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Distributional Effects of Trade and Tariffs Between and Within Countries

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy

in

Economics

by

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2012

The Dissertation of Martin Tobal approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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ABSTRACT OF THE DISSERTATION

Distribution Effects of Trade and Tariffs Between and Within Countries

by

Martin Tobal

Doctor of Philosophy

University of California, San Diego, 2012

Professor James Rauch, Chair

This dissertation consists of three theoretical papers that investigate how trade and tariffs redistribute income and welfare between countries and within countries. In the first paper, we set a perfect competition model of trade in intermediate (tasks) and final goods. Trade in intermediate goods will create income redistribution within a developed country and across workers whose jobs are of a different nature. In the

second paper, we set a monopolistic competition model of trade in product varieties. Tariffs and mutual trade liberalization will modify the pattern of trade in product varieties thereby causing welfare redistribution between countries of a similar development level. Finally, we set model of trade in final goods and intermediate goods in which the government from a developed country will promote domestic monopolies by imposing tariffs. The promotion of domestic monopolies will shift foreign rents and then redistribute income across countries with different development levels.

Chapter 1: A Model of Wage and Employment Impacts of Service Offshoring

Abstract

We develop a two-sector model of trade in final goods and intermediate tasks (services). Goods differ in skill-intensity and tasks differ in tradability. A country with high final goods productivity and abundant skilled labor relative to the rest of the world is shown to have incentives to import (offshore) both skilled and unskilled tasks that are greater for the latter. Consequently, given identical tradability schedules, more unskilled than skilled tasks are imported in equilibrium. With putty-clay technology for tasks that locks workers into occupations in the short run but allows retraining in the long run, transition from the non-offshoring to the offshoring equilibrium yields employment and real wage effects in line with the young empirical literature on service offshoring: both effects increase from negative to positive as tradability declines, with the switches from negative to positive occurring at a higher level of tradeability for skilled than unskilled tasks. More productive countries will have more losers because they offshore more tasks.

1.1 Introduction

The Information and Communication Technologies (ICT) revolution has allowed for the output of previously non-tradable labor tasks to be delivered electronically from overseas. The possibility of delivering output electronically has reduced the offshoring costs of the labor tasks, leading to the abrupt increase in service offshoring documented by Amiti and Wei (2005,2009), Crino (2009), and Treffler (2006). The boom of service offshoring has received increasing attention in the media and from academic research in recent years.

Researchers disagree about which characteristics of a task determine its propensity to be offshored. Ultimately, the answer to this debate will determine the nature of the jobs and the nature of the income that will be lost to service offshoring. We develop a model of offshoring in order to investigate wage and employment impacts for a country with high final goods productivity and abundant skilled labor relative to the rest of the world. We consider two sectors that have different skill-intensities and conceptualize production in terms of tasks that have different tradability. The costs of offshoring tasks are different and vary smoothly across the tasks in the manner of Grossman and Rossi-Hansberg (2008) (henceforth GRH). In this setup a task's propensity to be offshored depends on two labor dimensions: tradability and skill-intensity.

We identify a cutoff traded task, below which tasks are offshored due to high tradability and above which tasks are produced domestically due to low tradability. The cutoff traded tasks differ across skill groups so that a task's propensity to be

offshored depends on skill-intensity. Specifically, the cutoff traded task is greater for unskilled labor than it is for skilled labor, and thus domestic firms import a wider range of unskilled tasks. Central to the difference between the cutoff traded tasks is that the skill-premium is lower in the home-country relative to the rest of the world: a lower skill-premium turns the offshoring of unskilled tasks more profitable than the offshoring of skilled tasks.

The two labor dimensions are not just important for offshoring propensity as they also determine the wages of the tasks. The supplies of the tasks are perfectly inelastic as our putty-clay technology locks labor into tasks in the short run. Wages are then fully determined by demands, which shift as the ICT revolution permits to replace domestically-produced tasks with foreign-produced tasks. The extent of the shift in demand depends on tradability, with the shift being greater for the most tradable tasks. As the demand shifts are greater for the most tradable tasks, the ICT revolution decreases the wage of these tasks by a greater amount. Along the same lines, we show that the ICT revolution increases the wage of the non-offshored tasks.

Perceiving a higher wage in the non-offshored tasks, some workers switch from the offshored tasks to a non-offshored task. The switching of workers drives the employment responses of the tasks to service offshoring: employment falls in the offshored tasks where retraining takes place, but it increases in the non-offshored tasksto which workers transition. In order to switch tasks a worker must undergo a costly retraining process that provides her with knowledge that is specific to the non-offshored task. The costs of retraining differ within tasks as workers have a different

level of ability to retrain. However, the costs of retraining do not differ between tasks: workers are equally distributed across tasks based on their ability to retrain (this assumption requires that workers do not form expectations on the ICT revolution). Under these assumptions, all differences in the frequency of retraining across tasks arise from the wage differences causedby service offshoring. Service offshoring decreases the wage of the most tradable tasks by a greater amount, and therefore workers that fulfill these tasks have larger gains from retraining. Thus, retraining and then employment decreases are more frequent in the most tradable tasks. Employment changes increase smoothly with tradability as the wage decrease caused by offshoring is monotonic with a tradability index we identify.

The predictions of our model on wage impacts are novel to the theoretical literature. The impact on the wage of a task depends on its degree of tradability, and thus the set of tasks whose wage increases cannot be determined only based on skill-intensity. In other words, skill-levels are not sufficient for determining the set of workers who gain from service offshoring. This prediction overlaps with the intuitive idea that radiologists and physicians should not be equally affected by service offshoring –as their tasks have different tradability degrees-, even though they spend a similar amount of time at school. Despite not being sufficient, skill-intensity is necessary for determining wage responses in our model. Workers that fulfill unskilled tasks more strongly suffer from the increased exposure to foreign workers' competition arising from service offshoring (as it is more profitable to offshore unskilled tasks). Along these lines, the model predicts that the set of tasks whose wage

increases is greater for skilled tasks than it is for unskilled tasks. Furthermore, the set of "loser tasks" is greater for unskilled tasks and "losers" lose more if they fulfill an unskilled task, given tradability

The findings of our model differ from the outcomes shown by GRH in some important ways. In generating a greater cutoff task for unskilled labor, we rely on cross-country differences in factor proportions (a standard factor proportion argument): the skill-premium is lower in the home-country as this country is skilled-abundant. In contrast, GRH rely on a potential negative correlation between the tradability and the skill-intensity of the tasks (the parameters denoting common offshoring costs are different across skill groups). In their model the wage reducing effect arising from offshoring is isomorphic to an increase in the labor-supply, and thus reduces the wage of each task by the same amount (only if there are more factors than goods). In our model the wage reducing effect does not depend on the numbers of goods and factors and reduces the wage of the most tradable by a larger amount. Thus, we do not distinguish losers and winners from offshoring only based on skill-levels like GRH and the standard theory of trade. A corollary of the heterogeneity in the wage-reducing effect is that some workers gain from offshoring unambiguously even though they fulfill offshored tasks. Whereas in GRH this result arises under some circumstances, the result holds unambiguously in our setup. Finally, our employment responses vary smoothly with the set of tasks where employment decreases. The smoothness of the employment responses represents an advantage when confronting predictions with data.

Our model contributes to the literature on service offshoring through comparative statics that yield cross-sectional predictions for countries with different characteristics. We compare offshoring effects across countries with different degrees of technological advantage (more productive) and different levels of trade isolation (higher transport costs on goods). The comparative statics show that isolation magnifies the asymmetry of the offshoring effect across skill groups. In other words, there are more skilled winners and more unskilled losers in countries that face higher trade costs on final goods. The comparative statics also show that a higher productivity in final goods raises wages but creates more losers and more tasks offshored due to service offshoring. The key to this result is that technological advantage is not diminished by importing tasks.

The wage results of our model find some empirical support in an emerging literature, which suggests that tradabilty and skill-intensity are relevant for explaining wage changes. Hummels et al. (2011) study the impact of offshoring on Danish wages over the period that goes from 1995 to 2006. Employing matched worker-firm data, they show that offshoring increases the high-skilled wage and decreases the low-skilled wage. They also find that workers whose occupations involve routine tasks (more tradable tasks) suffer from larger wage decreases. Along the same lines Crino (2010) finds that changes in occupational wages are positively correlated with changes in occupational employment, even after controlling for variations in the occupational supply (given Crino's results on employment described below, this correlation indicates that wages have increased in skilled low-tradability occupations)

The smoothness of the employment responses makes our predictions consistent with the evidence on employment and switching rates across occupations provided by the young literature. Crino (2010) investigates the role of skill-intensity and the role of tradability by studying the effect of service offshoring on the U.S. white-collar population. He estimates the offshoring elasticity of demand in order to assess the impact of offshoring on the employment of different occupations. The positive employment responses are concentrated among the skilled occupations and that the negative responses are concentrated among the unskilled occupations. He also studies jointly the role of skill-intensity and the role of tradability: he constructs a tradability index based on job characteristics and estimates the probability of finding a positive employment response. This probability increases with an occupation's skill-intensity, given tradability, and decreases with tradability index, given skill-intensity.[1] Our results are also consistent with Trefler and Liu (2011), which maps workers' occupations with categories of services and studies the impact of service offshoring on switching rates across occupations. They find that service offshoring increases switching, with the impact being stronger on unskilled workers and workers fulfilling routine tasks. They also find that the impact of service offshoring on switching rates is likely to occur after a period of time. As we show below, our model predicts that workers switch gradually across tasks so that the full effect of offshoring appears only after some time.

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[1] Crino employs data at the occupational level, and thus these statements require a mapping between tasks – our unit of measure- and occupations. Any reasonable mapping would make the statements true as the skill-intensity of an occupation should increase with the relative weight of its skilled tasks; and the tradability of this occupation should also increase with the tradability of its tasks. For more details, please refer to section 1.5.

To isolate the effects of service offshoring, we simulate the ICT revolution with an abrupt reduction in the offshoring costs of the tasks, dividing our analysis into two regimes. The non-offshoring regime represents the pre-revolution period, and the offshoring regime represents the period after ICT shock. We present the offshoring regime in section 1.2. In section 1.3, we allow for trade in tasks and obtain offshoring results and wage responses at the task level. We introduce the retraining model in section 1.4, and use this model along with the wage responses to obtain the employment responses of the tasks. We summarize our predictions and confront them to the findings of the young empirical literature in section 1.5. Section 1.6 concludes and the appendix section proposes a discussion about the new role of public policy in an ICT-world.

1.2 Non-Offshoring Regime: Trade in Final Goods

This section develops a task-based model of trade in final goods. The offshoring costs of the tasks are assumed to be sufficiently large that no offshoring occurs. Firms demand domestically-produced tasks and workers choose a task to supply.

Model Setup

We consider a world with two regions: Home and the rest of the world. The variables concerning the rest of the world are identified by a superscript asterisk (*). Skilled workers and unskilled workers are distributed over two continuums, whose

being the measures of these continuums equal to L_s and L_u, respectively. The measure

of skilled workers is greater in Home, the skill-abundant country. More formally, we

write

$$\frac{L_s}{L_u} > \frac{L_s^*}{L_s^*}. \tag{1}$$

We denote the skilled-intensive good by Y_s, and the unskilled-intensive good

by Y_u. We will let Home import the unskilled-intensive good, which is the most

empirically appealing case and the prediction of any two-good two-factor textbook

model.

Home is a small country with a Hicks neutral technological advantage. As a

small country Home does not affect final goods prices that are taken as exogenous. We

will then write domestic and foreign wages in terms of these exogenous variables in

equilibrium. The appendix section shows that when Home is a large country domestic

wages can be written in terms of factor endowments, technologies, and the measure of

transportation costs that we introduce below.

We conceptualize the production process in terms of tasks, which are of two

types: there are skilled and unskilled tasks. We follow GRH, and assume that tasks

performed using a given labor-type require similar amounts of that labor. Specifically,

production of one unit of skilled tasks requires one unit of skilled labor, and

production of one unit of unskilled tasks requires one unit of unskilled labor. The tasks

are specific-factors: skilled tasks are only used to produce Y_s and unskilled tasks are

only used to produce Y_u. The measure of skilled tasks and the measure unskilled tasks

are normalized to 1 in the manner of GRH. Technologies are given by the following

Cobb-Douglas functions employed by Acemoglu et al. (2007)

$$Y_j = Ae^{\int_0^1 \ln(z_{i,j})di}, \qquad i \in [0,1], \qquad j \in [s,u], \qquad (2)$$

$$Y_j^* = e^{\int_0^1 \ln(z_{i,j}^*)di}, \qquad i \in [0,1], \qquad j \in [s,u], \qquad (3)$$

where $z_{i,j}$ denotes task i's usage in industry j, and $A > 1$ is Home's Hicks neutral

technological parameter. Output is defined only as producers employ all tasks, and

therefore the demand for every task will be greater than zero in equilibrium.

Furthermore these demands will be the same as the tasks enter symmetry in the

production function. The tasks are substitutes so that an increase in any task's usage

leads to an increase in output, holding the remaining tasks' usage constant. This

property of a Cobb-Douglas function is absent in GRH but will allow for import tasks

to generate output increases in the offshoring regime.

The goods market is perfectly competitive, and trade costs, which are of the

Samuelson-Bergson iceberg type (1952), apply to both goods. Specifically, for one

unit of a product to arrive in the other region $\tau > 1$ units must be shipped.

Equilibrium in the Non-Offshoring Regime

Any wage sequence $\{w_{i,j}\}_{i \ni [0,1]}^{j \ni [s,u]}$ must fulfill two sets of requirements in

equilibrium: clearing of the task-markets and the zero-profit conditions. We will begin

with market-clearing. Given the technology displayed above, cost minimization yields

the following output-constrained demands for tasks

$$z_{i,j}^d = Y_j \frac{e^{\int_0^1 \ln(w_{i,j})di}}{Aw_{i,j}}, \qquad i \in [0,1], \qquad j \in [s,u], \tag{4}$$

$$z_{i,j}^{*d} = Y_j^* \frac{e^{\int_0^1 \ln(w_{i,j}^*)di}}{w_{i,j}^*}, \qquad i \in [0,1], \qquad j \in [s,u], \tag{5}$$

where $z_{i,j}^d$ is the output-constrained demand for task i in sector j, and $w_{i,j}$ is the price of the task. The output-constrained demands are symmetric: when all tasks have the same price, they are all demanded in the same amount. Furthermore the demand for a task is zero only as its price goes to infinite.

Consider the supply of tasks. A worker is able to perform any of the tasks at her skill level, and supplies the task with the highest wage: the supply of a task is only zero as another task has a strictly higher price. As this is not equilibrium, all tasks must have the same price as we show in the appendix section. More formally, any market-clearing sequence of wages fulfills the following conditions

$$w_{i,s} = w_s, \qquad \forall\, i \in [0,1], \quad w_{i,u} = w_u, \qquad \forall\, i \in [0,1], \tag{6}$$

$$w_{i,s} = w_s, \qquad \forall\, i \in [0,1], \quad w_{i,u} = w_u, \qquad \forall\, i \in [0,1], \tag{7}$$

Plugging these conditions in the demands displayed in (4) and (5) yields the equilibrium quantity for each task. Equilibrium quantities are written as follows

$$z_{i,s} = L_s, \qquad \forall\, i \in [0,1], \qquad z_{i,u} = z_u, \qquad \forall\, i \in [0,1], \tag{8}$$

$$z_{i,s}^* = L_s^*, \qquad \forall\, i \in [0,1], \qquad z_{i,u}^* = z_u^*, \qquad \forall\, i \in [0,1]. \tag{9}$$

Labor of type j is allocated evenly across the j-intensive tasks in equilibrium.[2]

Equations (6)-(9) define market clearing in the task markets and yield, along with the zero-profit conditions, domestic wages in equilibrium.

To consider the zero-profits conditions note that complete specialization never takes place in equilibrium because tasks are specific factors. In an incomplete specialization equilibrium the zero-profits conditions are fulfilled when the effective price of each good equals its unit production cost. Under the constant returns to scale technology displayed above unit costs of production equal marginal costs so that marginal costs are written as follows

$$MC_j = \frac{e^{\int_0^1 \ln(w_{i,j})di}}{A}, \qquad i \in [0,1], \qquad j \in [s,u], \tag{10}$$

$$MC_j^* = e^{\int_0^1 \ln(w_{i,j}^*)di}, \qquad i \in [0,1], \qquad j \in [s,u], \tag{11}$$

where MC_j denotes the unit cost of production in sector j. The expressions for marginal costs are readily simplified by imposing the task market clearing conditions for prices. Using these simplified versions we equate marginal costs to the effective price of each good and obtain the following zero-profits conditions

$$p^T = \frac{w_s}{A}, \qquad \tau = \frac{w_u}{A}, \tag{12}$$

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[2] If the world were perpetually well described by the offshoring regime, even labor allocation across tasks would be Pareto efficient as it maximizes output. However, as offshoring takes place, a different labor allocation reduces retraining costs and might Pareto-dominant. In Appendix 1, I study a governmental policy that minimizes retraining costs without having to make any assumption on how much is labor is allocated to each task.

$$\tau p^T = w_s^*, \qquad 1 = w_u^*, \tag{13}$$

where p^T denotes the equilibrium relative price of the skilled-intensive good, τ is the iceberg cost measure, and the number 1 denotes that the price of the unskilled-intensive good has been chosen as the numeraire. Provided that final goods are not freely tradable, the effective price of the unskilled-intensive good is greater in Home because this country imports the product. Rearranging equations (12)-(13), we obtain the relative wages across countries by skill group. We will use these relative wages to address the effects of the ICT revolution in the next section. Rearranging equations (14)-(15) yields

$$\frac{w_s}{w_s^*} = \frac{A}{\tau}, \tag{14}$$

$$\frac{w_u}{w_u^*} = A\tau. \tag{15}$$

The Home-to-foreign wage increases with Home's Hicks neutral technological parameter for both skilled and unskilled labor. Furthermore, if Home's technological advantage is sufficiently large, domestic firms will offshore both skilled and unskilled tasks from the rest of the world. On the other hand, trade costs decrease the Home-to-foreign wage for skilled labor but increase this wage for unskilled labor. Hence, trade costs prevent relative wage equalization across regions as stated in the following equation

$$\frac{w_s}{w_u} = \frac{1}{\tau^2}\left(\frac{w_s^*}{w_u^*}\right) < \frac{w_s^*}{w_u^*}. \tag{16}$$

The skilled relative wage is lower in Home, reflecting its skill-abundance relative to the rest of the world. This will cause service offshoring to have a heterogeneous impact on workers with different skill levels in the offshoring regime.

There is empirical evidence suggesting that skilled relative wages are lower in countries with high final goods productivity. Psacharopulos (1994) provides the most comprehensive survey on schooling returns for the period preceding the ICT revolution. He concludes that private schooling returns such as the skilled relative wage are smaller in developed nations. For the same sample, Acemoglu (2003) shows that countries' skilled relative wages and skill-abundance are negatively correlated.

Furthermore, other factor proportion models have emphasized the link between non-relative wage equalization and heterogeneous offshoring effects. Deardorff (2005) sets a one-product model and conceptualizes production in terms of tasks-bundles. Non-relative wage equalization arises endogenously from having more bundles than goods. I concentrate on service offshoring and the ICT revolution, whose effects are occurring at a fine disaggregation level. Therefore, I choose the task-level and a simple but empirically founded argument for non-relative wage equalization. This simple argument allows me to emphasize the implications of non-relative wage equalization on labor market outcomes more strongly.

1.3 Offshoring Regime: Trade in Final Goods and Intermediate Tasks

This section allows for sufficiently low offshoring costs that domestic firms import tasks, and solves for the offshoring equilibrium. The transition from the non-

offshoring to the offshoring equilibrium represents the ICT revolution that took place in the early 1990s. The real wage effects of this revolution are obtained through a comparison of the non-offshoring and offshoring equilibria.

Setup of the Service Offshoring Model

As offshoring takes place firms make an additional choice relative to the previous section; they determine the set of offshored tasks by choosing which tasks to offshore. Following GRH we will let offshoring costs differ across tasks and determine a cutoff traded task I. In each of the two continuums tasks are ordered so that offshoring costs are non-decreasing and determined by the index i. Offshoring costs are expressed in terms of foreign labor requirements: a firm that performs task i abroad requires $\beta t(i)$ units of foreign labor, being β the GRH shift parameter.

As the ICT revolution hits the economy, there is a discrete fall in the shift parameter that reduces offshoring costs unevenly across tasks. Because the cost reduction is uneven, only some of the tasks will be offshored in equilibrium under the assumptions displayed below. Specifically, task i will be offshored if and only if its offshoring costs are lower than those of the cutoff traded task. In other words, task i will be offshored if and only if $i < I$.

We will assume that $t(.)$ is monotonic, twice differentiable and "sufficiently increasing" that only some tasks are offshored in equilibrium. An additional assumption ensures that domestic firms offshore at least some skilled tasks. This will

happen if Home's technological advantage is at least as large as stated in the following assumption

$$\frac{A}{\tau} > \beta t(0). \tag{17}$$

The bound on the technological parameter ensures that Home's skilled relative wage of the first regime is sufficiently large – refer to equation (14)-. Hence, domestic firms offshore some skilled tasks, despite facing offshoring costs.

Finally, it is important to note that the cutoff traded I task will not distinguish between tasks that are produced domestically and tasks that are produced in the foreign region. All tasks will be domestically-produced as the specificity of human capital behind the putty-clay technology makes labor immobile in the short run.

Kambourov and Manovskii (2009) provide empirical support for the putty-clay assumption and human capital specificity at the occupational-level: controlling for workers' experience, industry and employer tenure, they find that occupational tenure has a wage premium.[3] Human capital tends to be more specific for tradable occupations as noted by Ritter (2008) so that putty-clay is particularly relevant for understanding the effects of the ICT revolution. This technological change has made many occupations tradable.

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[3] Kambourov and Monovskii (2009) employ worker-level data on wages and identify workers' occupation and industry switches. Furthermore, they relate human capital specificity to wage changes for the 1969-1997 period

Equilibrium in the Offshoring Regime

Any wage sequence $\{w_{i,j}\}_{i \ni [0,1]}^{j \ni [s,u]}$ must fulfill an additional requirement in equilibrium relative to the previous section. Besides clearing the task markets and fulfilling the zero-profit conditions, the choice of the cutoff traded task I must be cost-minimizing given the wages implied by the sequence.

We will begin with the cost minimizing condition. Because relative wages are not equal across countries, cost-minimization yields a different cutoff traded task for each skill group; we will prove this result in the next subsection. The cutoff traded tasks minimize the marginal costs so that firms' cost-minimizing decisions are summarized by the following equation

$$Min_{C_j} MC_j(J_j) = \frac{e^{(1-J_j)\ln(w_{nt,j}) + \int_0^{C_j} \ln(w_j^* \beta t(i))di}}{A}, \quad j \in [s,u], \quad (18)$$

where J_j denotes the cutoff choice for skill group j, $w_j^* \beta t(i)$ is the effective importing price of task i, and $w_{nt,j}$ is the price of a non-traded task. We have imposed all non-offshored tasks with the same skill-intensity to have the same price. We have also imposed the price of an offshored task to equal its effective importing price. We will show below that wages must fulfill these conditions for the task-markets to be in equilibrium.

The minimization problems presented in (18) yields straight-forward offshoring rules. The rule for skill group j is written as follows

$$Import\ task\ i\ if\ and\ only\ if\ w_j^* \beta t(i) < w_{nt,j.} \quad (19)$$

Domestic firms offshore a task i if and only if importing this task reduces the marginal cost. Importing task i reduces the marginal cost if the importing price of the task is lower than its price in the domestic market $w_{nt,j}$. Based on the offshoring rules displayed above we obtain equilibrium conditions for the cutoffs

$$w_s^* \beta t(I_s) = w_{nt,s}, \qquad w_u^* \beta t(I_u) = w_{nt,u}, \tag{20}$$

where I_s and I_u are the skilled and the unskilled labor cutoffs in equilibrium, respectively. Equation (20) shows the relationships between the two endogenous variables: the price of non-offshored tasks and the cutoff for skill group j Firms must be indifferent between offshoring and purchasing the cutoff traded task in the domestic market. The equilibrium relationship shown in (20), along with the zero-profit conditions that we address below, will determine the endogenous variables.

We turn now to the second equilibrium condition: clearing in the domestic markets of tasks. The employment level of an offshord task is given by its inelastic supply and thus equals the employment level from the non-offshoring regime in equilirbium -L_j. The wage of the task is given by its effective importing price o: for wages lower than $w_j^* \beta t(i)$ the demand is greater than its demand in the non-regime, and for wages greater than $w_j^* \beta t(i)$ the demand equals zero so that there is an excess supply. This reasoning remains valid independent of a task's offshoring costs, and thus the equilibrium wage of any offshored task equals its effective import price. This confirms that some of the assumptions we have made in our discussion of the optimal offshoring rules are correct.

For a non-offshored task i_j'' the employment level is the same as the employment level from the non-offshoring regime in equilibrium. As firms do not offshore task i_j'' its demand is independent of offshoring costs and determined by the demand for the task from the non-offshoring regime.[4] This reasoning remains valid for any non-offshored task so that the equilibrium wage of any of these tasks is independent of offshoring costs. Furthermore, the equilibrium wage of all non-offshored tasks is the same as they all enter symmetrically in the production function shown in (2). This finding confirms that all of the assumptions we have made in our discussion of the optimal offshoring rules are correct.

Finally we address the last equilibrium requirement: the zero-profit conditions. These conditions yield the second relationship between the price of the non-offshored tasks and the cutoff traded task in equilibrium. As in the previous section, firms make zero-profits when unit production costs equal the effective prices of the goods. We employ the unit costs definition provided in (18), and our small-country assumption when writing domestic prices; as Home is a small country and does not affect either good prices or foreign wages, equations (12) and (13) are still valid in this section. Setting the zero-profit condition yields the following equations

$$\frac{w_s^*}{\tau} = \frac{e^{(1-J_s)\ln(w_{nt,s}) + \int_0^{J_s}\ln(w_s^*\beta t(i))di}}{A}, \qquad (21)$$

---

[4] The demand for the non-offshored tasks shifts upward due to the output increase in the second regime that we will mention below.

$$\tau w_u^* = \frac{e^{(1-J_u)\ln(w_{nt,u}) + \int_0^{J_u} \ln(w_u^* \beta t(i))di}}{A}. \tag{22}$$

Equations (21) and (22) implicitly define all vectors $(J_j, w_{nt,j})$ that fulfill the zero-profit conditions. We manipulate these equations to solve for the price of the non-offshored task, and obtain the following expressions

$$w_{nt,s}(J_s) = e^{\left[\ln(w_s^*) + \frac{\ln\left(\frac{A}{\tau}\right) - J_s\ln(\beta) - \int_0^{J_s} \ln(t(i))di}{1-J_s}\right]}, \tag{21'}$$

$$w_{nt,s}(J_u) = e^{\left[\ln(w_u^*) + \frac{\ln(A\tau) - J_u\ln(\beta) - \int_0^{J_u} \ln(t(i))di}{1-J_u}\right]}. \tag{22'}$$

Equation (21') states that the price of a non-offshored skilled task depends on the home country's technological advantage, the transport cost measure, the GRH shift parameter, and the choice of the cutoff task J_s. Equation (22') is the corresponding equation for the price of unskilled tasks.

Note in (21') that the price of the non-offshored tasks increases with any parameter change that reduces the unit production cost, holding the cutoff constant. Without loss of generality consider a decrease in the unit production cost caused by a rise in the home country's Hicks parameter. As the home country becomes more productive the price of the non-offshored tasks must rise so that the marginal cost returns to its original value. Only when the marginal cost returns to its original value, the zero-profit condition is restored.

As equation (21') shows the price that fulfills the zero-profits conditions for a given cutoff choice J_s, we will refer to this price as the "zero-profit wage" hereafter.

Note that the zero-profit wage collapses to its first regime value when the cutoff choice J_s equals zero. Specifically, the zero-profit wage collapses to the skilled wage implied by equations (12) and (13).

We employ the optimal offshoring rules derived in (20) and the zero-profits conditions shown in (21') and (22') to solve for the values of the endogenous variables in equilibrium. Then we will employ these values and the task-market clearing conditions to solve for the schedule of domestic wages in equilibrium. Finally, we will run comparative statics that yield empirically testable cross-sectional predictions for countries with a different TFP level and a different trade costs parameter.

Offshoring Imlications and Predictions

Figure 1-1 depicts the equilibrium for the particular case of a strictly convex offshoring cost function, which we represent with a solid and slightly weighted curve for the non-offshoring regime.[5] The vertical intercept of the curve is $\beta_0 t(0)$ and denotes the offshoring costs of the cheapest to offshore task. The offshoring cost curve shifts downward as the ICT revolution hits the economy so that β goes from β_0 to β_1 ($\beta_1 < \beta_0$). The new convex curve is more heavily weighted and represents offshoring costs in the offshoring regime. In the following we will refer to the curve for the offshoring regime as "the offshoring costs curve."

The square-dotted curve depicts the relationship between the zero-profit-to-foreign wage ratio $\frac{w_{nt,u}}{w_u^*}$ and the cutoff choice J_u -equation (22')- as iceberg costs are

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[5] We do not require this second derivative to be positive over the whole range of tasks; however, it is easier to make the exposition under this assumption

given by τ_0. The vertical intercept is the Home-to-Foreign unskilled relative wage from the non-offshoring regime. The circle-dotted curve shows the corresponding relationship for skilled labor -equation (21')-.

The equilibrium is given by market clearing in the task markets, and the fulfillment of the zero-profits conditions and the optimal offshoring rules. For unskilled labor, this equilibrium lies at the intersection of the square-dotted and the offshoring cost curves -$J_u = I_u^{\tau_0}$- as we show in the appendix section. Equivalently, the equilibrium for skilled labor is given by the intersection of the circle-dotted and the offshoring cost curves.

In equilibrium the cutoff traded task is greater for unskilled labor than it is for skilled labor -$I_u^{\tau_0} > I_s^{\tau_0}$- , and thus the skilled-abundant country -Home- offshores more unskilled tasks than skilled tasks. Graphically speaking, the cutoff tasks differ across skill groups as the vertical intercepts of the square- and the circle-dotted curves are different.[6] These intercepts represent the Home-to-foreign wage –by industry-, and thus we know that the cutoffs differ because relative factor prices do not equalize across countries in the non-offshoring regime.

The unskilled relative wage from the non-offshoring regime is greater for Home than it is for the foreign country because Home is the skilled-abundant country. As Home's unskilled relative wage is greater, domestic firms find it more profitable to offshore unskilled labor and then import a relatively larger set of unskilled tasks. In other words Home's skill abundance explains why relative factor prices do not

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[6] Appendix 4 proves this statement.

equalize and, ultimately, why the cutoff traded tasks differ across skill groups. Thus, the model highlights the relevance of factor proportions without neglecting the importance of tradability –as only task with sufficiently low offshoring costs are offshored. Hence, our model reconciles some aspects of GRH with traditional factor-proportion arguments.

Figure 1-2 depicts equilibrium as trade costs become higher and are then given by τ_1 ($\tau_1 > \tau_0$). By going from Figure 1-1 to Figure 1-2 we can compare the differential impact of service offshoring on two countries with different levels of trade costs. In Figure 1-2 the square-dotted curve shifts upward and the circle-dotted line shifts downward so that the set of unskilled offshored tasks enlarges and the set of skilled tasks shrinks relative to Figure 1-1 [7]

Service offshoring generates more asymmetries across skill-groups in a country that faces higher trade costs. An increase in trade costs exacerbates the impact of Home's skill abundance on relative wages by reducing its skilled wage and increasing its unskilled wage in the non-offshoring regime. Thus, offshoring unskilled labor is more profitable but offshoring skilled labor is less profitable for a country that faces higher trade costs; therefore, the difference between the cutoffs tasks is greater for this country increases relative to Figure 1-1. The model predicts that a country with higher trade costs will offshore more unskilled tasks and fewer skilled tasks.

Looking at how Home's relative wages from the non-offshoring regime change, we obtain predictions for countries with different final goods productivities. A

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[7] See Appendix 4 for a proof of this result

higher final goods productivity increases domestic wages so that offshoring the two types of labor becomes more profitable and firms import larger sets of tasks. The model predicts that more productive countries will offshore more unskilled and skilled tasks.

Wage Implications and Predictions

We build our intuition on the two competing effects that service offshoring has on domestic wages: the productivity effect and the foreign competition effect.

Offshoring allows firms to hire cheaper labor services abroad. This costs saving is isomorphic to an increase in firms' productivity, and thus the possibility of offshoring expands the output of the firms. The output expansion increases the demand for domestic labor so that offshoring has a wages-increasing- effect; we refer to this effect as the productivity effect hereafter.[89] On the other hand, the fact that firms can hire cheaper labor increases the exposure of domestic workers to foreign competition, and then offshoring also has a wages-reducing effect. Firms can purchase tasks at effective importing prices in the international market so that the wage of an offshored task is never greater than its import price in equilibrium. We refer to this wage-reducing effect as the foreign competition effect hereafter.

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[8] The productivity effect can be seen in figure 1A. Consider the case of unskilled labor and low trade costs in this figure. Over the set of tasks located to the left of the equilibrium $J_u < I_u^{\tau_0}$- the zero-profit price of a non-offshored task is greater than its effective import price; thus, firms save money and reduce their marginal costs by offshoring these tasks.

[9] GRH highlight the productivity effect from a theoretical perspective. Heshmati (2003), Olsen (2006) and Amiti and Wei (2009)[amiti2009service] are examples of papers that approach this effect from an empirical perspective.

The balance between the productivity effect and the foreign competition effect determines the sets of skilled losers and skilled winners from offshoring that are depicted in Figure 1-3. The square-dotted curves denote the wage schedule for skilled workers and the horizontal line indicates the wage that these workers perceive in the non-offshoring regime. These two curves-types intersect at the solid vertical line that identifies the indifferent skilled task i_s^h, for which workers receive the same wage in the offshoring regime and in the non-offshoring regime. Figure 1-4 shows the corresponding sets of losers and winners for unskilled workers.

We distinguish between three regions in Figure 1-3 and Figure 1-4. The first region is located further right and refers to workers that fulfill non-traded tasks. The wages of these workers increase relative to the non-offshoring regime thanks to the productivity effect. The second region refers to workers that fulfill the offshored tasks with the lowest offshoring costs; they are located further to the left in the figures. Service offshoring harms these workers via the foreign competition effect and makes them worse-off as we may have expected. Finally, the third region concerns workers that fulfill offshored tasks with relatively low offshotring costs; they are located to the left of the equilibrium cutoff traded tasks. Interestingly service offshoring makes these workers better off even though the types of tasks they fulfill are offshored. The offshoring costs of the tasks considered in the third region are low, and then so the foreign competition effect is; thus, the workers included in this region suffer less from the foreign competition effect than the benefit from the productivity effect.

Our predictions about the wage changes caused by offshoring differ in some important ways from the outocmes shown by GRH. In their model a worker's skill-level is sufficient for determining the response of her wage to offshoring. Their result is line with standard international trade theory which has traditionally predicted wage changes to increasing trade based on skill-levels in the manner of the Stolper-Samuelson theorem. Building upon their setup we show although some workers with a given skill level gain from offshoring, other workers with the same skill level lose from offshoring. Thus, we argue that skill-levels are not sufficient for understanding wage changesbecause the tradability of the task fulfilled by a worker determines its wage response to offshoring as well. The key to this result is that the foreign competition does not act homogenously across tasks with different tradability in our model: the foreign competition effect is stronger for offshorable tasks, which are less costly to replace with foreign labor. A corollary of the heterogeneity in the foreign competition effect is that a set of gain from service offshoring unambiguously even they fulfill offshored tasks. In GRH this occurs as long as the productivity effect is stronger than the foreign competition effect, which does occur unambigouslyt. In our model some of the workers that fulfill offshored tasks gain from offshoring under any circumstances.

The workers that fulfill offshored tasks but gain from offshoring are represented in Figure 1-5, which shows the market of an offshored task i'_j that benefits from offshoring, and the market of a non-offshored task. The wage of the two tasks from the non-offshoring regime w_j^1 lies at the intersection of the inelastic supply and

the demand for the tasks, which we denote by $z_1(Y_j^1)$ and indicate by a solid line. We denote the demand for the offshored task in the offshoring regime by $z_{i_j^1}^2(Y_j^2)$ and represent this demand with square dotted curves. The third chunk of this demand arises from the shift of $z_1(Y_j^1)$ due to the production increase caused by the productivity effect $-Y_j^2 > Y_j^1$.

The non-offshored task does not suffer from the foreign competition effect and then, graphically speaking, this effect is the vertical distance between the wage of the non-offshored task and the wage of the offshored task. We tag the productivity effect as "Prod" and employ the wage of the non-offhored task to obtain this effect: the productivity effect is the vertical distance between the wage of the task in the offshoring regime $w_{nt,j}$ and the wage of the task in the non-offshoring regime w_j^1. Workers from the third regions of the figures gain from offshoring so that the productivity effect is stronger than the foreign competition effect in Figure 1-5.

We turn back to Figures 1-3 and 1-4 to compare the wage schedule for unskilled workers to the wage-schedule for skilled workers. The proportion of "loser tasks" is greater for unskilled workers than it is for skilled workers. Note also that "unskilled losers" lose more than "skilled losers": the non-offshoring-to-offshoring wage ratio is lower for an unskilled loser than it is for a skilled loser, given tradability. These results show that the model keeps a role for skill-levels: service offshoring harms a greater number of unskilled tasks (occupations) and more strongly harms an unskilled worker, given tradability.

Finally we run comparative statics across countries; we compare the sets of winners and losers for countries with different levels of trade costs.[10] The Home-to-foreign wage for skilled workers from the non-offshoring regime increases with trade costs; equivalently the Home-to-foreign wage for unskilled workers falls with these costs. To compare the countries, Figures 1-6 and 1-7 represent the differences in the Home-to-foreign wage ratios with an increase in the foreign skilled wage and a fall in the foreign unskilled wage. We know that the country with higher costs also has a lower non-offshored-to-foreign wage for skilled workers but a higher ratio for unskilled workers. These differences are represented in Figures 1-6 and 1-7.

Note in these figures that there are more "skilled winners" and more"unskilled losers" in the country with higher trade costs. The intuition for this result arises from the changes in wages from the first regime. Higher costs emphasize Home's relative skill abundance so that its skilled relative wage is lower and its unskilled relative wage is greater. This makes foreign competition less intense for skilled workers but more intense for unskilled employees, and therefore the number of losers tasks is lower but the number of unskilled workers is greater; similarly unskilled losers lose more in the country with higher costs. Hence the model predicts that a skilled task from a country that faces higher trade costs is less likely to lose from service offshoring than an unskilled task from the same country.

The impact of trade costs on relative wages was the highlight of Redding and Schott (2003). They show that countries located further from global economic activity

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[10] Appendix 4 provides the proofs for te differential impact of service offshoring for countries with different characteristics.

have a lower skill premium and the intuition is found via the Stolper–Samuelson theorem: increased remoteness is isomorphic to a reduction in the relative price of the skill-intensive good. This intuition is also present in our model when it comes to understanding the change of wages from the non-offshoring regime. However, we argue that trade costs also impact wages through a second order effect and via service offshoring. Although the skilled workers from a skilled-abundant country lose remoteness in a non-offshoring regime, the fall in their wage reduces the amount of losers in an offshoring regime.

Turning back to the sets of winners and losers for countries with different characteristics we compare nations with different values for the GRH shift parameter. An increase in this parameter moves the economy back to the first regime so that foreign competition becomes less intense for both skilled and unskilled workers. Therefore, countries that are more isolated in terms of service offshoring should have fewer losers, independent of the considered skill-level.

On the other hand, as the GRH shift parameter goes to zero all tasks in the economy will be offshored in the same amount. In this two-good infinite-input economy, the wage of every j-skilled task will equal the wage perceived by the j-skilled workers in the rest of the world. In other words, as the GRH parameter goes to zero we have factor price equalization across regions. This result overlaps with the theory of factor-price equalization lenses developed by Deardorff (1994); in this theory, the region of factor price equalization (FPE) becomes the entire factor space as beta equals zero.

As for differences in final goods, the model predicts that higher final goods productivity enlarges the set of loser tasks for unskilled labor and also for skilled labor. An occupation from a skill-abundant country with a higher productivity should be more likely to lose from service offshoring and the key to this result is that technological advantage is not diminished by importing tasks.

1.4 The Retraining Process

As offshoring creates wage differences some workers have incentives for fulfilling a task with the same skill-intensity but different tradability from the task they fulfill before the ICT shock. Knowledge is task-specific so that these workers must undergo a retraining process. We model the process of retraining in this section and obtain the employment responses of the tasks to service offshoring. Employment will decrease in tasks for which retraining occurs and it will increase the non-offshored tasks.

Workers make two types of retraining decisions. First, they decide whether to invest in retraining or maintain their current task: retraining has an income-increasing effect as it permits to get a non-traded job but it also has a decreasing-income effect as it entails costs. Second, retrainees make decisions regarding their retraining plans. Specifically they decide the duration of their retraining programs R, and the number of hours they spend on retaining in each period h^t.

Workers are heterogeneous and thus they will make different retraining decisions of the two types. Decisions will depend on the task a worker fulfills before

the ICT shock: the higher the wage difference between this task and a non-offshored task, the more willing the worker will be to retrain. As retraining entails costs only workers whose tasks have sufficiently low wages will retrain.

The second dimension of heterogeneity is given by workers' ability to retrain, which will differ across workers that fulfill the same task before the shock. The retraining productivities of each measure of workers fulfilling the j-skilled task i are distributed according to a c.d.f. $g(.)$ with support $(\breve{a}, \vec{a})$, where $g(a^h)$ denotes the proportion of workers whose productivity is lower than a^h. We are implicitly assuming that individuals are identically distributed across tasks; if assumed otherwise we should specify a reason for why workers of different characteristics sort across occupations. Such an argument seems far from the characteristics of our setup: a model of perfect competition where wages equal marginal productivities in equilibrium and homogenous agents ex-ante that do not expect the ICT shock.

Without loss of generality we assume that workers' work lives equal T periods. To simplify the decision-making process, we follow Ben-Porath's (1967) seminal paper on human capital investment by making his same assumptions

1. Individual utility is not a function of activities involving time as an input.

2. An amount of time per period, normalized to 1, is allocated to activities producing earnings and retraining.

3. Complete asset markets: borrowing and lending takes place at a constant rate r.

Under these assumptions workers base their retraining decisions only on their lifetime income: a worker will retrain if and only if the discounted value of her

lifetime income is greater under the retraining option than it is under the non-retraining option. We will not address the retraining-non retraining decision for now and will instead analyze workers' optimal retraining programs. The decision to retrain will follow from this analysis: workers making long-term plans will prefer to avoid retraining and maintain their task.

When designing their programs, workers choose the sequence $\{h^t\}_{t_0}^R$ and duration R that maximize their lifetime income under the retraining option. In particular, a worker fulfilling the j-skilled task i whose retraining productivity is a^h maximizes the following expression

$$\underset{R_{i,j}^{a^h}, \{h_{i,j}^{a^h\,t}\}_{t=0}^{R_{ij}^{a^h}}}{Max}\, I_{i,j}^{a^h, Ret} = \tag{23}$$

$$\int_{t_0}^{R_{i,j}^{a^h}} \left(1 - h_{i,j}^{a^h\,t}\right) w_j^* \beta t(i) e^{-rt} dt + \int_{R_{i,j}^{a^h}}^{T} w_{nt,j} e^{-rt} dt,$$

where $I_{i,j}^{Ret}$ is the worker's lifetime income under the retraining option, $h_{i,j}^{a^h\,t}$, is the amount of hours she spends on retraining at period t, and $R_{i,j}^{a^h}$ is the length of her retraining plan.

Workers trade actual hours to effective hours of retraining and complete the learning process as they "produce" θ effective hours. To complete the description, we need to specify the technology that transforms actual to effective hours. We will assume a C.E.S. learning production function so that we can represent two features of any learning process. First, knowledge is better assimilated when spread over time, and then "crammers" end up spending a greater amount of total hours to obtain the

same results; we will call this the "cramming assumption" hereafter. Second, retrainees become tired and thus less productive after a long session of learning. Hence the optimal plan for a worker that fulfils the j-skilled task i arises from maximization of (23) subject to the following constraint

$$Q_{i,j} = a^h \left(\int_0^{R_{i,j}^{a^h}} \left(h_{i,j}^{a^h} \, t \right)^\rho dt \right)^{\frac{1}{\rho}} = \theta, \qquad (24)$$

where $Q_{i,j}$ denotes the worker's number of effective hours and $\rho < 1$ is a parameter of the production function that measures the sensitivity of the learning process to the length of the retraining program.

The worker faces a time-constraint limiting the retraining duration: no retraining program can last more than T periods -the length of the lifetime. We abstract from this constraint when solving the optimization problem, but we will impose it to the unconstrained solution displayed below. Given these considerations constrained maximization holding the length of the plan constant yields the following outcome

$$\lambda_{i,j}^{a^h \, *} = \frac{w_j^* \beta t(i)}{a^h} \left(\left(\frac{1-\rho}{r\rho} \right) \left(e^{R_{i,j}^{a^h} \left(\frac{r\rho}{1-\rho} \right)} - 1 \right) \right)^{-\left(\frac{1-\rho}{\rho} \right)}. \qquad (25)$$

Equation (25) shows the cost of the marginal effective hour of retraining $\lambda_{i,j}^{a^h \, *}$. Due to the "cramming assumption" this cost decreases as the length of the retraining process increases. We plug (25) and the optimal sequence of hours arising from the constrained maximization problem into the lifetime income definition

displayed in (23). This yields the following equilibrium condition for the length of the retraining plan

$$e^{-R_{i,j}^{a^h} r}\left(w_{nt,j} - w_j^* \beta t(i)\right) =$$

$$e^{R_{i,j}^{a^h}\left(\frac{r\rho}{1-\rho}\right)}\left(e^{R_{i,j}^{a^h}\left(\frac{r\rho}{1-\rho}\right)} - 1\right)^{-\frac{1}{\rho}} \tag{26}$$

$$*\left(\frac{\theta w_j^* \beta t(i)}{a^h}\right)r^{\frac{1}{\rho}}\left(\frac{1-\rho}{\rho}\right)^{-\left(\frac{1-\rho}{\rho}\right)}.$$

Equation (26) illustrates the trade-off faced by a retrainee when choosing the duration of her plan. The LHS shows the disadvantage of a long retraining process: as the plan duration increases, the worker begins her new task and start benefiting from the wage increase earlier. The RHS shows the advantage of a long retraining plan: the marginal cost of effective retraining falls and thus the worker gives up less income as the length of the plan increases.

Based on this trade-off workers choose the length of the plan. However, the retraining plans of some workers are so long that we cannot use (25) to solve for the length. For these workers, the marginal benefit from increasing the plan is greater than the marginal cost at any $R_{i,j}^{a^h}$. These workers would design perpetual plansif they were to live forever. Because perpetual programs are not feasible, we force these workers to design T-period retraining plans and show that this is their optimal strategy conditional retraining in the appendix section. The following condition states the imposition and shows the set of tasks for which (25) does not solve of the length of the plan

$$R_{i,j}^{a^{h^*}} = T,$$

$$if: \quad \frac{w_j^* \beta t(i)}{w_{nt,j}} < 1 + \frac{\theta}{a^h} r^{\frac{1}{\rho}} \left(\frac{1-\rho}{\rho}\right)^{-\left(\frac{1-\rho}{\rho}\right)}. \tag{27}$$

The inequality in (27) becomes less restrictive as the i index rises so that a worker belongs to this set only if the offshoring costs of her tasks are sufficiently large. Given offshoring costs, the inequality also becomes less restrictive as the zero-profit-to-foreign wage ratio falls; thus, there is a larger proportion of skilled tasks in the set -as opposed to unskilled tasks.[11] The plan lengths of the workers who do not belong to the set defined in (27) can be obtained from (26) and are written as follows

$$R_{i,j}^{a^{h^*}} = B_{i,j}^{a^{h^*}}$$

$$if: \quad B_{i,j}^{a^{h^*}} = -l\left(\frac{1-\rho}{r\rho}\right) \ln\left(1 - \frac{r^{\frac{1}{\rho}}\left(\frac{\rho}{1-\rho}\right)^{1-\rho}}{\left(\frac{\bar{a}}{\theta}\left(\frac{w_{nt,j}}{w_j^* \beta t(i)} - 1\right)\right)^{\rho}}\right) \tag{28}$$

$$R_{i,j}^{a^{h^*}} = T, \quad otherwise.$$

Statement (28) is composed of three lines. The first and second lines correspond to workers whose plans are shorter than their lifetime. The lengths depend on the retraining productivity of the workers and the task they fulfill before the shock. Unskilled workers and workers that fulfill tasks with low offshoring costs design shorter plans as they are more strongly harmed by offshoring; therefore, these worker more in a rush to complete the retraining process. Workers with high retraining productivities also design shorter plans.

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[11] We remind the reader that $\frac{w_s^*}{w_{nt,s}} < \frac{w_u^*}{w_{nt,u}}$ as we have shown in the previous section.

We are now ready turn back to the retraining-non-retraining decision. As noted above workers retrain if and only if their lifetime income is greater under the retraining option than it is under the non-retraining option. A worker's lifetime income under retraining is defined by equations (27)-(28), which we use to calculate the following income difference between the options

$$I_{i,j}^{a^h,Ret} - I_{i,j}^{a^h,NRet} =$$

$$\left(\frac{w_{nt,j} - w_j^* \beta t(i)}{r}\right)\left(e^{-R_{i,j}^{a^{h^*}}\left(\frac{r\rho}{1-\rho}\right)} - e^{-rT}\right), \tag{29}$$

where $I_{i,j}^{a^h,NRet}$ is the worker's lifetime income under the non-retraining option. From equation (29) we know that this worker will retrain if and only if:

$$R_{i,j}^{a^{h^*}} < T(1 - \rho). \tag{30}$$

A worker will retrain if the length of her optimal plan conditional on retraining is sufficiently small. Retraining is profitable for these workers as their "after-retraining lifetime" is sufficiently long that they can recover their human capital investment. [12] Thus only workers whose tasks have sufficiently low offshoring costs will retrain and unskilled workers will be more likely to retrain. Equation (30) yields the condition under which there is at least one worker that retrains in a task. There is retraining in

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[12] Besides, note any worker whose plan is forced to last T periods will not retrain; the tasks of these workers must have sufficiently high offshoring costs.

the j-skilled task i if at least the most productive workers make the human capital as noted in the following

$$R_{i,j}^{\vec{a}^*} \leq T(1 - \rho). \tag{31}$$

For a task that does not fulfill the inequality in (31) there is no retraining. The inequality yields the set of tasks in which offshoring occurs as the lengths increase smoothly with the offshoring cost of the tasks. In other words, there exists a cutoff for each skill level under which there is retraining and above which there is no retraining. We will refer to these cutoffs as "retraining cutoffs", and obtain them from the following expression

$$R_{\overline{I}_J}^{\vec{a}^*} = T(1 - \rho). \tag{32}$$

where $\overline{I}_J$ is the j-skilled retraining cutoff task. As we show in the appendix section the retraining cutoffs increase with the zero-profit-to-foreign wage ratio: an increase in the zero-profit-to-foreign wage ratio makes retraining more profitable so that workers in a larger proportion of tasks retrain. Because the zero-profit to foreign wage ratio is greater for unskilled workers, the set of tasks in which at least one worker retrains is greater for unskilled labor.

1.5   Predictions and Matching with Current and Further Empirical Evidence

We study our employment predictions based on our two types of cutoffs: the cutoff traded tasks and the retraining cutoffs. We show that these predictions and our wage results are consistent with the young empirical literature that we have presented in the introduction. The relationship between our employment and our wage predictions is also consistent with the young literature.

Figure 1-8 summarizes the predictions. As a result of service offshoring, employment increases in some tasks but it falls in others. The cutoff traded tasks determine the set of tasks for which employment increases. These tasks are the least tradable and are indicated with the square dotted lines located further right on the continuums labeled "Employment" in the figure. The retraining cutoffs determine the set of tasks for which employment falls. These tasks are located further to the left of the Employment continuums, and thus are the most tradable tasks. Our model predicts a labor reallocation from the most tradable tasks to the least tradable tasks. These predictions emphasize the tradability dimension of labor as it has been emphasized by Blinder (2009), Baldwin (2006) and Grossman and Rossi-Hansberg (2006), among other authors.

Our model highlights the role played by tradability without neglecting the traditional skill dimension of labor: the set of tasks for which employment increases is larger for the skilled tasks than it is for the unskilled tasks as indicated by a larger square dotted line on the upper continuum in Figure 1-8. As employment changes occur as workers switch tasks (occupations) in our model, our results also show that

service offshoring increases switching rates across occupations. The increase in switching rates is greater for unskilled workers than it is for skilled workers, as shown by Trefler and Liu (2011). Their data suggest that that the probability of switching occupations is greater for unskilled workers.

We argue that that skill-intensity and tradability are jointly relevant to understanding the employment effects of service offshoring as shown by Crino (2009, 2010). As his paper shows, our model predicts that the probability that an occupation responds positively to service offshoring [13]is increasing in skill-intensity, given tradability; and decreasing in tradability, given skill-intensity.

The model also yields predictions about the magnitude of the employment changes for each task based on its type. The magnitude of the employment changes are expressed in rates of change and indicated with different weights in our figure. As we move left on the continuums the lines become heavier weighted: easily offshorable tasks have higher rates of employment losses. The proportion of retrainees, and thus the employment decrease, of a task decreases with its tradability as workers are more strongly harmed in the most tradable tasks. Given tradability, the proportion is greater for an unskilled than it is for a skilled task.

We base our employment predictions on different lengths of retraining plans across heterogeneous workers. In this regard, it is important to note that the different lengths of retraining yield a gradual adjustment to new employment levels. Although

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[13] As noted in footnote 1, Crino employs data at the occupational level, and thus these statements require a mapping between tasks – our unit of measure- and occupations. Any reasonable mapping would make the statements true as the skill-intensity of an occupation should increase with the relative weight of its skilled tasks; and the tradability of this occupation should also increase with the tradability of its tasks.

there is no evidence that the employment adjustment s caused by service offshoring, this types of adjustment is intuitive and seems fairly realistic.

Figure 1-8 depicts also the wage predictions of the model. As we take the tasks as our unit measure our figure shows that the likelihood of finding a loser from service offshoring is greater for unskilled labor than it is for skilled labor. The figure replicates other outcomes from previous sections: unskilled losers lose more than skilled losers, given tradability. However, losers and winners are not fully determined by skill group: employees suffering from wage losses work in the least tradable tasks. The model is consistent with Hummels et al. (2011) as it argues that both tradability and skill-intensity determine the wage response to service offshoring of an occupation.

Our predictions also match other the empirical evidence provided by Crino regarding the correlation of wage changes and employment changes at the task-occupational level. Specifically we predict a positive correlation between wages and employment at the task-occupational level. The intuition is given by Crino, who argues that the changes were mostly generated by a demand shock as in our model.

Finally, consider our cross-sectional predictions for countries with different characteristics. As we have shown in Section in previous sections, countries with high trade costs offshore a larger set of unskilled tasks and a smaller set of skilled tasks. In terms of employment this means that countries facing higher trade costs have a smaller (larger) set of skilled (unskilled) tasks in which employment increases. An increase in trade costs also reduces the zero-profit-to-foreign wage ratio for skilled labor and raises the ratio for unskilled labor. As the retraining cutoffs are increasing in these

ratios, we also predict that countries with higher trade costs have a smaller set of skilled tasks and a larger set of unskilled tasks that lose employment. To the best of my knowledge there is no empirical study that investigates the impact of service offshoring but this maybe a line for further empirical research.

1.6   Conclusion

International competition has traditionally occurred among firms from different countries and involved sectors that use skilled labor with different relative intensities. The winners and losers from trade could then be recognized based on their skill-level, and thus international trade theory and empirical work have focused on the traditional skill dimension of labor.

The ICT revolution has changed the nature of international competition by reducing the offshoring costs of labor tasks. International competition seems to be occurring at a much finer level of disaggregation currently, causing job characteristics other than skill-intensity to play an important role. Tradability is expected to play an important role in determining the effects of increasing trade as labor tasks are of varying natures: tasks differ in their degrees of complexity, their requirements of personal interaction, their levels of routines, and the difficulties of their instructions to be understood by foreign workers. Thus we would expect the ICT revolution to have a varying impact on offshoring costs, and then a varying impact on the wages and on the employment of these tasks. Besides being intuitively relevant, tradability has been claimed as relevant by several authors.

We contribute to theory by showing that tradability plays a central role in the determination of the wage and the employment responses of the tasks. As the impact of service offshoring on a task depends on its tradability, this impact varies within skill groups. We suggest that the traditional skill dimension of labor has become an insufficient unit of analysis; the change in international competition will make it necessary to look at additional job's characteristics. Although the traditional labor dimension is not sufficient, we argue that this dimension is still relevant to understanding the impact of service offshoring, thereby overlapping with standard theory.

Further theoretical work could dig into our assumption of agents' being equally distributed across tasks based on their retraining productivities. This assumption is violated as there exist some type of sorting of heterogeneous workers into occupations with different characteristics. Along these lines, Trefler and Liu (2011) have studied how service ofsshoring sorts workers into occupations. They show a framework that is adaptable to their empirical strategy in order to motivate their empirical results.. Investigating further how service offshoring sorts workers into occupation from a theoretical perspective by building upon a general equilibrium model of international trade would be an interesting line for further research.

The paper opens lines for further empirical. We propose cross-sectional predictions for countries with different characteristics that have not been investigated in the literature; later empirical research could address these predictions using applicable data. On the other hand, data availability represents a major constraint

hampering investigations of the effects of the ICT revolution on developing countries. Apropos of developing countries, it would be particularly interesting to investigate if their wage behavior follows the logic proposed in this paper. The ICT revolution might have increased service exports and thus the wages of more offshorable tasks in such countries as India or China as suggested by anecdotic evidence. Ultimately, this is empirical question.
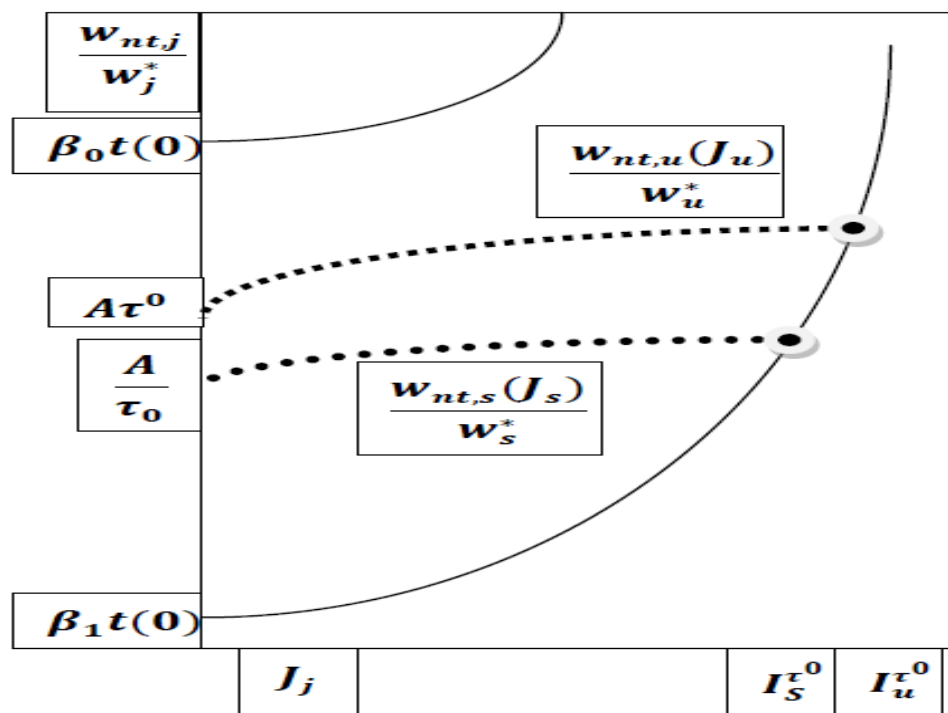
Figure 1-1: Equilibrium Cutoff Traded Tasks for Low Trade Costs

Notes: The x-axis shows the potential choices for the cutoff traded tasks. The y-axis is the zero-profit-to-foreign wage ratio.
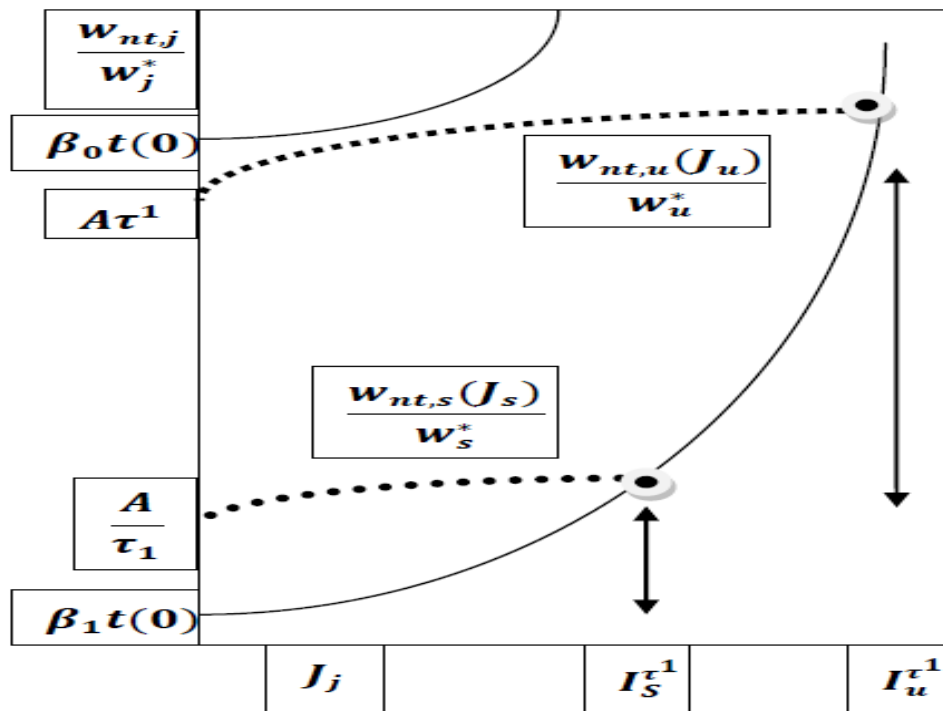
Figure.1-2: Equilibrium Cutoff Traded Tasks for High Trade Costs

Notes: The x-axis shows the potential choices for the cutoff traded tasks. The y-axis is the zero-profit-to-foreign wage ratio. The difference between the cutoffs across skill groups .as a results of the trade cost increase.
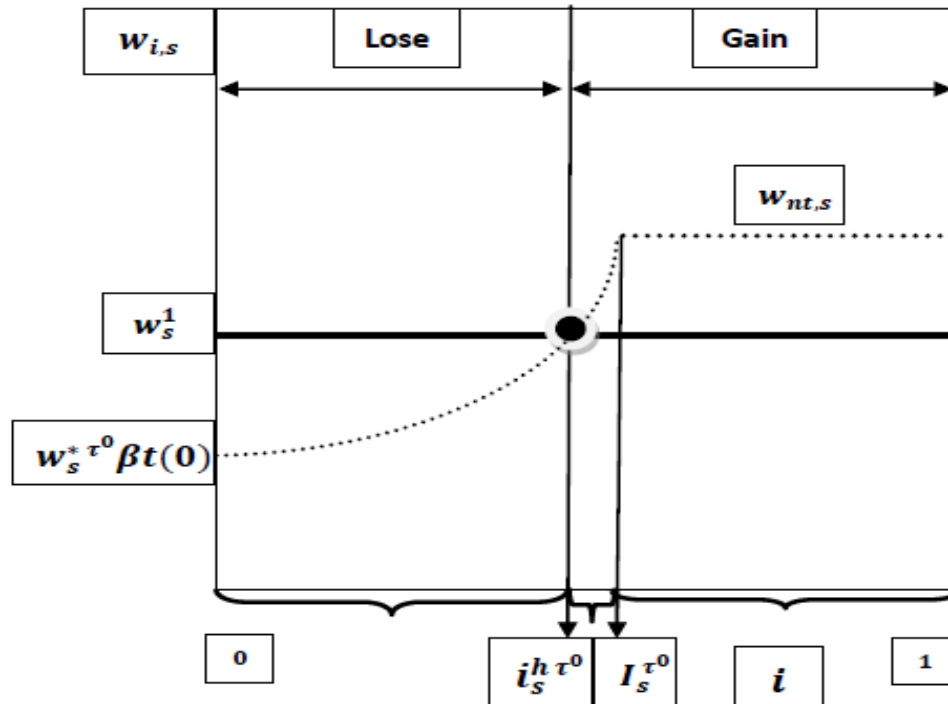
Figure 1-3: Schedule of Skilled Wages

Notes: The keys located at the bottom distinguish three regions: losers, winner fulfilling non-offshored tasks and winners fulfilling offshored tasks.
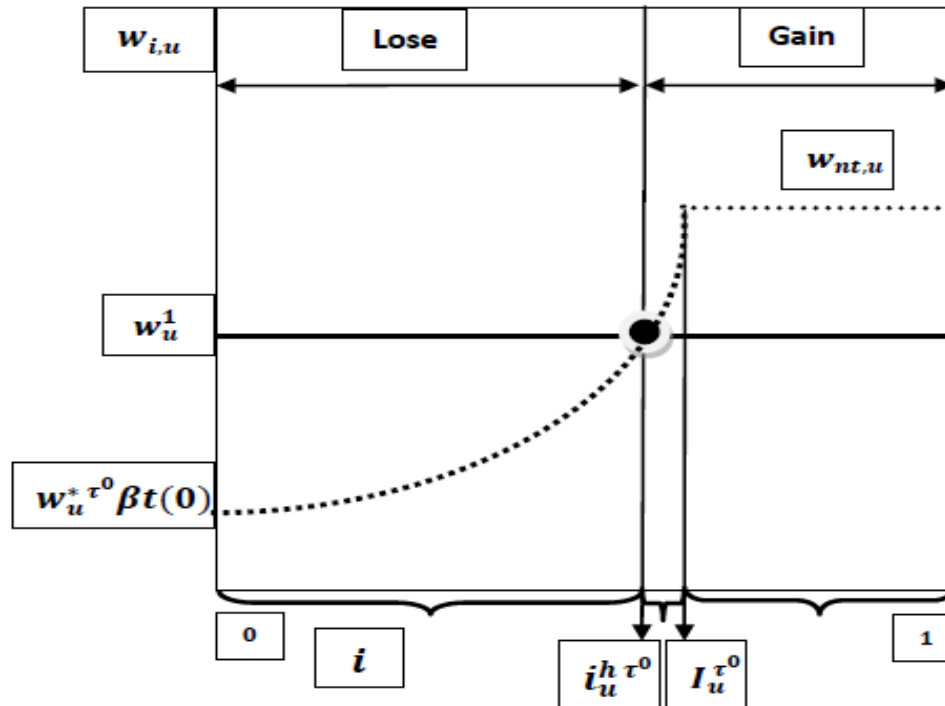
Figure 1-4: Schedule of Unskilled

Notes: The keys located at the bottom distinguish three regions: losers, winner fulfilling non-offshored tasks and winners fulfilling offshored tasks. The region of loser tasks is greater in this figurethan it is in figure 2.B.
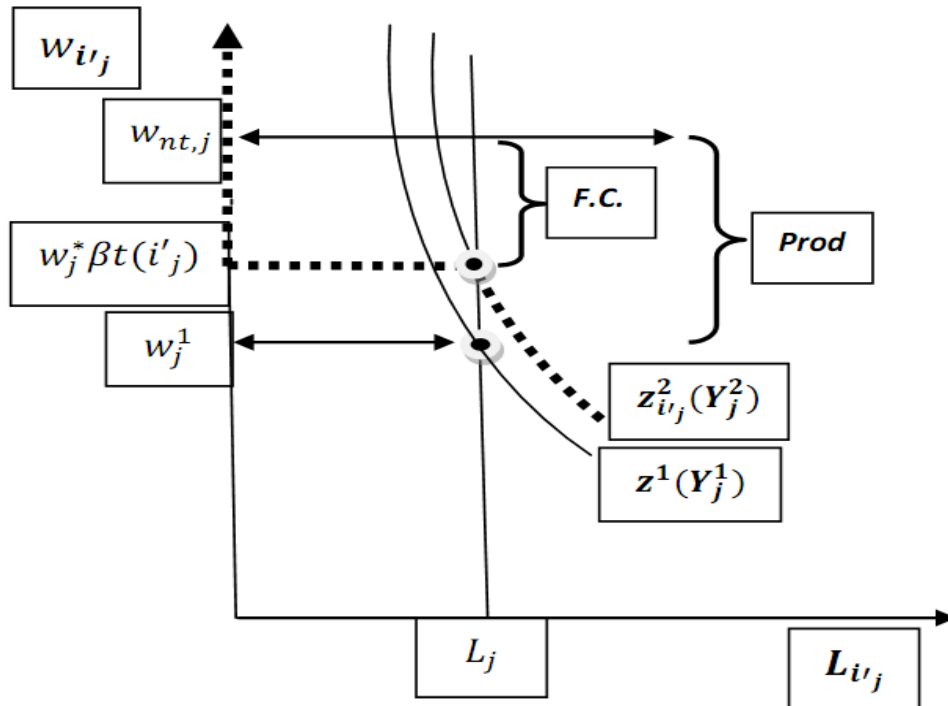
Figure 1-5: Labor Markets for an Offshored Task and for a Non-offshored Task

Notes: The productivity effect is stronger than the foreign competition effect so that workers that fulfill the offshored task gain from service offshoring.
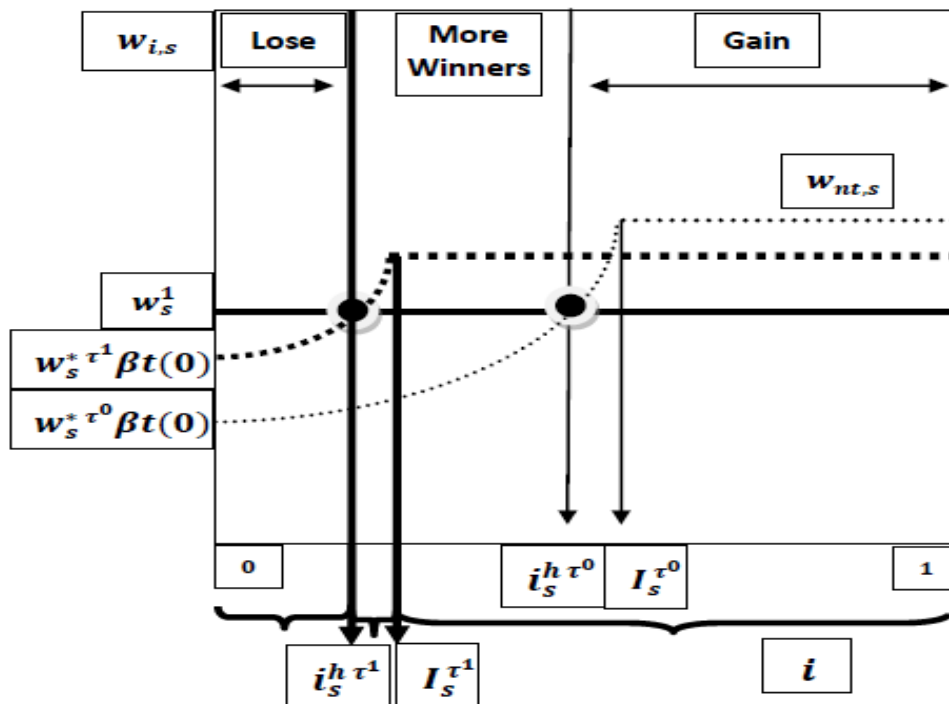
Figure 1-6: Change in the Schedule of Skilled Wages as Trade Cost Increase

Notes: A higher level of trade costs enlarges the set of skilled tasks that gain from service offshoring.
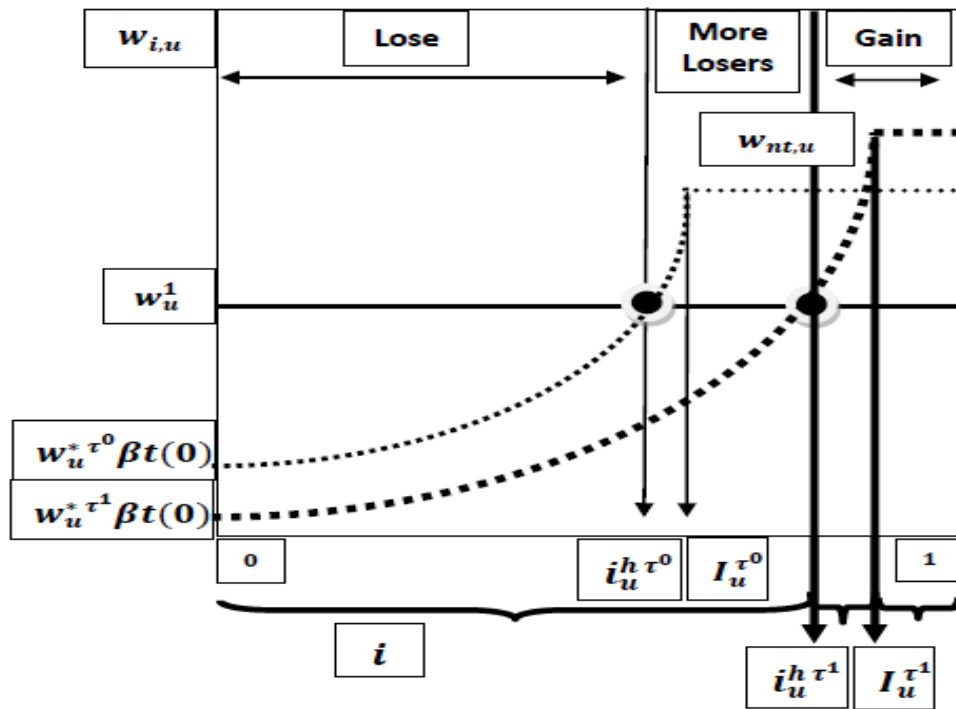
Figure 1-7: Change in the Schedule of UnsSkilled Wages as Trade Cost Increase

Notes: A higher level of trade costs enlarges the set of skilled tasks that gain from service offshoring.
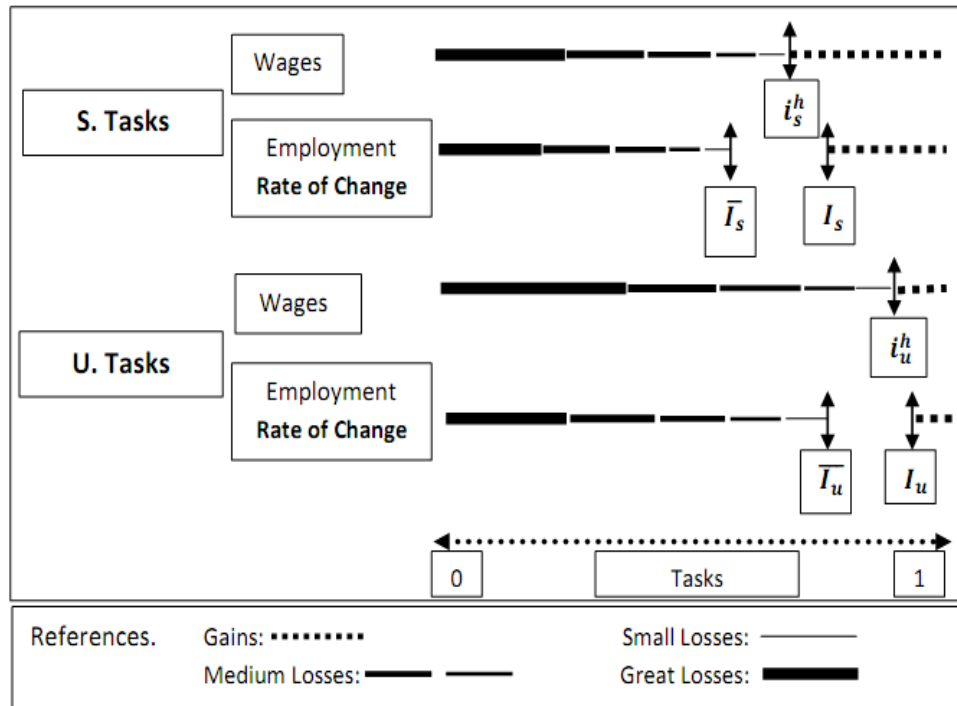
Figure 1-8: Summary of the Model's Predictions

Notes: The continumms at the top refer to predictions for the skilled tasks and the continuums at the bottom refer to the predictions for the unskilled tasks.

1.7   Appendices

Appendix 1.1

A well-informed government with expectations on the ICT shock will have incentives for accomplishing a policy to modify the ex-ante sorting of working across tasks. When studying this public policy we will abstract from firms and workers' expectations on the shock; considering these expectations may require a large departure from our original setup.

Several authors argue that the ICT revolution requires a change in the direction of public policy over two dimensions: educational policy and welfare programs. Krugman (2011) and Blinder (2009) claim that traditional education should be replaced with education that turns students more flexible and provide them with knowledge to fulfill non-tradable tasks. [14] Relative to welfare Baldwin (2006) argues that public policy should protect workers rather than sectors, and Blinder (2006) proposes improvements to the federal job training program. We will follow Blinder and Baldwin: we will obtain a system of transfers so that workers sort themselves into tasks in a more efficient way in terms of aggregate retraining. Hence we will make an efficiency argument for a welfare program.

We will characterize the transfer systems that generate Pareto improvements in the sorting of workers across task relative to the free-market solution. These labor allocations will fulfill a necessary condition for Pareto efficiency: they will maximize

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[14] Krugman argues that college degrees do not guarantee good jobs, and Blinder claims that a college degree "may no longer be a panacea."

aggregate lifetime income, given the employment level of each task. Thus, the transfer system implemented by the government will only reallocate workers across tasks.

We are now ready to explore the analytics. For the purpose of finding the lifetime income-maximizing allocations, we will distinguish two different sets of tasks. The first set contains tasks where no retraining occurs so that we have non-offshored tasks and offshored tasks. For some ofshhored tasks workers design perpetual retraining plans independent of their retraining productivity, and thus we will always have offshored tasks in the first set. The lifetime income of a worker who does not retrain and then belongs to the first is written as follows

$$I_{i,j}^{a^h,NRet} = \left(\frac{w_{nt,j}}{r}\right)(1 - e^{-rT})$$

$$I_{i,j}^{a^h,NRet} = \left(\frac{w_j^* \beta t(i)}{r}\right)(1 - e^{-rT})$$

where the first equation is for a worker employed in a non-offshored tasks, and the second equation is for a worker employed in an offshored task. Note that the lifetime income of a worker from the first set of tasks does not depend on her retraining productivity.

We now consider the second set of tasks which is composed of tasks where at least one worker retrains. This set will be non-empty as a lifetime income – maximizing policy will always induce some retraining. The lifetime income of a worker who retrains and then belongs to the second set of tasks is written as follows

$$I_{i,j}^{a^h,Ret} = \frac{w_j^* \beta t(i)}{r} - \frac{w_{nt,j}}{r} e^{-rT}$$

$$+ \left(\frac{w_{nt,j} - w_j^* \beta t(i)}{r} \right) e^{-R_{i,j}^{a^{h^*}} \frac{\rho}{1-\rho}} -$$

The lifetime income of the worker increases with her retraining productivity as a higher productivity reduces the length of her retraining plan. Thus, income depends on retraining productivities for workers the second set of tasks.

As income does not depend on productivities for workers from the first set of tasks but it depends for workers from the second se,t there is room for a welfare-improving policy: aggregate lifetime is maximized as workers with a high-productivity are assigned to the second set of tasks. More formally we state the characterization of the Pareto-improving labor allocations as follows

Characterization: There are Pareto-improving allocations of labor relative to the free-market solution where the workers with the lowest productivities sort into tasks where retraining does not occur. Furthermore these allocations are Weakly Pareto-Efficient allocations.

Accomplishing a policy that implements any of these allocations has redistribution effects relative to the free-market outcome. Some of the workers with the highest retraining productivities are taken from a non-offshored task to an offshored tasks, and thus these workers are worse-off. The government may employ a compensation system: collecting taxes from the least productive workers and transferring some of the tax revenue to the workers with the highest retraining productivities.

The characterization is not constrained to any range of parameters but it has nothing to say about the sorting of workers across tasks for the set of tasks where retraining occurs. We address this issue by studying the conditions under which sorting high-productivity workers into tasks where retraining is frequent is Pareto-improving -Retraining is more frequent for tasks with a large wage-differential relative to a non-offshored task. We will refer to the conditions as the decreasing monotone property of a workers' sorting as workers' retaining productivitities will fall (non-strictly) with the tradability index i.

A government that implements a workers' sorting with the decreasing monotone property increases the average retraining productivity for the tasks with low i. This induces a fall in the length of the retraining plans so that the income associated with these tasks is higher. On the other hand the average retaining productivity falls for tasks with high i, increasing the lengths of their plans and thus reducing their income. If the former effect is stronger than the latter effect, a workers' sorting with the decreasing monotone property is welfare –improving. In other words, a decreasing monotone allocation is lifetime income-maximizing if the reallocation of retraining productivities it generates increases income so that $. \frac{dI_{i,j}^{a^h,Ret}}{da^h di} < 0$. This happens if and only if:

$$\theta = \frac{1}{\rho} > \frac{w_{nt,j}}{w_j^* \beta t(0)},$$

where θ measures the sensitivity of a worker's retraining expenditure to the length of his retraining plan. A higher value for the measure denotes a higher sensitivity of

expenditure to the length of the retraining plan. The parameter condition ensures that

the sensitivity is sufficiently large, and then so is the increase in income for the tasks

with low i. Under the parameter condition this income increase more than

compensates for the fall in income for income for the tasks with high i.

Appendix 1.2

In this appendix we solve Home's wages in terms of countries' labor

endowments, technologies and transportation costs, assuming that Homes is a large

country.

As Home is a large country we have an additional equilibrium condition

because the market for the skill-intensive good must clear. Home's excess supply of

the skill-intensive good must equate foreign's excess demand augmented by transport.

If consumers have identical Cobb-Douglas preferences, this market-clearing condition

is written as follows

$$AL_s - \frac{\alpha I}{p^T} = \tau(\frac{\alpha I^*}{\tau p^T} - L_s^*)$$

where $I = A(p^T L_s + \tau L_u)$ and $I^* = \tau p^T L_s^* + L_u^*$ are the incomes of Home and foreign,

respectively. Employing market clearing and the zero-profits conditions condition we

obtain

$$w_u = A\tau$$

$$w_s = A \left(\frac{\alpha}{1-\alpha}\right) \left(\frac{A\tau L_u + L_u^*}{AL_s + \tau L_s^*}\right)$$

Q.E.D.

Appendix1. 3

This appendix shows that $I_u > I_s$ if $\frac{w_u}{w_u^*} > \frac{w_s}{w_s^*}$. and proves the comparative

statics results.

Assume that $\frac{w_u}{w_u^*} > \frac{w_s}{w_s^*}$ and evaluate $\frac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}$ at I_u:

$$\frac{w_{nt,u}(I_u)}{w_u^* \beta t(I_u)} = e^{\left[\frac{\ln\left(\frac{w_u}{w_u^*}\right) - \ln(\beta) - \int_0^{I_u} \ln(t(i))di}{1 - I_u}\right]} = 1$$

which must be greater than

$$\frac{w_{nt,s}(I_u)}{w_s^* \beta t(I_u)} = e^{\left[\frac{\ln\left(\frac{w_s}{w_s^*}\right) - \ln(\beta) - \int_0^{I_u} \ln(t(i))di}{1 - I_u}\right]}$$

Find now that

$$\frac{d\left(\frac{w_{nt,s}(J_s)}{w_s^* \beta t(J_s)}\right)}{dJ_s} = \frac{w_{nt,s}(J_s)}{w_s^* \beta t(J_s)} \left[\frac{\ln\left(\frac{w_{nt,s}(J_s)}{w_s^* \beta t(J_s)}\right)}{1 - J_s} - \frac{t'(J_s)}{t(J_s)}\right]$$

This expression is negative at $J_s = I_u$ because $\frac{w_{nt,s}(I_u)}{w_s^* \beta t(I_u)} < 1$.

In equilibrium we must have $\frac{w_{nt,s}(I_s)}{w_s^* \beta t(I_s)} = 1$ so that $\frac{w_{nt,s}(I_s)}{w_s^* \beta t(I_s)}$ must increase. This

proves that I_s cannot be in the region $J_s \geq I_u$.

Q.E.D.

We now prove the comparative statics. Note that

$$\frac{dI_j}{d\tau} = -\frac{\left(\dfrac{d\left(\dfrac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}\right)}{d\tau}\right)_{J_j=I_j}}{\left(\dfrac{d\left(\dfrac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}\right)}{dj_j}\right)_{J_j=I_j}}$$

For the case of skilled labor and the case of unskilled labor the denominator is

$$\left(\frac{d\left(\frac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}\right)}{dj_j}\right)_{J_j=I_j} < 0$$

For skilled labor the numerator is negative $\dfrac{d\left(\dfrac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}\right)}{d\tau} < 0$ so that $\dfrac{dI_j}{d\tau}$ is also negative.

For unskilled labor the numerator is positive $\dfrac{d\left(\dfrac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}\right)}{d\tau} < 0$ so that $\dfrac{dI_j}{d\tau}$ is also positive.

For the Hicks' neutral parameter we have

We now prove the comparative statics. Note that

$$\frac{dI_j}{dA} = -\frac{\left(\dfrac{d\left(\dfrac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}\right)}{dA}\right)_{J_j=I_j}}{\left(\dfrac{d\left(\dfrac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}\right)}{dj_j}\right)_{J_j=I_j}}$$

For skilled labor and unskilled labor we have that the numerator $\dfrac{d\left(\frac{w_{nt,j}(J_j)}{w_j^* \beta t(J_j)}\right)}{dA} > 0$ so

that $\dfrac{dI_j}{dA}$ is also positive.

A similar reasoning proves the result for the GRH shift parameter.

Appendix 1.4

      This appendix shows that there are more winners and fewer losers for the case of skilled labor. The worker h employed in task i and sector j who earns the same wage rate with respect to the first regime is obtained as follows

$$\frac{w_j}{w_j^* \beta} = \beta t\left(i_j^h\right)$$

      We have that $\dfrac{w_u}{w_u^*} > \dfrac{w_s}{w_s^*}$ and t(.) is increasing i, then $i_s^h < i_u^h$.

Q.E.D.

Appendix 1.5

      This appendix shows that the best strategy for workers whose retraining programs are longer than T periods in the unconstrained problem is to set the duration to T. Consider the F.O.C. of the unconstrained problem, and note that the marginal net benefit from increasing the duration of the program is

$$\left(\frac{\theta w_j^* \beta t(i)}{a^h}\right) r^{\frac{1}{\rho}} \left(\frac{1-\rho}{\rho}\right)^{-\left(\frac{1-\rho}{\rho}\right)} \left(1 - e^{-R_{i,j}^{a^h}\frac{r}{1-\rho}}\right)^{-\frac{1}{\rho}}$$

$$-e^{-R_{i,j}^{a^h}r}\left(w_{nt,j} - w_j^*\beta t(i)\right)$$

The two terms are monotonically decreasing in $R_{i,j}^{a^h}$, and then the marginal benefit is positive for $R_{i,j}^{a^h} < R_{i,j}^{a^h *}$. Hence, the worker can keep enlarging the program as long as the length is shorter than lifetime.

Appendix 1.6

This appendix derives the j-skilled retraining cutoff task. We employ equations (32) to replace for the length of the optimal plan in (38) the and obtain

$$I_j = t'\left(\left(\frac{w_{nt,j}}{w_j^*\beta}\right)\left(\frac{(\frac{\vec{a}}{\theta}(1 + e^{Tr\rho}))^{\frac{1}{\rho}}}{(\frac{\vec{a}}{\theta}(1 + e^{Tr\rho}))^{\frac{1}{\rho}} + r^{\frac{1}{\rho}}\left(\frac{\rho}{1-\rho}\right)^{\frac{1-\rho}{\rho}}}\right)\right).$$

This expression increases in the zero-profits to foreign wage ratio.

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Chapter 2: Entry Barriers, Rent-Shifting, and the Home-Market Effect

Abstract

We introduce entry barriers into an otherwise standard model of the home market effect. Entry barriers cause market sizes to become endogenous by creating rents. We show that the endogeneity of market size has four implications. First, endogenous market size magnifies the standard home market effect. Second, it is no longer true that both countries benefit unambiguously from mutual trade liberalization. In particular, if rents are sufficiently large and country sizes are sufficiently unequal, a trade agreement will reduce welfare in the smaller country. Third, an increase in entry barriers increases the market size of the larger country. Despite the reduction in product variety, welfare in the larger country may actually increase. Fourth, governments can use trade policy to shift foreign rents to their countries and enlarge their home markets, generating a greater incentive for "beggar-thy-neighbor" trade policies than in the standard mode.

2.1   Introduction

Profits or rents have traditionally been absent from general equilibrium models of international trade. Recently Neary (2009) has introduced profits into a general equilibrium model of trade by fixing the number of firms and assuming oligopolistic competition. However, he does not study the rent-shifting that is the highlight of the partial equilibrium literature initiated by Brander and Spencer (1984, 1985). In this paper we study the impact of rents and rent-shifting in a standard home market effect model modified to include barriers to entry.

Brander and Spencer (henceforth, BS) show that governments can employ tariffs to shift rents from foreign nations. They build upon partial equilibrium models of oligopolistic competition in which domestic firms interact strategically with foreign firms.[15] Profits are greater than zero as barriers prevent the number of firms from reaching its free-entry level, under which firms' profits are zero. [16]Thus, governments have incentives for employing trade policy to increase the profits of domestic firms: tariffs that are set before the market interaction stage provide domestic firms with a strategic advantage, and thus increase domestic profits. As the tariffs worsen the relative position of foreign firms, an increase in domestic tariffs reduces foreign profits. Hence, tariffs increase the profits of a fixed number of domestic firms by shifting rents from foreign nations.

Although the rent-shifting motivation was the source of prolific research in the 1980s, it was not until Neary's model that international trade theory considered profits

[15] This literature shows that the rent-shifting motive exists for different trade instruments and not only tariffs ee and Dixit (1984) for another examples of this literature.
[16] Profits are just one form of rents. In this paper we considers various forms

in a general equilibrium model. General equilibrium models of international trade had avoided the question of rents for different reasons. The two main streams of the comparative advantage theory, the Ricardian and Heckscher–Ohlin models, build upon perfect competition scenarios in which there is no room for profits. Although it allows for monopolistic competition, the models of the home market effect fail to consider rents because they assume free entry so that entrants erode all profits. Finally, in the heterogeneous firm models introduced in Melitz (2003) the profits of specific firms are greater than zero but aggregate rents remain zero: unsuccessful entrants fully erase the profits generated by successful firms

Neary considers rents by introducing profits into a main stream model of international trade. He builds upon a Ricardian model à la Dornbusch-Fischer-Samuelson where each country has technological advantages in sectors with different characteristics. In his model profits arise for the same reason as in the literature initiated by BS: in each sector there is oligopolistic competition and a ffixed number of firms which is lower than the free-entry level due to entry barriers.. However, Neary does not study the rent-shifting motivation and did not relate rents to standard trade theory results.

We study the impact of rents and rent-shifting in a modified model of the home market effect. Rents arise for the same reason as they arise in Neary and the literature initiated by BS: we consider entry barriers. The differences being that we consider all kinds of rents and not only profits and that we focus on barriers that are associated with regulation. In our model governments' regulation creates entry barriers that

generate a fixed value of rents per-firm instead of a fixed number of firms as in Neary's setup and the literature initiated by BS. Although we link rents to individual firms by fixing rents per-firm, these rents may accrue to any resident from the origin-country of the firm associated with the rents. For instance, if the source of entry barriers is an abuse of patent protection, the rents will accrue to firms and we will call the, profits. However if the source of entry barriers is an excess of red-tape regulation, the rents will accrue to bureaucrats and administrative employees as they do in the real world, according to Djankov et al.'s (2002). Any kind of entry barrier that relates to regulation and generates rents that accrue to residents is consistent with the mechanism of our model.

Our model also differs from Neary as we build upon a model of the home market effect instead of upon a Ricardian framework. Specifically, we build upon the seminal contribution by Helpman and Krugman (1985) in which consumers have preferences over a composite good of varieties and over an outside homogeneous good. Our model thus relates closely to Ossa's setup (2010) which shows that governments have incentives for setting tariffs in a Helpman and Krugman's model. In his setup a tariff rise increases the effective price of foreign varieties so that domestic consumers shift expenditure towards domestic varieties. The shift in expenditure increases the number of domestic producers and reduces the number of foreign producers. Therefore, a tariff has two competing effects on a country's price index: the tariff increases the effective price on foreign varieties, but it shrinks the set of imported varieties. Ossa shows that the former effect is stronger than the latter so that

a tariff rise reduces the price index of the home country. In showing this result, Ossa makes the standard free-entry assumption from the home market effect literature, and therefore is unable to consider either rents or the rent-shifting motivation.

In our model entry barriers generate rents and then a rent-shifting motivation by causing market sizes to become endogenous. Entry barriers allow for firms to make profits so that a country's income depend the number of domestic firms that is determined endogenously. Being rents per firm fixed, the higher is the number of domestic firms, the higher a country's income and thus the larger its market size. The rent-shifting motivation arises because a tariff rise increases the number of domestic firms and reduces the number of foreign firms, thereby increasing domestic income and reducing foreign income. Unlike in Neary's model and the literature initiated by BS, rent-shifting occurs as the number of domestic firms increases in our model–or more generally speaking, the number of domestic varieties-.

In our model a government has incentives for rising in order to shift foreign rents, but also to reduce the price index as in Ossa's setup. We generalize Ossa's outcome on the price index in a framework augmented with rents and entry barriers: a tariff rise will reduce the price index of the home country as the effect of a smaller set of imported varieties will be stronger than the effect of the increase in their price. Furthermore, the incentives for setting high tariffs will be quantitatively stronger in our model than in the standard model.

The endogeneity of market sizes caused by entry barriers has three important implications besides the appearance of the rent-shifting motivation. The first

implication of that the standard home market effect exacerbates. An increase in a country's world labor share makes the home market more attractive and thus increases the number of firms from the home-country. The increase in the number of domestic firms increases the income of the home-country, thereby inducing more entry to the domestic market endogenously. This endogenous force is the reason for the magnification of the standard home market effect.

A second implication of endogenous market sizes is that mutual trade liberalization no longer makes the two countries better off unambiguously. Mutual trade liberalization reduces the market size and the number of firms of the small country. The reduction in the number of firms reduces income of the small country and has an increasing effect on its price index. If rents are sufficiently large and the country is sufficiently small, the income decrease and the price index increase will be sufficiently strong. Hence, trade agreements may harm countries of a small size.

Finally, the endogeneity of market sizes guarantees that an increase in the degree of entry barriers will increase a large country's market size and thus have a welfare-increasing effect for this country. This welfare-increasing effect is sufficiently strong that the large country benefits from higher entry barriers for some parameter values. This result challenges the idea that higher entry barriers are related to lower welfare unambiguously.

The paper relates to a set of models aiming to justify the existence of the W.T.O. as we describe a motivation for setting high tariffs Bagwell and Staiger (1997) use a terms-of-trade externality motivation to provide a rationale for trade agreements,

and Mrazova (2009) builds upon a n-good set-up with the goal of better understanding W.T.O. negotiations. Our modelabstact for terms-of-trade externalities and differs from Mrazovak's work because we build upon a standard general equilibrium model of trade. Finally, the paper connects to Haufler and Wooton's work (1999) as our rent-shifting mechanism is similar to theirs. In their model governments employ policy to persuade foreign firms to achieve foreign direct investment and shift rents by extracting their profits via lump sum taxes. Although the mechanisms are similar we study a different type of policy and consider different types of barriers.

The empirical support for the existence of entry barriers that create rents comes from evidence provided by development economists and by industrial organization economists. The relationship between entry barriers and rents has been an old concern in the industrial organization literature. Empiricists have analyzed differences in entry barriers across sectors and over time, but only a few have provided generic evidence. Geroski (1995) provides the most comprehensive survey by considering estimations of an entry equation where entry depends on the difference between expected post-entry profits and entry costs. [17] Geroski concludes that entry barriers tend to be high because most estimates of "limit profits", i.e., the profit level at which entry becomes zero in the entry equation, are positive. He also concludes that entry seems to react sufficiently slow that it does not erode profits based on the estimate of a beta

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In several of these studies entry costs depends on observable proxies for entry barriers. Entry barriers that relate to regulation show up through direct channels -as the proxies are direct measures of regulation- or through indirect channels – as regulation interacts with other barriers. Furthermore, other studies considered by Geroski (1995) models entry costs as a fixed effect and thereby provides a generic estimate of the barriers.

parameter in the entry equation. The beta parameter measure the response of entry to ex-post profits and is often small and imprecisely estimated.

The link between entry barriers and rents has become a concern in recent studies in the field of development economics. There is a large body of literature on red-tape regulation initiated by Djankov et al.'s (2002) which employs data on the number of procedures, official time, and official costs required for firms to start operating legally. Djankov et al.'s (2002) find that official costs are high in most countries and show that the excessive regulation creates rents that accrue to bureaucrats and administrative employees. Ciccone et al. (2007) examine the sectors considered by Djankov et al. but enlarged the sample with additional requirements for firm operation. They find that entry is slower in industries where it is necessary to register land, build facilities, purchase equipment and procure specific licenses. [18]They also show that the speed of entry decreases with the strength of these requirements.

In summary, evidence from the fields of industrial organization and development economics suggests that entry barriers exist and create rents. Despite this evidence, it was not until Neary that rents have been introduced into a general equilibrium model of trade.

We develop a home market effect model modified to account for entry barriers and rents in the remainder of this paper. In the next section, we present the model setup and solve for the autarky equilibrium. Then we show that our method for conceptualizing entry barriers is consistent with Neary's model and the literature

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[18] Ciccone et al. (2007) use a model of the home-market effect tostudy delayed entry. However, their dynamic environment is built to explain intersectorial labor reallocation, whereas our paper emphasizes the role of rents.

initiated by BS. In section 2.3 we solve for the trade equilibrium and show that entry

barriers exacerbate the standard home market effect and make it no longer true that

mutual trade liberalization is unambiguously beneficial. In section 2.3, we also study

the welfare implications of an increase in entry barriers. Section 2.4. studies the

motivation for rent-shifting policies and section 5 concludes.

2.2   Autarky Economy

In this section we present the model setup and solve for the equilibrium in an

autarky regime. We also introduce our measure of entry barriers and compare the

equilibrium properties for different degrees of entry barriers. The comparison shows

that our measure is consistent with Neary's model and the literature initiated by BS.

Model Setup

We consider a country called Home and study its autarky equilibrium. The

utility of the representative consumer depends on a single homogeneous outside good

and a composite of differentiated manufacturing products. Preferences are represented

by a Cobb-Douglas-C.E.S. function which is written as follows

$$U = \left[\sum_{i=0}^{N} z_i^{\frac{\theta-1}{\theta}} \right]^{\frac{\alpha\theta}{\theta-1}} y^{1-\alpha}, \tag{33}$$

where z_i is the consumption of variety i, y denotes the consumption of the

homogeneous good, α is the expenditure share associated with varieties, $\theta > 1$

denotes the elasticity of substitution among the varieties, and N refers to the total

amount of varieties. Under an autarky regime all of these varieties are produced at Home. Technologies are represented by the following (inverse) production functions

$$L_y = y, \tag{34}$$

$$L_i = f + bz_i^s, \tag{35}$$

where L_y denotes the labor required to produce y units of the outside good, and L_i denotes the total labor required to supply z_i^s units of variety i. Production of manufacturing goods is given by the increasing returns to scale shown in (35) and based on two components: b, the marginal labor requirement, and f, the fixed labor requirement. There is monopolistic competition in the market of manufacturing goods and perfect competition in the market of the outside homogenous good.

The regulatory environment is summarized by an exogenous parameter E: a higher parameter value indicates a higher degree of entry barriers- $E \ni (0, \infty)$. The degree of entry barriers determines fully the value of rents per-firm that we call c hereafter, $c \ni (0, \infty)$. The relationship is given by an increasing function $\pi : E \to c$ so that the higher is the entry barriers degree, the higher the value of rents per-firm.

We fix the value of the parameter E at some value $\bar{E}$, which describes the degree of barriers in the considered economy; for now $\bar{E}$ may be any value in the interval $(0, \infty)$ Thus, the following equation describes fully the regulatory environment

$$\bar{c} = \pi(\bar{\bar{E}}\,), \qquad\qquad (36)$$

where $\bar{c}$ denotes the value of rents per-firms associated with the degree of entry barriers in this economy $\bar{E}$. The form of the rents shown in (36) depends on the nature of the entry barriers considered. Because any entry barrier that relates to regulation and generates local rents is consistent with the main mechanism of the model, these rents may take different forms. The entry barriers may relate to environmental regulation and, for instance, refer to requirements for environmental impact statements. The entry barriers may also refer to a lack of financial regulation so that credit constraints are excessively large. When credit constraints are excessively large, the rents accrue to firms so that we should call them profits.

Autarky Equilibrium

An equilibrium is defined as a vector of prices and total number of firms for which the labor market, the homogeneous market and the manufacturing goods markets clear, when rents per-firm equal $\bar{c}$. We set these equilibrium conditions in order to find the values for the endogenous variables.

Under perfect competition the price of the homogenous good must equal its unit production cost in equilibrium. This equilibrium condition determines the wage rate that we show in the following equation

$$W = p_h = 1, \tag{37}$$

where W is the wage rate, p_h is the price of the outside good and the number 1

indicates that this price has been set as the numeraire $-p_h = 1$. Utility maximization

with the preferences shown above then yields the following demands

$$y^d = (1 - \alpha)I, \tag{38}$$

$$z_i^d = \frac{p_i^{-\theta}}{P^{1-\theta}} \alpha I, \tag{39}$$

where y^d denotes the demand for the outside good, I denotes income, P is Home's

price index, z_i^d is the demand for variety i and p_i is the price of that variety. The price

index is determined via utility maximization and written as follows

$$P = [\textstyle\sum_{i=0}^{N} p_i^{1-\theta}]^{\frac{1}{1-\theta}}. \tag{40}$$

The indirect utility function is obtained by plugging the demand functions

displayed in (38) and (39) into (33), which yields the following expression:

$$V = \alpha^\alpha (1 - \alpha)^{1-\alpha} P^{-\alpha} I. \tag{41}$$

Home's income is given by the household labor earnings and the aggregate

value of the rents, which may accrue to the government, to the household or to

bureaucrats and administrative employees. The household labor earnings equal the

labor supply (because the wage rate is 1) and the aggregate value of the rents equals the number of firms multiplied by the value of rents per firm $\bar{c}$.[19] The income of the representative consumer is then summarized as follows

$$I = L + n\bar{c}, \tag{42}$$

where L denotes Home's labor supply and N is the total number of firms. Each manufacturers sets profit-maximizing prices using the demands shown in (39). Because these demands have a constant price elasticity that equals θ, firms charge a constant mark-up over the marginal cost

$$\frac{\theta b}{\theta - 1} = p = p_i = 1, \qquad \forall\, i \in [0, N]. \tag{43}$$

In the manner of Helpman and Krugman we have chosen units chosen such that $\frac{\theta - 1}{\theta} = b$. This choice of units yields an equilibrium price for varieties equal to 1; $p = 1$. Given this profit maximization price, equation (36) is written as follows

$$\pi = \frac{z_i^S}{\theta} - f = \bar{c}. \tag{36'}$$

Equation (36') determines the quantity of each manufacturing product in equilibrium. This quantity is written as follows:

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[19] n a one-period setup, savings are zero so that agents spend all the rents in consumption goods. The rents may accrue to the government, to the firms or to the household. Therefore, zero-savings means that the government's budget is balanced and that household's dividends equal the value of the rents that accrue to the firms.

$$z_i^s = z_i^e = z = \theta(\bar{c} + f), \qquad \forall \, i \in [0, N], \qquad (44)$$

where the equality denotes that the market of variety i is in equilibrium. Equation (44) reflects the intuitive idea that markets with higher entry barriers tend to have firms of a larger size.

The total number of varieties is given by equilibrium in the market of the outside good. This equilibrium is determined by the demand for the homogenous good -shown in (4)- and the supply, which is given by the amount of labor that is left after producing all varieties. The total number of varieties is then written as follows

$$N = \frac{\alpha L}{\theta(\bar{c} + f) - \alpha \bar{c}} < \frac{\alpha L}{\theta f} = \bar{N}, \qquad (45)$$

where $\bar{N}$ is the total number of firms (or varieties) under the free-entry assumption. The total number of firms depends on firm size $\theta(\bar{c} + f)$; a larger firm size reduces the number of firms for a given expenditure in varieties. The total number of firms also depends on the total expenditure in manufacturing goods –represented by $\alpha \bar{c}$ and αL in (36'); a higher expenditure increases the demand for varieties so that more firms enter the market.

An increase in entry barriers has two competing effects. On the one hand an increase in entry barriers makes firm size larger, and thereby reduces the total number of firms. On the other hand an increase in entry barriers increases profits and income, and thus increases the expenditure in manufacturing goods. The latter effect is stronger than the former effect, and therefore an increase in entry barriers reduces the total

number of firms. In other words, the total number of firms is lower in this model than it is under the free-entry assumption.

Consistency of the Entry Barriers Measure

We investigate the welfare effects of an increase in entry barriers for the autarky economy. This analysis will create a benchmark for use in the next section, in which we will study the effects of an entry barriers increase under a trade regime. We will also employ the analysis to show that our measure of entry barriers is consistent with Neary's model, the literature initiated by BS, and other standards employed by industrial organization economists.

We will begin with the comparison between our model and the partial equilibrium models of oligopolistic competition that are standard in the literature initiated by BS.[20] In this literature an increase in entry barriers increases both individual and industry profits, but it augments prices and thus reduces consumer surplus. Because the effect on consumer surplus more than offset the profits increase, these models associate entry barriers with a lower level of social welfare. In our model an increase in the entry barriers measure also yields a lower level of social welfare. To show this we employ equation (36') and write the aggregate value of rents as follows

$$N = \frac{\alpha L}{\frac{\theta f}{\bar{c}} + \theta - \alpha}. \qquad (46)$$

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[20] A simple way to think about rhis is a model of competition a la Cournot.

An increase in the entry barriers measure reduces the total number of firms but increases the value of rents per-firms. Because the latter effect is stronger than the former, the value of total rents and then income increase with the measure of entry barriers; an increase in the entry barriers measure has a welfare-increasing through its impact on income. However, the reduction in the total number of firms increases the price index, and thus the increase in the entry barriers measure has a welfare-reducing effect. In the appendix section we prove that the price index effect is stronger than the income effect, and thus an increase in entry barriers reduces welfare under an autarky regime. Hence, the choice of introducing entry barriers as a fixed value of rents per firm in our model is consistent with both Neary's and the literature initiated by BS.

Moreover, as we employ the Herfindahl index to measure market concentration, our modeling is consistent with the intuitive idea that market concentration increases with entry barriers. We construct the Herfindahl index for this economy from equations (44) - (45) and show the index in the following

$$HH = \sum_{i=0}^{N} s_i^2 = \frac{\theta^2(\theta(\bar{c} + f))(\bar{c} + f)^2}{\alpha L} \qquad (47)$$

where $s_i = \frac{z_i}{\sum_{i=0}^{N} z_i}$ denotes market share of firm i. A higher value for the entry barrier measure increases the HH index, indicating a higher market concentration. Hence our entry barrier measure is also consistent with other standards employed in the field of industrial organization.

2.3 Trade Regime with Equal Trade Costs across Countries

We state the assumptions that are required to avoid complete specialization under the trade regime and provide evidence for an assumption on the cross-country difference in the measures of entry barriers. Under these assumptions we derive the trade regime equilibrium and investigate its properties by running comparative statics exercises.

Model Setup and Assumptions

We consider two countries referred to as Home and Foreign and indicate the variables concerning the latter with a superscript asterisk (*). Preferences are identical across countries so that utility of the representative consumer in Foreign is summarized by a function analogous to (33). Technologies are also identical across countries, and then foreign production is given by functions analogous to (34) and (35). The manufacturing goods market is monopolistically competitive and the homogeneous good market is perfectly competitive.

Trade costs apply only to manufacturing goods and are of the Samuelson iceberg type: for a unit of a manufacturing product to arrive in the other country τ units must be shipped, $\tau > 1$. These iceberg costs are decomposed into transport costs and trade barriers. We keep the former identical across countries and let the latter differ across nations in the following section. In the manner of Ossa we refer to trade

barriers as tariffs for the sake of concreteness; however, trade barriers may reflect any policy impediments to trade.[21]

As we set a trade regime we need to make a prejudgment on how entry barriers differ across countries. The prejudgment is not trivial as a country's welfare depends on the difference between its entry barriers measure and the entry barriers measure of the other country. Thus, we employ data to answer the question of whether entry barriers differ across countries with the characteristics of the trading partners from our model. We test whether the height of the entry barriers caused by regulation differs across countries that have similar labor productivity but may differ in market size. To proxy for countries' regulatory environments we employ the Doing Business (DB) indicators from the World Bank .The proxies for productivity and market size come from IMF data on income and population. As we show in the appendix section the empirical study justifies the following assumption

$$E = E^* = \bar{\bar{E}}, \quad and\ therefore \quad c = c^* = \bar{c}, \quad (48)$$

where E^* measures the degree of entry barriers in Foreign and c^* is the value of rents per-firm associated with this degree. Equation (48) assumes that the value of the entry barriers measure is the same for the two countries in our model.

Finally, we make a set of assumptions to rule out the uninteresting case of complete specialization. To ensure that both countries produce at least one unit of a manufacturing product we assume that the countries are sufficiently equal in size. We

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[21] As Ossa, we abstract from tariff revenue to make the model tractable.

refer to Home's world labor share as S_l and to the vector of exogenous parameters as $\boldsymbol{\Gamma}$

so that we can write our assumptions as follows

$$S_l < \frac{1}{1+\rho}\left(1 - \frac{\rho N(\boldsymbol{\Gamma})\bar{c}}{L^W}\right) = \underline{S_l}$$

$$S_l > \frac{\rho}{1+\rho}\left(1 + \frac{N(\boldsymbol{\Gamma})\bar{c}}{L^W}\right) = \overline{S_l},$$

$$(49)$$

where $\rho = \tau^{1-\theta}$ denotes the measure of iceberg costs, L^W is the world labor supply

and $N(\boldsymbol{\Gamma})\bar{c}$ denotes the aggregate value of world rents. The equations in (49) make

explicit the dependence of the total number of firms on the vector of exogenous

parameters. In the appendix section we replace the equilibrium total number of firms

in (49) and show the assumptions in terms of these parameters. The assumptions are

standard restrictions in the home market effect literature. In particular, as we impose

$\bar{c} = 0$ in (48) this equation converges to the restrictions imposed by Helpman and

Krugman. Note that for these restrictions to be fulfilled, it is necessary to place an

upper bound on the value of rents per worker which is written as follows:

$$\frac{N(\boldsymbol{\Gamma})\bar{c}}{L^W} < \frac{1}{2\rho} - \frac{1}{2}, \qquad (50)$$

The upper bound on the value of rents per worker becomes more restrictive as

trade cost fall and the economy approaches free trade (ρ increases). As trade costs fall

each country's number of firms more strongly depends on its world labor share. The

bounds on labor shares then become more restrictive, and thus the minimum rents per

worker that is required to fulfill both bounds decreases. In the appendix section we show (50) in terms of the exogenous parameters.[22]

Finally, we assume that both countries produce the outside good so that there is not complete specialization. [23] We follow Ossa and place an upper bound on the income share spent on varieties so that the total number of varieties in the economy is sufficiently low. Thus, the amount of labor that each country requires to produce all varieties and the outside good is sufficiently low that assumption in (49) and (50) ensure incomplete specialization. The upper bound on the share of income spent on varieties is as follows

$$\alpha < \frac{\rho\theta(\bar{c}+f)}{(\theta(\bar{c}+f)-\bar{c})(1+\rho)},\qquad(51)$$

We make the set of assumptions composed of equations (49)-(51) hereafter. Each country will then produce at least one unit of the outside good and one unit of a variety so that there is no complete specialization.

Trade Equilibrium

The equilibrium is characterized by a vector of prices, total and domestic numbers of firms under which the maximizing agents clear the markets. In equilibrium the value of rents per-firm is given by equation (48'). In a trade regime, there is an extra market clearing condition and an extra unknown compared to the equilibrium

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[22] We follow Helpman et al. (2009) and treat N as a continuous variable

[23] Given the set of assumptions shown in (49)-(50), a sufficient condition for both countries to produce the outside good is that their labor supply is sufficiently large that they have some remaining after all varieties in the economy are produced.

from the previous section. The extra condition is market clearing for foreign

manufacturing products and the extra unknown is the number of foreign firms. We

proceed by setting the equilibrium conditions and finding the values for the

endogenous variables.

Because every nation produces the outside good, perfect competition equalizes

wages and the good price across countries. We set this price as the numeraire and

write the following

$$W = W^* = p_h = 1, \tag{52}$$

Utility maximization with the above preferences yields the demands for the

outside goods, which are written as follows:

$$y^{d*} = (1 - \alpha)I, \tag{53}$$

$$y^{d*} = (1 - \alpha)I^*, \tag{54}$$

where (53) is Home's demand for the outside good. Utility maximization also yields

the demand for the Home produced and the Foreign-produced, which are written as

follows

$$z_i^d = \frac{p_i^{-\theta}}{P^{1-\theta}} \alpha I + \frac{\rho p_i^{*-\theta}}{P^{*1-\theta}} \alpha I^*, \tag{55}$$

$$z_i^{*\,d} = \frac{\rho p_i^{-\theta}}{P^{1-\theta}} \alpha I + \frac{p_i^{*\,-\theta}}{P^{*\,1-\theta}} \alpha I^*. \tag{56}$$

where equation (55) shows the demand for a Home-produced variety. We employ the demands in (53)-(56) to obtain countries' indirect utility functions, which are summarized by the following equations

$$V = \alpha^\alpha (1 - \alpha)^{1-\alpha} P^{-\alpha} I, \tag{57}$$

$$V^* = \alpha^\alpha (1 - \alpha)^{1-\alpha} P^{*\,-\alpha} I^*. \tag{58}$$

A country's welfare increases with income and decreases with the price index. The price indices are written as follows

$$P = [\sum_{i=0}^{n} p_i^{1-\theta} + \sum_{i=0}^{n^*} \rho p_i^{*\,1-\theta}]^{\frac{1}{1-\theta}}, \tag{59}$$

$$P^8 = [\sum_{i=0}^{n} \rho p_i^{1-\theta} + \sum_{i=0}^{n^*} p_i^{*\,1-\theta}]^{\frac{1}{1-\theta}}, \tag{60}$$

where n denotes the number of firms from Home. Countries' incomes depend on labor earnings and on the rents generated by entry barriers, and are summarized as follows

$$I = L + n\bar{c}, \tag{61}$$

$$I^* = L^* + n^* \bar{c}. \tag{62}$$

As shown in equations (61) and (62), a country's income in terms of the homogeneous good increases with its number of domestic firms. Because this number is endogenous, income levels and market sizes become endogenous variables. One of the contributions of our model is to highlight the endogeneity of market size and to assess its implications.

Note in (61) and (62) that all rents associated with domestic firms accrue to domestic income, and thus, only residents benefit from these rents. By definition, all entry barriers that create rents accruing to "the government" or to bureaucrats satisfy the income definitions shown in (61) and (62).Profits, on the other hand, may accrue to investors whose portfolios contain shares of foreign assets; however, the latter case is empirically irrelevant given the strong evidence of home equity bias. Several recent studies argue that investor portfolios are disproportionately composed of domestic assets so that most profits associated with domestic firms accrue to residents. [24]This evidence and the fact the other sorts of rents undoubtedly accrue to residents suggest the use of the income definitions shown in (61) and (62). Hence, we make the non-strong assumption that all rents associated with domestic firms accrue to home income and employ these definitions hereafter.[25]

We establish the pricing rules for firms now. The demands for varieties have constant price elasticity equal to θ, and then firms charge a constant mark-up over marginal cost. Making the same unit choice as in the autarky equilibrium we write:

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[24] The seminal paper in this literature is French and Poterba (1991)]. For recent evidence, see Lane and Molesi-Ferretti (2003Lutje and Menkhoff (2007) and Strong and Xu (2003).

[25] The full home bias is a simplifying but not basic assumption. As long as domestic income increases with the number of domestic firms, the channels described in this paper still exist.

$$\frac{\theta b}{\theta - 1} = p = p_i = p_i^* = 1, \qquad \forall \, i \in [0, N]. \tag{63}$$

Note that we are not imposing price equalization across products or countries. Instead, price equalization arises from equal labor productivity across countries and incomplete specialization –so that wages are equal.. The pricing rule displayed in (43), along with Equation (48), determines the equilibrium quantity of each manufacturing product. This quantity for a domestic variety and for a foreign variety is written as follows

$$z_i^s = z_i^e = z = \theta(\bar{c} + f), \qquad \forall \, i \in [0, n], \tag{64}$$

$$z_i^{*\,s} = z_i^{*\,e} = z^* = \theta(\bar{c} + f) = z, \qquad \forall \, i \in [0, n^*]. \tag{65}$$

Equations (64) and (65) state that firm size is the same across the two countries, which is an implication of the countries' having the same height of entry barriers. These equations and market clearing determine Home's number of domestic firms in equilibrium. In presenting Home's number of domestic firms we follow Helpman and Krugman and show this number as a proportion of the total number of firms. Home's share of firms is thus written as follows

$$S_n = \frac{n}{N(\Gamma)} = \frac{S_l(1 + \rho) - \rho\left(1 + \frac{N(\Gamma)\bar{c}}{L^W}\right)}{(1 + \rho) - 2\rho\left(1 + \frac{N(\Gamma)\bar{c}}{L^W}\right)}. \tag{66}$$

Two results that are implicit in equation (66) find their counterpart in the model by Helpman and Krugman, a widely used version of the seminal home-market effect. First, Home's share of firms is increasing in Home's labor share: larger markets are more conducive to the creation of new businesses as they allow serving a larger amount of consumers freely (without making consumers pay the iceberg costs). As an increase in Home's labor share causes a more than proportional increase in Home's share of firms, we say that there is a "home-market effect." In other words, firms concentrate disproportionally in the country with the largest market size. The second result that finds its counterpart in Helpman-Krugman's setup is that Home's share of firms becomes more sensitive to Home's labor share as the economy approaches free trade.

Turning back to our equilibrium we solve for the total number of firms by imposing clearing in the market of the outside good. The total number of firms in this economy is thus written as follows

$$N = \frac{\alpha L^W}{\theta(\bar{c} + f) - \alpha \bar{c}}. \qquad (67)$$

The total number of firms depends on the total expenditure on varieties and on the firm size, as it did under the autarky regime in the previous section. More importantly, this number is independent of trade cost so that when we run comparative statics on the trade costs parameter we can think of the total number of firms as being fixed.

Basic Comparative Statics

We run comparative statics exercises and investigate the properties of the equilibrium formed by equations (66)-(67), whose stability we prove in the appendix section. In our first exercise we investigate how rents modify Helpman and Krugman's home-market effect. The following proposition summarizes the result

Proposition 1. *If* $\bar{c} > 0$ *and (49) holds, then* $\frac{dS_n}{dS_l} > \frac{1+\rho}{1-\rho}$ *; thus, the existence of rents magnifies* Helpman- Krugman's *home-market effect under incomplete specialization.*

We show the magnification of the home-market effect in Figure 2.1, where the x-axis denotes Home's labor share and the y-axis denotes Home's share of firms. The segment labeled A depicts the relationship between the two shares when rents are zero -as in Helpman-Krugman's setup-, reflecting the steepness of the segment the extent of the standard home-market effect. As rents become positive (and we move from the Helpman-Krugman setup to our model), the A segment rotates counterclockwise over the point $\left(\frac{1}{2}, \frac{1}{2}\right)$ which illustrates the only situation where rents do not modify the equilibrium relative to the Helpman-Krugman model. The new relationship between Home's labor share and Home's share of firms is represented by the segment labeled B. The steepness of segment B is greater than the steepness of segment A, and thereby the existence of rents magnifies the home-market effect.

The magnification of the home-market effect can be understood based on the additional enlargement of the home-market caused by the existence of rents. Consider an increase in Home's labor share from S_1 to S_2 in Figure 2.1 so that the home market

enlarges exogenously. The exogenous enlargement of the home-market makes Home a more attractive business location, and thus the number of domestic firms increases as predicted by Helpman and Krugman. This increase in the number of domestic generates endogenously an additional enlargement of the home-market. when rents are greater than zero: as there is a higher number of firms creating rents domestic rents increase, which in turn attracts more firms to the home-country. Hence, rents exacerbate the standard home market effect. In the appendix section we show that the magnification of the home market is increasing in the measure of entry barriers s\and thus in the value rents per firm.

We turn back to our comparative statics exercises in order to investigate the impact of a change in the income share spent on varieties. We state the outcome of the exercise in the following proposition

Proposition 2. *Home's share of firms increases with the income share spent on varieties if and only if Home is a large county. More formally we write $\frac{dS_n}{dS_l} > 0$ if and only if $S_l > \frac{1}{2}$.*

An increase in the income share spent on varieties increases world rents by raising the total number of firms. The income share increase raises the demand for varieties so that market entry is in principle more profitable. This attracts a higher number of firms as understood from (67) so that world rents become higher. A higher proportion of these rents accrue to the large country, and thus the income –and market size- of the large country increases by more than the income –and market size-of the

small country. As the large country's market size increases by more this country's share of firms increases as understood from (66). Hence a rise in the income share spent on varieties increases the large country's share of firms.

Welfare Implications of Mutual Trade Liberalization

We show that mutual trade liberalization -a fall in the trade costs parameter- benefits the large country but harms the small country under some circumstances. Mutual trade liberalization benefits every country so that trade agreements are Pareto-improving unambiguously in the Helpman-Krugman model.

We take the Helpman- Krugman model as our benchmark. In their model income levels are exogenous, and thus the only endogenous variable the welfare of a small country depends on is its price index Mutual liberalization creates competing effects on the price index and then on the welfare of a small country. The fall in tariffs reduces the effective prices of the imported varieties, thereby having a price-index reducing effect. The fall in tariffs also reduces the number of domestic firms in the small country, thereby enlarging the set of imported products and having a price index increasing effect. The price index reducing effect is greater than the price index increasing effect so that mutual liberalization improves the welfare of a small country unambiguously in the Helpman- Krugman model. The following remark states the result

Remark. *In the Helpman-Krugman model mutual trade liberalization improves welfare for the large country but has two competing effects on the price index and welfare of the small country.[26] The reduction in effective import prices more than offsets the increase in the imported products set, and therefore the net welfare impact is unambiguously positive.*

The existence of rents reinforces the price index increasing effect of mutual liberalization and generates an additional welfare-reducing effect through its impact on income. Thus, mutual trade liberalization may worsen the small country off

The price index increasing effect is greater because mutual liberalization causes a greater reduction in the small country's number of firms, when rents are greater than zero. Rents make the relative market size of the small country smaller than in Helpman-Krugman's model by creating endogenously more rents in this country than in the large country. Note also that mutual trade liberalization makes countries' shares of firms more sensitive to market size, and thus reduces the share of firms for the small country. The relative market of the small country is smaller in our model so that mutual liberalization creates a greater reduction in its share of firms. As the share of firms of the small country decreases by a larger amount, its import product set expands largely in this model than in Helpman-Krugman's model. Hence, the introduction of rents makes the increase in the price index of the small country greater.

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[26] Note that the types of effects are welfare-improving for the large country.

Mutual liberalization also reduces the income of the small country when rents are greater than zero. In our model this income depends on the small country's number of firms as firms create rents. As mutual liberalization reduces the number of firms of small country, it also reduces its income level. Hence, rents create an additional welfare-reducing effect for a small country relative to Helpman and Krugman's model.

Proposition 3 states that mutual trade liberalization reduces the welfare of the small country for a reasonably large set of parameters. We describe a particular subset within this set of parameters, and therefore provide a sufficient condition under which mutual liberalization reduces a small country's welfare. Proposition 3 is written as follows.

Proposition 3. Trade Agreement. *A trade agreement benefits Home if the home-country is large and may harm Home if the home-country is small.*[27]*If the rents associated with a firm and the elasticity of substitution are sufficiently large, mutual liberalization harms Home when the home-country is sufficiently small. More formally, if $\theta > \theta^{MTL}$, where $\theta^{MTL} < 2$, and $\bar{c} > c^{MTL}$, there is a S_l^{MTL} such that*

$$\bar{S}_l < S_l^{MTL} < \frac{1}{2} \text{ and } \frac{dV(S_l^{MTL})}{d\rho}.$$

Proposition 3 states that the income loss more than offsets any price index reduction that mutual liberalization may cause under some conditions. The lower bound on the elasticity of substitution ensures that any price index reduction is

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[27]Note again that the two effects are welfare-improving for a large country.

sufficiently small. This bound is a considerably mild restriction, as this parameter only takes values greater than 1. Furthermore the small country be sufficiently small that the reduction in the small countries' number of firms is large (and thus its price index tendency to increase and its income fall are sufficiently strong). Finally, Proposition 3 requires sufficiently large entry barriers and rents, which guarantees that this model is sufficiently different from the Helpman-Krugman's model.

As mutual liberalization may worsen the small country off, a trade agreement may create a conflict of interest between the large country and the small country in our model. However, the welfare gains for the large country are greater than in Helpman-Krugman's model, and therefore the Pareto efficiency of the agreement might be restored with a transfer system that compensates the small country.

Welfare Implications of a Change in Entry Barriers

We employ our analysis from the previous as our benchmark to study the welfare implications of an increase in entry barriers. As an example to motivate our analysis we can think of the TRIPs agreement signature. The agreement established international standards for intellectual property protection that affected trade partners of a low- and middle-income.

For illustrative purposes, we will divide the analysis in two steps. First, we link the changes in aggregate variables caused by the increase in entry barriers to welfare implications that affect the two countries. Second, we investigate how the increase in entry barriers affects each country based on its market size.

In a trade equilibrium the increase in entry barriers has welfare implications through its impact on aggregate variables. These implications are isomorphic to the welfare implications for a country under an autarky regime, which we have discussed in Section 2. Specifically, an increase in entry barriers reduces the total number of firms thereby increasing world's income the price indices of the two countries. The increase of the price indices more than offsets the world's income, and therefore an entry barrier increase has a welfare-reducing effect for both countries. We call the welfare-reducing effect of an entry barriers increase the "autarky effect" hereafter. Besides being consistent with the literature initiated by BS and Neary's model, the autarky effects are consistent with several articles claiming that a strength of intellectual property protection increases market concentration, prices and rents.If the "autarky effects" were the only welfare implications, a change in regulation that increases entry barriers would harm the two countries in our model.

An increase in entry barriers also creates welfare effect based on country size as the entry barriers increase changes countries' shares of firms. We employ equations (66) and (67) to investigate how countries' shares of firms change and assert the following remark.

Remark. *An increase in entry barriers increases (lowers) the share of firms of the large (small) country. More formally, $\frac{dS_n}{d\bar{c}} > 0$ if and only if $S_l > \frac{1}{2}$.*

The increase in entry barriers increases the large country's share of firms as it increases world rents (and this country's share is increasing in world rents as noted in

our discussion of Proposition 2). Furthermore, if the increase in the share of firms is sufficiently large, an increase in entry barriers also increases the large country's absolute number of firms. This increases the large country's income and has a price index reducing effect. We will call the welfare increasing effects of an increase in entry barriers "size-dependent effects"

The size-dependent effects are sufficiently large that they more than offset the autarky effects for a set of parameters. Hence the welfare of the large country increases as stated in the following proposition.

Proposition 4. Entry Barriers Change. *An increase in entry barriers harms a small country and benefits a sufficiently large country for a set of parameters. More formally, there is a $S_l^{CEB}(\Gamma^{CEB})$ such that $\frac{1}{2} < S_l^{CEB} < \underline{S_l}$ and $\frac{dV(S_l^{CEB}(\Gamma^{CEB}))}{d\bar{c}} > 0$*

Proposition 4 disentangles the welfare effects of an entry barriers increase for a large country. The Proposition partially characterize the set of parameter for which the large country benefits from the entry barriers increase by providing a subset within the set and provides a set of parameters under which this country benefits. In the appendix section we prove the result for an economy that is sufficiently open to trade that the size-dependent effects are arge enough to compensate the autarky effects.

Figure 2-2 assumes that Home is the large country and illustrates that Home must be sufficiently large that it benefits from the increase in entry barriers as stated in Proposition 4. The horizontal axis denotes the measure of entry barriers -ranging from $\bar{c} = 0$ to $\bar{c} = 50$- , the vertical axis shows the level of indirect utility, and the

remaining axis denotes the labor share of the large country. Home's labor share ranges from 0.5 to 0.522, allowing the country to be large and to be sufficiently large. If Home's labor share is in the neighborhood of +0.5, its utlity is greater for $\bar{c} = 0$ than it is for $\bar{c} = 50$. However, when Home is sufficiently large the opposite is true: forlabor shares in the neighborhood of -0.522 its utility is greater for $\bar{c} = 50$.

2.4   Trade Regime with Different Trade Costs across Countries

We let trade costs vary across countries and study the motivations of these countries for raising tariffs unilaterally. A rise in tariffs will increase the number of domestic firms and shrink the set of imported products, thereby having a price index-reducing effect. This effect will more than offset the increase in effective importing prices caused by the tariffs increase so the price index will fall. In other words, we show that Ossa's l results are robust to the introduction of entry barriers and rents. Furthermore, we show that a rise in tariffs rise increases the income of the home country, and therefore governments have a rent-shifting motivation for raising tariffs. This rent-shifting motivation is sufficiently large that the incentive for "beggar-thy-neighbor" trade policies is greater than it is in the standard model by Ossa.

Model Setup and Assumptions

Utility functions are identical across countries and are represented by a function analogous to (33). Furthermore, technologies are also identical and given by functions the analogous to (34) and (35). The manufacturing goods market remains

monopolistically competitive, and the homogeneous good market remains perfectly competitive.

Trade costs still apply only to varieties and represent tariffs or any impediment to trade. In particular, $\rho_H = \tau_H^{1-\theta}$ denotes the tariffs measure on domestic products, and $\rho_F = \tau_F^{1-\theta}$ denotes the same measure for foreign products.

As in the previous section we make assumption on Home's labor share so that both countries produce at least one unit of a manufacturing good. The assumption is written as follows

$$S_l < \frac{1 - \rho_F\rho_H - \rho_F(1 - \rho_H)\left(1 + \frac{N(\mathbf{\Gamma})\bar{c}}{L^W}\right)}{1 - \rho_F\rho_H} = \underline{S_l}$$

$$S_l > \frac{\rho_H(1 - \rho_F)\left(1 - \frac{N(\mathbf{\Gamma})\bar{c}}{L^W}\right)}{1 - \rho_F\rho_H} = \bar{S_l}.$$

(68)

The upper bound on Home's labor share ensures that at least one producer of varieties is from Foreign; the lower bound guarantees that at least one producer is from Home. The lower bound is decreasing in Home's tariffs - increasing in ρ_H-: as Home's tariffs increase, this country requires a lower labor share (and market size) so that one variety producer enters the domestic market. The upper bound and the lower bound can only hold simultaneously when the value of rents per worker is sufficiently low. Specifically, we make the following assumption

$$\frac{\mathrm{N}(\boldsymbol{\varGamma})\bar{c}}{\mathrm{L}^W} < \frac{(1-\rho_H)(1-\rho_F)}{\rho_F + \rho_H - 2\rho_F\rho_H} \qquad (69)$$

Finally, we establish a set of sufficient conditions under which the two countries produce the outside good. In the manner of the previous section we impose an upper bound on the share of income spent on varieties and write this bound as follows

$$\begin{aligned} \alpha &< \frac{\rho_F(1-\rho_H)\theta(\bar{c}+f)}{(\theta(\bar{c}+f)-\bar{c})(1-\rho_F\rho_H)}, \qquad if\ \rho_H < \rho_F, \\[2mm] \alpha &< \frac{\rho_H(1-\rho_F)\theta(\bar{c}+f)}{(\theta(\bar{c}+f)-\bar{c})(1-\rho_F\rho_H)}, \qquad if\ \rho_H > \rho_F. \end{aligned} \qquad (70)$$

Provided that the set of assumptions in (68) is fulfilled, the set in (70) ensures that there is not complete specialization in equilibrium.

Trade Equilibrium

An equilibrium is characterized by a vector of prices, total and domestic numbers of firms under which the maximizing agents clear the markets. In equilibrium the value of rents per-firm is given (48'). The equilibrium conditions are the same as in the previous section with the exception of the market clearing condition for manufacturing products. We proceed by setting the equilibrium conditions and finding the values for the endogenous variables.

Equilibrium in the outside good market yields the same number of total firms as in the previous section so that we define this number with equation (67) in this section as well. The total number of firms is the same as in the previous section

because cross-country differences in trade costs do not alter either the world supply or the world demand for the outside good.

Equilibrium in the markets of varieties yields the same the price and quantity for each variety as in the previous section. However, differences in trade costs modify the demand for varieties, which we write in the following

$$z_i^d = \frac{1}{g}\alpha I + \frac{\rho_F}{g^*}\alpha I^*, \tag{71}$$

$$z_i^{*\,d} = \frac{\rho_H}{g}\alpha I + \frac{1}{g^*}\alpha I^*, \tag{72}$$

where we set the price of varieties to 1, and g and g^* are decreasing monotonic transformations of the price indices in which terms we present the outcomes of this section. The price index transformations are given by the following expressions

$$g = P^{1-\theta} = n + n^*\rho_H, \tag{73}$$

$$g^* = P^{*\,1-\theta} = n\rho_H + n^*, \tag{74}$$

where we have imposed symmetry in prices across varieties. We write countries' indirect utility functions in terms of the transformations as follows

$$V = \alpha^\alpha (1-\alpha)^{1-\alpha} g^{\frac{\alpha}{1-\theta}} I, \tag{75}$$

$$V^* = \alpha^\alpha (1-\alpha)^{1-\alpha} g^{*\frac{\alpha}{1-\theta}} I^*. \tag{76}$$

Note a country's welfare is increasing in its g transformations. We are now ready to

derive Home's share of firms that clears the markets of varieties and write this share as

follows

$$S_n = \frac{S_l(1-\rho_F\rho_H)-\rho_H(1-\rho_F)\left(1+\frac{\mathrm{N}(\boldsymbol{\Gamma})\bar{c}}{\mathrm{L^W}}\right)}{1-\rho_F\rho_H-(\rho_H+\rho_F-2\rho_F\rho_H)\left(1+\frac{\mathrm{N}(\boldsymbol{\Gamma})\bar{c}}{\mathrm{L^W}}\right)}. . \tag{77}$$

Equation (77) shows that larger markets are still more conducive to starting new

businesses: Home's share of firms is increasing in Home's labor share. Furthermore,

Home's share of firms increases with Home's tariffs and decreases with Foreign's

tariffs as we shown in the appendix section. The equilibrium of the model as trade

costs differ across countries is defined by equations (67) and (77), which we employ to

run comparative statics exercises in the following.

Comparative Statics: New Large Country Definition and Rent-Shifting

We obtain a novel definition for a large country and show that allows

governments raise tariffs to reduce their price indices shift foreign rents to their home

countries.

An increase in the entry barriers measure increases world rents, and thus raises

the share of firms for the large country. Thus, we can obtain a definition for a large

country by investigating the conditions under Home's share of firms increases with the

entry barriers measure. Running a comparative exercise on the entry barriers measure we state the following proposition.

Proposition 5. *Home's share of firms increases with the measure of entry barriers under incomplete specialization if and only if* $S_l > \frac{\rho_H(1-\rho_F)}{\rho_H+\rho_F-2\rho_F\rho_H} = \overline{\overline{S_n}}$.

The large country definition provided in proposition 5 is different from the definition provided in Proposition 1. Proposition 5 states that if Home's tariffs are sufficiently large, Home is a large country even though its labor share is lower than a half (if $\overline{\overline{S_n}}<\frac{1}{2}$) As Home's tariffs are sufficiently large, so are the effective prices of imported varieties for domestic consumers. Thus, domestic consumers shift their expenditure towards domestic varieties, thereby making entry to the domestic more profitable and increasing the number of domestic firms.for domestic firms Home's market size. Hence, market size is not fully determined by labor shares when tariffs differ across countries.

Because a tariffs rise makes the home country more attractive and increases its number of firms, a tariffs rise shrinks the set of imported products in this country. The effect of the shrinkage in the set of imported products more than offsets the increase in the effective importing prices so that a tariffs rise reduces the price index of the home-country. The following proposition formalizes this result.

Proposition 6. A tariff rise shrinks the set of imported varieties but increases the effective price of these varieties. The former effect is stronger than the latter effect,

and thus a rise in tariffs decreases the price index. A rise in foreign tariffs enlarges the set of imported varieties so that a country's price index increases with foreign tariffs. We write $\frac{dg}{d\rho_H} > 0$ and $\frac{dg}{d\rho_F} < 0$.

Proposition 6 states that a country's price index decreases with domestic tariffs and increases with the tariffs of its commercial partner. An increase in Foreign's tariffs shift the expenditure of foreign consumers towards foreign varieties, thereby making market entry to the foreign market more profitable and increasing the number of foreign firms. Hence, the Homes' set of imported products increases so that the rise in foreign tariffs the price index of the home country.

Proposition 6 confirms that our paper yields the same qualitative results as Ossa's model and shows that his results are robust to the introduction of entry barriers and rents. We more thoroughly compare the motivations for raising tariffs described in Ossa to the motivations described in our model. In our model not only does a tariffs rise reduce the price index, but it also shifts rents from the foreign country. An interesting question then is how the incentives for raising tariffs differ quantitatively in the two models. The following proposition compares the incentives from the two models.

Proposition 7. The rate of utility change arising from a tariffs rise is greater in this model than it is in Ossa's setup. We denote the rate of utility change in Ossa as $V^{\ddot{O}ssa}$ and the same rate in our model as $V^{\ddot{E}B}$. Thus, we say that a tariffs rise causes

the following changes in Ossa's model $V^{\ddot{O}ssa} = g^{\ddot{O}ssa}$, and the following change in

our model $V^{\ddot{E}B} = \left(\frac{\alpha}{1-\theta}\right)\left(g^{\ddot{O}ssa} + A\right) + I^{\ddot{E}B}$, where $A > 0$, $I^{\ddot{E}B} > 0$.

Proposition 7 states that the incentives for raising tariffs, when expressed in

change rates, are greater in this model than they are in Ossa's setup for two reasons.

First, the increase in the number of domestic firms increases the domestic income in

our model as firms create rents. Second, the rate of increase in the g function is greater

in our model as this rate can be expressed as Ossa's rate plus a positive term. In our

model, the increase in the number of domestic firms increases the income and then the

market size of the home-country. The increase in the market size increases

endogenously the number of domestic firms, which makes competition more intense

and therefore reduces the number of foreign firm. As the number of foreign firms

decreases by a larger amount in our model, the shrinkage of the imported products set

is greater than it is in Ossa's setup.

We add to Ossa's model an additional motivation for raising tariffs, thereby

reconciling the rent-shifting motivation initiated b BS with Ossa's setup. This

distinguishes our paper from Ossa's from a qualitative perspective. Our model also

differs from his in quantitative terms as the incentives for raising tariffs are stronger

when expressed in rates of change in our paper.

2.5   Conclusion

We have added entry barriers to a general equilibrium model of international

trade and investigated its implications for trade patterns and welfare. We have shown

that the rents generated by entry barriers modify results from standard theory. As rents are considered larger markets benefit not only from higher labor earnings but also from higher rents. Thus, we have shown that .market size plays a more relevant role than predicted by the models of the home-market effect.

The existence of rents exacerbates the home market effect literature initiated by Krugman (1980). The reason being that the creation of new businesses triggers an endogenous force that enlarges the market size, thereby making the creation of new firms even more attractive.

We also emphasizes the importance of market size by showing that market sizes might distinguish between countries that gain and countries that lose from mutual trade liberalization.In particular, if entry barriers are sufficiently large and the trading partners are sufficiently unequal in size, mutual liberalization harms small countries. This result is an innovation in the literature of the home-market effect and challenges the Pareto optimality of trade agreements in other main streams models of international trade. It would be interesting, for instance, to investigate whether our result on trade liberalization holds as we include the standard forces triggered by a tariff rise in n a factor proportion model. In these models small countries gain from trade agreements as a tariffs falls eliminates price distortions for both consumers and producers. We do not consider welfare-increasing effects of trade agreements in this paper.

In addition, the paper shows that market size is determined not only by labor forces but also by domestic and foreign tariffs. An increase in domestic tariffs

increases the demand for a country's products, and thus raises its market size. The market size increase makes the creation of new firms more profitable so that the income of the home country increases and its price index decreases. Hence, this paper reconciles the rent-shifting literature initiated by BS with Ossa's setup.

Finally, we show that an increase in entry barriers may benefit a large country, challenging the idea that higher entry barriers are welfare-reducing unambiguously. e. In this respect, this paper connects to an emergent line of research investigating the consequences of specific entry barriers such as market failure and credit constraints (see Feenstra,(2011)). Rather than pursing this line of research, we have taken a more general approach to addressing entry barriers: we have taken the existence of entry barriers as given to highlight their economic implications.. Further research could build an integrated framework that makes it possible to further investigate the bidirectional causal relationship between trade and entry barriers.

Table 2-1: Cross-Country Differences in Entry Barriers Caused by Regulation

Dependent Variable	D.B. Ranking		
Independent Variables	I	II	III
GDP (P.P.P.)	-0.007***		-0.003
	(0.003)		(0.002)
GDP Per Capita (P.P.P.)		-0.002***	-0.002***
		(0.000)	(0.000)
Constant	89.931***	115.692***	116.053***
	(3.881)	(3.916)	(3.920)
Observations	173	173	173
R^2	0.046	0.416	0.42
Standard errors in parenthesis	***p<0.01	**p<0.05	**P<0.1**

Notes: The dependent variable is the DB ranking. In Column (1), the independent variable is G.D.P., and in Column (2), the independent variable is income per capita. Column (3) includes the two variables..
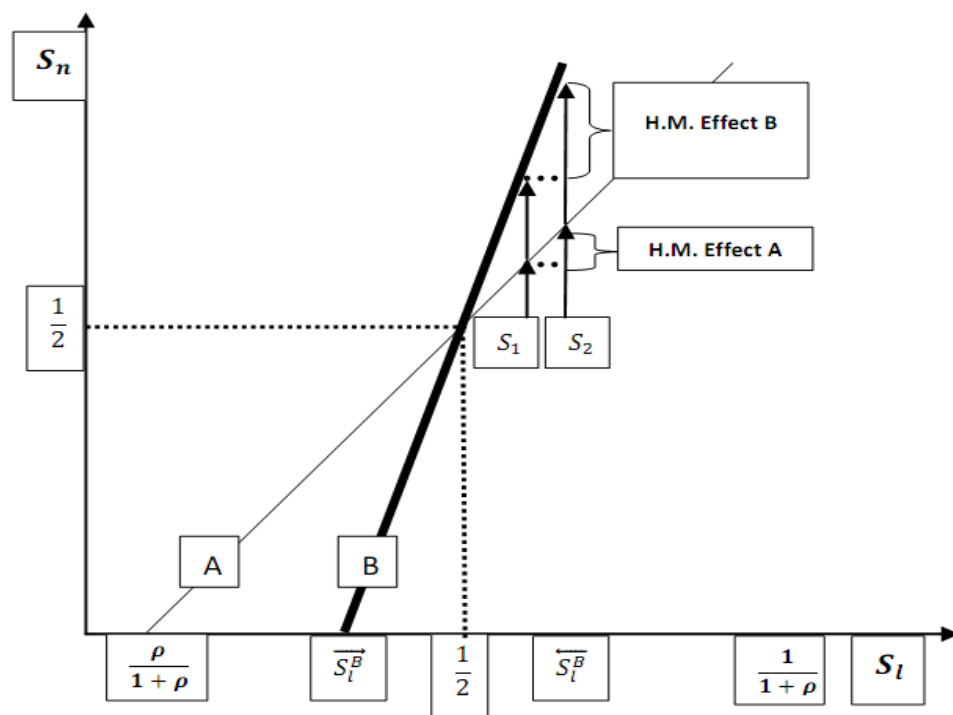
Figure 2-1: Magnification of the Home-Market Effect

Notes: The x-axis shows Home's labor share and the y-axis shows Home's share of firms. The segment B corresponds to the case where rents are greater than zero so that the home-market effect is magnified.
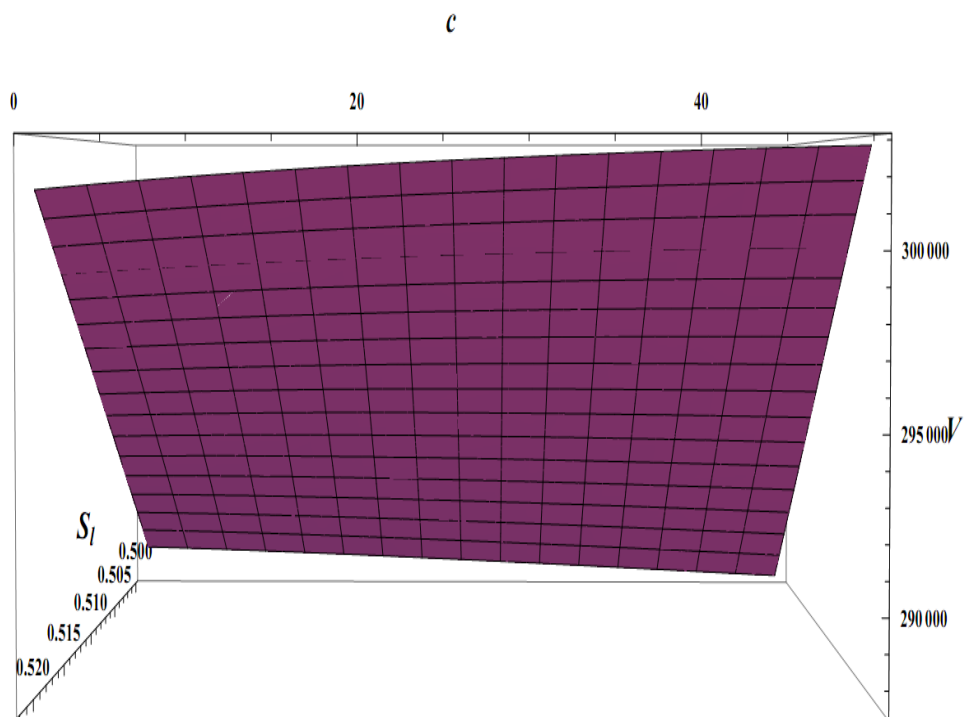
Figure 2-2: Utility Change for a Large Country after an Entry Barriers Increase

Notes: As the large country is sufficiently large an increase in the entry barriers measure increases utility.

2.6   Appendix

Appendix 2.1

In this appendix we justify assumption (48') by studying differences in the degree of entry barriers caused by regulation from an empirical perspective. In particular, we compare degrees of entry barriers across countries with the characteristics of the trading partners trading partners considered in our model: countries with similar labor productivities levels but different market sizes. A preliminary, intuitive interpretation suggests that countries with similar productivity levels will have similar degrees of regulation. We test this intuitive idea employing the Doing Business (DB) indicators from the World Bank and data from the IMF.

The DB ranks economies based on indicators that measure the regulations that affect the life cycles of domestically owned firms. Many indicators assume that firms do not engage in foreign trade; however, the ranking remains a useful proxy for regulatory environments. Our sample includes the 173 countries that appear in the IMF estimates for GDP, which proxies for market size, and income per capita, which proxies for labor productivity. These income measures are expressed in P.P.P. terms. In all regressions, the dependent variable is the 2010 DB ranking, and the independent variables are the proxies for labor productivity and market size.

Table 1 displays the results. In Column (1), the independent variable is G.D.P., and in Column (2), the independent variable is income per capita. Column (3) includes the two variables. The results displayed in the first two columns of Table 1 suggest that the variation in the countries' regulatory environments is better explained by labor

productivity than it is explained by market size. Whereas only 4.6 % of the index

variability is accounted for by the GDP, 41.6% of the same variability is accounted for

by the income per capita. Furthermore, G.D.P. loses its significance but income per

capita remains significant in Column (3), in which the two variables are included in

the same regression. These results suggest that countries with similar labor

productivity levels but different market sizes have similar regulatory environments.

Appendix 2.2

      This appendix shows that the total number of firms that we have shown in (45)

clears the outside good market. The appendix also shows that utility decreases with the

entry barriers measure in an autarky regime. To set equilibrium in the homogeneous

good market, we first state the labor usage per-firm under the equilibrium quantity.

This labor usage per-firm is the following

$$l_i = \theta(\bar{c} + f) - \bar{c},$$

The supply of the homogenous good is then written as follows

$$H^s = L - N(\theta(\bar{c} + f) - \bar{c}).$$

Under the income definition displayed above, the demand for the good is the

following

$$H^d = (1 - \alpha)(L + N\bar{c})$$

Hence, equilibrium is given by

$$H^d = H^s \xrightarrow{yields} N = \frac{\alpha L}{\theta(\bar{c} + f) - \alpha\bar{c}},$$

which is the total number of firms from (45).

We show that utility decreases with the entry barriers measure. Replacing in (41) for N and I and taking the derivative with respect to the enrtry barriers measure we get

$$\frac{dV}{d\bar{c}} = \frac{-((\theta - \alpha)\bar{c} + f(1 - \alpha))\alpha L(\frac{\alpha L}{\theta(\bar{c} + f) - \alpha\bar{c}})^{\frac{\alpha}{\theta - 1}}}{(\theta(\bar{c} + f) - \alpha\bar{c})^2}$$

$$< 0.$$

This proves that indirect utility falls with the entry barriers measure.

Q.E.D.

Appendix 2.3

This appendix shows the set of conditions in equations (49) and (50) in terms of the exogenous parameters. As for equation (49), we plug our definition for the total number of firms into this equation and obtain

$$S_l < \frac{(\bar{c} + f)\theta\rho}{(\theta(\bar{c} + f) - \alpha\bar{c})(1 + \rho)} = \underline{S_{l'}}$$

$$S_l > \frac{f\theta + \bar{c}(\theta - (1 + \alpha)\rho)}{(\theta(\bar{c} + f) - \alpha\bar{c})(1 + \rho)} = \bar{S}_{l'}.$$

As for (50), we plug the same definition and obtain

$$f\theta(1 - \rho) + \bar{c}\big(\theta(1 - \rho) - \alpha(1 + \rho)\big) > 0,$$

which requires the following condition to hold:

$$\textit{Nothing,} \qquad\qquad \textit{if } \alpha < \frac{\theta(1 - \rho)}{1 + \rho},$$

$$\bar{c} < \frac{f\theta(1 - \rho)}{\alpha(1 + \rho) - \theta(1 - \rho)} = \ddot{c}, \qquad \textit{if } \alpha > \frac{\theta(1 - \rho)}{1 + \rho}.$$

Appendix 2.4

This Appendix shows Home's firms share in terms of the exogenous parameters, it shows the stability of the equilibrium, and proves the comparative statics results from section 3. Plugging our definition for the total number of firms in Home's share yields the following

$$S_n{}^* = \frac{S_l(f\theta + \bar{c}(\theta - \alpha))(1 + \rho) - (c + f)\theta\rho}{f\theta(1 - \rho) + \bar{c}\big(\theta(1 - \rho) - \alpha(1 + \rho)\big)}$$

We employ this expression to prove the stability of the equilibrium. To this end, we remind the reader that equilibrium in the markets of manufacturing products requires

$$\frac{I}{g} = \frac{I^*}{g^*}.$$

The equilibrium is then stable if $\frac{I}{g} - \frac{I^*}{g^*} > 0$ for any $S_n < S_n{}^*$. Subtracting the

terms, we obtain the following

$$\frac{I}{g} - \frac{I^*}{g^*}$$

$$= \frac{S_n(L^W(1-\rho) - 2\bar{c}N\rho) + L^W S_l(1+\rho) + (N\bar{c} + L^W)\rho}{(1 - S_n(1-\rho))(-S_n(1-\rho) - \rho)}.$$

The expression is positive and therefore the model is stable.

Q.E.D.

We go over the comparative statics results now. Taking the expression for

Home's share of firms given in this appendix 2.1, we prove the magnification of the

home-market effect.

$$\frac{dS_n{}^*}{dS_l} - \frac{1+\rho}{1-\rho} =$$

$$\frac{2\bar{c}\alpha\rho(1+\rho)}{f\theta(1-\rho) + \bar{c}(\theta(1-\rho) - \alpha(1+\rho))} > 0.$$

where the last inequality results from the assumption on the value of rents per firm.

Taking the derivative of the expression that shows up above with respect to the entry

barriers measure, we obtain

$$\frac{dS_n{}^*}{d\bar{c}dS_l} = \frac{2\bar{c}\alpha\rho\theta(1+\rho)}{(f\theta(1-\rho) + \bar{c}(\theta(1-\rho) - \alpha(1+\rho)))^2} > 0.$$

This shows that the home market effect increases with the entry barriers measure. Furthermore, taking the expression for Home's share of firms displayed in this appendix, we obtain the following result

$$\frac{dS_n^*}{d\alpha} = \frac{\bar{c}(c+f)(-1+2S_l)\theta\rho(1+\rho)}{(f\theta(1-\rho)+\bar{c}(\theta(1-\rho)-\alpha(1+\rho)))},$$

therefore: $\frac{dS_n^*}{d\alpha} > 0$ if and only if $S_l > \frac{1}{2}$.

Appendix 2.5

This appendix proves Proposition 3. We plug the equilibrium values in our definition for indirect utility function and obtain the following expression for Home

$$V = \left(\alpha(1+\rho)\right)^{\frac{\alpha}{\theta-1}}(c+f)\theta$$

$$* \left(\frac{L^W(S_l(f\theta+\bar{c}(\theta-\alpha))(1-\rho)-\bar{c}\alpha\rho)}{(\theta(\bar{c}+f)-\alpha\bar{c})(f\theta(1-\rho)+\bar{c}(\theta(1-\rho)-\alpha(1+\rho)))}\right)^{1+\frac{\alpha}{\theta-1}}$$

We take the derivative of the expression displayed above with respect to the trade cost parameter and obtain

$$\frac{dV}{d\rho} = \frac{V}{(\theta-1)}(\frac{\alpha}{1+\rho}+$$

$$\frac{\bar{c}(-1+2S_l)\alpha(\alpha+\theta-1)(\theta(\bar{c}+f)-\alpha\bar{c})}{(S_l(\theta(\bar{c}+f)-\alpha\bar{c})(1-\rho)-\bar{c}\alpha\rho)(f\theta(1-\rho)+\bar{c}(\theta(1-\rho)-\alpha(1+\rho)))}).$$

The former term inside the square bracket is positive. The latter term is positive if and only if $S_l > \frac{1}{2}$. Therefore, the trade agreement makes the large size-country better off. As for the small size-country, the latter term is negative, and thus

this country is worse off if and only if the latter term is greater than the former term in absolute value. This happens when the labor share of Home (the small country in this case) is lower than an upper bound as the latter term increases with Home's labor share. The upper bound is written as follows

$$S_l^{MTL} =$$

$$\frac{\bar{c}((\alpha + (\theta - 1)(1 + \rho))(\theta(\bar{c} + f) - \alpha\bar{c}) + \alpha(f\theta + \bar{c}(\alpha + \theta))\rho^2)}{(\theta(\bar{c} + f) - \alpha\bar{c})(-f\theta(1 - \rho)^2 + \bar{c}(\theta - \theta(\rho - 4)\rho - (2 + \alpha(\rho - 3)(1 + \rho)))}$$

It now suffices to prove that this upper bound is greater than the lower bound on Home's labor share that avoids complete specialization. Subtracting the bounds we obtain

$$S_l^{MTL} - \underline{S_l} =$$

$$\frac{(-f\theta(1 - \rho)\rho + \bar{c}(1 + \rho + \theta(-1 - (2 - \rho)\rho) - \alpha(1 - \rho^2)))}{(1 + \rho)\left(-f\theta(1 - \rho)^2 + \bar{c}\left(\theta - \theta(\rho - 4)\rho - \left(2 + \alpha(\rho - 3)(1 + \rho)\right)\right)\right)} \quad ($$

$$* (f\theta(1 - \rho) + \bar{c}(\theta(1 - \rho) - \alpha(1 + \rho)))$$

From here we have different situations based on the values of α and $\bar{c}$:

$$if \ \bar{c} > c^{MTL} =$$

$$\frac{f\theta(1 - \rho)^2}{(\theta - \theta(\rho - 4)\rho - (2 + \alpha(\rho - 3)(1 + \rho))(1 + \rho)} \quad and$$

$$\alpha > -\frac{\theta\rho}{1+\rho} - \frac{\theta-2}{3-\rho}, \text{ then}$$

$$S_l^{MTL} - \underline{S_l} > 0.$$

However, note that the condition on α is always fulfilled $if \ \theta > \theta^{MTL} < 2$. It might be possible that $\theta > \theta^{MTL}$ so that we need $\alpha > -\frac{\theta\rho}{1+\rho} - \frac{\theta-2}{3-\rho}$ and simultaneously

we need $\bar{c} < \ddot{c}$ in order for the bound on rents per worker to be fulfilled; this would

not be a problem because $c^{MTL} < \ddot{c}$

Q.E.D.

Appendix 2.6

This appendix proves Proposition 4. We take the expression for Home's

indirect utility displayed in the previous appendix. Taking derivative of this expression

with respect to $\bar{c}$ yields the following

$$\frac{dV}{d\bar{c}} = \frac{V}{(\theta - 1)} \left(\frac{f(1 - \alpha) + c(\theta - \alpha)}{(\bar{c} + f)(-\bar{c}\alpha + (\bar{c} + f)\theta)} + \right.$$

$$\left. \frac{f(2S_l - 1))\theta(\alpha + \theta - 1)(1 - \rho)\rho}{(S_l(\theta(\bar{c} + f) - \alpha\bar{c})(1 - \rho) - \bar{c}\alpha\rho)(f\theta(1 - \rho) + \bar{c}(\theta(1 - \rho) - \alpha(1 + \rho)))} \right),$$

This proves that a small size-country is always worse off. As for the large size-

country, the latter term in the square bracket is positive. Therefore, if this termsoffsets

the negative former term, the large-size country is better off.

We employ Home's indirect utility function and the parameter values for the

simulation depicted in Figure 2.2.Thus, we employ $\rho = 0.9; f = 100; \theta = 6;$

$L = 500000; \alpha = 0.15$. This choice guarantees that the economy is sufficiently open

to trade. We choose values for the labor share and $\bar{c}$ in the intervals $\bar{c} \ni (0,50)$ and

$S_l \ni (0.5; 0.522)$ so that Home is a large size-country. In particular, we choose the

middle point of the c-interval and set $\bar{c} = 25$. From here, we distinguish two cases for

these parameter values.

$$if\ S_l = 0.511, \quad then\ \frac{dV}{d\bar{c}} = \frac{V}{(\theta - 1)}(0.000114248)$$

$$If\ S_l = 0.505, \quad then\ \frac{dV}{d\bar{c}} = \frac{V}{(\theta - 1)}(-0.0028131)\ .$$

This proves Proposition 4.

    Q.E.D.

Appendix 2.7

This appendix shows the set of restrictions on Home's labor share and on the rents per worker in terms of the exogenous parameters. The appendix also shows proposition 5.

We plug our definition for the total number of firms in the restriction for Home's labor shares and obtain

$$S_l < \frac{\theta(\bar{c} + f)(1 - \rho_F)(1 - \rho_H) - \bar{c}\alpha(1 - \rho_F\rho_H)}{(\theta(\bar{c} + f) - \alpha\bar{c})(1 - \rho_F\ \rho_H)}$$

$$S_l > \frac{(c + f)\theta\rho_H(1 - \rho_F)}{(\theta(\bar{c} + f) - \alpha\bar{c})(1 - \rho_F\rho_H)}$$

As for the restriction on the rents per worker we get

$$\theta(\bar{c} + f)(1 - \rho_F)(1 - \rho_H) - \bar{c}\alpha(1 - \rho_F\rho_H) > 0,$$

which requires the following condition to hold

$$\text{Nothing,} \qquad\qquad if\ \alpha < \frac{\theta(1-\rho_F)(1-\rho_H)}{1+\rho},$$

$$\bar{c} < \check{c}, \qquad\qquad if\ \alpha > (1 - \rho_F\ \rho_H),$$

$$\check{c} = \frac{\theta f(1-\rho_F)(1-\rho_H)}{\alpha(1-\rho_F\rho_H) - \theta\theta(1-\rho_F)(1-\rho_H)}$$

To the purpose of proving Proposition 5. we first write Home's share of firms in terms of the exogenous parameters. This yields

$$S_n^{\ *} =$$

$$\frac{S_l(\theta(\bar{c}+f)-\alpha\bar{c})(1-\rho_F\rho_H) - (\bar{c}+f)\theta\rho_H(1-\rho_F)}{\theta(\bar{c}+f)(1-\rho_F)(1-\rho_H) - \bar{c}\alpha(1-\rho_F\rho_H)}$$

Taking the derivative of this expression with respect to the entry barriers measure yields the following

$$\frac{dS_n^{\ *}}{d\bar{c}} =$$

$$\frac{(1-\rho_F\rho_H)\theta\alpha f(S_l(\rho_F+\rho_H-2\rho_F\rho_H)-\rho_H(1-\rho_F))}{(\theta(\bar{c}+f)(1-\rho_F)(1-\rho_H)-\bar{c}\alpha(1-\rho_F\rho_H))^2}.$$

which is positive if and only if $S_l > \frac{\rho_H(1-\rho_F)}{\rho_H+\rho_F-2\rho_F\rho_H} = \overline{\overline{S_n}}.$

Q.E.D.

Appendix 2.8

This appendix proves that Home's share of firms increases with its own tariffs and decreases with foreign trade costs, and it proves Propostion 6. Since world rents are independent of tariffs, we can work with the definition of Home's share that do not

replace for the total number of firms. Taking the derivative with respect to the tariffs

measures we obtain the following

$$\frac{dS_n^*}{d\rho_H} =$$

$$\frac{\left(1 + \frac{N(\pmb{\Gamma})\bar{c}}{L^W}\right)(1 - \rho_F)(\frac{\rho_F N(\pmb{\Gamma})\bar{c}}{L^W} - (1 - S_l)(1 - \rho_F))}{(1 - \rho_F\rho_H - (\rho_H + \rho_F - 2\rho_F\rho_H)\left(1 + \frac{N(\pmb{\Gamma})\bar{c}}{L^W}\right))^2}$$

$$< 0.$$

where the last inequality results from the parameter restriction to avoid complete

specialization Consider now a change in tariffs, we have the following

$$\frac{dS_n^*}{d\rho_f} =$$

$$\frac{\left(1 + \frac{N(\pmb{\Gamma})\bar{c}}{L^W}\right)(1 - \rho_H)(S_l(1 - \rho_H) - \frac{\rho_H N(\pmb{\Gamma})\bar{c}}{L^W})}{(1 - \rho_F\rho_H - (\rho_H + \rho_F - 2\rho_F\rho_H)\left(1 + \frac{N(\pmb{\Gamma})\bar{c}}{L^W}\right))^2} > 0.$$

where the last inequalityarises from the parameter restriction that we have imposed in

order to avoid complete specialization. We show that Home's g function is increasing

in domestic tariffs –and decreasing in ρ_H-, and therefore we show that the price index

of the home-country is decreasing in Home's tariffs. We replace for the value of

Home's share of firms and the total number of firms in the g function and take the

derivative of this function with respect to Home's tariffs. Thus, we obtain the

following

$$\frac{dg}{d\rho_H} =$$

$$\frac{-\rho_F(S_l(1-\rho_H) - \frac{\rho_H N(\boldsymbol{\Gamma})\bar{c}}{L^W})}{\left(1 - \rho_F\rho_H - (\rho_H + \rho_F - 2\rho_F\rho_H)\left(1 + \frac{N(\boldsymbol{\Gamma})\bar{c}}{L^W}\right)\right)} +$$

$$\frac{(-\frac{\rho_F N(\boldsymbol{\Gamma})\bar{c}}{L^W} - (1 - S_l)(1 - \rho_F))(1 - \rho_F\rho_H)}{\left(1 - \rho_F\rho_H - (\rho_H + \rho_F - 2\rho_F\rho_H)\left(1 + \frac{N(\boldsymbol{\Gamma})\bar{c}}{L^W}\right)\right)^2}$$

$$<0.$$

where the last inequality arises from the fact that the two terms are negative under the sets of conditions we have imposed to avoid complete specialization

Appendix 2.9

This appendix shows Proposition 7. To this purpose, we keep working with Home's labor share in terms of the total number of firms. In Ossa's model, the rate of change due to a rise in domestic tariffs is written as follow

$$g^{\ddot{o}ssa} = \frac{\rho_F}{1 - \rho_F\rho_H}.$$

In our model, the same rate is written as follows

$$g^{\ddot{E}B} = \frac{\rho_F}{1 - \rho_F \rho_H} +$$

$$\frac{\frac{\mathrm{N}(\pmb{\Gamma})\bar{c}}{\mathrm{L}^{\mathrm{W}}}(1 - S_l)(1 - \rho_H) - \frac{\rho_F \mathrm{N}(\pmb{\Gamma})\bar{c}}{\mathrm{L}^{\mathrm{W}}})}{\left(1 - \rho_F \rho_H - (\rho_H + \rho_F - 2\rho_F \rho_H)\left(1 + \frac{\mathrm{N}(\pmb{\Gamma})\bar{c}}{\mathrm{L}^{\mathrm{W}}}\right)\right)}.$$

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Chapter 3: Incomplete Contracts, Industrial Linkages, and Profits-Shifting

Abstract

We develop a model of trade in final goods and inputs between a developing country -the South- and a developed country -the North- and show that tariffs are welfare-improving for the South within a setting of incomplete contracts. We employ two standard strands of competing arguments: tariffs will foster linkages between input producers but they will create price-distortions. The profits-shifting effects of the linkages will more than offset the welfare-reducing effects of price-distortions in industries with a sufficiently low comparative disadvantage. The range of protected industries and its average tech-intensity will decrease with the overall comparative disadvantage of the South.

3.1 Introduction

The question of whether government intervention in product markets can improve welfare is a centuries-old topic. A strand of arguments accentuates that intervention distorts prices in comparative disadvantage industries (see for example, The World Bank's report (1993)). A competing strand stresses that intervention fosters linkages between input producers (see for example, Pack and Westphal (1986), Okuno-Fujiwara (1988) and Rodrik (1996)).

We develop a model of trade in final goods and inputs between a developing country -the South- and a developed country -the North- and use this model to show that a particular form of intervention is welfare-improving within a setting of incomplete contracts. We employ arguments from the two strands described in the previous paragraph to show that tariffs improve welfare: tariffs will foster linkages between input producers but they will distort prices. The former effect will be stronger than the latter effect in industries where the comparative disadvantage is sufficiently low.

The degree of comparative disadvantage of the South will vary across industries. Production of final goods will involve two types of complement inputs; the relative intensity of the hi-tech and the low tech input will vary across industries. Producing the hi-tech input will be more expensive in the South than in the North, and thus the South will have a greater comparative disadvantage in industries whose usage of the hi-tech input is more intensive.

Industrial linkages will arise between the producer of the hi-tech input and the producer of the low-tech input, which will be of a different type in the manner of Antras (2005). We will think of hi-tech input producers as supplying final goods, and thus consider two suppliers for each final good.[28] Although we consider the hi-tech input producers as the suppliers, the profits of the two types of producers will depend on the sales of the final good. This will create the industrial linkage: the optimal production-level of an input producer will depend on the other producer's production-level.

To foster the linkage the government must ensure that the two producers in a given industry are from the South. We will assume that the low-tech input producer is from this country; therefore, the government must ensure that the hi-tech input producer is also from the South to foster the linkage. To this end the government will use tariffs on final goods to change the free-trade equilibrium outcome arising from the strategic interaction of firms.

In every industry there will be a potential hi-tech input producer from the South and a potential hi-tech input producer from the North; however, a hi-tech producer from the South will not enter the market in the free trade equilibrium outcome. The Northern producer will threaten the producer from the South with initiating a price-war. The threat will be credible as the Northern producer faces lower production costs -producing the hi-tech input is more expensive in the South as noted

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[28] We think of final good suppliers as being the hi-tech input producers only for expositional purposes. Analogously we could think of there being a competitive fringe of final good supplier that buys the inputs from the input producers.

above-. Hence the hi-tech input producer from the South will not enter the market under free-trade.

The tariff will cause market entry by the hi-tech input producer from the South thereby fostering a linkage with a low-tech input producer. The tariff will change the outcome of the price-war by increasing the price of the final good supplied by the Northern producer. The producer from South will then credibly threaten the Northern producer with winning the price-war. Hence only the producer from the South will supply the hi-tech input in the protected industry.

Market entry by the producer from the South is profitable, and then the tariff increases domestic profits. [29] The increase in domestic profits occurs at the expense of the North as the tariff also deters entry by the producer from this country. In other words, the government from the South can foster a linkage that generates profits-shifting by imposing a tariff. This profits-shifting will be the motivation for setting the tariff: the increase in domestic profits will increase the producer surplus and thus welfare. On the other hand the tariff will increase the final good price as production costs for the market entrant are higher than for the Northern producer whose entry was deterred. The price increase will reduce the consumer surplus so that the tariff will have a welfare-reducing effect.

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[29]There is large evidence that domestic firms made profits thanks to policies that fostered linkages in East-Asia. Large conglomerates called *Keiretsus* and *Chaebols* made big profits in Japan and Korea thanks to "picking winner" strategies. In Taiwan medium-sized firms sold inputs to small manufacturers at a profit -Feenstra (2000)-. Akyus (1996) claims that high corporate profits and other profit-related incomes caused the high savings rates observed in these countries. Specifically, Aykus notes that operating surplus in industry, plus transport and communications in Japan was around 55% for manufacturing, compared to about 25% in the United States and United Kingdom.

The government from the South will impose the tariff if its welfare-increasing effect more than offsets its welfare-reducing effect. This will occur in industries where the comparative disadvantage of the South is sufficiently low which use the hi-tech input less intensively. In these industries the tariff-level that is required for market entry is low, and then so is the welfare-reducing effect of the tariff. Hence the government will impose tariffs in industries where the comparative disadvantage is sufficiently low.

The paper relates to the two strands of competing arguments mentioned in the first paragraph. These strands arise from the discussions on the rapid development experienced by a number of East Asian countries from the 1960's through the 1980's. As argued by the first strand tariffs will distort prices in comparative disadvantages industries in our model. The second stream argues that linkages between intermediate and final good producers originate investments coordination failures. In the manner of the "Big Push" theory, coordination failures lead to zero investment by local producers.[30]As noted by this second strand we argue that the government can intervene to foster linkages between producers. However the government fosters linkages in order to shift profits and not to solve coordination failures in our model.

The paper also relates closely to another stream of literature where failures generate sub-optimal investment: the incomplete contracting literature (see for example Williamson (1985), Grossman and Hart (1986)). Among this literature the paper relates the closest to Antras (2005). Although we borrow some features from

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[30] The stream that supports the existence of industrial linkages builds upon scale economies, imperfectly tradability of inputs. In this regard, Rodrik (1995) argues that specialized labor services tend to be non-tradable and Rauch (2000), along the same lines, that differentiated products have higher trade costs.

Antras our setup differs from his in some important ways. We do not focus on a firm's choice of organizational form, and therefore we assume that firms from different countries choose the same organization-type. As we focus on how tariffs create linkages our assumptions on firms' nationalities differ from Antras': in our model hi-tech input producers may be from either country but all low-tech input producers are from the South.[31] Unlike Antras we consider only incomplete contracts as every contract will involve a party from the South. The motivation comes from the poor institution-quality in the South shown by Levchenko (2007).

The paper provides a rationale for tariffs based on profits-shifting and then also relates to the literature initiated by Brander and Spencer (1985). Their setting is one of strategic interaction where domestic oligopolies compete with foreign companies. Like in this model the government can set tariffs before market interaction, thereby providing domestic firms with a strategic advantage. As a result of the strategic advantage domestic firms make higher profits at the expense of foreign companies.[32]. Our mechanism differs from theirs in that tariffs do not shift profits as a fixed number of domestic firms with a given organizational form make higher profits. In our model tariffs induce market entry of profitable domestic firms so that our mechanism is closer to the profits-shifting channel described in Tobal (2012).[33]

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[31] We could consider vertically integrated firms that manufacture in the South instead of firms that contract independent manufacturers, and all results of the paper would still hold. This would represent better the South Korean situation but worse the Taiwanese case as understood from footnote 1.

[32] See Mzrazvova (2010) and Ossa (2011a) for more recent contributions to this literature.

[33] Note that if we considered the case of vertically integrated firms mentioned in foot note 3 firms would be expandind their business in a profitable manner instead of entering the market.

Finally the paper relates to Levchenko (2007), whose empirical evidence shows that the South has a comparative disadvantage in contract-intensive industries arising from its to poor quality of institutions. The paper differs from his theoretical approach in that we introduce a second source of comparative disadvantage: technological differences across countries for producing inputs.

We develop the model in the remainder of this paper. In section 3.2 we display the model setup, and show that the North specializes in all the contract-intensive goods under free-trade. In section 3.3 we show that trade protection is welfare-improving for the South, and that both the range of protected industries and its average tech-intensity depends on the comparative disadvantage degree.

3.2   Model Setup and Free-Trade Equilibrium

We introduce a model of trade between the developed and the developing country. Goods are produced in contract-intensive industries, and production involves the two types of inputs and producers from Antras. The North is shown to produce hi-tech inputs in every industry. This result is in line with Levchenko where only the North specializes in contract-intensive goods under free-trade.

Model Setup

We consider a world with two countries, the North and the South, and indicate the variables concerning the former with a superscript n, and the variables concerning

the latter with a superscript s. The wage w is assumed to be greater in the North so that the North-to-South wage ratio is greater than 1, $\omega = w^n/w^s > 1$.

There is a continuum of contract-intensive goods y_z of a length normalized to 1, which should be thought of as the institutionally intensive good from Levchenko. We focus on Southern consumers as we will study trade protection of the Southern market. These consumers' demand for a good y_z is written as follows

$$y_z = \lambda p_z^{-1/(1-\alpha)}, \qquad 1 < \alpha < 0, \qquad 0 \leq z \leq 1, \qquad (78)$$

where p_z is the good's price, and producers take the parameter λ as given.

Production of good y_z involves the two types of inputs and producers from Antras: a research center produces the hi-tech input x_h, and a manufacturing plant produces the low-tech input x_l. The research center must contract an independent plant for the provision of the low-tech input. Incomplete contracts apply in the South, the country with the poorest quality of institutions: if either the research center or the manufacturer is from the South (or both), the parties cannot contract on the quality or the quantity of the inputs.

Inputs can be of a good or bad quality. If any input is of a bad quality, output equals zero. If both inputs are of a good quality, output is written as follows

$$y_z = \mu_z x_h^{1-z} x_l^z, \qquad \mu_z = z^{-z}(1-z)^{-(1-z)}. \qquad (79)$$

Final goods differ in tech-intensity: high values of z denote low intensity.

Any input of a bad-quality can be produced at zero costs. Production of the hi-tech input may occur in the North or the South; research centers may be from either country. However, production costs differ across countries as stated in the following.

Assumption. *One unit of a good-quality hi-tech input requires one unit of labor in the North, and a^s units in the South. The parameter a^s is assumed to exceed the North-to-South wage so that the South has a comparative disadvantage in the production of the hi-tech input. More formally, we assume: $a^s > \omega > 1$.*

On the other hand production of the low-tech input is assumed to occur only in the South; manufacturers are only from this country. Specifically, one unit of a good-quality low-tech input requires one unit of Southern labor. As all manufacturers are from the South every contract is signed by at least one Southern party. Hence, all contracts considered in the paper will be incomplete.

A research center from each country decides whether to enter the market and contract a Southern manufacturer; the research centers from both countries decide simultaneously. A market entrant faces a small cost ε, reflecting the monetary and non-monetary costs of matching with a plant and signing a contract. Contract incompleteness implies that the parties do not specify the quality or quantity of inputs. Contracts only specify the lump-sum transfer T that the research center receives from the plant; the transfer makes the manufacturer break even like in Antras so that the research center keeps all industry-profits π_z. Anticipating this, the research center will

contract the manufacturer and enter the market if and only if profits cover the contracting costs associated with entry $-\pi_z > \varepsilon$.

Once the research center enters the market, it observes the decision made by the other center. Then the center and the manufacturer have an interaction *à la Antras*: the parties make relationship-specific investments, and bargain à la Nash ex-post over the quasi-rents. Like Antras we consider the symmetric solution so that each party is left with half of the quasi-rents. In this paper the key is that quasi-rents depend on the sales of the final product, and therefore investments are zero when no rents are expected. Figure 3-1 summarizes the timing of events.

Free Trade Equilibrium

The game played by the two research centers and the Southern manufacturing plants is solved by backward induction. The quasi-rents of each relationship depend on the final good market outcome which in turn depends on the market structure. There are four possible market structures: there may be two duos of inputs producers, a single duo formed by a research center from the North, a duo from the South, or no firms in the market. We study the four cases next.

Consider the two market structures in which one of the duos acts as a monopolist. Consumers buy the product at the price set by the monopolist so that the quasi-rents generated by the duo equal its market revenues. The parties anticipate this, and maximize the ex-post profits they are left with when making investment decisions. In the appendix section we show that profits-maximization yields the following price

for a duo formed by a research center from the North and for a duo from the South respectively

$$p_z^n = \frac{2(w^n)^{1-z}(w^s)^z}{\alpha}, \tag{80}$$

$$p_z^n = \frac{2w^s(a^s)^{1-z}}{\alpha}. \tag{81}$$

where p_z^n is the price of the monopolist duo formed by the research center from the North. The presence of α in (80) and (81) shows that monopolistic prices are higher than marginal costs in the two cases, which is the prediction of any standard monopoly-model. High prices are also due to incomplete contracts that overinflate prices in this model; this effect is present in Antras and represented by the number 2. A novel result is that incomplete contracts have no impact on market prices in a duopoly, as shown below in this paper.

Rolling back in time, Southern manufacturers anticipate that the final good will sell at the price in (80) for the case of a center from the North, and at the price in (81) for the case of a Southern center. Specifically manufacturers anticipate that the quasi-rents of a monopolistic relationship are positive, and thus the transfer T is greater than zero. Furthermore the profits made by the research centers are greater than zero. In the appendix section we show that when the transfers make the manufacturers breakeven profits are given by the following expressions

$$\pi_z^n = \lambda\left(1 - \frac{\alpha}{2}\right)(p_z^n)^{\frac{-\alpha}{1-\alpha}}, \tag{82}$$

$$\pi_z^s = \lambda \left(1 - \frac{\alpha}{2}\right) (p_z^s)^{\frac{-\alpha}{1-\alpha}}, \tag{83}$$

where π_z^n is the profits made by the monopolist duo formed by the Northern center.

Profits are greater than contracting costs in both cases so that a research center enters the market when that leads to a monopolistic situation. In other words, a research center enters the market when the research center from the other country does not. Hence a structure with no firms in the market does not occur in the equilibrium path, and the two monopolistic structures are candidates for equilibrium outcomes.

Consider the remaining structure, a duopoly with the two duos of producers simultaneously in the market. Each duo knows that its sales are zero unless its price is the lowest, and therefore the duos get involved into a "price-war." The duo that wins the war is the duo with the lowest marginal cost; specifically, this duo accomplishes input investments so that its price equals the other duo's marginal cost. Marginal costs in industry z are as follows

$$MC_z^n = (w^n)^{1-z}(w^s)^z, \qquad MC_z^s = w^s(a^s)^{1-z}, \tag{84}$$

where MC_z^n is the marginal cost of the duo formed by the Northern center. This duo has the lowest cost in every industry as the North has a comparative advantage in the hi-tech input $a^s > \omega > 1$. Therefore, the duo formed by the research center from the North wins the price-war by setting a market price equal to $MC_z^s - \hat{\varepsilon}$, where $\hat{\varepsilon}$ shows that he duo formed by the research center from the North "cuts the price" of the other duo. In this scenario, the North obtains positive rents and it earns the profits associated with the market price it sets.

The duo formed by the research center from the South loses the war and obtains zero rents. As both parties anticipate zero rents no party accomplishes input investments, and the final good is never produced. Rolling back in time the manufacturer anticipates this so that the transfer is negative; and then net profits associated with entry are lower than zero -$\pi_z^s - \varepsilon < 0$. Thus, the research center from the South does not enter the market as the Northern research center does. Hence, a duopoly does not occur in the equilibrium path, and the two monopolistic structures are the only possible equilibrium outcomes.

Turning back to the price-war, the quasi-rents of the duo formed by the research from the North are positive, and thus so is the transfer and the net profits $\pi_z^n - \varepsilon > 0$. Therefore, a research center from the North enters the market even when the Southern the center does. Hence, the only monopolist duo that enters in the equilibrium path is formed by a research center from the North, and this duo charges the price shown in (80). This characterizes the equilibrium path under free-trade.

The free-trade equilibrium is consistent with Levchenko where only the North produces the contract-intensive goods due to poor institutions-quality in the South. Instead of focusing on final products we have focused on intermediate goods. Introducing poor institution-quality in the South and a second dimension of comparative advantage, we have shown that only the North produces hi-tech inputs used for producing contract-intensive goods. These are the only inputs whose local production increases a country's rents, and the only inputs that can be produced by either country in this model.

3.3 Tariffs

This section shows that it is welfare-improving for the Southern government to change the equilibrium outcome by setting tariffs. No research center from the South enters the market so that a tariff causing entry has profit-shifting effects relative to free-trade. Profits-shifting is shown to be stronger than the welfare costs on consumers for sufficiently low comparative disadvantage industries. Developing countries whose comparative disadvantage in every industry is lower are shown to protect a wider range of industries.

Profits-Shifting Tariffs

The Southern government sets tariffs before the entry-stage. That is, we add to the timing shown in Figure 3-1 a first stage where the government protects the market. Among all options, we first study profits-shifting tariffs. To shift profits a tariff must cause entry of a research center from the South as research centers keep all industry-profits. The research center enters the market if it wins the price-war triggered by the virtual entry of the two centers. The following equation determines the ad-valorem tariff causing entry into industry z

$$\tau_z > MC_z^s / MC_z^n = (a^s/\omega)^{1-z} , \qquad (85)$$

where τ_z denotes the market-entry tariff. Under tariffs greater than the North-to-South marginal cost, no price allows the Northern center to win the price-war making profits. The North-to-South marginal cost increases monotonically with the tech-intensity of

the protected industry. Hence, entry into industries with a larger comparative

disadvantage requires stronger trade protection.

Under the tariff the research center from the South wins the war. This research

center enters the market independent of the Northern center's action, but the Northern

center enters only as the former center does not. Hence, the Southern center is the only

market entrant in the equilibrium path under the tariff.

The Southern center and manufacturer produce inputs so as to maximize the

profits they are left with, and thus the price under the tariff is that shown in (4).This

price is greater than the price under free trade -shown in (80)- so that protection causes

welfare losses for Southern consumers. The welfare loss caused by the tariff in

industry z is the difference between the following expressions

$$C_z^{FT} = \int_{p_z^n}^{\infty} \lambda p_z^{-1/(1-\alpha)} \, dp_z = \lambda \left(\frac{1-\alpha}{\alpha} \right) (p_z^n)^{\frac{-\alpha}{1-\alpha}}, \qquad (86)$$

$$C_z^{TP} = \int_{p_z^s}^{\infty} \lambda p_z^{-1/(1-\alpha)} \, dp_z = \lambda \left(\frac{1-\alpha}{\alpha} \right) (p_z^s)^{\frac{-\alpha}{1-\alpha}}, \qquad (87)$$

where C_z^{FT} and C_z^{TP} are consumer surplus under free-trade and trade protection.

Relative to the free trade, the welfare loss is greater in industries where the

comparative disadvantage is larger as entry requires into these industries requires

stronger protection. Although protection reduces consumer surplus, a profits-shifting

tariff fosters a linkage between a research center and a manufacturer relative to free-

trade. The profits-shifting generated by the linkage increases producer surplus in the

South by an amount that equals the profits made by the research center. Hence, the increase in producer surplus caused by the tariff is shown in (6) for industry z.

If the increase in producer surplus is stronger than the fall in consumer surplus, protection increases welfare. The following Lemma summarizes the result

Lemma 1. *There is a cutoff industry $\bar{z}^{TP}$ that determines the industry-set for which the welfare effects of profits-shifting are greater than the costs imposed on domestic consumers. Hence, trade protection is welfare-improving for any industry z such that $z \in (\bar{z}^{TP}, 1)$.*

Lemma 1 proposes a rationale for trade protection based on profits-shifting relative to free-trade. This rationale is consistent with Levchenko where free-trade eliminates jobs that create rents in the institutionally intensive sector.

The tariff shown in (85) is preferred over free-trade as profits-shifting more than offsets the effects of the domestic price increase. However, other ad-valorem tariffs may be preferred over the profits-shifting tariff shown in (85). The following Lemma states that no tariff dominates a profits-shifting tariff in terms of welfare

Lemma 2. *Free-trade and profits-shifting tariffs are welfare–improving relative to tariffs that do not cause market entry by Southern centers; that is, relative to any tariff τ_z such that $\tau_z \leq MC_z^s / MC_z^n$ in industry z. Hence, profits-shifting tariffs are optimal for the set of industries z such that $z \in (\bar{z}^{TP}, 1)$.*

Tariffs not causing market entry only affect welfare through their impact on final goods prices and quantities. Under these tariffs the research center from the North and the Southern manufacturer anticipate a lower demand, and therefore lower quasi-rents for each input production level. As a result, the parties reduce their input investments relative to free-trade and produce a lower quantity at a higher effective importing price. In the appendix section we prove this result.

Lemma 2 reinforces profits-shifting as a rationale for trade protection: only tariffs that shift rents are preferred over free-trade. The Lemma states that the South is better-off producing goods within the set $(\bar{z}^{TP}, 1)$, for which it does not have a comparative advantage. This result argues against The World Bank's ideas and the comparative advantage argument. However, there is a role for comparative advantage in the model as welfare changes caused by protection decreases monotonically with tech-intensity. In other words, welfare gains are lower –and negative- for industries with a large comparative disadvantage. Hence, the South only protects industries with a sufficiently low comparative disadvantage.

Countries with Different Overall Comparative Disadvantage

We analyze the link between a developing country's comparative advantage profile and trade protection. The analysis is motivated by two observations. First, that the sectoral configuration of the East Asian economies (Japan, South and Taiwan) shifted to mid-tech industries, but the configurations of other protectionist countries from Latin-America did not. Second, it is motivated by the connection between a

country's profile and its success in fostering linkages that was noted by Rodrik. He claims that intervention successfully fostered linkages in East Asia as South Korea and Taiwan had a lower comparative disadvantage in the types of goods produced by rich nations.

To distinguish between countries with a different comparative advantage profile, I run a comparative statics exercise on the term a^s/ω. This term measures comparative disadvantage in the hi-tech input and in the types of goods produced by rich nations. Comparative statics yields the following graphs

Figure 3-2 depicts the set of protected industries for a developing country with a lower comparative disadvantage in the types of goods produced by rich nations such as South Korea and Taiwan. Figure 3-3 the analogue for other developing countries such as Argentina or Brazil. Note two main differences between the figures: the protected industries-set and the tech-intensity of the average protected industry are greater for the East Asian case. More formally, we write

Lemma 3. *A country with a lower comparative disadvantage in contract intensive goods protects a wider industry-range with a greater average tech-intensity. We have that $\frac{d\bar{z}^{TP}}{d(a^s/\omega)} > 0.$*

As the value for a^s/ω is smaller the South produces the hi-tech input at lower costs. Lower costs reduce the tariff at which a Southern center enters the market, and therefore the domestic price increase in every industry. Lower costs also increase the profits made by a Southern entrant in every industry. Protection becomes more

welfare-improving in every industry so that the indifferent industry shifts to the left as understood from the figures. Thus, a lower a^s/ω value increases the protected-industry set and the tech intensity of its average industry.

Lemma 3 implies that trade protection should be more effective at shifting industrial configurations to mid-tech industries in countries with a lower a^s/ω such as South Korea or Taiwan. These countries should also be successful at fostering linkages in more industries as noted by Rodrik. Interestingly, another implication is that the lower the degree of comparative disadvantage, the more a country is willing to distort its free-market pattern of trade.

3.4   Conclusions

The governments of Japan, Korea and Taiwan applied industry-selective interventions to create purposefully profits above free-market levels. These profits played an important role in the rapid economic growth, as they were a necessary condition for the abnormally high savings and investment rates observed in North-East Asia -Akyuz (1996), Rodrik (1995)-.

As firms make profits, profits-shifting is a motivation for setting tariffs as suggested by the evidence provided by Ossa (2011 b). This paper shows that profits-shifting is relevant as it justifis the use of trade protection to foster linkages. This occurs as profits-shifting is stronger than the price-distortions effects predicted by The World Bank and the comparative argument.

Countries with a lower comparative disadvantage, where price distortions created by profits-shifting tariffs are lower, have more incentives to protect the domestic market. These countries protect a wider range of industries with a higher tech-intensity average. This result is consistent with Rodriks' perception on the North-East Asian economies, and with the fact that other developing and protectionist did not succeed at fostering linkages successfully.
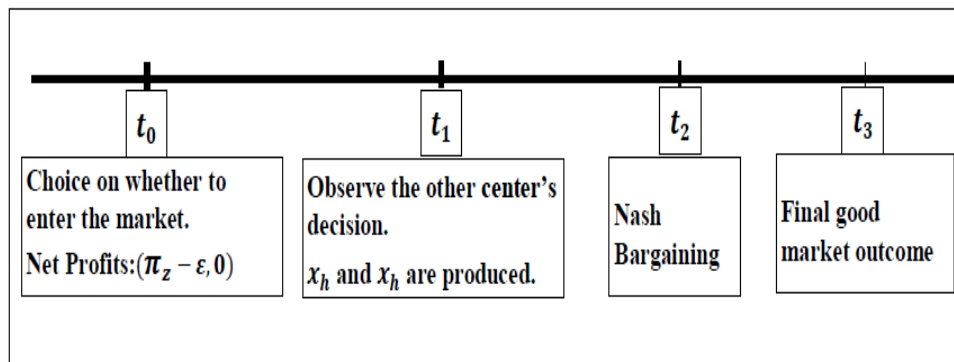
Figure 3-1: Timing of the Events

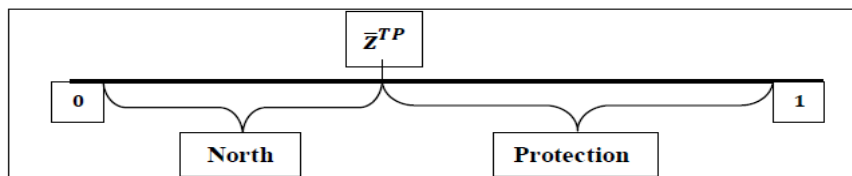**Notes:** There are two research center that could potentially enter the market..

Figure 3-2: Schedule of Protected Industries for Low Overall Comparative Disadvantage

Notes: As the overall comparative disadvantage of the South is low, this country protects a wider range of industries with a higher average tech-intensity.
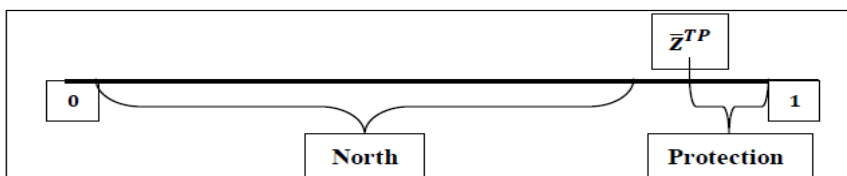
Figure 3-3: Schedule of Protected Industries for High Overall Comparative Disadvantage

Notes: As the overall comparative disadvantage of the South is High, this country protects a smaller range of industries with a lower avergae tech-intensity.

3.5 Appendices

Appendix 3.1

This appendix proves that prices in monopolistic situation are given by (80) and (81), and (82) and (83) respectively.

Consider a monopolist duo from the South in industry z. Employing (78) we obtain market revenues as a function of the market prices, which are written as follows

$$y_z p_z = \lambda (p_z)^{\frac{-\alpha}{1-\alpha}},$$

We will use this expression at the end of the proof. For now let's write revenues in terms inputs.

$$y_z p_z = \lambda^{1-\alpha} \mu_z x_h^{\alpha(1-z)} x_l^{\alpha(z)},$$

In the Nash bargaining symmetric solution parties keep half of the ex-post quasi-rents. Anticipating this and given the expression for market revenues provided above, the research center and the manufacturing plant solve the following maximization problems respectively

$$Max_{x_h}: \frac{\lambda^{1-\alpha} \mu_z^{\alpha} x_h^{\alpha(1-z)} x_l^{\alpha(z)}}{2} - w^s a^s x_h,$$

$$Max_{x_l}: \frac{\lambda^{1-\alpha} \mu_z^{\alpha} x_h^{\alpha(1-z)} x_l^{\alpha(z)}}{2} - w^s x_l.$$

Combining the first order conditions yield by each problem we get

$$x_l = \left[\frac{z}{1-z}\right] a^s x_h.$$

Plugging this into the first order conditions we obtain input usage in equilibrium:

$$x_l = \frac{\lambda z}{(a^s)^{\frac{\alpha(1-z)}{1-\alpha}}(2w^s/\alpha)^{\frac{1}{1-\alpha}}},$$

$$x_h = \frac{\lambda(1-z)}{(a^s)^{\frac{1-\alpha z}{1-\alpha}}(2w^s/\alpha)^{\frac{1}{1-\alpha}}}.$$

We then plug the first two in equation (2) to obtain equilibrium output:

$$y_z = \frac{\lambda}{((a^s)^{1-z}2w^s/\alpha)^{\frac{1}{1-\alpha}}}.$$

Replacing this output value in (78) we obtain

$$p_z^s = \frac{2w^s(a^s)^{1-z}}{\alpha},$$

which is the price shown in equation (81). Let's use this expression along with input usage in equilibrium to obtain total costs

$$w^s x_l + w^s a^s x_h = \lambda \frac{\alpha}{2}(p_z^s)^{\frac{-\alpha}{1-\alpha}}.$$

Given these costs and the revenues expression we obtained above, profits are

$$\pi_z^s = \lambda\left(1 - \frac{\alpha}{2}\right)(p_z^s)^{\frac{-\alpha}{1-\alpha}},$$

as shown in (83).

For a monopolist duo formed by a center from the North, the expression for revenues is the same. The maximization program is written as follows

$$Max_{x_h}: \frac{\lambda^{1-\alpha}\mu_z^\alpha x_h^{\alpha(1-z)} x_l^{\alpha(z)}}{2} - w^n x_h$$

$$Max_{x_l}: \frac{\lambda^{1-\alpha}\mu_z^\alpha x_h^{\alpha(1-z)} x_l^{\alpha(z)}}{2} - w^s x_l.$$

Combining first order conditions we get

$$x_l = \left[\frac{zw^n}{(1-z)w^s}\right]x_h$$

Plugging this into the first order conditions we obtain input usage in equilibrium

$$x_l = \frac{\lambda z}{(w^s)^{\frac{1-\alpha(1-z)}{1-\alpha}}(w^n)^{\frac{\alpha(1-z)}{1-\alpha}}(2/\alpha)^{\frac{1}{1-\alpha}}},$$

$$x_h = \frac{\lambda(1-z)}{(w^s)^{\frac{\alpha z}{1-\alpha}}(w^n)^{\frac{1-\alpha z}{1-\alpha}}(2/\alpha)^{\frac{1}{1-\alpha}}}.$$

We then plug the first two in equation (79) to obtain equilibrium output

$$y_z = \frac{\lambda}{(2(w^n)^{1-z}(w^s)^z/\alpha)^{\frac{1}{1-\alpha}}}$$

Replacing this output value in (1) we obtain

$$p_z^n = 2(w^n)^{1-z}(w^s)^z/\alpha,$$

which is the price shown in equation (80). Let's use this expression along with input usage in equilibrium to obtain total costs:

$$w^s x_l + w^n x_h = \lambda \frac{\alpha}{2}(p_z^n)^{\frac{-\alpha}{1-\alpha}}.$$

Given these costs and the revenues expression we obtained above, profits are

$$\pi_z^n = \lambda\left(1 - \frac{\alpha}{2}\right)(p_z^n)^{\frac{-\alpha}{1-\alpha}},$$

as shown in (92).

Q.E.D.

Appendix 3.2

This appendix proves Lemmas 1 and 3.

A profits-shifting tariff is welfare-improving if and only if the producer surplus increase caused by the entry of the research center from the South more than

compensates for consumer surplus decrease. Hence, trade protection is welfare-

improving in industry z if the following condition holds

$$\pi_z^s \geq C_z^{FT} - C_z^{TP}.$$

Employing equations (6), (9) and (10) to replace for each term, we get

$$\lambda\left(\frac{1-\alpha^2/2}{\alpha}\right)(p_z^s)^{\frac{-\alpha}{1-\alpha}} > \lambda\left(\frac{1-\alpha}{\alpha}\right)(p_z^n)^{\frac{-\alpha}{1-\alpha}},$$

or

$$\frac{p_z^s}{p_z^n} < \left(\frac{1-\alpha^2/2}{1-\alpha}\right)^{\frac{1-\alpha}{\alpha}}.$$

Replacing the price-ratio for the definitions given in (3) and (4) yields

$$z > 1 - \left(\frac{1-\alpha}{\alpha}\right)\frac{Log(\frac{1-\alpha^2/2}{1-\alpha})}{Log(a^s/\omega)}.$$

Therefore, we have

$$\bar{z}^{TP} = 1 - \left(\frac{1-\alpha}{\alpha}\right)\frac{Log(\frac{1-\alpha^2/2}{1-\alpha})}{Log(a^s/\omega)} < 1.$$

where the last inequality comes from the assumption that $a^s > \omega > 1$.

This proves Lemma 1.

The derivative of the expression given above for $\bar{z}^{TP}$ with respect to a^s/ω is positive. This proves Lemma 3.

Q.E.D.

Appendix 3.3

This appendix proves Lemma 2.

A tariff not causing entry of a research center from the South only changes the demand and then the quasi-rents of the monopolist duo formed by a research center from the North. As the effective importing price for Southern consumers equals $\tau_z p_z$, the monopolist faces the following demand

$$y_z = \lambda(\tau_z p_z)^{-1/(1-\alpha)}..$$

The quasi-rents of the relationship equal total revenues, which in turn can be written as follows using equation (79)

$$y_z p_z = \lambda^{1-\alpha} \mu_z x_h^{\alpha(1-z)} x_l^{\alpha(z)} \tau_z^{-1}...$$

Following the same steps as in a previous appendix we get

$$x_l = \frac{\lambda z}{(w^s)^{\frac{1-\alpha(1-z)}{1-\alpha}} (w^n)^{\frac{\alpha(1-z)}{1-\alpha}} (\tau_z 2/\alpha)^{\frac{1}{1-\alpha}}},$$

$$x_h = \frac{\lambda(1-z)}{(w^s)^{\frac{\alpha z}{1-\alpha}} (w^n)^{\frac{1-\alpha z}{1-\alpha}} (\tau_z 2/\alpha)^{\frac{1}{1-\alpha}}}.$$

We then plug the first two in equation (2) to obtain equilibrium output

$$y_z = \frac{\lambda}{(\tau_z 2(w^n)^{1-z}(w^s)^z/\alpha)^{\frac{1}{1-\alpha}}}.$$

Replacing this output value in (1) we obtain

$$p_z^n = 2(w^n)^{1-z}(w^s)^z/\alpha,$$

which is the price shown in equation (80).

The price perceived by the research center from the North does not change; however the price paid by consumers equals $\tau_z p_z^n$, and therefore increases.

As the quantity exchanged is lower and we still are on the inverse demand curve we know that the tariff revenue does not compensate, and therefore welfare falls price paid by consumer is greater.

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