, we use the following notation to denote relative incomes, $\frac{w_\delta^i}{w_\eta^i} \equiv \mathcal{W}_{\delta\eta}^i$ for $\delta,\ \eta \in \{l, m, h\}$ and $i \in \{N, S\}$. For example, $\mathcal{W}_{ml}^N$ denotes the relative wage of middle to low skill agents in the North.

---

[26] The formal assumption is that $z_{II} < \hat{z}^*(\theta^N, \theta^S, \varphi^N, \varphi^S, \gamma, \beta) < 1$, where $\hat{z}^*$ is implicitly defined by $\left[\frac{\frac{\varphi^N(1-\hat{z}^{*2})}{2(1-\varphi^N)}}{\left(\frac{\varphi^S\theta^S+\varphi^N\theta^N\beta\hat{z}^{*2}}{2\theta^S(1-\varphi^S)}\right)^\beta}\right]^{\hat{z}^*}\left[\frac{\frac{\varphi^N\theta^N(1-\hat{z}^*)^2}{2(1-\theta^N)}}{\left(\frac{\varphi^S\theta^S+\varphi^N\theta^N\beta\left[1-(1-\hat{z}^*)^2\right]}{2(1-\theta^S)}\right)^\beta}\right]^{1-\hat{z}^*} = \left(\hat{z}^*\frac{(1-\beta)\varphi^N\theta^N}{\gamma\varphi^S\theta^S}\right)^{1-\beta}$.

[27] This is equivalent to assuming a fixed cost of importing per type of input paid by each importer, $\psi \equiv 1-\beta$. Note that the returns on exporting knowledge are zero for northern high skill agents.

[28] To ensure profits are greater than middle skill worker wages, we assume that $A > \varphi^N\frac{\theta^N+\theta^S}{2\theta^S(1-\varphi^N)}$. Further, to guarantee that middle skill workers earn more than low skill, a sufficient condition for the North is that $\theta^N < (2-\varphi^N)^{-1}$, and for the South, $\frac{\varphi^S\theta^S+\beta\varphi^N\theta^N\tilde{z}_I(\hat{\alpha})^2}{\varphi^S\theta^S+\beta\varphi^N\theta^N\left[1-(1-\tilde{z}_I(\hat{\alpha}))^2\right]}\frac{1-\theta^S}{\theta^S(1-\varphi^S)} > 1$, with $\hat{\alpha} \equiv \frac{\varphi^S\theta^S}{\beta\varphi^N\theta^N} \leq 1$ and $\tilde{z}_I(\hat{\alpha}) \equiv -\hat{\alpha} + \sqrt{\hat{\alpha}(1+\hat{\alpha})}$. We set $\bar{z} = 1/2$ in this section for analytical convenience.

Proposition 8 *(First Globalization) The First Globalization equilibrium features the following properties:*

1. *North:* $\mathcal{W}_{ml}^N$, $\mathcal{W}_{hm}^N$ *(and* $\mathcal{W}_{hl}^N$*) are increasing in* z_I.

2. *South:* $\mathcal{W}_{ml}^S$ *decreases in* z_I *for* $z_I < \tilde{z}_I$ *and increases afterwards. The comparative statics for* $\mathcal{W}_{hm}^S$ *and* $\mathcal{W}_{hl}^S$ *depend on the parameter values of* φ^N, φ^S *and* γ. *For* $\gamma\varphi^S/\varphi^N$ *smaller than a threshold,* $\mathcal{W}_{hm}^S$ *and* $\mathcal{W}_{hl}^S$ *are increasing in* z_I. *Otherwise, non-monotonicities may appear.*

The relative wage of high to both middle and low skill workers in the North, $\mathcal{W}_{hm}^N$ and $\mathcal{W}_{hl}^N$, increases because profits of final good producers rise with globalization, while middle and low skill wages decrease because labor demand falls. In the South, $\mathcal{W}_{hm}^S$ and $\mathcal{W}_{hl}^S$ increase with globalization when southern high skill agents are scarce enough relative to northern demand, i.e., φ^N/φ^S is large. In this case, the increase in the return of exporting offsets the decline in profits.

The rest of the results are analogous to proposition 1. The only additional insight is that the northern demand effect is exacerbated (as $\varphi^N\theta^N > \varphi^S\theta^S$). This reduces the volume of First Globalization trade, $\tilde{z}_I$, above which $\mathcal{W}_{ml}^S$ increases.

Proposition 9 *(Second Globalization) The Second Globalization equilibrium features the following properties:*

1. *North:* $\mathcal{W}_{ml}^N$ *increases in* z_I *and in* z_{II} *for* $z_{II} < \tilde{z}_{II}(z_I)$ *and decreases afterwards.* $\mathcal{W}_{hm}^N$ *(and* $\mathcal{W}_{hl}^N$ *) is increasing in* z_{II} *and decreases in* z_I.

2. *South:* $\mathcal{W}_{ml}^S$ *increases in* z_{II} *and* z_I. *The comparative statics for* $\mathcal{W}_{hm}^S$ *and* $\mathcal{W}_{hl}^S$ *depend on the parameter values of* φ^N, φ^S *and* γ. *For* $\gamma\varphi^S/\varphi^N$ *smaller than a threshold,* $\mathcal{W}_{hm}^S$ *and* $\mathcal{W}_{hl}^S$ *are increasing in* z_I. *Otherwise, non-monotonicities may appear.*

Northern high skill agents benefit vis-à-vis middle and low skill workers because the production of final good can be done at a lower unit cost, while northern labor demand declines. In the South, as in proposition 8, when the relative supply of high skill agents is sufficiently low, $\mathcal{W}_{hm}^S$ and $\mathcal{W}_{hl}^S$ increase. The rest of the results in proposition 9 are analogous to proposition 2. Finally, the interdependence results stated in propositions 3 and 4 go through in this generalized set-up.[29]

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

[29]The interdependence result in the North is identical to proposition 3. For the South, see Appendix A for the proof.

declining thereafter. This is consistent with our model.[30] During the First Globalization, the model predicts that the relative wage of low skill workers decreases with respect to middle and high skill agents. In the Second, the relative wage of middle to low skill workers may still increase, but at a lower rate than in the First Globalization. It eventually decreases, according to proposition 9. The wage of high relative to middle and low skill workers unambiguously increases. Note that this implies wage polarization in the Second Globalization. Figure 10 reports the predictions of our model and data on U.S. wage inequality used in Autor et al. (2008).[31]

Appendix E introduces a skill distribution over agents to endogenize the labor supply. In our simulations, we specialize the skill and population distributions to Pareto. The difference between North and South is that both distributions for the North First Order Stochastically Dominate the respective distributions for the South. From this exercise we want to emphasize two things. First, we find that all the comparative statics results for the relative wages are analogous to the ones derived in this section. Second, additional natural insights emerge when endogenizing the labor supply. The mass of northern agents selecting into middle skill jobs endogenously shrinks with the Second Globalization. Figure 11 shows this effect and wage polarization in the North. Finally, wage inequality can increase in the South even without introducing exporting knowledge (i.e., for $\beta = 1$).

To conclude, the results for the Two Souths stated in Subsection 4.2, and for the Technology Adoption extension presented below (Subsection 5.2) apply in this extension of the model. This is intuitive because $\mathcal{W}^i_{ml}$ behaves in the same manner as in the baseline model and its behavior is the main driver of the results.

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

[30] The comparative statics derived for the North do not depend on the exporting sector assumption (i.e., are independent of β).

[31] To check predictions of our model for the South is harder because neither our predictions for relative wages of high skilled nor the empirical evidence seem to point into a clear direction, see for example Goldberg and Pavcnik (2007) and Verhoogen (2008).

uses tasks as inputs, but it uses them more intensively. More precisely,

$$\text{Old Technology}: \quad \int_0^1 \ln I(z)dz,$$
$$\text{New Technology}: \quad \int_{\overline{z}}^1 \ln[\xi I(z)]dz, \quad \text{with } \xi = e^{-\frac{2-\overline{z}}{1-\overline{z}}} < 1.$$

The particular choice of ξ is for tractability.The only relevant assumption is that $0 < \xi < 1$, implying a more intensive use of tasks in $z \in [\overline{z}, 1]$ in the New Technology.

The profits of the technologies in equilibrium are

$$\pi^{Old} = \int_0^{z_I} \ln(p^S(z))^{-1}dz + \int_{z_I}^1 \ln(p^N(z))^{-1}dz - 1, \tag{16}$$
$$\pi^{New} = \int_{\overline{z}}^{z_{II}} \ln(p^S(z))^{-1}dz + \int_{z_{II}}^1 \ln(p^N(z))^{-1}dz - 1. \tag{17}$$

Proposition 10 *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.*

The economic force driving proposition 10 is that the Old Technology benefits from the First Globalization by replacing northern intermediates by cheaper southern products. As a result, the deeper the First Globalization is, the more profitable the Old Technology is.

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 10 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.).

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 supply of low skill workers. In each country, a final good is produced by 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 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 wage inequality 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 of 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. For the South, we show that the relative wage increases during the Second Globalization, and it has a U-shape pattern during the First.

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 captial (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 extended the baseline model to three skill levels. This model generated robust predictions consistent with the 90/50 and 50/10 measures of U.S. wage inequality in the last 30 years. In particular, this model featured wage polarization during the Second Globalization. For the South, we had increasing inequality when southern skills are relatively scarce. 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.

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. Moreover, we are currently working in modeling transportation and monitoring costs to study how they interact and how the trade patterns assumed in this paper can be rationalized as an equilibrium outcome. Finally, our model has brought about several empirical implications, such as interdependence, which we would like to further investigate and take to the data.

References

Acemoglu, D. (1998). Why do new technologies complement skills? directed technical change and wage inequality. *The Quarterly Journal of Economics*, 113(4):1055–1089.

Acemoglu, D. (1999). Changes in unemployment and wage inequality: An alternative theory and some evidence. *American Economic Review*, 89(5):1259–1278.

Acemoglu, D. (2003). Patterns of skill premia. *Review of Economic Studies*, 70(2):199–230.

Amiti, M. and Davis, D. R. (2008). Trade, firms, and wages: Theory and evidence. NBER Working Papers 14106, National Bureau of Economic Research, Inc.

Anderson, J. E. (2009). Globalization and income distribution: A specific factors continuum approach. NBER Working Papers 14643, National Bureau of Economic Research, Inc.

Antràs, P., Garicano, L., and Rossi-Hansberg, E. (2006a). Offshoring in a knowledge economy. *The Quarterly Journal of Economics*, 121(1):31–77.

Antràs, P., Garicano, L., and Rossi-Hansberg, E. (2006b). Organizing offshoring: Middle managers and communication costs. NBER Working Papers 12196, National Bureau of Economic Research, Inc.

Attanasio, O., Goldberg, P. K., and Pavcnik, N. (2004). Trade reforms and wage inequality in colombia. *Journal of Development Economics*, 74(2):331–366.

Autor, D. and Dorn, D. (2008). Inequality and specialization: The growth of low-skill service jobs in the united states. Working papers, MIT.

Autor, D. H., Katz, L. F., and Kearney, M. S. (2008). Trends in u.s. wage inequality: Revising the revisionists. *The Review of Economics and Statistics*, 90(2):300–323.

Autor, D. H., Katz, L. F., and Krueger, A. B. (1998). Computing inequality: Have computers changed the labor market? *The Quarterly Journal of Economics*, 113(4):1169–1213.

Autor, D. H., Levy, F., and Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *The Quarterly Journal of Economics*, 118(4):1279–1333.

Blinder, A. S. (2006). Offshoring: The next industrial revolution? *Foreign Affairs*.

Blum, B. S. (2008). Trade, technology, and the rise of the service sector: The effects on us wage inequality. *Journal of International Economics*, 74(2):441–458.

Buera, F. J. and Shin, Y. (2008). Financial frictions and the persistence of history. Working paper, UCLA.

Candelaria, C., Daly, M., and Hale, G. (2009). Beyond kuznets: persistent regional inequality in china. Working Paper 2009-07, Federal Reserve Bank of San Francisco.

Costinot, A. and Vogel, J. (2009). Matching and inequality in the world economy. Working papers, MIT.

Currie, J. and Harrison, A. E. (1997). Sharing the costs: The impact of trade reform on capital and labor in morocco. *Journal of Labor Economics*, 15(3):S44–71.

Davidson, C., Matusz, S. J., and Shevchenko, A. (2008). Globalization and firm level adjustment with imperfect labor markets. *Journal of International Economics*, 75(2):295–309.

Dinopoulos, E., Syropoulos, C., and Xu, B. (2009). Intraindustry trade and wage-income inequality. Working paper, University of Florida.

Dixit, A. K. and Grossman, G. M. (1982). Trade and protection with multistage production. *Review of Economic Studies*, 49(4):583–94.

Dustmann, C., Ludsteck, J., and Schnberg, U. (2007). Revisiting the german wage structure. IZA Discussion Papers 2685, Institute for the Study of Labor (IZA).

Egger, H. and Kreickemeier, U. (2009). Firm heterogeneity and the labor market effects of trade liberalization. *International Economic Review*, 50(1):187–216.

Feenstra, R. C. and Hanson, G. H. (1996). Foreign investment, outsourcing and relative wages. In Robert Feenstra, G. G. and Irwin, D., editors, *The Political Economy of Trade Policy: Papers in Honor of Jagdish Bagwati*. MIT Press.

Goldberg, P. K. and Pavcnik, N. (2007). Distributional effects of globalization in developing countries. *Journal of Economic Literature*, 45(1):39–82.

Goos, M. and Manning, A. (2007). Lousy and lovely jobs: The rising polarization of work in britain. *The Review of Economics and Statistics*, 89(1):118–133.

Grossman, G. M. and Maggi, G. (2000). Diversity and trade. *American Economic Review*, 90(5):1255–1275.

Grossman, G. M. and Rossi-Hansberg, E. (2006). The rise of offshoring: it's not wine for cloth anymore. *Proceedings*, pages 59–102.

Grossman, G. M. and Rossi-Hansberg, E. (2008). Trading tasks: A simple theory of offshoring. *American Economic Review*, 98(5):1978–97.

Hanson, G. H. and Harrison, A. (1999). Trade liberalization and wage inequality in mexico. *Industrial and Labor Relations Review*, 52(2):271–288.

Haskel, J. E. and Slaughter, M. J. (2003). Have falling tariffs and transportation costs raised us wage inequality? *Review of International Economics*, 11(4):630–650.

Helpman, E., Itskhoki, O., and Redding, S. (2008). Inequality and unemployment in a global economy. NBER Working Papers 14478, National Bureau of Economic Research, Inc.

Hummels, D. (2007). Transportation costs and international trade in the second era of globalization. *Journal of Economic Perspectives*, 21(3):131–154.

Katz, L. F. and Murphy, K. M. (1992). Changes in relative wages, 1963-1987: Supply and demand factors. *The Quarterly Journal of Economics*, 107(1):35–78.

Markusen, J. (2006). Offshoring of business services in small open economies: Toward a general-equilibrium modeling approach. *Brookings Trade Forum 2005: Offshoring White-Collar Work*.

Markusen, J. and Strand, B. (2008). Offshoring of business services in small open economies: Toward a general-equilibrium modeling approach. *Journal of Industry, Competition and Trade*, 8(3):231–246.

Matsuyama, K. (2007). Beyond icebergs: Towards a theory of biased globalization. *Review of Economic Studies*, 74(1):237–253.

Munshi, K. and Rosenzweig, M. (2009). Why is mobility in india so low? social insurance, inequality, and growth. Working Paper 14850, National Bureau of Economic Research.

Ohnsorge, F. and Trefler, D. (2007). Sorting it out: International trade with heterogeneous workers. *Journal of Political Economy*, 115(5):868–892.

Paweenawat, A. and Townsend, R. M. (2009). Villages as small open economies. Working paper, MIT.

Prasad, E. (2002). Wage inequality in the united kingdom, 1975-99. IMF Working Papers 02/42, International Monetary Fund.

Robertson, R. (2000). Trade liberalisation and wage inequality: Lessons from the mexican experience. *The World Economy*, 23(6):827–849.

Robertson, R. (2004). Relative prices and wage inequality: evidence from mexico. *Journal of International Economics*, 64(2):387–409.

Topalova, P. (2005). Trade liberalization, poverty, and inequality: Evidence from indian districts. NBER Working Papers 11614, National Bureau of Economic Research, Inc.

Trefler, D. (2006). Service offshoring: Threats and opportunities. *Brookings Trade Forum 2005: Offshoring White-Collar Work*.

Verhoogen, E. A. (2008). Trade, quality upgrading, and wage inequality in the mexican manufacturing sector. *The Quarterly Journal of Economics*, 123(2):489–530.

Wood, A. (1995). How trade hurt unskilled workers. *The Journal of Economic Perspectives*, 9(3):57–80.

Yeaple, S. R. (2005). A simple model of firm heterogeneity, international trade, and wages. *Journal of International Economics*, 65(1):1–20.

Zhu, S. C. and Trefler, D. (2005). Trade and inequality in developing countries: a general equilibrium analysis. *Journal of International Economics*, 65(1):21–48.

A Proofs and Auxiliary Propositions

Proof of Proposition 2 Using equations (8) to (11) and the trade cost structure, (13), the relative wages of middle skill workers are

$$\frac{w_m^N}{w_l^N} = \frac{1 - z_I^2 - z_{II}^2 + \left(\frac{1}{2}\right)^2}{(1-z_I)^2 + (1-z_{II})^2 - \left(\frac{1}{2}\right)^2} \frac{1-\theta^N}{\theta^N}, \tag{18}$$

$$\frac{w_m^S}{w_l^S} = \frac{1 + z_I^2 + z_{II}^2 - \left(\frac{1}{2}\right)^2}{2 - (1-z_I)^2 - (1-z_{II})^2 + \left(\frac{1}{2}\right)^2} \frac{1-\theta^S}{\theta^S}. \tag{19}$$

Taking the partial derivative of the relative wage equation in the North, we find that it is increasing in z_{II} as long as $z_{II} < \tilde{z}_{II}(z_I) \equiv \frac{1}{2}(3-2z_I) - \sqrt{1 - z_I(3-2z_I)}$. For the relative wage in the South, the sign of the partial derivative with respect to z_{II} is the same as the sign of $-3/4 + z_I(2z_{II} - z_I) + z_{II}(1 + z_{II})$. This is non-negative as long as $0 \leq z_I \leq 1/2 \leq z_{II}$. ∎

Proof of Proposition 3 Direct differentiation of $\tilde{z}_{II}(z_I)$ yields to the first claim of the proposition. For the second claim, it suffices to show that the cross partial of the relative wage of middle skill workers $\frac{\partial^2}{\partial z_I \partial z_{II}} \left(\frac{w_m^N}{w_l^N}\right)$ is increasing in z_I. The terms dominating the sign can be reduced to the analysis of $(38z_{II} - 30z_I - 1)$ which is bounded below by 3. ∎

Proof of Proposition 4 From direct differentiation of the relative wage with respect to z_I, it follows that its partial derivative is positive if and only if $z_I > \tilde{\tilde{z}}_I(z_{II}) \equiv \sqrt{2z_{II}^2 + z_{II} + 1} - 1/2 - z_{II}$. Differentiation of $\tilde{\tilde{z}}_I(z_{II})$ with respect to z_{II}, yields $\frac{1}{2}\left(\frac{4z_{II}+1}{\sqrt{2z_{II}^2+z_{II}+1}} - 2\right) > 0$ for $z_{II} \in [1/2, 1]$. Direct substitution of $z_{II} = 1/2$, shows that $\tilde{\tilde{z}}_I(z_{II} = 1/2) = \tilde{z}_I$. ∎

Proposition 11 *In the two Souths model of Subsection 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. Given the assumption made in the text that wages of middle skill are higher than low skill agents, the price schedule in a country i, $p^i(z)$, is strictly increasing in z. Moreover, given two sets of equilibrium wages, taking the log-derivative of the pricing function shows that the pricing 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 $w_{l,Southeast} < w_{l,Southwest}$ and that $w_{m,Southeast} > w_{m,Southwest}$. 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 5 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 $E_f[z] = \frac{1}{4}\left(z_I^2 - \frac{\theta^N}{2\theta^S+\theta^N}\left(z_{II}^2 - \overline{z}^2\right)\right)$. Equalization of low skill wages implies that $E_f[z] = 1 - \frac{1}{2}\left(z_I - \frac{z_I^2}{2} - \frac{\theta^N}{2\theta^S+\theta^N}\left[z_{II} - \overline{z} - \left(\frac{z_{II}^2-\overline{z}^2}{2}\right)\right]\right)$. This two conditions cannot be satisfied at the same time, and thus, the price schedule will be different in Southeast and Southwest.

Note first that by the assumption made in the main text that middle skill workers earn higher wages than low skill workers the price schedules are strictly increasing. This implies that the price schedules cross at most once. We show that $p_{\text{Southeast}}(z) \leq p_{\text{Southwest}}(z)$ for $z \leq \check{z}_I$, where $0 \leq \check{z}_I < z_I$ by contradiction. Suppose that $\check{z}_I \geq z_I$. This means that the price in Southeast is less than in Southwest for all the First Globalization tradeable intermediates. This implies that North and Southwest will purchase the First Globalization tradeable intermediates in Southeast and North will offshore the Second Globalization tasks to Southeast too. By integrating the labor demands, we obtain that the difference in middle skill wages between Southeast and Southwest is $\varphi(\theta^s(1-\varphi))^{-1}((2\theta^S + \theta^N)z_I^2 + \theta^N(z_{II}^2 - \overline{z}^2))$ which is strictly positive. Repeating the procedure for low skill wages yields a difference of $\varphi(1-\theta^s)^{-1}\left[(2\theta^S + \theta^N)(z_I - z_I^2) + \theta^N\left(z_{II} - \overline{z} - \left(\frac{z_{II}^2-\overline{z}^2}{2}\right)\right)\right]$, which is strictly positive too. This is, both middle skill and low skill wages are higher in Southeast. Thus, as $p(z) \propto w_m^z w_l^{1-z}$, we have that prices at which intermediates are sold in Southeast are more expensive than in Southwest, contradicting the initial hypothesis.

Assume now that there exist a threshold $\check{z}_I$ such that $0 \leq \check{z}_I \leq z_I$. Integrating the demands for middle skill and low skill labor, we find that the difference between middle skill labor in Southeast and Southwest is

$$\varphi(2\theta^s(1-\varphi))^{-1}((2\theta^S + \theta^N)\left(z_I^2 - \check{z}_I^2\right) + \theta^N(z_{II}^2 - \overline{z}^2)),$$

which is strictly positive. For the low skill wages, we find that

$$\varphi(1-\theta^s)^{-1}\left[(2\theta^S+\theta^N)\left(2\left(\check{z}_I-\frac{\check{z}_I^2}{2}\right)-\left(z_I-\frac{z_I^2}{2}\right)\right)+\theta^N\left(z_{II}-\overline{z}-\left(\frac{z_{II}^2-\overline{z}^2}{2}\right)\right)\right].$$

The sign of the expression is indeterminate. It turns out that the relevant condition for the term to be negative is given by the condition $\check{z}_I < 1-\sqrt{1-\xi}$, where $\xi \equiv z_I - \frac{z_I^2}{2} - \frac{\theta^N}{2\theta^S+\theta^N}\left(z_{II}-\frac{z_{II}^2}{2}-\overline{z}+\frac{\overline{z}^2}{2}\right)$. Note that the threshold $1-\sqrt{1-\xi}$ is increasing in z_I and decreasing z_{II}. As the previous result shows, it will have to be the case that the low skill wage in Southwest is higher than in Southeast to have an equilibrium consistent with $0 \leq \check{z}_I \leq z_I$, i.e., the condition $\check{z}_I < 1-\sqrt{1-\xi}$ has to be satisfied. Moreover, in order to have a competitive equilibrium, it has to be the case that the intermediates are purchased from the cheapest provider. This implies the pattern of trade stated in the proposition. ∎

Proof of Proposition 6 The threshold $\check{z}_I$ can expressed implicitly as the solution to the problem $p_{\text{Southeast}}(z) = p_{\text{Southwest}}(z)$ for $z \in [0, 1-\sqrt{1-\xi}]$ (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

$$\left(\frac{w_{m,\text{Southeast}}}{w_{m,\text{Southwest}}}\right)^z\left(\frac{w_{l,\text{Southeast}}}{w_{l,\text{Southwest}}}\right)^{1-z} \tag{20}$$

will be exactly one by some z between zero and one. Consider the case in which $z \in (0, 1-\sqrt{1-\xi})$. Inspection of the explicit equation (20) 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,

$$\frac{\partial \check{z}_I}{\partial z_i}\left[\ln A - \ln B + \frac{\check{z}_I}{A}\frac{\partial A}{\partial \check{z}_I} + \frac{(1-\check{z}_I)}{B}\frac{\partial B}{\partial \check{z}_I}\right] = -\frac{\check{z}_I}{A}\frac{\partial A}{\partial z_i} - \frac{(1-\check{z}_I)}{B}\frac{\partial B}{\partial z_i}, \tag{21}$$

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 7 The relative wages in Southeast and Southwest are proportional

to

$$\frac{w_m^{\text{Southeast}}}{w_l^{\text{Southeast}}} \propto \frac{2\int_0^{\check{z}_I} z dz + \int_{1/2}^{z_{II}} z dz + C_1}{2\int_0^{\check{z}_I}(1-z)dz + \int_{1/2}^{z_{II}}(1-z)dz + C_2}, \qquad \frac{w_m^{\text{Southwest}}}{w_l^{\text{Southwest}}} \propto \frac{2\int_{\check{z}_I}^{z_I} z dz + C_3}{2\int_{\check{z}_I}^{z_I}(1-z)dz + C_4},$$

where C_j is a constant. Using proposition 6 and noting that $0 \leq \check{z}_I < z_I \leq 1/2 \leq z_{II} \leq 1$, the result follows. ∎

Proof of Proposition 8 Wages can be expressed as

$$w_m^N = \varphi^N \frac{1 - z_I^2 - z_{II}^2 + \overline{z}^2}{2(1-\varphi^N)}, \tag{22}$$

$$w_l^N = \varphi^N \theta^N \frac{(1-z_I)^2 + (1-z_{II})^2 - (1-\overline{z})^2}{2(1-\theta^N)}, \tag{23}$$

$$w_m^S = \frac{\varphi^S \theta^S + \beta \varphi^N \theta^N (z_I^2 + z_{II}^2 - \overline{z}^2)}{2\theta^S(1-\varphi^S)}, \tag{24}$$

$$w_l^S = \frac{\varphi^S \theta^S + \beta \varphi^N \theta^N \left[1 - (1-z_I)^2 - (1-z_{II})^2 + (1-\overline{z})^2\right]}{2(1-\theta^S)}. \tag{25}$$

Earnings of northern high skill agents are

$$w_h^N = \int_0^1 \ln I^N(z) dz - \int_0^1 p^N(z) I^N(z) dz. \tag{26}$$

In the South, in addition to profits, high skill earn a return on their exporting knowledge,

$$\begin{aligned} w_h^S &= \int_0^1 \ln p^S(z)^{-1} dz - 1 + (z_I + z_{II} - \bar{z})(1-\beta)\frac{\varphi^N}{\gamma\varphi^S}\frac{\theta^N}{\theta^S} \\ &= \ln A - \ln\left(w_m^S w_l^S\right)^{\frac{1}{2}} - 1 + (z_I + z_{II} - \bar{z})(1-\beta)\frac{\varphi^N}{\gamma\varphi^S}\frac{\theta^N}{\theta^S}. \end{aligned} \tag{27}$$

For the comparative statics exercise, consider the North first. The partial derivatives of equations (22) and (23) with respect to z_I are negative. Thus, given that (26) is increasing in z_I, it follows that $\mathcal{W}_{hm}^N$ and $\mathcal{W}_{hl}^N$ are increasing in z_I. Note that by setting $z_{II} = \bar{z}$, $\mathcal{W}_{ml}^N \propto \frac{1+z_I}{1-z_I}$, which is increasing in z_I.

For the South,

$$\mathcal{W}_{ml}^S = \frac{\varphi^S\theta^S + \beta\varphi^N\theta^N z_I^2}{\varphi^S\theta^S + \beta\varphi^N\theta^N\left[1-(1-z_I)^2\right]} \frac{1-\theta^S}{\theta^S(1-\varphi^S)}.$$

Define $\hat{\alpha} \equiv \frac{\varphi^S\theta^S}{\beta\varphi^N\theta^N} \leq 1$. Partial derivation of $\mathcal{W}_{ml}^S$ with respect to z_I shows that it is decreasing in z_I for $z_I < \tilde{z}_I(\hat{\alpha})$ and increasing afterwards, where $\tilde{z}_I(\hat{\alpha}) \equiv -\hat{\alpha} + \sqrt{\hat{\alpha}(1+\hat{\alpha})}$. Note that $\tilde{z}_I'(\hat{\alpha}) > 0$ and $\tilde{z}_0(0) = 0$.

Note that as $\varphi^S\gamma/\varphi^N \to 0$, the only relevant term for the wage of high skill workers in equation (27) is the last one (because the other terms are bounded above), which is increasing in z_I. For low enough values of $\varphi^S\gamma/\varphi^N$ (e.g., in the limiting case $\varphi^S\gamma/\varphi^N \to 0$) this effect will dominate in the comparative statics of $\mathcal{W}^S_{hm}$ and $\mathcal{W}^S_{hl}$, because the derivative of equations (24) and (25) with respect to z_I are bounded. Finally, note that the rest of the terms in (27) are decreasing with z_I. By a continuity argument, $\mathcal{W}^S_{hm}$ and $\mathcal{W}^S_{hl}$ are increasing for $\varphi^S\gamma/\varphi^N < \varepsilon$, for some $\varepsilon > 0$. If this condition is not satisfied, the two forces play a role and we would generically have a hump-shape pattern. ∎

Proof of Proposition 9 Consider the North first. The proof for $\mathcal{W}^N_{hm}$ and $\mathcal{W}^N_{hl}$ being increasing in z_{II} is analogous to proposition 8, and is omitted. Note that $\mathcal{W}^N_{ml} \propto \frac{1-z_I^2-z_{II}^2+\bar{z}^2}{(1-z_I)^2+(1-z_{II})^2-(1-\bar{z})^2}$. Proof in proposition 2 shows that it is decreasing in z_{II} for $z_{II} < \tilde{z}_{II}(z_I) = 1 - z_I + \bar{z} - \sqrt{2(1-z_I)(\bar{z}-z_I)}$. For $\bar{z} = 1/2$ we have that $\tilde{z}_{II}(z_I) = \frac{1}{2}(3-2z_I) - \sqrt{1-z_I(3-2z_I)}$.

For $\bar{z} = 1/2$, after some manipulation on the partial derivative of $\mathcal{W}^S_{ml}$ with respect to z_{II}, we find that the $\mathcal{W}^S_{ml}$ is increasing in z_{II} for $z_{II} \geq 1/2$. Thus, as $z_{II} > 1/2$, $\mathcal{W}^S_{ml}$ is increasing in the Second Globalization. The remainder of the proof to derive the comparative statics of $\mathcal{W}^S_{hm}$ and $\mathcal{W}^S_{hl}$ for z_{II} is analogous to the proof of proposition 8. ∎

Proposition 12 *(Interdependence in the South) $\mathcal{W}^S_{ml}(z_I, z_{II})$ in the Second Globalization exhibits a non-monotone pattern with respect to z_I. It decreases for $z_I < \tilde{\tilde{z}}_I(z_{II})$, and increases thereafter. The threshold $\tilde{\tilde{z}}_I(z_{II})$ is increasing in z_{II} and $\tilde{\tilde{z}}_I(z_{II} = 1/2) = \tilde{z}_I$.*

Proof From direct differentiation of $\mathcal{W}^S_{ml}(z_I, z_{II})$ with respect to z_I, it follows that it is positive if and only if

$$z_I > \tilde{\tilde{z}}_I(z_{II}) = \frac{1}{2} - \frac{\varphi^S\theta^S}{\beta\varphi^N\theta^N} - z_{II} + \sqrt{\frac{(2z_{II}-1)\,z_{II}\,(\beta\varphi^N\theta^N)^2 + 2z_{II}\beta\varphi^S\theta^S\varphi^N\theta^N + (\varphi^S\theta^S)^2}{(\beta\varphi^N\theta^N)^2}}.$$

Differentiation of $\tilde{\tilde{z}}_I(z_{II})$ with respect to z_{II} and algebra manipulation, show that it is increasing. Direct substitution of $z_{II} = 1/2$, shows that $\tilde{\tilde{z}}_I(z_{II} = 1/2) = \tilde{z}_I$. ∎

Proof of Proposition 10 Define $\Delta\pi(z_I, z_{II}) \equiv \pi^{New} - \pi^{Old}$, the difference in profits between the two technologies,

$$\Delta\pi(z_I, z_{II}) = \int_{\bar{z}}^{z_{II}} \ln\left(\frac{p^S(z)}{p^N(z)}\right)^{-1} dz - \left(\int_0^{z_I} \ln(p^S(z))^{-1}dz + \int_{z_I}^{\bar{z}} \ln(p^N(z))^{-1}dz\right). \quad (28)$$

The first term in (28) summarizes the relative benefit of adopting the New Technology, whereas the second captures the additional benefit of using the Old Technology. The equation $\Delta\pi(z_I, z_{II}) = 0$ implicitly defines the threshold $\hat{z}_{II}(z_I)$ above which the New Technology starts to be adopted. The partial derivative of equation (28) with respect to z_{II} is positive, because

$p^N(z) > p^S(z)$ in the trade region. The partial derivative of equation (28) 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

$$\ln\left(\frac{p^N(z_I)}{p^S(z_I)}\right) + \int_0^{z_I} \frac{\partial}{\partial z_I} \ln(p^S(z))^{-1} dz + \int_{z_I}^{\bar{z}} \frac{\partial}{\partial z_I} \ln(p^N(z))^{-1} dz. \tag{29}$$

The first term in (29) is positive as long as $p^N/p^S > 1$ for traded goods, which is assumed to be true to derive the equilibrium. The second and third terms can be expressed as

$$\frac{(2z_I - \bar{z} + 2)\bar{z}}{1 + z_I^2} - \frac{2z_I\left(-2z_I^4 + 3z_I^3 + 2z_I^2 + z_I + 2\right)}{z_I^6 - 2z_I^5 - z_I^4 - z_I^2 + 2z_I + 1}, \tag{30}$$

This expression can be reduced to

$$\frac{(\bar{z} - z_I)(2 - z_I - \bar{z})}{1 - z_I} + \frac{z_I}{1 + z_I(2 - z_I)} + \frac{z_I \bar{z}^2}{1 - z_I^2} - \Psi(z_I) z_I^3, \tag{31}$$

where $\Psi(z_I) < 4$. It is easy to show that the sum of the last three terms is positive. The first term is also positive. Therefore, using the implicit function theorem it follows that $\hat{z}_{II}(z_I)$ is increasing in z_I. ∎

B 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 prefer this measure over years of education to exploit the full variation. The same qualitative results apply when using years of education instead of our measure. 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 (2008). 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 (2008) 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).

C Third Globalization

In this appendix we study what happens if communication costs continue to secularly decrease in the three types version of the model. In the main text we assumed that southern final good producers never find it optimal to offshore production, but here we show that this condition will eventually fail to hold as more inputs become tradeable.

We characterize an equilibrium with heterogeneous trade costs. We consider that some goods can be traded at no cost and that some others cannot be traded at all. In particular the final good and a measure of inputs χ can be freely traded. Let this measure χ be defined as $\chi = \{z | z \in [0, z_I] \cup [\overline{z}, z_{II}]\}$, with $z_I \leq \overline{z} \leq z_{II}$.

Proposition 13 *There exist two thresholds $z_I^* \leq \overline{z}$ and $z_{II}^* \leq 1$ such that if $z_I < z_I^*$ and $z_{II} < z_{II}^*$, South is the only country producing the inputs in χ. If $z_I > z_I^*$ or $z_1 > z_{II}^*$, then South specializes in the production of inputs below the threshold z_I^* or z_{II}^* and North in the goods above.*

Proof Consider the case in which North and South transition from autarky to a very limited range of trade. The prices of inputs in autarky are relatively cheaper in the South $\frac{p^N(z, z_I=0, z_{II}=\overline{z})}{p^S(z, z_I=0, z_{II}=\overline{z})} > 1$ for all $z \in [0, 1]$. Conversely, consider the case in which all inputs are tradeable, North has comparative advantage at producing the relatively more skill intensive goods because the fraction of educated people in the North is larger. Moreover, note that the price schedules are monotone in z both in the North and in the South. Then, by a continuity argument there exists a threshold that separates both cases. Moreover, by the fact that $\frac{p^N}{p^S}$ is strictly decreasing in the threshold of inputs that can be traded, this threshold will be unique. (This comes from the fact that the prices schedules are monotonic in z and can cross at most once). ∎

Using proposition 13, we can encompass the results presented in the main text for the First and Second Globalizations as a particular case in which the thresholds $(z_I^*,\ z_{II}^*)$ are not reached.

In what follows, we assume that during the First Globalization offshoring was not reversed from the South to the North, this is, the threshold z_I^* was not reached (i.e., $z_I < z_I^*$). We

focus our analysis on what could happen if communication costs further decrease and z_{II} goes beyond z_{II}^*. We label this as Third Globalization.

Proposition 14 *The threshold $z_{II}^*(z_I, z_{II})$ implicitly defined by the equation*

$$\frac{p^N(z_I, z_{II}, z_{II}^*(z_I, z_{II}))}{p^S(z_I, z_{II}, z_{II}^*(z_I, z_{II}))} = 1,$$

if it exists, is unique. Over the parameter values of z_I and z_{II} for which $z_{II}^*(z_I, z_{II})$ is defined, the function $z_{II}^*(z_I, z_{II})$ is continuous in its arguments, monotonically increasing in z_I and monotonically decreasing in z_{II}.

Proof Existence and uniqueness are a particular case of proposition 13. The rest follows from the implicit function theorem. ∎

The pattern of production in the Third Globalization is as follows. North produces middle skill ($z \in [z_I, \overline{z}]$) and high skill tasks ($z \in [z_{II}^*, 1]$) and offshores the lowest skill intermediates ($z \in [0, z_I]$) and middle skill tasks ($z \in [\overline{z}, z_{II}^*]$). South produces all the inputs except the highest skill tasks ($z \in [z_{II}^*, z_{II}]$) which southern high skill agents offshore.

Taking as given z_I and z_{II} and letting $z_{II}^*(z_I, z_{II})$ be the threshold implicitly defined as the task that has the same price in the North and the South, we can characterize the equilibrium results following analogous derivations to the main text.

In the Third Globalization equilibrium, northern high skill agents offshore inputs indexed by $z \in [0, z_I] \cup [\overline{z}, z_{II}^*]$ and southern high skill agents offshore inputs indexed by $z \in (z_{II}^*, z_{II}]$. In our simulations we find that the equilibrium features the following properties in the North:

1. The relative wage of middle to low skill workers increases in z_{II} and decreases in z_I.
2. The relative wage of high to middle skill workers is increasing in z_{II} and decreasing in z_I.

In the Third Globalization southern high skill agents offshore the most skilled intensive tasks (e.g. financial services) and this translates in an increase in wage inequality in the bottom of the distribution and a reduction in wage inequality in the top of the northern income distribution.

D Endogenous Labor Supply Choice with Two Occupations

In this appendix we extend the baseline model to allow agents to self select in any of the two occupations of the economy. We assume that agents can be ordered along the skill dimension. Let $j \in [0, 1]$ be the index of an agent and assume a uniform distribution over j. We denote

by $s^i(j)$ the skill of agent j in country i. Without loss of generality, our index of agents is such that $s^i(j) \leq s^i(j')$ for $j < j'$. For simplicity, assume that the function $s^i(j)$ is measurable for $j \in [0,1]$. North and South only differ on $s^i(j)$, where $s^N(j)$ first order stochastically dominates $s^S(j)$, this is

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

As in the baseline model, each agent is endowed with one unit of labor. If an agent chooses to be employed in a middle skill job, the agent can supply $s^i(j) \cdot 1$ units of labor. This implies that wages described in Section 3 should now be interpreted as wages per unit of effective labor. If an agent chooses to be employed as low skill worker, agents' supply of low skill labor is one.

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 middle skill worker, another agent j', with $j < j'$ will also work as middle 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 middle skill workers.

The level of skills $\bar{s}^i$ in which an agent is indifferent between being employed in a middle or low skill job is $\bar{s}^i(j)w_s^i = w_u^i$. Let $\bar{j}^i$ denote the indifferent agent in country i.[32] It follows that the mass of agents employed as low skill workers in country i is $\int_0^{\bar{j}} dj = \bar{j}^i$.

Proposition 15 *The comparative statics of the mass of middle skill workers,* $1 - \bar{j}^i$ *, with respect to* z_I *and* z_{II} *are the same as the comparative statics of the relative wage of middle skill workers derived in Section 4 for the exogenous supply case (equations* (18) *and* (19)*),* $i \in \{N, S\}$.

Proof The indifference conditions can be rewritten as

$$\bar{s}^N(\bar{j}^N)\frac{1 - z_I^2 - z_{II}^2 + \bar{z}^2}{2(1 - \bar{j}^N)} = \frac{(1 - z_I)^2 + (1 - z_{II})^2 - (1 - \bar{z})^2}{2\bar{j}^N}, \tag{32}$$

$$\bar{s}^S(\bar{j}^S)\frac{1 + z_I^2 + z_{II}^2 - \bar{z}^2}{2(1 - \bar{j}^S)} = \frac{2 - (1 - z_I)^2 - (1 - z_{II})^2 + (1 - \bar{z})^2}{2\bar{j}^S}. \tag{33}$$

Consider the case for the North. Equation (32) can be rewritten as

$$\frac{(1 - \bar{j}^N)}{\bar{j}^N \bar{s}^N(\bar{j}^N)} = \frac{\theta^N}{(1 - \theta^N)}\frac{w_m^N}{w_l^N}. \tag{34}$$

The left hand side of (34) is increasing in $1 - \bar{j}^N$ and the right hand side is increasing in $\frac{w_m^N}{w_l^N}$.

[32] In the case that $\bar{s}^i$ is in a flat region, we are assuming a particular assignment of agents with the same skill level $\bar{s}^i$ to middle and low skill jobs, but this is not payoff relevant.

An analogous arguments applies for the South. ∎

An implication of this proposition is 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 skills during the First Globalization in the North. However, this complementarity effect diminishes and it will eventually be overturned as Second Globalization progresses and more skill intensive tasks are offshored to the South. The results in the Appendix C for the Third Globalization (i.e., when a threshold z_{II}^* is surpassed and South offshores the most skill intensive tasks to the North), show that the new pattern of trade will complement skills again.

For the South, assuming we start the First Globalization above $\tilde{z}_I$, we have that trade complements skills in the First and the Second Globalization, whereas in the Third it will be a substitute.

Proposition 16 *The relative wage of middle to low skill workers has the same comparative statics for z_I and z_{II} as the ones described in the baseline model.*

Proof Consider an agent j with skill $s^i(j) > \bar{s}^i(z_I, z_{II})$. The relative wage is

$$\frac{s^i(j)w_m^i}{w_l^i} = \frac{s^i(j)}{\bar{s}^i(z_I, z_{II})}. \tag{35}$$

For the last equality, we used the indifference condition for agent $\bar{j}^i$. It follows from proposition 15 that, as long as agent j is employed as middle skill worker, the relative wage of agent j has the same comparative statics as $\frac{w_m^i}{w_l^i}$. ∎

This proposition implies that the results derived in the baseline model are not an artifact of having an exogenous supply of middle and low skill workers. The results in Section 4 go through when the occupation decision is endogenized and the supplies vary with z_I and z_{II}. Moreover, in the next proposition, we show that this result does not depend on the assumption that agents are uniformly distributed.

Proposition 17 *The results in propositions 15 and 16 extend to an arbitrary distribution over the index of agents.*

Proof Denote by $f(j)$ an arbitrary density function over the set of agents, indexed by j. Let $\Theta(\bar{j}^i)$ denote the mass of agents choosing low skill jobs, $1 - \int_{\bar{j}^i}^1 f(j)dj$. Consider the case of the North. The indifferent agent $\bar{j}^N$, is pinned down by setting the relative wage equal to one. This equation can be written as

$$\frac{(1 - \Theta(\bar{j}^N))}{\Theta(\bar{j}^N)\bar{s}^N(\bar{j}^N)} = \frac{\theta^N}{(1-\theta^N)}\frac{w_m^N}{w_l^N}, \tag{36}$$

the left hand side is decreasing in the threshold $\bar{j}^N$. Therefore, the mass of agents selecting into middle skill jobs has the same comparative statics with respect to z_I and z_{II} as $\frac{w_m^N}{w_l^N}$.

To proof the second part of the proposition for the North, consider an agent j with skill $s^N(j) > \bar{s}^N(z_I, z_{II})$. The relative wage is

$$\frac{s^N(j)w_m^N}{w_l^N} = \frac{s^N(j)}{\bar{s}^N(z_I, z_{II})}.$$

It follows from the discussion of equation (36) that, as long as agent j is employed as middle skill worker, the relative wage of agent j has the same comparative statics as $\frac{w_m^N}{w_l^N}$.

The proof is analogous for the South. ∎

E Endogenous Labor Supply Choice with Three Occupations

In this appendix, we introduce a skill distribution over agents to endogenize labor supply decisions in the three types model presented in Subsection 5.1. The set-up is analogous to the model with a continuum of skills presented in Appendix D. We denote by $s^i(j)$ the skill of agent j in country i and order the agents such that $s^i(j) \leq s^i(j')$ for $j < j'$. North and South only differ on $s^i(j)$, where $s^N(j)$ first order stochastically dominates $s^S(j)$. Each agent is endowed with one unit of labor. If the agent chooses to be employed as a middle skill worker, the agent can supply $s^i(j) \cdot 1$ units of labor. If the agent chooses to be employed as high skill, the production function is multiplied by $h(s^i(j))$, with $h'(s^i(j)) > 0$. If the agent chooses to be employed as low skill worker, agents' supply of labor is one.

Let $\bar{j}^i$ denote the agent indifferent between choosing a low and a middle skill job and $\bar{J}^i$ the agent indifferent between choosing a high and a middle skill job in country i. Let Θ^i denote $\int_{\bar{J}^i}^1 s^i(j)dj$. Let $F^i(\cdot)$ denote the cumulative distribution over population in country i. Then, to characterize the equilibrium we need to solve a system of four equations and four unknowns,

$$\begin{aligned}
s^N(\bar{j}^N)\frac{\left(1-z_I^2-z_{II}^2+\bar{z}^2\right)}{2(F^N(\bar{J}^N)-F^N(\bar{j}^N))} &= \frac{(1-z_I)^2+(1-z_{II})^2-(1-\bar{z})^2}{2F^N(\bar{j}^N)}, \\
s^N(\bar{J}^N)\frac{\left(1-z_I^2-z_{II}^2+\bar{z}^2\right)}{2(F^N(\bar{J}^N)-F^N(\bar{j}^N))}\Theta^N &= h(s(\bar{J}^N))\left(\int \ln\left(\frac{h(s(\bar{J}^N)}{p(\bar{j}^i,\bar{J}^i)}\right)dz-1\right), \\
s^S(\bar{j}^S)\frac{\Theta^S+\Theta^N(z_0^2+z_{II}^2-\bar{z}^2)}{2(F^S(\bar{J}^S)-F^S(\bar{j}^S))} &= \frac{\Theta^S+\Theta^N\left[1-(1-z_I)^2-(1-z_{II})^2+(1-\bar{z})^2\right]}{2F^S(\bar{j}^S)}, \\
s^S(\bar{J}^S)\frac{\Theta^S+\Theta^N(z_0^2+z_{II}^2-\bar{z}^2)}{2(F^S(\bar{J}^S)-F^S(\bar{j}^S))} &= h(s^S(\bar{J}^S))\left(\int \ln\left(\frac{h(s^S(\bar{J}^S))}{p(\bar{j}^i,\bar{J}^i)}\right)dz-1\right)+ \\
&\quad + \frac{1-F^N(\bar{J}^N)}{\gamma(1-F^S(\bar{J}^S))}(1-\beta)(z_I+z_{II}-\bar{z}).
\end{aligned}$$

We specialize $s^i(j)$ and the population density to Pareto distributions. North is assumed to have both a larger density of high skill agents and that skills of northern agent j are higher than agent's counterpart in the South. Both statements are to be understood in First Order Stochastic Dominance terms.

Figure 12 presents the results for the North in the First Globalization. The simulations indicate that the thresholds $\bar{j}^N$ and $\bar{J}^N$ are decreasing in z_I. This means that, as First Globalization progresses, the number of agents selecting into low skill jobs decreases and the number of agents selecting into high skill jobs increases unambiguously. As a result, the number of agents selecting into middle skill jobs (this is, $F^N(\bar{J}^N) - F^N(\bar{j}^N)$) can either decrease or increase. There are two economic forces at play. First, the relative demand of low skill jobs to middle skill declines (a relative demand effect). Second, profits of the final good production increase as globalization progresses, making high skill jobs more attractive. These two forces go in opposite directions in the First Globalization. However, our simulations seem to indicate that the mass of middle skill agents always increases.

Figure 13 shows the results for the Second Globalization in the North. It reports a decline in the mass of middle skill workers. Moreover, we see that the mass of low skill workers decreases and eventually increases. The mass of high skill workers increases. This is, the threshold $\bar{j}^N$ features a U-shape pattern and $\bar{J}^N$ is decreasing in z_{II}. However the decline in the mass of middle skill agents is robust. The two economic forces described above point now in the same direction. The relative demand of middle skill workers declines in the Second Globalization. Moreover, high skill workers' income increases. As a result, $\bar{J}^N$ declines faster than $\bar{j}^N$, reducing the mass of middle skill agents.

In figure 11, we report the income distribution in the North from our simulation for two different levels of z_{II}, holding z_I constant. We see that the equilibrium features wage polarization. The income of middle skill decreases and the mass of middle skill workers decreases too. The decrease in demand offsets the fall in supply.

We find that the comparative statics for the relative wages in the North, $\mathcal{W}^N_{hm}$, $\mathcal{W}^N_{hl}$ and $\mathcal{W}^N_{ml}$, are analogous to the ones derived in the previous section.

Finally, consider the South. For $\beta = 1$, the thresholds $\bar{j}^S$ and $\bar{J}^S$ are increasing in z_I, see figure 14. $\bar{j}^S$ features an inverse U-shape and $\bar{J}^S$ increases in z_{II}, see figure 15. For low γ values it can be the case that $\bar{J}^S$ becomes decreasing in both z_I and z_{II}. The mass of low skill agents increases and the mass of high skill agents decreases. Perhaps the most interesting results from the simulations are that for $\beta = 1$ the relative wage of high to middle skill, $\mathcal{W}^S_{hm}$, increases in the South for the First and Second Globalization and that the relative wage of high to low skill, $\mathcal{W}^S_{hl}$ has a U-shape in the First Globalization and increases in the Second. The behavior of $\mathcal{W}^S_{ml}$ is analogous to the one described in the main text.

Tables

Table 1: Interdependence 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 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 B for detailed data definitions and sources.

Table 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 for industry.

Figures

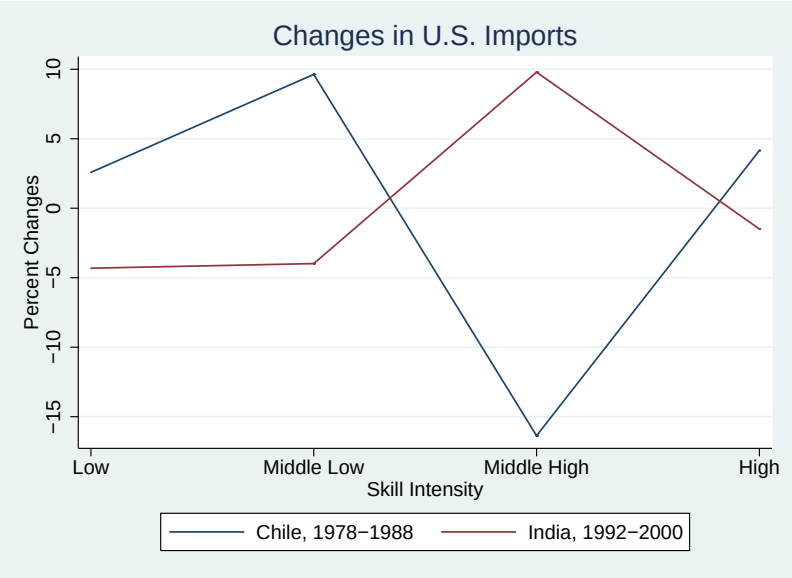

Figure 3: Changes in U.S. imports from India and Chile for different skill levels. For comparability with our tariff data, we can only consider the period 1978-1988 for the First Globalization. For India, the series starts in 1992 to dampen the effect of the trade liberalization in 1991, documented in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

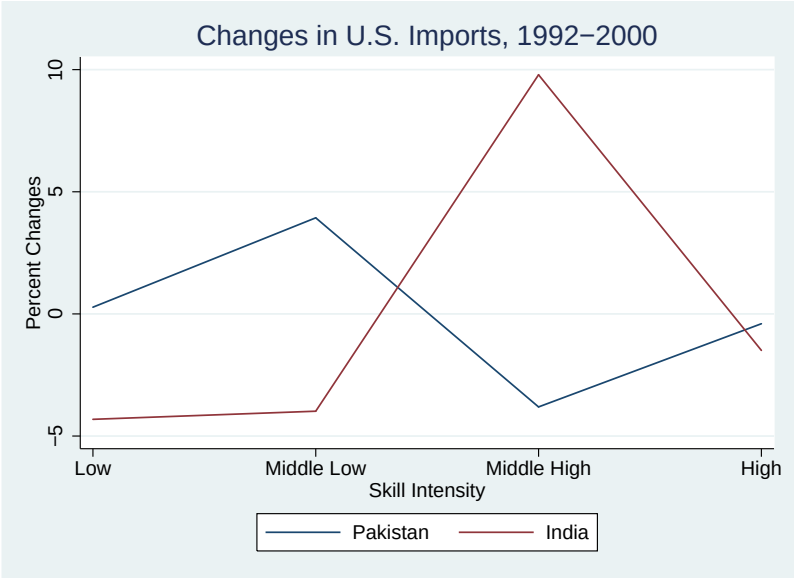

Figure 4: Changes in U.S. imports from India and Pakistan for different skill levels. Source: Feenstra U.S. Imports Database.

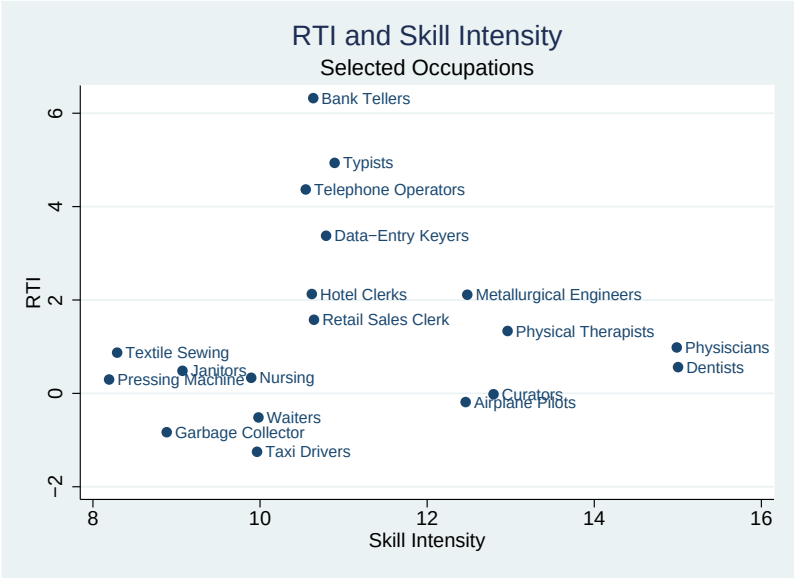

Figure 5: Examples of RTI for Selected Occupations. Source: Autor and Dorn (2008).

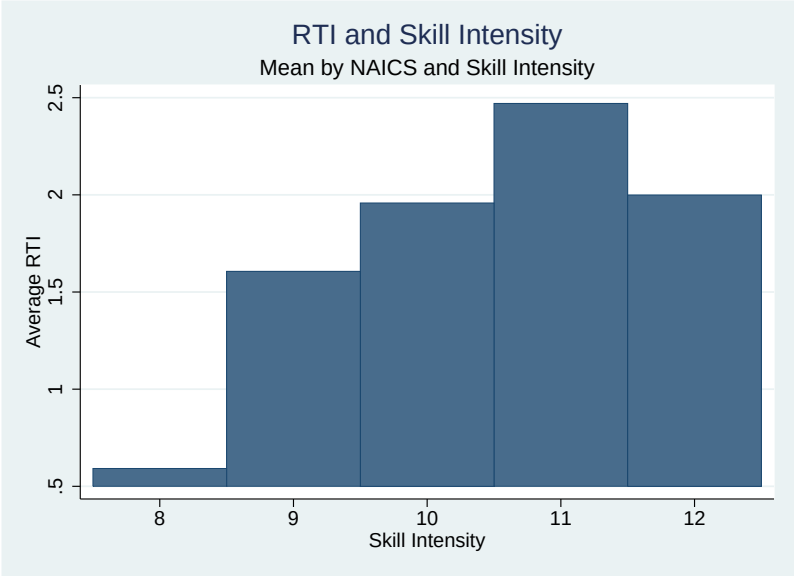

Figure 6: Average Skill Intensity by U.S. Industry. Source: RTI from Autor and Dorn (2008).

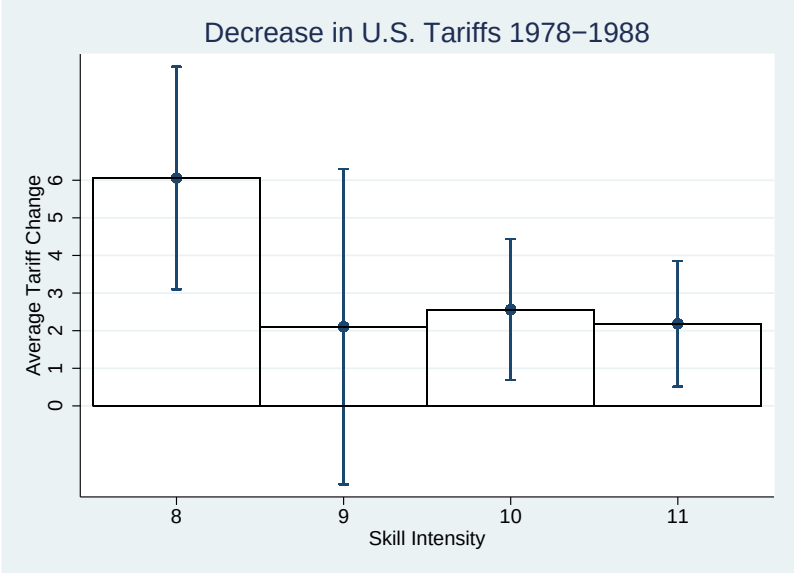

Figure 7: Changes in U.S. Tariffs by Skill in the First Globalization. (Two Std. Dev. bars). Source: Feenstra tariff data.

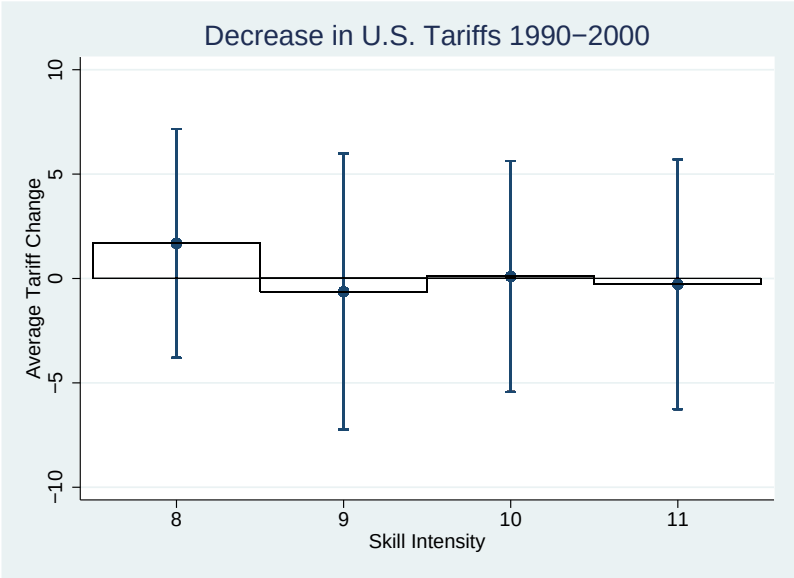

Figure 8: Changes in U.S. Tariffs by Skill in the Second Globalization. (One Std. Dev. bars). Source: Romalis tariff data.

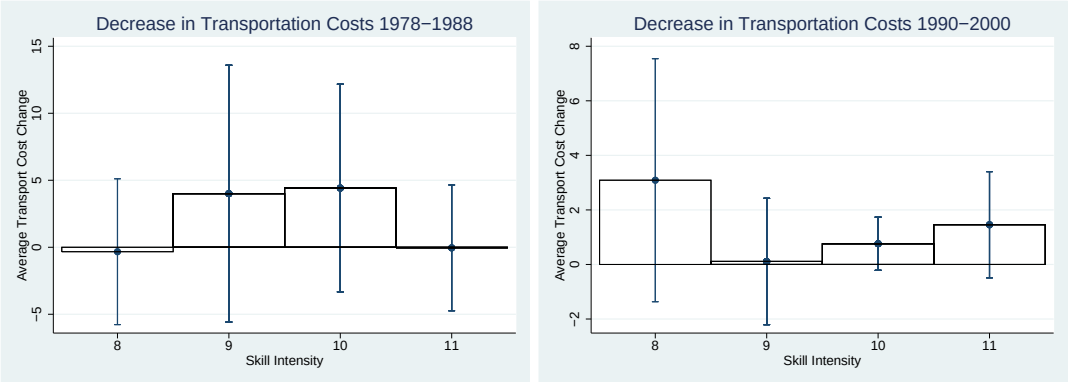

Figure 9: Changes in U.S. Transportation Costs (Insurance and Freight). One Std. Dev. bars are shown. Source: Feenstra database.

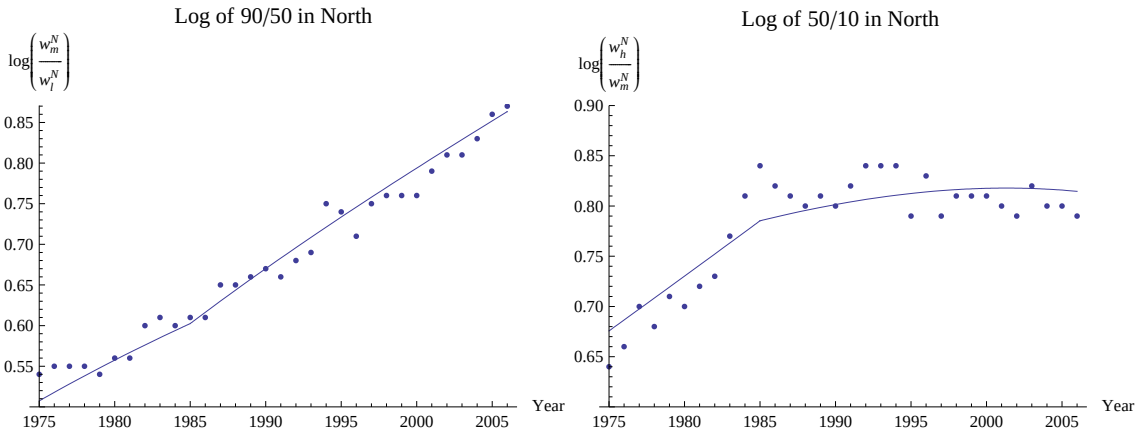

Figure 10: Model versus Autor et al. (2008) estimates. We take the structural change to be 1987, as in Autor et al. First globalization is a shift from $z_I = .15$ to $z_I = .21$. Second globalization is a shift from $z_{II} = .5$ to $z_{II} = .64$. We assume $\theta^N = .55$, $\theta^S = .2$, $\varphi^N = \varphi^S = .5$ and $A = .68$.

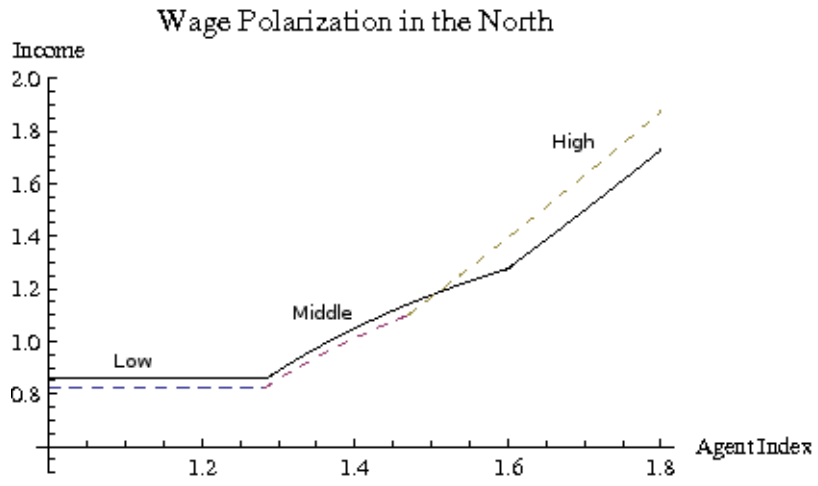

Figure 11: Changes in income distribution in the North. Solid line for the First Globalization, dashed line for the Second. Each segment corresponds to one occupation.

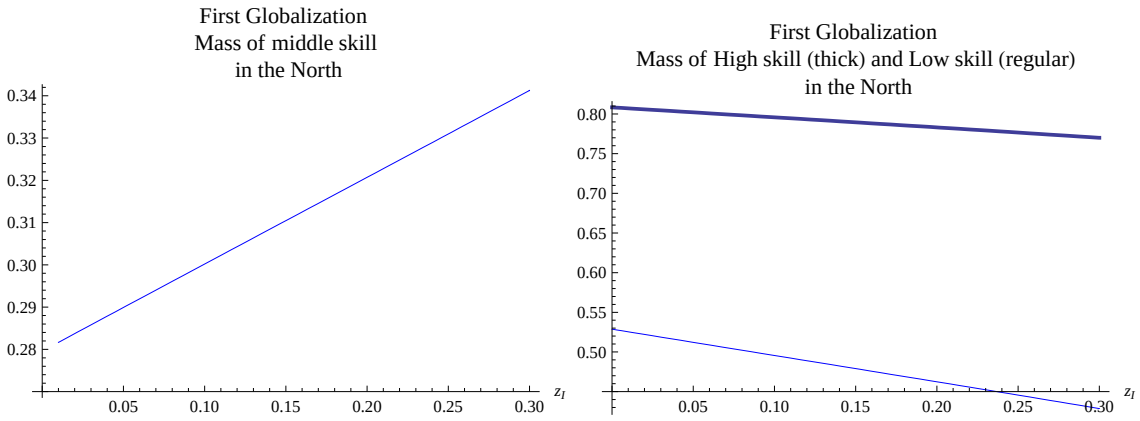

Figure 12: Comparative statics of the mass of northern agents in each occupation for the First Globalization.

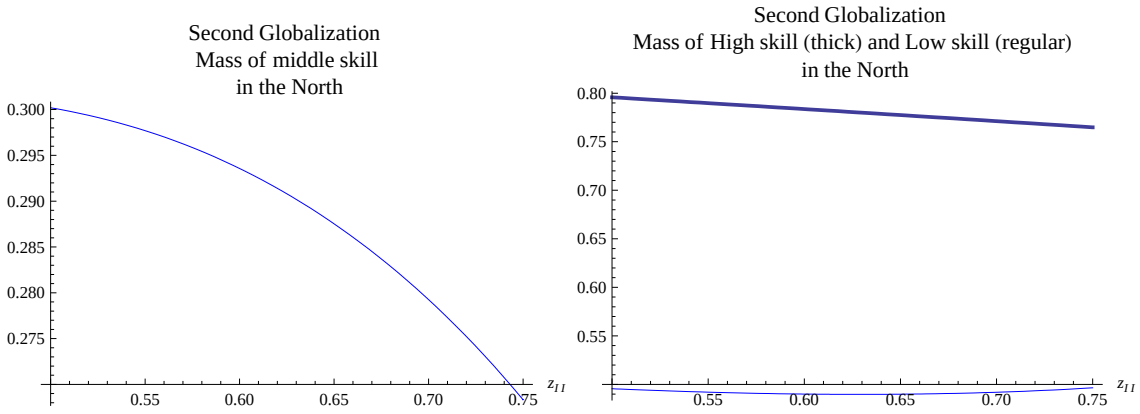

Figure 13: Comparative statics of the mass of northern agents in each occupation for the Second Globalization.

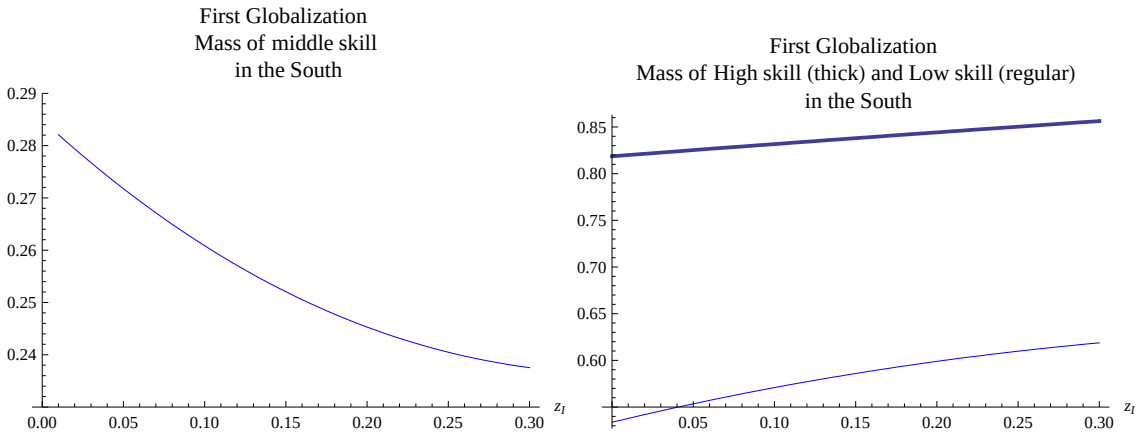

Figure 14: Comparative statics of the mass of southern agents in each occupation for the First Globalization.

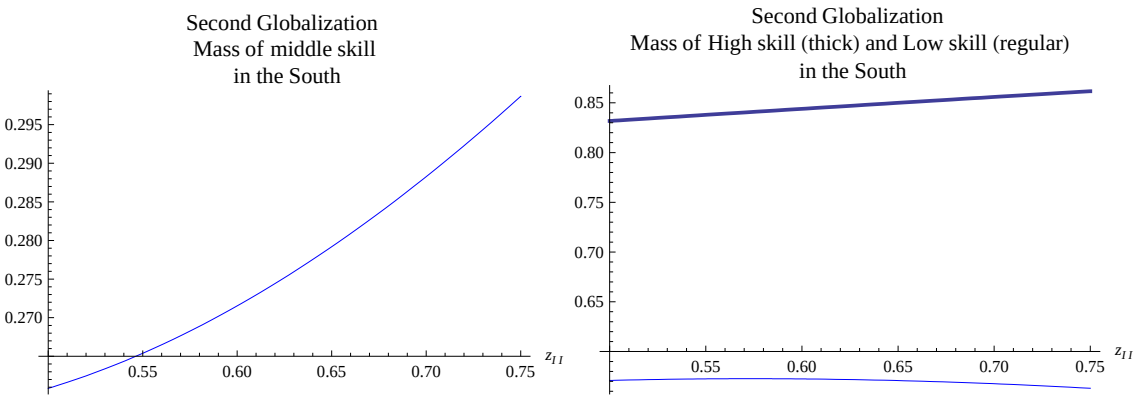

Figure 15: Comparative statics of the mass of southern agents in each occupation for the Second Globalization.