Essays on Liberalization and Trade Policy in Developing Economies under Increasing Returns

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ABSTRACT

Developing countries occupy an important place in the world trade pattern of today. Taking advantage of low wages in these countries, the low technology and labor intensive stages of production in many product lines are outsourced here. Hence participation in Global Value Chains for a developing country on the one hand generates employment in manufacturing thereby helping realize economies of scale arising out of division of labor, on the other hand the gains from trade accruing from such participation may be low due to presence of severe distortions like weak legal and financial institutions, and may cause distributional conflicts. My dissertation studies the role of trade and investment liberalization policies for developing countries in the presence of increasing returns.

Chapter 2 of the thesis focuses on trade in both final good and the differentiated varieties of an intermediate input between a capital abundant country and a labor abundant country. The intermediate input sector comprises monopolistically competitive firms of heterogeneous productivity. I analyze the impact on the two countries of moving from autarky to free trade. When trade in varieties is subject to both fixed and variable trade costs, the impact of a bilateral liberalization is studied with the help of a numerical simulation.

Chapter 3 considers a small open economy characterized by open urban unemployment and rural-urban migration. The urban sector produces an import-competing (tariff protected) final good and a non-traded input that is subject to increasing returns to scale. The rural sector produces the exportable by combining the input with rural labor. In this structure the policy impacts of a foreign capital inflow and an increase in tariff protection are studied.

In Chapter 4, I consider a two country, three sector and one factor model of trade and unemployment. Trade takes place in one homogeneous good (costlessly) and the varieties of two differentiated industrial goods (subject to variable trade cost). Equilibrium unemployment of the Shapiro-Stiglitz type is modeled. In this structure I analyze the impact of a unilateral, sector-specific trade policy on industrial relocation in both the protected and unprotected sectors, and on the employment rates in the two countries.

Turning again to the case of a small open economy, in Chapter 5, I combine the production structure studied in Chapter 2 with the assumption that the Home economy imports a fixed number of Foreign varieties at a given price (subject to a tariff). Here

I study the productivity and welfare effects of an inflow of foreign capital assuming full repatriation of foreign profits.

Summary, conclusions and possible extensions for future research are outlined in Chapter 6.

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Chapter 1

INTRODUCTION

Recent years have seen a backlash against globalization in many countries, especially among the rich, developed nations. While not denying the justified welfare gains from free trade, concerns have been raised against the distributional impacts of trade and the effect of foreign competition on domestic labor markets. The discussion around the benefits or losses from free trade for developed countries should first be put in a historical context. Access to the huge markets of Asian countries in the colonial period has contributed in a large part to the high standard of living of today's Western Europe and the USA. The success of the modern industrialized giants (developed countries) has often been attributed to free-market based capitalism characterized by free trade and large export markets that incentivize innovation by producers.

Learning from the experience of the developed countries, arguments were made in global policy debates in favour of opening up the domestic markets of the newly independent countries in the mid-to-late twentieth century as a means of raising their standard of living. Trade policy reforms based on liberalization, globalization and privatization were an essential prerequisite to the conditional loans given by the IMF to struggling developing countries, like India in 1991. As the former colonies of Asia and Africa embarked upon the path of development through industrialization immediately after achieving their independence, many of them adopted protectionist trade policies to develop the domestic industrial sector, arguing that the infant domestic industrial sector should be protected from foreign competition, at least in the initial stages of development. Observing the facts that the rate of growth is manufacturing is much higher than in agriculture, the infant industry argument prescribes import of capital and technical know-how from advanced countries alongwith imposing high trade barriers on foreign manufactures. But empirical research has shed doubt on the validity of this policy. Dodzin and Vamvakidis 2004 study the impact of trade liberalization in a panel of 92 countries over the period 1962-2000. They find that increased openness to trade caused an increase in the value added share of production of industry at the expense of the agriculture share. The authors conclude that trade leads the developing countries to industrialization, in contrast to the infant industry argument.

Global reductions in trade barriers and technological improvements in transportation and information and communications sectors have brought about a sea change in trade patterns worldwide, which in turn has had a significant impact on composition and volume of national outputs and rewards to factors of production in countries of all income groups. The colonial pattern of trade–rich countries exporting manufacturing goods and their colonies exporting back raw materials and other primary goods–has diminished significantly, giving room for intra-industry trade (IIT) in most sectors. Brülhart 2009 studies the evolution of IIT over the period 1962-2006. He outlines the patterns of global IIT in 2006: larger countries tend to trade in a larger set of industries, trade among high income countries features the highest IIT shares on average and the highest 5-digit IIT level is observed for trade among lower-middle-income countries. He suggests that vertical fragmentation of production processes across country borders might be central to explaining global IIT patterns.

Vertical fragmentation of production across borders has become one of the core features of international trade and production in recent years. Using recent data Los, Timmer, and Vries 2015 provide evidence on the current state of Global Value Chains (GVCs). Based on a new input-output model of the world economy, covering 40 countries and 14 manufacturing product groups, they derive the distribution of value added by all countries involved in the production chain of any final good. They find that in most production chains the share of value added outside the country-of-completion has increased since 1995. Given the importance of GVCs in modern industrial structure and the preponderance of IIT in lower-middle-income countries, suggesting the prevalence of vertical fragmentation across borders, the natural question arises: does fragmentation of production contribute to growth? And should developing countries strive towards greater GVC participation? In an empirical study of 40 advanced and emerging economies, Carmo Hermida, Santos, and Bittencourt 2022 analyze whether economic growth is impacted by international fragmentation of production and participation in GVCs. They find that international fragmentation of production and GVC participation can raise GDP per capita growth rates. They infer that vertical specialization, measured by foreign intermediate imports, is actually more important than GVC participation (which includes both forward and backward participation; see Antràs 2020 for a review of GVC terminology). Carmo Hermida, Santos, and Bittencourt 2022 find evidence that a country's engagement in low-technology GVCs contributes to higher growth rate. Using manufacturing sector data in India for the period 1990-2014, (Boehm and Oberfield 2023) study the link between greater fragmentation of supply chains and productivity and find that the increased demand for manufactures following the liberalization of the 1990s caused increases in specialization. They also find evidence of economies of scale in specialization.

Given the empirical evidence, a case may be made for reducing the trade barriers in developing countries–which are on average still higher than those in developed countries–and also inviting foreign direct investment by liberalizing their capital accounts. This implies the advocacy of policies pursuing export-led growth for developing economies instead of the import-substitution policy based on the infant-industry argument. But another valid argument raised is whether the developing countries would accrue gains of similar magnitude from trade liberalization as those of the developed nations. Because the developing countries are often plagued with numerous distortions like unemployment, poor quality of legal and financial institutions, etc., it might argued that liberalization policies in these countries might give different results, especially when economies of scale arising from specialization are taken into account.

The present thesis studies theoretically the impact of liberalization and trade policies on productivity, reward to factors of production and its distribution, unemployment, welfare and also industrial concentration. This is studied in models featuring realistic production structures like vertical fragmentation, input-output linkages and increasing returns, while incorporating salient features of developing and emerging economies like labor abundance in the factor proportions sense, labor market rigidity and rural-urban migration, equilibrium unemployment and smallness relative to the trading partner.

In Chapter 2, inter and intra-industry trade between a capital abundant (developed) country and a labor abundant (developing) country is studied, featuring firm heterogeneity and upstream and downstream sectors. In contrast with the neo-classical trade theory, after opening to trade the real wage in the capital abundant country rises but it may fall in the labor abundant country. Also the study finds that the within-industry selection effects prevalent in the firm-heterogeneity trade literature can occur even without a finite trade cost if the factor intensity differs between entry and production costs.

In Chapter 3, the focus is on a small open economy characterized by open urban unemployment and rural-urban migration. Here I study trade policies–inward looking (tariff) and outward looking (investment liberalization)–for achieving the twin goals of employment generation and welfare improvement. Using the concept of

Marshall stability for the model, an inflow of foreign capital is found to reduce specialization in the increasing returns intermediate input sector, irrespective of any factor intensity ranking between the two sectors competing for capital. Further, a foreign capital inflow into a protected sector with full repatriation of profits, is found to be always welfare reducing, even if the protected sector is labor intensive.

In Chapter 4, sector-specific unilateral tariff is analyzed in a two-country world with trade in a homogeneous good and two differentiated goods produced under increasing returns. As a result of a unilateral tariff imposed on imported varieties in one sector, there is firm entry in both the protected and unprotected industries in the tariff-imposing country, while there is firm exit in both the protected and unprotected industries in its trading counterpart. Also modeled is a frictional labor market resulting in equilibrium unemployment. Hence a sector-specific tariff through industrial relocation creates manufacturing sector jobs and increases the employment rate in the tariff-imposing country, while it leads to industrial delocation in the trading counterpart, thereby leading to a fall in the rate of employment in that country.

Chapter 5 studies foreign capital inflow into a tariff-protected, increasing returns sector featuring firm heterogeneity, in a small open economy with full repatriation of profits attributable to foreign capital. An inflow of foreign capital, by increasing the mass of entrants in the domestic differentiated good sector, increases competition among domestic firms. This bids up the wage rate and consequently increases the cut-off productivity through exit of the least productive firms. Thus a foreign capital inflow raises industrial productivity by reallocating resources towards the more productive firms. As the domestic (import-competing) industry expands, it does not necessarily reduce cheaper imports. The volume of imports may even rise. In addition, a foreign capital inflow with full repatriation of foreign profits can increase welfare if the varieties are sufficiently complementary.

Chapter 2

TRADE INDUCED SELECTION EFFECTS: FACTOR INTENSITY DIFFERENCE IN ENTRY AND PRODUCTION COSTS

2.1 Introduction

Why do countries engage in trade? The neoclassical theory of trade suggests that differences in factor endowments form the basis of trade. A country exports the good which intensively uses the factor the country is relatively endowed in. On the other hand, the New Trade Theory considers trade between similar countries where goods produced by the same industry are traded in because of consumers' love for variety. A hybrid of the two approaches is considering trade between countries differing in relative factor endowments that are engaged in intra-industry trade produced by monopolistically competitive firms. Until recently this strand of literature considered firms to be homogeneous in productivity. Bernard, S. Redding, and Schott 2007 consider a factor-proportions driven model of intra-industry trade between two countries where each nation has two monopolistically competitive industries populated by heterogeneous firms and the two industries differ in factor intensity. But Bernard, S. Redding, and Schott 2007 assumes that in a given industry the factor intensity is same for sunk cost and production costs. Bai et al. 2021 find evidence using Chinese firm-level data that factor intensity varies between entry and production costs.

This paper develops a model of trade between a capital abundant country (Home) and a labor abundant country (Foreign) trading in a labor intensive final good and a continuum of varieties of capital intensive intermediate goods. While the intermediate goods are produced with labor and capital, the final good uses the intermediate goods and labor as inputs in its production. Further, in the production of the intermediates a sunk cost in terms of capital is incurred and the production costs are entirely in labor terms[1]. In this model the free trade equilibrium is characterised by factor

[1] In neo-classical trade theory goods are classified as labor intensive or capital intensive by comparing their factor intensities. In the current paper the factor intensities of the intermediate and final goods cannot be determined directly. Here capital is embodied in the intermediate good only, along with labor. The final good combines, in a Cobb-Douglas fashion, the intermediate good with additional labor. Hence the intermediate good is labelled capital intensive and the final good is labelled labor intensive.

price equalization and factor proportions driven comparative advantage determines the trade pattern. Unlike Bernard, S. Redding, and Schott 2007 selection effects are present under free trade and are guided by factor proportions. In Home the wage-rental ratio falls while selection becomes weaker while Foreign has a higher wage-rental ratio and stricter selection under free trade. Free trade also leads to a higher real wage rate in Home but the change in the real wage rate in Foreign is ambiguous. The model also delivers a few results under costly trade scenario and these results are verified in a numerical simulation of the costly trade model. With the introduction of costly trade the familiar Stolper-Samuelson mechanism is observed: a rise in the wage-rental ratio reallocates labor away from intermediates and towards the final goods sector (this occurs for Foreign in the numerical simulation) and a fall in the wage-rental ratio reallocates labor away from the final good and towards the intermediate goods sector (this is observed in Home's case in the simulation). Under costly trade irrespective of the level of variable trade cost a fall in the wage-rental ratio leads to weaker selection (Home in the simulation) and a rise in the wage-rental ratio leads to stricter selection (Foreign in the simulation).

My paper contributes to two strands of literature. Several studies have incorporated Hecksher-Ohlin motives for trade in an otherwise standard increasing returns variety-trade model[2]. In this literature this paper is closest to Chakraborty 2003 which considers trade in both intermediates and final goods between a labor abundant nation and a capital abundant one. Unlike my model, this paper considers homogeneous firms, hence selection effects are absent. Further Chakraborty 2003 only studies a free trade equilibrium unlike the present analysis of both free and costly trade regimes.

Since M. Melitz 2003 a number of studies have analysed the impact of trade liberalisation in a monopolistically competitive intra-industry trade model while allowing for firm heterogeneity[3]. Bernard, S. Redding, and Schott 2007 model a Melitz-type heterogeneous firm trade model with Hecksher-Ohlin type trade pattern based on differences in factor endowments. Two countries differing in their endowments of skilled-to-unskilled labor trade in varieties produced by two industries producing with different factor intensities. But unlike my model theirs assumes that the factor intensities in entry cost and production cost are same in a given industry, though

[2] Helpman and Krugman 1985 provide a textbook analysis of this type of models assuming homogeneous firms.Sen, Ghosh, and Barman 1997, Marjit and Mandal 2021, Nayak 2020, Marjit, Mandal, and Yang 2024 introduce factor intensity difference in fixed and variable costs and thus combine Hecksher-Ohlin and variety trade models.

[3] See Demidova and Rodriguez-Clare 2013, Felbermayr, Jung, and Larch 2013. M. J. Melitz and S. J. Redding 2014 provides an excellent overview of this literature.

they do hypothesise in a footnote that changing the intensity in entry and production would lead to further selection effects. In Bernard, S. Redding, and Schott 2007 as a country opens up to free trade the cut-off productivities of its industries do not change relative to autarky. In the current paper opening up to free trade changes the cut-off productivity in the intermediate goods sector (it falls in the capital abundant country and rises in the labor abundant country). Also Bernard, S. Redding, and Schott 2007 considers trade in final goods while this paper studies trade in both intermediates and final goods.

When firms endogeneously choose their production technology, in a factor-proportions based trade model with firm heterogeneity, Furusawa and Sato 2008 find that factor prices are equalized across countries if their technologies are same, hence arguing that the capital abundant country tends to have a higher state of technology. Like this paper they show that free trade results in productivity equalization, though with an additional assumption on technology, but they do not analyze liberalisation in a costly trade scenario.

Bai et al. 2022 develop a Hecksher-Ohlin trade model with perfectly competitive firms of heterogeneous productivity. Like my paper they consider different factor intensities in entry and production costs but unlike this paper they consider trade in final goods produced in perfectly competitive industries.

2.2 The Model

Consider an economy (Home) that is endowed with L mass of labor and capital of mass K. First I derive the closed economy equilibrium, then I shall remove all barriers to trade and derive the free trade equilibrium.

2.2.1 Autarky

Since I am analysing the equilibrium of Home I shall refrain from country subscripts in this sub-section. Home produces only one final good Y according to the production function:

$$Y = X^{\alpha} L_Y^{1-\alpha}; \quad \alpha < 1 \tag{2.1}$$

where

$$X^{\frac{\sigma-1}{\sigma}} = \int_{\Omega} x(\omega)^{\frac{\sigma-1}{\sigma}} \, d\omega$$

; $\sigma > 1$ is the elasticity of substitution, X is a CES aggregate of intermediate goods, Ω is the set of varieties produced and L_Y is the labor employed in the final good sector.

The monopolistically competitive intermediate goods sector is similar to M. Melitz

2003. Ex-ante identical firms first pay a sunk cost of F^e units of capital to enter the market and get a productivity draw from the exogenously given distribution $G(z)$[4]. After entering the market a producing firm with productivity z pays a fixed cost of f units of labor and charges a profit-maximizing price $p = \frac{w}{\rho z}$ where $\rho = \frac{1}{1-\sigma}$ is the inverse of the markup and $\frac{1}{z}$ units of labor is the variable input paid at the rate of w[5]. Now, the demand for a variety, derived from the final good producer's optimization problem, is given by

$$x = \frac{p^{-\sigma}}{P^{1-\sigma}} \alpha p_Y Y$$

where

$$P^{1-\sigma} = \int_{\Omega} {p_a}^{1-\sigma} \, da$$

is the price index in the intermediate goods sector and $\alpha p_Y Y$ is the total expenditure on intermediate goods by the final good producer. Hence the profits of a firm with productivity z, from the variety demand function and the mark-up pricing rule, are given by:

$$\pi(z) = \frac{1}{\sigma}\left(\frac{\rho z}{w}\right)^{\sigma-1} P^{\sigma-1} \alpha p_Y Y - wf$$

Hence it follows that the profits are monotonically increasing in a firm's productivity. Consequently firms that can cover the fixed cost with their revenue will produce, that is to say, firms with productivity greater than the cut-off level z^* will produce, where z^* is given implicitly by the following equation:

$$(\frac{w}{\rho z^*})^{1-\sigma} P^{\sigma-1} \frac{\alpha}{1-\alpha} w L_Y = \sigma w f \tag{2.2}$$

where use has been made of the fact that $p_Y Y = \frac{wL_Y}{1-\alpha}$ (since the final goods sector is perfectly competitive) and, taking the final good to be the numeraire, $p_Y = 1$.

The free entry condition states that the expected profits from entering the market should be equal to the sunk entry cost. That is, the entry cost should equal the probability of success times the average profit per firm. Denoting aggregate profits by Π and the mass of surviving firms by M the free entry condition is

$$[1 - G(z^*)] \frac{\Pi}{M} = rF^*$$

[4]Sunk costs denote the capital intensive expenses such as market research, etc. which are incurred before production takes place. Hence these costs are denoted in terms of capital.

[5]The assumptions regarding denoting the sunk costs of entry in terms of capital and denoting the total production costs in labor terms, are understandably restrictive. In a general case, all costs should depend on the prices of both factors-labor and capital. However, these assumptions bring forth the results of factor-proportion driven trade in a stark way.

where

$$\Pi = M \int_{z^*}^{\infty} \pi(z) \frac{g(z)}{1 - G(z)}\, dz$$

Invoking the relation between the revenues of any two producing firms, using the definition of profits and the cut-off productivity relation we get

$$J(z^*)wf = rF^e \tag{2.3}$$

where, as in M. Melitz 2003, $J(z^*) = \int_{z^*}^{\infty} [(\frac{z}{z^*})^{\sigma-1} - 1] g(z)\, dz$.
The full employment condition for labor is given by (multiplied by the wage rate on both sides)

$$wL = wL_X + wL_Y \tag{2.4}$$

where the two terms on the R.H.S. are the wage bills in the intermediate goods sector and the final good sector respectively. The wage bill in the intermediate goods sector equals the revenue of the intermediate goods sector minus rental payments to capital owners (profits):

$$\begin{aligned} wL_X &= \text{Revenue of intermediate goods sector} - \text{Profits}(\pi) \\ &= \sigma[\pi + \text{Total Fixed Costs (TFC)}] - \pi \\ &= (\sigma - 1)\pi + \sigma \text{TFC} \\ &= (\sigma - 1)M^e wfJ(z^*) + \sigma M^e wf(1 - G(z^*)) \end{aligned} \tag{2.5}$$

where M^e is the mass of entrants.
Now, since capital is only used in entry of intermediate good firms, full employment of capital implies

$$K = M^e F^e$$

Hence, from equations 2.4 and 2.5

$$wL = (\sigma - 1)M^e wfJ(Z^*) + \sigma M^e(1 - G(z^*))wf + wL_Y \tag{2.6}$$

Using the free entry condition equation (6) can be rewritten as:

$$L = M^e f[(\sigma - 1)J(z^*) + \sigma(1 - G(z^*))] + L_Y. \tag{2.7}$$

Since $J(z^*)$ and $(1 - G(z^*))$ are decreasing in z^*, equation 2.7 represents an upward sloping curve in $(z^* - L_Y)$ plane, as depicted in figure 2.1.
As the final good sector is perfectly competitive, α fraction of the sales revenue of the final good goes to buy the intermediate input and the rest is paid as wages to

laborers employed in this sector. This implies, $\alpha p_Y Y = PX$ and $(1-\alpha)p_Y Y = wL_Y$. Hence, considering $p_Y = 1$,

$$\begin{aligned} wL_Y &= (\frac{1-\alpha}{\alpha})PX \\ &= \sigma(\frac{1-\alpha}{\alpha})M^e w f[J(z^*) + (1-G(z^*))] \end{aligned}$$

Or,

$$L_Y = \sigma(\frac{1-\alpha}{\alpha})M^e f[J(z^*) + (1-G(z^*))] \tag{2.8}$$

Noting that the R.H.S. in equation 2.8 is a decreasing function of z^*, equation 2.8 represents a downward sloping curve in $(z^* - L_Y)$ plane as graphically shown in figure 2.1.

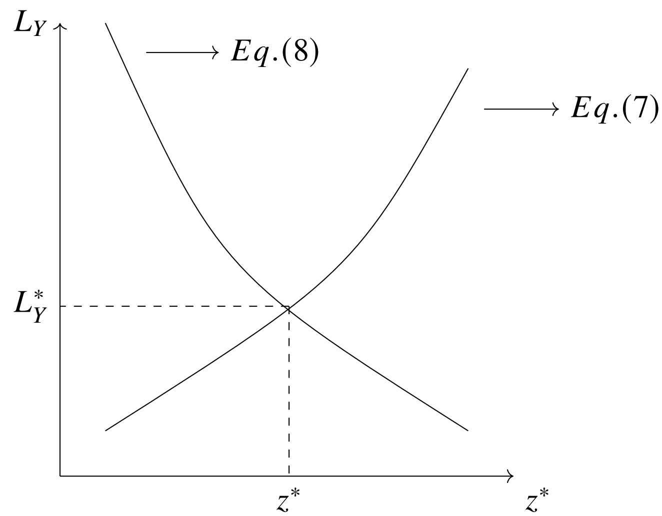

Figure 2.1: Autarky Equilibrium

To solve for the autarky equilibrium we need the equilibrium values of five endogenous variables: z^*, w, r, L_Y and P from five equations: 2.2, 2.3, 2.4, 2.5 and 2.8. This system of five equations in five variables has been reduced to two equations-2.7 and 2.8, in two variables–z^* and L_Y. Hence figure 2.1 depicts the autarky equilibrium.

Since the final good is the numeraire, we have

$$1 = P^\alpha w^{1-\alpha}$$

Therefore, the wage rate is given by:

$$w = (M^e)^{\frac{\alpha}{\sigma-1}} [\int_{z^*}^{\infty} (\frac{1}{\rho z})^{1-\sigma} g(z)\, dz\,]^{\frac{\alpha}{\sigma-1}}$$

where

$$P^{1-\sigma} = M^e \int_{z^*}^{\infty} (\frac{w}{\rho z})^{1-\sigma} g(z)\, dz\ .$$

Given the wage rate the equilibrium value of the intermediate goods price index is also determined (since the mass of entrants is fixed by the capital stock).

Given the wage rate, the value of the rental rate of capital can be calculated from the free-entry condition as:

$$r = \frac{J(z^*) w f}{F^e}$$

The mass of entrants is fixed by the capital market equilibrium condition:

$$M^e = \frac{K}{F^e}$$

Now, having solved for all endogenous variables in autarky, note that, using equations 2.7 and 2.8 we get :

$$(\sigma-1)M^e w f J(z^*) + \sigma M^e w f (1-G(z^*)) + \sigma(\frac{1-\alpha}{\alpha}) M^e w f [J(z^*) + (1-G(z^*))] = wL$$

Using the capital market equilibrium condition and canceling the wage rate on both sides, we get

$$(\sigma-1) f J(z^*) + \sigma f (1-G(z^*)) + \sigma(\frac{1-\alpha}{\alpha}) f [J(z^*) + (1-G(z^*))] = \frac{L}{K} F^e \quad (2.9)$$

Clearly, the cut-off productivity will be higher in the capital abundant country.

2.2.2 Free Trade

I allow for both intermediate and final goods to be traded, as in Chakraborty 2003. Home (indexed by i) freely trades with Foreign (indexed by j). As in autarky, I assume, $p_Y = 1$. Under free trade there are no fixed or variable costs of exporting, hence all the operating firms in the intermediate goods sector of both countries will serve both markets. Hence we get a common price index in the intermediate goods sector, P, defined as :

$$P^{1-\sigma} = P_i^{1-\sigma} = P_j^{1-\sigma} = M_i^e \int_{z_i^*}^{\infty} (\frac{w_i}{\rho z})^{1-\sigma} g(z)\, dz\ + M_j^e \int_{z_j^*}^{\infty} (\frac{w_j}{\rho z})^{1-\sigma} g(z)\, dz$$

Proposition 2.1 *Under free trade both countries have the same wage rate.*

Proof: As $p_Y = 1$ we have,

$$1 = w_i^{1-\alpha} P^{\alpha} = w_j^{1-\alpha} P^{\alpha}$$

So there is a common wage rate w in both countries. ■

The intuition for this result is as follows. As the final good is produced by perfectly competitive firms there is average cost pricing in the final good sector. And free trade in the final good implies equalization of its average cost across countries. Now the average cost of the final good has two components - the cost of the intermediate goods composite and the wage rate. Since the intermediates are freely traded the CES price index is equalized in both countries. Hence both countries must have the same wage rate for the final good to be traded at the same price.

Proposition 2.2 *Under free trade both countries have the same cut-off productivity.*

Proof: The zero cut-off productivity conditions of the two countries are given by

$$(\frac{w}{\rho z_i^*})^{1-\sigma} P^{\sigma-1} \frac{\alpha}{1-\alpha} w(L_{Yi} + L_{Yj}) = \sigma w f \tag{2.10}$$

$$(\frac{w}{\rho z_j^*})^{1-\sigma} P^{\sigma-1} \frac{\alpha}{1-\alpha} w(L_{Yi} + L_{Yj}) = \sigma w f \tag{2.11}$$

From equations 2.10 and 2.11 it is clear that the cut-off productivity is the same (z^*) in the two countries. ■

The zero cut-off productivity condition states that the marginal firm in both countries earns zero profits. Since the two countries have the same wage rate all intermediate good firms in both countries face the same fixed cost of production. This implies that the marginal firms in the two countries earn identical revenue. Again, since the wage rate is equalized across countries two firms earning same revenue implies they have the same productivity.

Proposition 2.3 *Under free trade both countries have the same rental rate on capital.*

Proof: The free entry conditions in the two countries are

$$J(z^*) w f = r_i F^e \tag{2.12}$$

$$J(z^*) w f = r_j F^e \tag{2.13}$$

Hence the rental rates are also equalized across countries.■

As free trade equalizes the wage rate and the cut-off productivity across countries this results in identical expected profits for any potential entrepreneur in both countries.

Free entry implies then the entry cost must be same in the two countries. Since entry cost is paid in terms of capital this results in equalization of rental rate in the two countries.
In free trade equilibrium we thus observe factor price equalization (FPE). When only the final and intermediate goods are mobile the factor rewards are equalized as if the two countries were a single integrated economy.

Proposition 2.4 *The capital abundant country is a net exporter of capital intensive intermediate goods and a net importer of labor intensive final good.*

Proof: The net exports of country i (capital abundant) are given by:

$$NX = \int_{z^*}^{\infty} [M_i^e(\frac{L_{Yj}}{L_{Yi} + L_{Yj}})v(z) - M_j^e(\frac{L_{Yi}}{L_{Yi} + L_{Yj}})v(z)]g(z)\, dz$$

where $v(z) = (\frac{w}{\rho z})^{1-\sigma} P^{\sigma-1} \frac{\alpha}{1-\alpha}(L_{Yi} + L_{Yj})w$
Here

$$\begin{aligned}
&NX > 0 \text{ if} \\
&M_i^e L_{Yj} - M_j^e L_{Yi} > 0 \\
\Leftrightarrow &M_i^e[L_j - [(\sigma-1)M_j^e J(z^*)f + \sigma M_j^e(1 - G(z^*))f]] \\
&- M_j^e[L_i - [(\sigma-1)M_i^e J(z^*)f + \sigma M_i^e(1 - G(z^*))f]] > 0 \\
\Leftrightarrow &M_i^e L_j - M_j^e L_i > 0 \\
\Leftrightarrow &\frac{1}{F^e}[K_i L_j - K_j L_i] > 0
\end{aligned}$$

which is true as country i is capital abundant. Now, as trade is balanced, this net export of intermediate goods of country i must be financed by an equivalent import of the final good. ■
The pattern of trade is determined by Hecksher-Ohlin type comparative advantage based on factor proportions, same as in Chakraborty 2003. Thus adding firm heterogeneity does not lead to a reversal of trade pattern. Evidence of such a trade pattern was empirically found in Ng and Yeats 1999. Here capital abundance leads to a specialization in the upstream stage of production while labor abundance leads to a specialization in the downstream stage. In this way factor abundance provides one explanation of a country's location in the global supply chain.

Proposition 2.5 *Under free trade the cut-off productivity of the capital abundant country falls and the cut-off productivity of the labor abundant country rises.*

Proof: The full employment of labor conditions of the two countries are:

$$wL_{Xi} + wL_{Yi} = wL_i \tag{2.14}$$

$$wL_{Xj} + wL_{Yj} = wL_j \tag{2.15}$$

And we know that because of the form of the final good's production function under free trade the ratio of the combined reward to labor employed in the final good sector in the two countries to the combined revenue of the intermediate goods sector in the two countries is $\frac{1-\alpha}{\alpha}$:

$$\frac{w(L_{Yi} + L_{Yj})}{w\sigma(M_i^e + M_j^e)f[J(z^*) + 1 - G(z^*)]} = \frac{1-\alpha}{\alpha}$$

$$\Rightarrow w(L_{Yi} + L_{Yj}) = \frac{1-\alpha}{\alpha} w\sigma(M_i^e + M_j^e)f[J(z^*) + 1 - G(z^*)] \tag{2.16}$$

Adding equations 2.14 and 2.15 and using equations 2.16 and 2.5 we get

$$M_i^e[(\sigma - 1)wfJ(z^*) + \sigma wf[1 - G(z^*)]] +$$
$$M_j^e[(\sigma-1)wfJ(z^*)+\sigma wf[1-G(z^*)]] + \frac{1-\alpha}{\alpha} w\sigma f(M_i^e+M_j^e)[J(z^*)+1-G(z^*)] = w(L_i+L_j) \tag{2.17}$$

Using equations 2.12 and 2.13, equation 2.17 can be rewritten as:

$$(\sigma-1)fJ(z^*)+\sigma f[1-G(z^*)] + \frac{1-\alpha}{\alpha}\sigma f[J(z^*)+1-G(z^*)] = \frac{L_i + L_j}{K_i + K_j}F^e \tag{2.18}$$

As country i is capital abundant, we have

$$\frac{L_i}{K_i} < \frac{L_i + L_j}{K_i + K_j} < \frac{L_j}{K_j}$$

Therefore, (using equations 2.9 and 2.18) moving from autarky to free trade, the cut-off productivity of country i falls while that of country j rises. ■

Due to the Stolper-Samuelson effect on opening up to free trade the capital abundant country experiences a rise in the rental-wage ratio while the labor abundant country experiences a fall in the rental-wage ratio. As production costs are paid in terms of labor while entry costs are paid in terms of capital this implies that for the capital abundant country entry costs rise relative to expected profits while for the labor abundant country entry costs fall relative to expected profits. Consequently in order to maintain free entry expected profits need to rise in the capital abundant nation leading to firm entry and expected profits need to fall in the labor abundant nation which results in firm exit. So the capital abundant country observes a fall in the cut-off productivity while the labor abundant country observes a rise in the cut-off productivity.

In the capital abundant country selection becomes weaker, less productive firms enter and thus average industry productivity falls. While in the labor abundant country selection becomes stricter, less productive firms exit the market and consequently average industry productivity rises.

Proposition 2.6 *Under free trade the wage-rental ratio of the capital abundant country falls while that of the labor abundant country rises.*

Proof: Using the two free entry conditions under free trade and 2.5, and the fact that $J'(.) < 0$ it follows that the wage-rental ratio of country i falls while that of country j rises.■

As in the perfectly competitive Hecksher-Ohlin framework in our monopolistically competitive model also free trade leads to a rise in the relative reward of the abundant factor and a fall in the relative reward of the scarce factor in both nations.

Proposition 2.7 *Moving from autarky to free trade the mass of operating firms in the capital abundant country rises and the mass of operating firms in the labor abundant country falls.*

Proof: The masses of operating firms in the two countries are given by:

$$M_i = M_i^e(1 - G(z^*)) \tag{2.19}$$

$$M_j = M_j^e(1 - G(z^*)) \tag{2.20}$$

Using Proposition 2.5 and equations 2.19 and 2.20 under free trade M_i rises and M_j falls. ■

This implies that free trade leads to an expansion of the comparative advantage industry and a contraction of the comparative disadvantage industry. There exists empirical evidence for this result in the literature. Álvarez and López 2008 find that after trade liberalisation the number of firms increases in comparative advantage industries. Nataraj 2011 finds that as a result of trade liberalisation in India there is evidence of exit of smallest, least productive firms.

Proposition 2.8 *Under free trade the wage rate of the capital abundant country rises and the change in the wage rate of the labor abundant country is ambiguous.*

Proof: The equations for the price index in the intermediate goods sector in country i under autarky and free trade can be written as:

$$(\frac{P_i}{w_i})^{1-\sigma} = M_i^e \int_{z_i^*}^{\infty} (\frac{1}{\rho z})^{1-\sigma} g(z)\, dz \tag{2.21}$$

$$(\frac{P_i}{w_i})^{1-\sigma} = (M_i^e + M_j^e) \int_{z^*}^{\infty} (\frac{1}{\rho z})^{1-\sigma} g(z)\, dz \tag{2.22}$$

Since the cut-off productivity of country i falls under free trade and $M_j^e > 0, \sigma > 1$, $(\frac{P_i}{w_i})$ falls under free trade. And as $p_Y = 1$ we have:

$$(\frac{P_i}{w_i})^{\alpha} w_i = 1 \tag{2.23}$$

Since $0 < \alpha < 1$, w_i rises under free trade.
Similarly the relevant equations for country j are given as:

$$(\frac{P_j}{w_j})^{1-\sigma} = M_j^e \int_{z_j^*}^{\infty} (\frac{1}{\rho z})^{1-\sigma} g(z)\, dz \tag{2.24}$$

$$(\frac{P_j}{w_j})^{1-\sigma} = (M_i^e + M_j^e) \int_{z^*}^{\infty} (\frac{1}{\rho z})^{1-\sigma} g(z)\, dz \tag{2.25}$$

$$(\frac{P_j}{w_j})^{\alpha} w_j = 1 \tag{2.26}$$

Here as the cut-off productivity in country j rises under free trade, the change in $(\frac{P_j}{w_j})$ is ambiguous, which implies the change in w_j is ambiguous.■
This result hinges upon the change in the intermediates' price index in free trade relative to autarky and this change is caused by two effects - *selection effect* and *variety effect*. As free trade increases the mass of firms serving the market in both countries the variety effect depresses the price index in both countries. Under free trade the mass of available varieties to the consumer in Home rises unambiguously (weaker selection), thereby depressing the price index but in Foreign the mass of available varieties to the consumer falls (stronger selection) thereby increasing the price index (note that a subset of varieties is no longer under production in free trade). The relative strengths of these two effects determine the change in price

index and hence in the wage rate in Foreign.

Since the final good is the numeraire the real reward of the scarce factor in the capital abundant country rises while the real reward of the abundant factor in the labor abundant country may fall! This surprising result marks a significant distinction between the Hecksher-Ohlin framework and the current paper.

2.2.3 Costly Trade

In this section I introduce fixed and variable costs of export, and lay out the costly trade model, indexing equations for capital abundant Home by i and those for labor abundant Foreign by j. In the next subsection I parameterize and then numerically solve the model. Here I assume that the fixed cost of export f_x is paid in terms of labor of the exporting country. The variable costs of export are of the standard iceberg type, $\tau > 1$ units of output need to be shifted to deliver 1 unit of output to the marketplace. The fixed and variable export costs are assumed to be symmetric across countries.

The domestic and export productivity cut-offs of the two countries are implicitly given by the following equations (where the first subscript denotes the location of the seller and the second subscript denotes the location of the buyer):

$$(\frac{w_i}{\rho z_{ii}})^{1-\sigma} P_i^{\sigma-1} \frac{\alpha}{1-\alpha} w_i L_{Yi} = \sigma w_i f \tag{2.27}$$

$$(\frac{w_j}{\rho z_{jj}})^{1-\sigma} P_j^{\sigma-1} \frac{\alpha}{1-\alpha} w_j L_{Yj} = \sigma w_j f \tag{2.28}$$

$$(\frac{w_i \tau}{\rho z_{ij}})^{1-\sigma} P_j^{\sigma-1} \frac{\alpha}{1-\alpha} w_j L_{Yj} = \sigma w_i f_x \tag{2.29}$$

$$(\frac{w_j \tau}{\rho z_{ji}})^{1-\sigma} P_i^{\sigma-1} \frac{\alpha}{1-\alpha} w_i L_{Yi} = \sigma w_j f_x \tag{2.30}$$

For each country dividing the L.H.S. and R.H.S. of the export cut-off equation by that of the domestic cut-off equation we get:

$$\frac{z_{ij}}{z_{ii}} = \frac{P_i}{P_j} (\frac{w_i L_{Yi}}{w_j L_{Yj}})^{\frac{1}{\sigma-1}} (\frac{f_x}{f})^{\frac{1}{\sigma-1}} \tau \tag{2.31}$$

$$\frac{z_{ji}}{z_{jj}} = \frac{P_j}{P_i} (\frac{w_j L_{Yj}}{w_i L_{Yi}})^{\frac{1}{\sigma-1}} (\frac{f_x}{f})^{\frac{1}{\sigma-1}} \tau \tag{2.32}$$

As the final good is the numeraire we have

$$\frac{P_i}{P_j} = (\frac{w_i}{w_j})^{(\frac{\alpha-1}{\alpha})}$$

Hence equations 2.31 and 2.32 can be rewritten as

$$\frac{z_{ij}}{z_{ii}} = (\frac{w_i}{w_j})^{(\frac{\alpha-1}{\alpha}+\frac{1}{\sigma-1})}(\frac{L_{Yi}}{L_{Yj}})^{\frac{1}{\sigma-1}}(\frac{f_x}{f})^{\frac{1}{\sigma-1}}\tau \tag{2.33}$$

$$\frac{z_{ji}}{z_{jj}} = (\frac{w_j}{w_i})^{(\frac{\alpha-1}{\alpha}+\frac{1}{\sigma-1})}(\frac{L_{Yj}}{L_{Yi}})^{\frac{1}{\sigma-1}}(\frac{f_x}{f})^{\frac{1}{\sigma-1}}\tau \tag{2.34}$$

Denoting $B = (\frac{f_x}{f})^{\frac{1}{(\sigma-1)}}\tau$ and $A = (\frac{w_i}{w_j})^{(\frac{\alpha-1}{\alpha}+\frac{1}{\sigma-1})}(\frac{L_{Yi}}{L_{Yj}})^{(\frac{1}{\sigma-1})}$ the condition that the export cutoff is greater than the domestic cutoff (or, $\frac{z_{ij}}{z_{ii}} > 1$ and $\frac{z_{ji}}{z_{jj}} > 1$) implies $BA > 1$ and $\frac{B}{A} > 1$. This implies $B > 1, A > 1$ and $B > A$. Now, the free-entry condition implies that the expected profits from the domestic and export markets must equal the sunk costs of entry for each country. This implies

$$J(z_{ii})w_i f + J(z_{ij})w_i f_x = r_i F^e \tag{2.35}$$

$$J(z_{jj})w_j f + J(z_{ji})w_j f_x = r_j F^e \tag{2.36}$$

As the total expenditure on intermediate goods must equal the total income generated in the intermediate goods sector, we have the following two equations:

$$\sigma M_i^e w_i[f[J(z_{ii}) + (1 - G(z_{ii}))] + f_x[J(z_{ij}) + (1 - G(z_{ij}))]] = w_i(L_i - L_{Yi}) + r_i K_i \tag{2.37}$$

$$\sigma M_j^e w_j[f[J(z_{jj}) + (1 - G(z_{jj}))] + f_x[J(z_{ji}) + (1 - G(z_{ji}))]] = w_j(L_j - L_{Yj}) + r_j K_j \tag{2.38}$$

As before, the mass of entrants in each country is fixed by the domestic capital stock.

$$K_i = M_i^e F^e \tag{2.39}$$

$$K_j = M_j^e F^e \tag{2.40}$$

From the zero-profit condition of the final good sector we get

$$\frac{\alpha}{1-\alpha}w_i L_{Yi} = \sigma M_i^e w_i f[J(z_{ii}) + (1 - G(z_{ii}))] + \sigma M_j^e w_j f_x[J(z_{ji}) + (1 - G(z_{ji}))] \tag{2.41}$$

$$\frac{\alpha}{1-\alpha}w_j L_{Yj} = \sigma M_j^e w_j f[J(z_{jj}) + (1 - G(z_{jj}))] + \sigma M_i^e w_i f_x[J(z_{ij}) + (1 - G(z_{ij}))] \tag{2.42}$$

I assume ex-ante firm productivity follows a Pareto distribution,

$$G(z) = 1 - (\frac{b}{z})^\beta$$

Here I assume

$$\beta > \sigma - 1$$

so that firm profits are finite. Hence,

$$\begin{aligned} J(a) &= (\frac{b}{a})^{\beta} \frac{(\sigma-1)}{\beta-(\sigma-1)} \\ &= (\theta-1)(\frac{b}{a})^{\beta} \end{aligned}$$

where $\theta = \frac{\beta}{\beta-(\sigma-1)}$.

Assuming the final good to be the numeraire, we can rewrite the zero cut-off productivity equations as below:

$$(\frac{w_i}{\rho z_{ii}})^{1-\sigma} w_i^{(\frac{\alpha-1}{\alpha})(\sigma-1)} \frac{\alpha}{1-\alpha} L_{Yi} = \sigma f \tag{2.43}$$

$$(\frac{w_j}{\rho z_{jj}})^{1-\sigma} w_j^{(\frac{\alpha-1}{\alpha})(\sigma-1)} \frac{\alpha}{1-\alpha} L_{Yj} = \sigma f \tag{2.44}$$

$$(\frac{w_i \tau}{\rho z_{ij}})^{1-\sigma} w_j^{(\frac{\alpha-1}{\alpha})(\sigma-1)} \frac{\alpha}{1-\alpha} w_j L_{Yj} = \sigma w_i f_x \tag{2.45}$$

$$(\frac{w_j \tau}{\rho z_{ji}})^{1-\sigma} w_i^{(\frac{\alpha-1}{\alpha})(\sigma-1)} \frac{\alpha}{1-\alpha} w_i L_{Yi} = \sigma w_j f_x \tag{2.46}$$

The free-entry conditions can be rewritten as:

$$(\theta-1) b^{\beta} w_i [f(z_{ii})^{-\beta} + f_x(z_{ij})^{-\beta}] = r_i F^e \tag{2.47}$$

$$(\theta-1) b^{\beta} w_j [f(z_{jj})^{-\beta} + f_x(z_{ji})^{-\beta}] = r_j F^e \tag{2.48}$$

Again, the income equals expenditure identity in the intermediate goods sector implies,

$$\sigma M_i^e w_i \theta b^{\beta} [f(z_{ii})^{-\beta} + f_x(z_{ij})^{-\beta}] = w_i(L_i - L_{Yi}) + r_i K_i \tag{2.49}$$

$$\sigma M_j^e w_j \theta b^{\beta} [f(z_{jj})^{-\beta} + f_x(z_{ji})^{-\beta}] = w_j(L_j - L_{Yj}) + r_j K_j \tag{2.50}$$

Also, from the zero-profit condition of the final good sector we get

$$\frac{\alpha}{1-\alpha} w_i L_{Yi} = \sigma \theta b^{\beta} [M_i^e w_i f(z_{ii})^{-\beta} + M_j^e w_j f_x(z_{ji})^{-\beta}] \tag{2.51}$$

$$\frac{\alpha}{1-\alpha} w_j L_{Yj} = \sigma \theta b^{\beta} [M_j^e w_j f(z_{jj})^{-\beta} + M_i^e w_i f_x(z_{ij})^{-\beta}] \tag{2.52}$$

The last eight equations describe the costly trade model that I consider. Since these equations are non-linear in most endogeneous variables the model is analytically intractable. I evaluate the effect of a bilateral liberaliZation in this model through a numerical simulation.

2.3 Numerical Simulation

In this section I parameterize the model in the case of costly trade and then I numerically solve it. In calibrating the model I have used the elasticity of substitution $\sigma = 3.8$ as estimated by Bernard, S. Redding, and Schott 2007. For calibrating the Pareto distribution I have used $\beta = 3.4; b = 0.2$ which along with the value of σ ensure that firm profits are finite. The cost parameters and the values of labor and capital endowments are given as follows: $f = f_x = 0.1; K_i = 1200; L_i = 1000; K_j = 1000; L_j = 1200$. All the afore mentioned parameters are in line with Bernard, S. Redding, and Schott 2007. α is taken at an intermediate value of 0.5. The costly trade model thus parameterized I perform a bilateral liberalization exercise by changing the variable trade cost from 65% to 20% (that is, the bilateral τ decreases from 1.65 to 1.2 in steps of 0.05 which considers only those data points showing that the export cut-off is greater than the domestic cut-off for both countries). The effects of such liberalization are described in the following subsections.

2.3.1 Effect on factor-price ratio

In the costly trade scenario we get a Stolper-Samuelson type result for rental-wage ratio. Figure 2.2 shows that as the variable trade cost falls capital abundant Home experiences a rise in the rental-wage ratio while labor abundant Foreign experiences a fall in the rental-wage ratio.

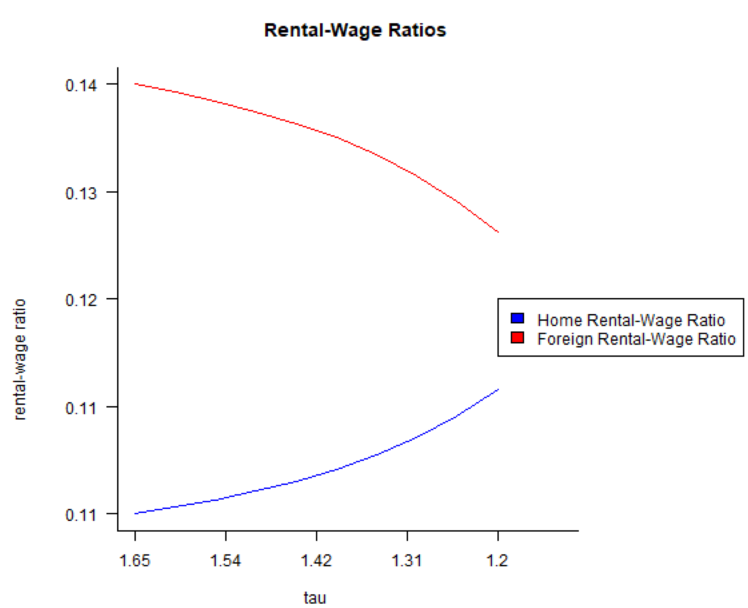

Figure 2.2: Rental-Wage Ratios

2.3.2 Productivity effects

For both Home (Figure 2.3) and Foreign (Figure 2.4) as the variable trade cost falls the domestic cut-off rises and the export cutoff falls. This implies that as a result of bilateral liberalization the mass of exporters rises in both countries and the efficiency of the intermediate goods sector increases in both countries.

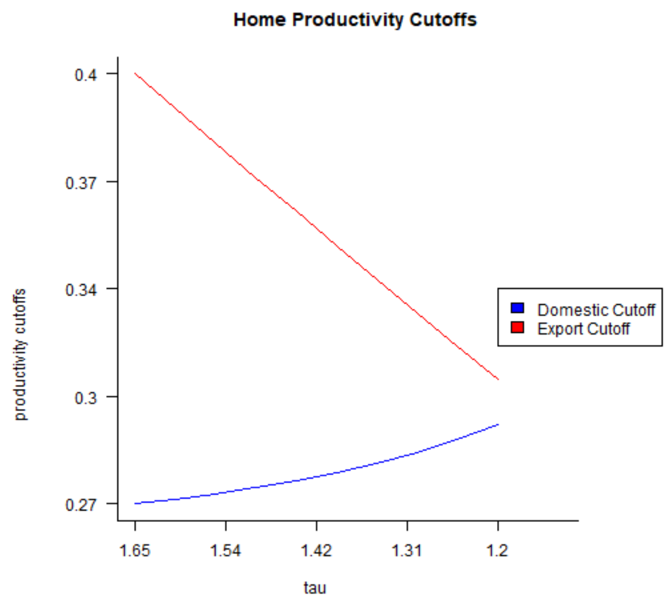

Figure 2.3: Home Productivity Cut-offs

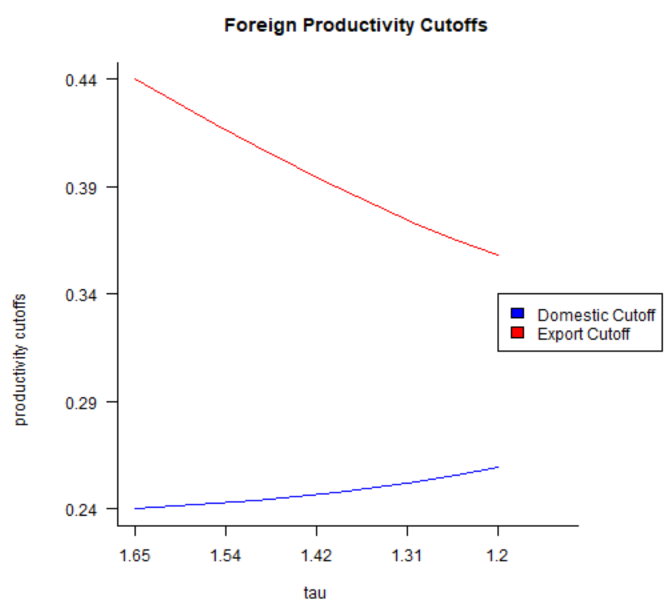

Figure 2.4: Foreign Productivity Cut-offs

We know from Proposition 2.5 that the Home cut-off productivity falls in a move

from autarky to free trade. Interestingly the domestic cut-off productivity of Home lies between the autarky and free trade cut-off values for all considered values of the variable trade cost. Also likewise the Foreign domestic cut-off productivity is greater than its autarky value and less than its free trade value for all τ between 1.2 to 1.65. Theoretically this can be linked to the change in the rental-wage ratio.
Under free trade we have (for Home)

$$J(z^*)wf = rF^e$$
$$\Rightarrow (\theta - 1)b^{\beta}(z^*)^{-\beta} f = \frac{r}{w}F^e$$

And under costly trade we have,

$$J(z_{ii})w_i f + J(z_{ij})w_i f_x = r_i F^e$$
$$\Rightarrow (\theta - 1)b^{\beta}(z_{ii})^{-\beta} f + (\theta - 1)b^{\beta}(z_{ij})^{-\beta} f_x = \frac{r_i}{w_i}F^e$$

Hence, if $\frac{r_i}{w_i}$ falls from free trade to costly trade, then

$$(z_{ii})^{-\beta} < (z^*)^{-\beta} \Rightarrow z_{ii} > z^*$$

This implies that a fall in the rental-wage ratio leads to stricter selection. Next I consider for Foreign the move to costly trade from autarky and show that a rise in the rental wage ratio leads to weaker selection.
Under autarky we have (for Foreign)

$$J(z_j^*)w_j f = r_j F^e$$
$$\Rightarrow (\theta - 1)b^{\beta}(z_j^*)^{-\beta} f = \frac{r_j}{w_j}F^e$$

And under costly trade we have,

$$J(z_{jj})w_j f + J(z_{ji})w_j f_x = r_j F^e$$
$$\Rightarrow (\theta - 1)b^{\beta}(z_{jj})^{-\beta} f + (\theta - 1)b^{\beta}(z_{ji})^{-\beta} f_x = \frac{r_j}{w_j}F^e$$

Hence, if $\frac{r_j}{w_j}$ falls from autarky to costly trade, then $(z_{jj})^{-\beta} < (z_j^*)^{-\beta} \Rightarrow z_{jj} > z_j^*$. Assuming there exists at least one point where $z_j^* < z_{jj} < z^*$ the above result and Proposition 2.6 imply that if $\frac{r_j}{w_j}$ rises from free trade to costly trade, then $(z_{jj})^{-\beta} > (z_j^*)^{-\beta} \Rightarrow z_{jj} < z_j^*$.

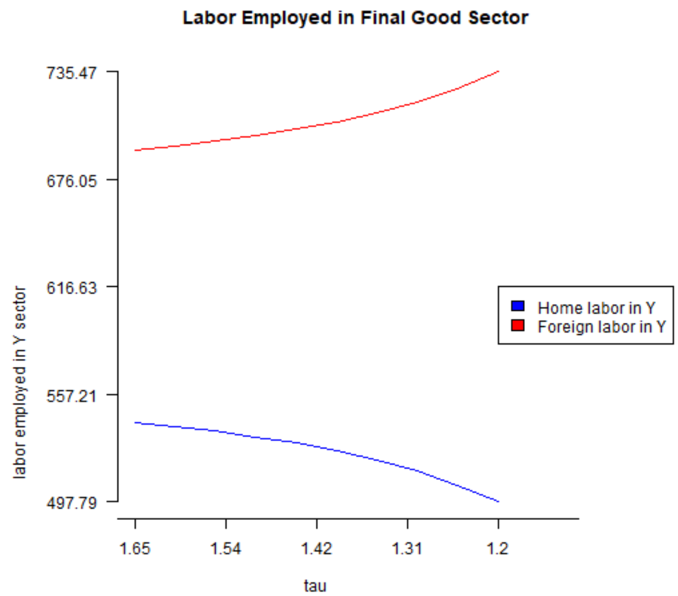

Figure 2.5: Labor in Final Good Sector

2.3.3 Labor allocation across upstream and downstream sectors

Due to bilateral liberalization as the rental-wage ratio of Home rises the labor employed in the final good sector falls while the opposite happens in Foreign, as shown in Figure 2.5

This is nothing but the Stolper-Samuelson effect which states that as the relative price of a factor increases the sector intensively using that factor expands, and vice-versa. In the structure I have laid down this can be seen in the following manner.

$$
\begin{aligned}
w_i L_{xi} &= \text{Revenue of intermediate goods sector} - \text{Profits}(\pi) \\
&= \sigma[\pi + \text{Total Fixed Costs (TFC)}] - \pi \\
&= (\sigma - 1)\pi + \sigma \text{TFC} \\
&= (\sigma - 1)M_i^e[J(z_{ii})w_i f + J(z_{ij})w_i f_x] + \sigma M_i^e[(1 - G(z_{ii}))w_i f + (1 - G(z_{ij}))w_i f_x] \\
&= (\sigma - 1)M_i^e[(\theta - 1)b^\beta((z_{ii})^{-\beta}w_i f + (z_{ij})^{-\beta}w_i f_x)] + \sigma M_i^e[b^\beta((z_{ii})^{-\beta}w_i f + (z_{ij})^{-\beta}w_i f_x)] \\
&= M_i^e[b^\beta w_i f(z_{ii})^{-\beta}((\sigma - 1)(\theta - 1) + \sigma) + b^\beta w_i f_x(z_{ij})^{-\beta}((\sigma - 1)(\theta - 1) + \sigma)] \\
&= M_i^e((\sigma - 1)(\theta - 1) + \sigma)(b^\beta w_i f(z_{ii})^{-\beta} + b^\beta w_i f_x(z_{ij})^{-\beta}) \\
&= M_i^e((\sigma - 1) + \frac{\sigma}{\theta - 1})(r_i F^e) \\
&= ((\sigma - 1) + \frac{\sigma}{\theta - 1})r_i K_i
\end{aligned}
$$

$$
\Rightarrow \frac{w_i L_{xi}}{r_i K_i} = \frac{w_j L_{xj}}{r_j K_j} = ((\sigma - 1) + \frac{\sigma}{\theta - 1})
$$

This implies that as $(\frac{w_i}{r_i})$ rises, L_{xi} falls and L_{Yi} rises. Also if $(\frac{w_i}{r_i})$ falls, L_{xi} rises and L_{Yi} falls.

2.3.4 Change in wage rate

As the final good is the numeraire the nominal wage rate (reward of labor) is also the real reward of labor. Due to liberalization the wage rate in both countries increases. Keeping all other parameters the same I have checked for $\alpha = 0.2, 0.25, 0.75$ but in those cases also the wage rate in both countries increases as a result of bilateral liberalization. But for unilateral liberalisation, the wage rate of the liberalising country increases while that of the other country falls (here α is taken to be 0.5). In Figure 2.6 the Wage Rate Curves of the two countries intersect, which is just a feature of this particular parametric combination. For other values of α the curves may not intersect.

Figure 2.6: Wage Rate

2.3.5 Change in rental rate

Again, since the final good is the numeraire the nominal rental rate is also the real rental rate. Due to liberalization, as shown in Figure 2.7 the rental rate in capital-abundant Home rises while the rental-rate in labor-abundant Foreign falls.

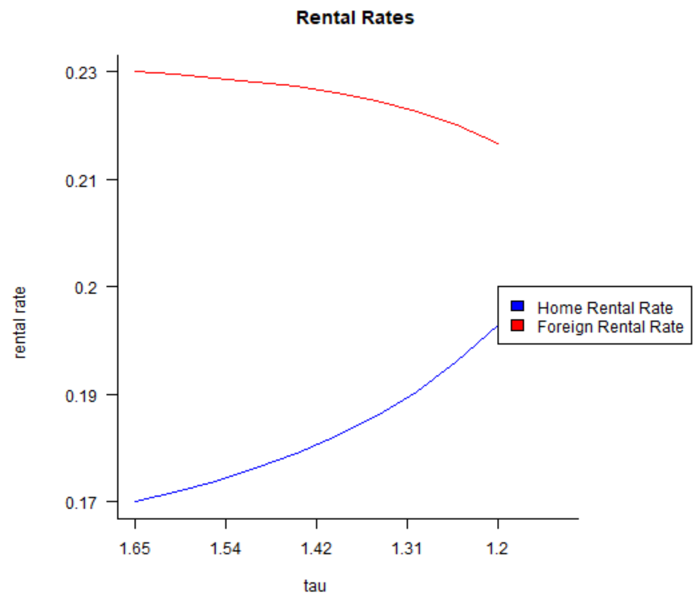

Figure 2.7: Rental Rate

2.4 Conclusion

I develop a factor-proportions driven model of intra-industry trade in intermediate goods and trade in final goods with firm heterogeneity and allowing for entry to be more capital intensive than production. In this framework I analyze the free trade equilibrium and examine bilateral liberalization through a numerical simulation of the model for costly trade.

In contrast to Bernard, S. Redding, and Schott 2007 I find that as a country opens up to free trade the average industry productivity changes and this change is guided by factor-proportions. Specifically, upon opening up to free trade the capital abundant country observes an influx of less efficient firms and its average industry productivity drops. On the other hand, the labor abundant country experiences an increase in average industry productivity as the least productive firms exit the market. Though the wage-rental ratio behaves in accordance with the Stolper-Samuelson result, in a departure from the said result the real wage rises in the capital abundant country while it may fall in the labor abundant country. Further, as trade costs fall, I find Stolper-Samuelson type behavior operational in rental-wage ratios which influences the labor allocation across industries.

The model can be extended in several ways. Firstly, allowing for capital mobility across countries would make the mass of entrants in both countries to be endogenous variables and not fixed by capital stock like in this paper. Secondly, a comparison of the welfare and distributional effects of tariff on goods and tax on capital flows seems to be an interesting avenue of further research. Lastly, allowing firm productivity to change over time would significantly enrich the model and generate the possibility of dynamic gains from trade driven by comparative advantage. These extensions are left for future research.

Chapter 3

INCREASING RETURNS AND RURAL-URBAN MIGRATION: IMPACT OF CAPITAL INFLOW AND TARIFF

3.1 Introduction

Urban unemployment is a persistent problem faced by many developing countries. Despite having large numbers of urban unemployed workers, they experience migration of rural workers to urban areas in expectation of higher income. Consequently, the developing countries face the twin challenges of curbing urban unemployment and increasing real incomes. Trade theorists, using the celebrated Harris and Todaro 1970 (henceforth H-T) structure have analysed several policies for economic development in the context of a small, unemployment-ridden, open economy.

Foreign capital inflow in a (tariff) protected (capital intensive) import competing sector with the capital income being fully repatriated, is generally found to be immiserizing, a result shown by the seminal work of Brecher and Diaz Alejandro 1977[1]. Hence on welfare grounds inviting foreign capital into a protected sector is not recommended for a small open economy, but a foreign capital inflow might be a suitable option for reducing urban unemployment[2]. Also, for an unemployment-ridden economy, increase in tariff protection for a labor intensive sector might be politically justifiable on grounds that it creates jobs as the protected sector expands. However, an import tariff in an H-T type economy has been found to be welfare reducing[3].

A common feature in the studies supporting aforementioned conventional wisdom is that the urban sector good is produced under constant returns. However, increasing returns is an important aspect of modern industrial production, especially the production of capital intensive goods. Another important aspect of modern production structure is the existence of non-traded goods. In dual economies the production structure increasingly exhibits input-output linkages between industry and agriculture[4]. The present paper incorporates increasing returns in the produc-

[1] Brecher and Diaz Alejandro 1977 proved the result for a two-good, full employment economy. M. A. Khan 1982 extended the result to a two-sector H-T economy with intersectorally immobile capital.

[2] Beladi and Yabuuchi 2001 and Yabuuchi, Beladi, and Wei 2005 establish conditions under which an inflow of foreign capital might reduce urban unemployment.

[3] See Chen and E. Choi 1994

[4] See Marjit 1991, Beladi and Marjit 1996 and Marjit, Broll, and Mitra 1997

tion of non-traded intermediate inputs and agriculture-industry linkage in an H-T structure and analyzes the effects of an inflow of foreign capital, and an increase in tariff protection, on unemployment and welfare.

This paper is related to a long line of research examining the validity of the celebrated Brecher and Diaz Alejandro 1977 result in other frameworks including H-T type distortions; a subset of this line of research concerns itself with determining conditions under which a foreign capital inflow into a protected sector may not be welfare immiserizing. Chandra and M. Khan 1993 and Grinols 1991 introduce informal sector into an H-T model and re-analyze the welfare effect of a foreign capital inflow. Gupta 1994 uses the H-T model to study the effects of an inflow of foreign capital on income distribution and social welfare. Beladi and Yabuuchi 2001, in an H-T model with an urban informal sector, find that if free trade prevails initially then a tariff-induced inflow of foreign capital might be welfare improving. Yabuuchi, Beladi, and Wei 2005 extends the analysis to cover policy impacts on income distribution.

Chaudhuri 2007 assumes that the agriculture sector produces, besides the export commodity, a non-traded final good and finds that a foreign capital inflow with tariff protection may not be welfare reducing and might also reduce unemployment. He assumes that foreign capital enters only the urban final output sector while in the present paper it enters in both final output and intermediate input sectors. Beladi and Marjit 2000, in a model where the intermediate good is produced under constant returns, find that an influx of foreign capital in a protected sector may be welfare improving even when the foreign capital income is entirely repatriated. Beladi and Marjit 2000 consider foreign capital inflow only in the (protected) intermediate input sector while in the current paper capital flows into both the (protected) final output sector and the intermediate input sector. Chaudhuri, Yabuuchi, and Mukhopadhyay 2006 analyze the impact of investment and trade liberalization policies on unemployment and welfare in an H-T structure with an urban informal sector. In their paper the urban and rural sectors use different types of capital while in ours only the urban sector uses capital directly as an input. The third sector in their model is an informal sector which provides input to the urban formal sector but in our paper the third sector is a formal sector producing an input for the rural sector.

Chakraborty 2001 contributes to the literature by introducing increasing returns via specialization gains due to increased intermediate varieties (like the current model) and he concludes that a capital inflow, while it expands the import competing sector, it may also increase the import volume and thus raise the possibility of a welfare gain if the imported inputs are sufficiently complementary with the domestically produced inputs.

The current paper makes a two-fold contribution to this line of thought. Firstly, under the limiting case of constant returns the model shows that an inflow of foreign capital, although is immiserizing, the result holds for both factor intensity rankings between the urban sector outputs; the protected sector may even be labor intensive and the welfare still falls. Secondly, when increasing returns are considered, I find that a foreign capital inflow reduces specialization unlike the result obtained in Chakraborty 2001, and welfare falls due to fall in aggregate factor income and the expansion of the tariff distorted sector.

Another strand of literature examines the impact of trade policy on welfare for a small open economy under variable returns to scale. Beladi 1988 constructs an H-T model with the outputs of both the manufacturing and agriculture sectors subject to general production functions exhibiting variable returns to scale to the industry but constant returns to the firm. After comparing aggregate welfare under free trade and under import-substitution policies as well as export promotion policies, he concludes that if the elasticity of returns to scale of the agriculture sector is not lower than that of the manufacturing sector then export promotion policies are superior to free trade while import-substitution policies are inferior to free trade. An opposite conclusion is arrived at if the elasticity of the returns to scale in the manufacturing sector is greater than that of the agriculture sector. The current paper models increasing returns in the urban sector to produce an intermediate input which is used in the rural sector. In this framework an increase in tariff protection leads to a redistribution of income from labor to capital and the change in welfare is ambiguous. J.-Y. Choi 1999, in a mobile capital H-T model, finds that factor growth under variable returns to scale may lower the welfare of a small open economy. In contrast, the current paper shows that capital accumulation under increasing returns unambiguously lowers welfare.

This paper is also related to the literature studying the impact of tariff policies on unemployment in a small open economy. Chen and E. Choi 1994 use a two sector H-T model to study the impact of trade policies on urban unemployment and welfare. In their paper an increase in tariff reduces the rural wage and increases urban unemployment. Also they find an increase in tariff to be welfare reducing. Beladi and Marjit 1996 find, in an H-T framework, that a tariff unambiguously decreases urban employment if the protected sector is capital intensive and can decrease total employment even if the protected sector is labor intensive. In a model similar to

Beladi and Marjit 1996, I find that tariff protection can both raise and lower urban and total employment, irrespective of the factor intensity ranking of the protected sector.

Lastly, there is also a relatively sparse and recent literature on development policies evaluated in H-T type models with imperfectly competitive markets. Chi-Chur Chao and Yu 1994 examine the welfare effects of an inflow of foreign capital in a model with oligopolistic competition in manufacturing and urban unemployment. They find the change in welfare to be ambiguous in the short run but in the long run a foreign capital inflow always improves national welfare. In an H-T type model with Cournot competition among manufacturing sector firms, Beladi, Chi-Chur Chao, et al. 2020 find that raising the quota on foreign capital decreases the unemployment ratio, expands the output of urban firms in the short run, while in the long run it can widen the wage gap between urban skilled and rural unskilled labor. Oladi and Gilbert 2011 study intra-industry North-South trade in varieties in a model with urban unemployment. They find that increasing tariff on Northern varieties decreases the rate of unemployment in South but changes in both the level of unemployment and welfare in South are ambiguous. In an extension of this model, Gilbert, Beladi, and Oladi 2015 study both intra-industry trade in varieties and inter-industry trade in agriculture and manufacturing. The analysis shows, due to labor market distortion in the South, comparative advantage in agriculture may arise there. Also, trade liberalization may decrease Southern welfare. Li and Jia 2022 model a monopolistically competitive sector of Dixit-Stiglitz type that produces an intermediate input to be used by a mixed-ownership firm in the urban sector. In a long-run, mobile capital case the authors find a partial privatization to be beneficial, in that it increases specialization and lowers unemployment rate. I contribute to this literature by evaluating the impact-on specialization within the non-traded variety sector-of an inflow of foreign capital and increased protection to the traded sector. Allowing for both factor intensity rankings between the traded and the non-traded sectors, I find that a capital inflow and increased protection both cause the final output sector to expand and the variety sector to contract, reducing the gains from specialization.

The paper is structured as follows. Section 3.2 describes the structure of the model and discusses the implication of increasing returns in this structure. Section 3.3 derives the stability condition assuming that the market for the intermediate input is Marshall stable. Sections 3.4 and 3.5 discuss the impacts of foreign capital inflow and increase in tariff protection respectively. Finally, Section 3.6 concludes.

3.2 Model

I have a small open economy broadly divided into two sectors: a rural sector and an urban sector. The rural sector produces, under constant returns, the export good Y using rural labor (L_R) and an aggregate of the differentiated varieties of an intermediate input (produced in the urban sector).

$$Y = Y(L_R, \left[\sum_{i=1}^{n} x_i^{\rho}\right]^{\frac{1}{\rho}}), \quad 0 < \rho < 1 \tag{3.1}$$

where x_i is the quantity of variety i used and the degree of differentiation of varieties is measured by the elasticity of substitution between any two varieties, which is $\sigma = \frac{1}{1-\rho} > 1$.

The urban sector produces a (import-competing) final good Z under constant returns using as inputs labor and capital, according to the production function

$$Z = Z(L, K) \tag{3.2}$$

The urban sector also produces the varieties of the differentiated intermediate input $x_i, i = 1, ..., n$.

Each variety is produced by a monopolistically competitive firm using both labor and capital[5]. To produce a variety, the firm incurs both fixed cost as well as variable cost, both using labor and capital with the same intensity. The variable cost component is produced by a linearly homogeneous technology using both labor and capital. We have

$$p = (a_{LX}\overline{w} + a_{KX}r) \tag{3.3}$$

where a_{ij} is the amount of factor i utilized in the production of unit output of sector j, $\overline{w}$ is the institutionally fixed urban wage and p is the marginal cost of production. We assume that the fixed cost component is also produced by the same linearly homogeneous technology using the same two factors. Hence we denote fixed costs, F as

$$F = ap$$

where $a > 0$ is a constant.

The existence of a fixed cost leads to increasing returns at the firm level. Denoting the price of a variety as q, the profit maximizing pricing rule for a variety states that

[5] Ethier 1982 first used such a framework to formalize increasing returns due to specialization in a Hecksher-Ohlin type model. See Lovely 1997 for policy issues in this framework.

the price is a constant markup over the marginal cost,

$$q(1 - \frac{1}{\sigma}) = p$$

This implies,

$$\Rightarrow q = \frac{p}{\rho} \tag{3.4}$$

We assume that free entry drives down profits to zero. So for each monopolistically competitive firm, its surplus (revenues less the variable cost of production) goes towards covering fixed cost of production. Thus we have

$$\frac{qx}{\sigma} = ap \Leftrightarrow x = a\sigma\rho \tag{3.5}$$

Thus the same quantity of each variety is produced in equilibrium.
This implies,

$$\begin{aligned} \left[\sum_{i=1}^{n} x_i^{\rho}\right]^{\frac{1}{\rho}} &= n^{\frac{1}{\rho}} x \\ &= n^{\alpha} x, \qquad \alpha = \frac{1}{\rho} > 1 \end{aligned} \tag{3.6}$$

Each monopolistically competitive firm takes the number of varieties, n as given but it is endogeneously determined in general equilibrium. Also, using standard results we get the price index of the varieties, P as

$$\begin{aligned} P &= \left[\sum_{i=1}^{n} q_i^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \\ &= n^{1-\alpha} q \end{aligned} \tag{3.7}$$

We have the following zero profit conditions for Z and Y:

$$(1 + t)\overline{p_Z} = a_{LZ}\overline{w} + a_{KZ}r \tag{3.8}$$

$$\overline{p_Y} = a_{XY}P + a_{LY}w_R \tag{3.9}$$

where a bar over the price of a good indicates that it is traded, and w_R is the rural wage. Note that the consumers face the price $p_Z = (1 + t)\overline{p_Z}$ where t is the amount of tariff imposed.
The factor market equilibrium conditions are the following:

$$[a_{LZ}Z + a_{LX}n(x + a)](1 + \lambda) + a_{LY}Y = \overline{L} \tag{3.10}$$

$$a_{KZ}Z + a_{KX}n(x + a) = \overline{K} = K^h + K^f \tag{3.11}$$

where $\lambda \equiv \frac{U}{L_U}$ is the ratio of unemployed labor to total urban employment; K^h and K^f are respectively the home capital stock and foreign capital.
Lastly, the Harris-Todaro migration equation states that the expected urban wage equals the rural wage rate. That is,

$$\overline{w}\frac{L_U}{U + L_U} = w_R$$

where $\frac{L_U}{U+L_U}$ is the probability of employment. Using the definition of λ we can rewrite the above equation as

$$\overline{w} = w_R(1 + \lambda) \tag{3.12}$$

The model is solved as follows. Equation 3.8 determines r, which in turn, determines p from equation 3.3. From equation 3.4, q is a function of p, which implies from equation 3.7, P is a function of n. Hence from equation 3.9, w_R is a function of n. Now, market clearing for the intermediate input requires $n^\alpha x = a_{XY}Y$. This implies, using equations 3.6 and 3.1, the rural labor employed ($L_R \equiv a_{LY}Y$) is a function of n. Hence equations 3.10 and 3.11 determine Z and n. Thus all endogeneous variables in the model are determined.

3.2.1 Implications of Increasing Returns

Before turning to the model stability it is pertinent at this point to explain how external economies of scale enter into our model. In what follows I denote proportional change by a circumflex, thus $\widehat{a} = \frac{da}{a}$ for any variable a. Log-differentiating equation 3.7 we have:

$$\widehat{P} = (1 - \alpha)\widehat{n} + \widehat{q} \tag{3.13}$$

Using equations 3.4 and 3.13 we have,

$$\widehat{P} = (1 - \alpha)\widehat{n} + \widehat{p}$$
$$\Rightarrow \widehat{P} = (1 - \alpha)\widehat{n}$$

where use has been made of equation 3.3. As $\alpha > 1$ we see that an expansion in varieties depresses the price index of the intermediate input in the rural sector.
Further, using equations 3.5 and 3.6 we have,

$$\widehat{n^\alpha x} = \alpha\widehat{n}$$

This implies that an increase in the number of varieties keeping the resources devoted to the intermediate input sector constant, will raise the amount of total input used in the rural sector. Thus, gains from specialization accrue due to the presence of external economies. The mechanics of increasing returns described above is incorporated into a two-sector Harris-Todaro model with input-output linkage. In such a theoretical model the impact of investment liberalization and trade policy are analyzed following Ronald W. Jones 1965.

3.3 Stability

I assume that the market for the non-traded input $n^{\alpha}x$ (let us denote this by X) is Marshallian stable and thus derive a stability condition (see Ide and Takayama 1991 and Chakraborty 2006 for use of Marshallian stability in a model with increasing returns).

I propose the following adjustment process for the intermediate good sector output X:

$$\dot{X} = \beta \left[\frac{P^D(X)}{P^S(X)} - 1 \right], \qquad \beta > 0 \tag{3.14}$$

where '.' denotes time derivative and β is the speed of adjustment, and P^D and P^S are respectively the demand price and (notional)supply price of X. Linearizing equation 3.14 around the equilibrium value $\bar{X}$ we get

$$\dot{X} = \beta \frac{(X - \bar{X})}{\bar{X}} \left(\frac{\widehat{P^D}}{\widehat{X}} - \frac{\widehat{P^S}}{\widehat{X}} \right)$$

where $\widehat{P}^D$ and $\widehat{P}^S$ are evaluated at the equilibrium value. For X to converge to $\bar{X}$, the coefficient of X has to be negative. Hence we have

$$\left(\frac{\widehat{P^D}}{\widehat{X}} \right) - \left(\frac{\widehat{P^S}}{\widehat{X}} \right) < 0 \tag{3.15}$$

From equation 3.4 we have:

$$\widehat{X} = \alpha \widehat{n} \tag{3.16}$$

From equation 3.7 we have

$$\widehat{P} = (1 - \alpha)\widehat{n} + \widehat{q}$$

Using equations 3.4 and 3.3 this implies

$$\widehat{P} = (1 - \alpha)\widehat{n}$$

And using equation 3.6 we get

$$\widehat{P} = \left(\frac{1-\alpha}{\alpha}\right)\widehat{X}$$

Hence,

$$\left(\frac{\widehat{P^S}}{\widehat{X}}\right) = \frac{1-\alpha}{\alpha} \tag{3.17}$$

Log-differentiating equation 3.11 and denoting $\gamma_{Kj} = \frac{a_{Kj}j}{\overline{K}}, j = Z, X$ we get:

$$\gamma_{KZ}\widehat{Z} + \gamma_{KX}\widehat{n} = 0 - \gamma_{KZ}(\theta_{LZ}\sigma_Z(\widehat{\overline{w}} - \widehat{r})) - \gamma_{KX}(\theta_{LX}\sigma_X(\widehat{\overline{w}} - \widehat{r}))$$

where $\sigma_Z \equiv \frac{\widehat{a_{KZ}}-\widehat{a_{LZ}}}{\widehat{\overline{w}}-\widehat{r}}$ is the elasticity of substitution between capital and labor in sector Z, σ_X is similarly defined, θ_{ij} is the share of input i in the unit cost of good j, and use has been made of the envelope property. As urban wage and the return on capital do not change due to a capital inflow, we have

$$\gamma_{KZ}\widehat{Z} + \gamma_{KX}\widehat{n} = 0 \tag{3.18}$$

Log-differentiating equation 3.10 and denoting $\gamma_{Lj} = \frac{a_{Lj}(1+\lambda)}{\overline{L}}, j = Z, X$ we get

$$\gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} + \frac{L_U}{\overline{L}}\lambda\widehat{\lambda} + \left(\frac{L_R}{\overline{L}}\right)(\widehat{a_{LY}} - \widehat{a_{XY}} + \widehat{X}) = -\gamma_{LZ}\widehat{a_{LZ}} - \gamma_{LX}\widehat{a_{LX}}$$

$$\Rightarrow \gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} + \frac{L_U}{\overline{L}}\lambda\left(-\frac{1+\lambda}{\lambda}\widehat{w_R}\right) + \left(\frac{L_R}{\overline{L}}\right)\widehat{X} =$$

$$-\gamma_{LZ}(-\theta_{KZ}\sigma_Z(\widehat{\overline{w}} - \widehat{r})) - \gamma_{LX}(-\theta_{KX}\sigma_X(\widehat{\overline{w}} - \widehat{r})) - \left(\frac{L_R}{\overline{L}}\right)\sigma_Y(\widehat{P} - \widehat{w_r})$$

$$\Rightarrow \gamma_{LZ}\left(-\frac{\gamma_{KX}}{\gamma_{KZ}}\widehat{n}\right) + \gamma_{LX}\frac{\widehat{X}}{\alpha} - \frac{L_U}{\overline{L}}(1+\lambda)\left(-\frac{\theta_{XY}}{\theta_{LY}}\widehat{P}\right) + \left(\frac{L_R}{\overline{L}}\right)\widehat{X} =$$

$$-\left(\frac{L_R}{\overline{L}}\right)(\sigma_Y(\widehat{P} - \widehat{w_r}))$$

$$\Rightarrow \left(-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}} + \gamma_{LX}\right)\left(\frac{\widehat{X}}{\alpha}\right) - \frac{L_U}{\overline{L}}(1+\lambda)\left(-\frac{\theta_{XY}}{\theta_{LY}}\widehat{P}\right) + \left(\frac{L_R}{\overline{L}}\right)\widehat{X} =$$

$$-\left(\frac{L_R}{\overline{L}}\right)\left(\frac{\sigma_Y}{\theta_{LY}}\right)\widehat{P}$$

$$\Rightarrow \left[-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}\alpha} + \frac{\gamma_{LX}}{\alpha} + \frac{L_R}{\overline{L}}\right]\widehat{X} =$$

$$-\left[\frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}} + \left(\frac{L_R}{\overline{L}}\right)\left(\frac{\sigma_Y}{\theta_{LY}}\right)\right]\widehat{P}$$

$$\therefore \left(\frac{\widehat{P^D}}{\widehat{X}}\right) = \frac{\left[-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}\alpha} + \frac{\gamma_{LX}}{\alpha} + \frac{L_R}{\overline{L}}\right]}{-\left[\frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}} + \left(\frac{L_R}{\overline{L}}\right)\left(\frac{\sigma_Y}{\theta_{LY}}\right)\right]}$$

Then putting the values of $\left(\frac{\widehat{P^S}}{\widehat{X}}\right)$ and $\left(\frac{\widehat{P^D}}{\widehat{X}}\right)$ in equation 3.15 we have

$$\frac{\left[-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}\alpha}+\frac{\gamma_{LX}}{\alpha}+\frac{L_R}{\overline{L}}\right]}{-\left[\frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}+\left(\frac{L_R}{\overline{L}}\right)(\frac{\sigma_Y}{\theta_{LY}})\right]}<\left(\frac{1-\alpha}{\alpha}\right)$$
$$\Rightarrow -\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}}+\gamma_{LX}+\alpha\left(\frac{L_R}{\overline{L}}\right)$$
$$>(\alpha-1)\frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}+(\alpha-1)\left(\frac{L_R}{\overline{L}}\right)(\frac{\sigma_Y}{\theta_{LY}})$$

$$\Rightarrow -\gamma_{KX}\gamma_{LZ}+\gamma_{KZ}\left[\gamma_{LX}+\alpha\left(\frac{L_R}{\overline{L}}\right)\right]$$
$$>\gamma_{KZ}\left[(\alpha-1)\frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}+(\alpha-1)\left(\frac{L_R}{\overline{L}}\right)(\frac{\sigma_Y}{\theta_{LY}})\right] \tag{3.19}$$

This implies that $\Delta > 0$ as I claim in the next section. The above equation can also be rearranged to give the following equation that I use later in the chapter:

$$B \equiv \left[\gamma_{LX}-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}}\right] >$$
$$\left[\frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1)-\left(\frac{L_R}{\overline{L}}\right)\left(\alpha-(\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right]\equiv A \tag{3.20}$$

The stability condition is represented graphically in Figure 3.1. The initial equilibrium is at point E_0 with the output of the intermediate input at X_0 and its price at P_0. According to Marshall stability the demand curve D cuts the supply curve S from above. If, due to change in any exogeneous parameter, X falls below X_0 then the demand price is higher resulting in an increase in output. Whereas if X rises above X_0 the supply price is higher, leading to a fall in output. Thus the system is stable.

3.4 Foreign Capital Inflow

3.4.1 Output and Employment Effects

Since I am interested in evaluating the impact of a foreign capital inflow, I assume the domestic capital stock to be constant[6]. Hence we have $\widehat{K^f} > 0 \Rightarrow \widehat{\overline{K}} > 0$. From equation 3.11 we have

$$\gamma_{KZ}\widehat{Z}+\gamma_{KX}\widehat{n}=\widehat{\overline{K}}-\gamma_{KZ}(\theta_{LZ}\sigma_Z(\widehat{\overline{w}}-\widehat{r}))-\gamma_{KX}(\theta_{LX}\sigma_X(\widehat{\overline{w}}-\widehat{r}))$$

[6]In fact I assume the domestic capital stock to be zero in order to compare our results with those in Brecher and Diaz Alejandro 1977, as discussed in the next subsection.

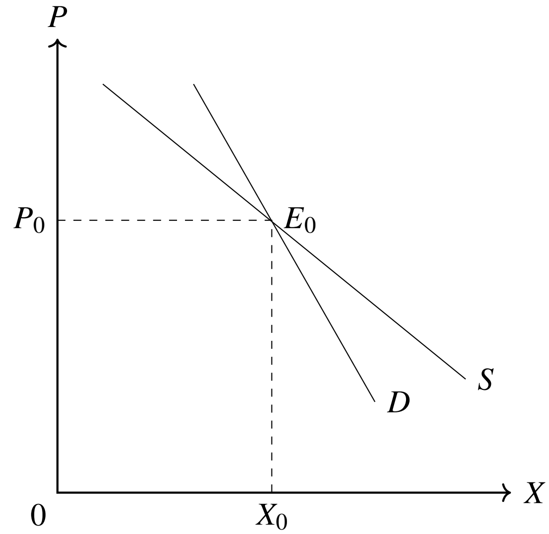

Figure 3.1: Marshallian Stable Equilibrium

$$\Rightarrow \gamma_{KZ}\widehat{Z} + \gamma_{KX}\widehat{n} = \widehat{\overline{K}} \tag{3.21}$$

From equation 3.10 we have

$$\gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} + \frac{L_U}{\overline{L}}\lambda\widehat{\lambda} + \left(\frac{L_R}{\overline{L}}\right)(\widehat{a_{LY}} - \widehat{a_{XY}} + \widehat{X}) = -\gamma_{LZ}\widehat{a_{LZ}} - \gamma_{LX}\widehat{a_{LX}}$$

$$\Rightarrow \gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} + \frac{L_U}{\overline{L}}\lambda\left(-\frac{1+\lambda}{\lambda}\widehat{w_R}\right) + \left(\frac{L_R}{\overline{L}}\right)\widehat{X} =$$

$$-\gamma_{LZ}(-\theta_{KZ}\sigma_Z(\widehat{\overline{w}} - \widehat{r})) - \gamma_{LX}(-\theta_{KX}\sigma_x(\widehat{\overline{w}} - \widehat{r})) - \left(\frac{L_R}{\overline{L}}\right)\sigma_Y(\widehat{P} - \widehat{w_R})$$

$$\Rightarrow \gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} - \frac{L_U}{\overline{L}}(1+\lambda)\left(-\frac{\theta_{XY}}{\theta_{LY}}\widehat{P}\right) + \left(\frac{L_R}{\overline{L}}\right)\alpha\widehat{n} =$$

$$-\left(\frac{L_R}{\overline{L}}\right)\sigma_Y(\widehat{P} - \widehat{w_R})$$

$$\Rightarrow \gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} + \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(1-\alpha)\widehat{n} + \left(\frac{L_R}{\overline{L}}\right)\alpha\widehat{n} =$$

$$-\left(\frac{L_R}{\overline{L}}\right)(\frac{\sigma_Y}{\theta_{LY}})\widehat{P}$$

$$\Rightarrow \gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} + \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(1-\alpha)\widehat{n} + \left(\frac{L_R}{\overline{L}}\right)\alpha\widehat{n} =$$

$$\left(\frac{L_R}{\overline{L}}\right)(\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\widehat{n}$$

$$\Rightarrow \gamma_{LZ}\widehat{Z}+$$

$$\left[\gamma_{LX} - \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right]\widehat{n} = 0 \tag{3.22}$$

From equations 3.21 and 3.22 we get,

$$\widehat{Z} = \frac{\begin{vmatrix} \widehat{\overline{K}} & \gamma_{KX} \\ 0 & \left[\gamma_{LX} - \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right] \end{vmatrix}}{\Delta}$$

where

$$\Delta = \begin{vmatrix} \gamma_{KZ} & \gamma_{KX} \\ \gamma_{LZ} & \left[\gamma_{LX} - \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right] \end{vmatrix}$$
$$= \gamma_{KZ}\left[\gamma_{LX} - \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right]$$
$$- \gamma_{LZ}\gamma_{KX}$$

$$\Rightarrow \Delta = -\gamma_{LZ}\gamma_{KX} +$$
$$\gamma_{KZ}\left[\gamma_{LX} - \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right]$$

From the Marshall stability (equation 3.19) we have $\Delta > 0$. Then the comparative static impacts on sectoral outputs in the urban sector are given by

$$\frac{\widehat{Z}}{\widehat{\overline{K}}} = \frac{\left[\gamma_{LX} - \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right]}{\Delta} \tag{3.23}$$

$$\frac{\widehat{n}}{\widehat{\overline{K}}} = -\frac{\gamma_{LZ}}{\Delta} < 0 \tag{3.24}$$

Here $\frac{\widehat{Z}}{\widehat{\overline{K}}} > 0$ because from equation 3.20, $A < \gamma_{LX}$ where
$A = \left[\frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) - \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right]$.
The effect on the rural wage is derived as

$$\begin{aligned} \frac{\widehat{w_R}}{\widehat{\overline{K}}} &= -\frac{\theta_{XY}}{\theta_{LY}}\frac{\widehat{P}}{\widehat{\overline{K}}} \\ &= \frac{\theta_{XY}}{\theta_{LY}}(\alpha-1)\frac{\widehat{n}}{\widehat{\overline{K}}} \\ &= -\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1)\frac{\gamma_{LZ}}{\Delta} < 0 \end{aligned} \tag{3.25}$$

Hence from the migration equation we get

$$\frac{\widehat{\lambda}}{\widehat{\overline{K}}} = -\frac{1+\lambda}{\lambda}\frac{\widehat{w_R}}{\widehat{\overline{K}}} > 0$$

Note that for $\alpha \to 1$, $\frac{\widehat{w_R}}{\widehat{\overline{K}}} = \frac{\widehat{\lambda}}{\widehat{\overline{K}}} = 0$, like the earlier literature on Harris-Todaro type models with constant returns.

Thus I have proved the following Proposition and Corollary:

Proposition 3.1 *As a result of a foreign capital inflow:*
(a) The urban final output sector expands;
(b) The urban intermediate good sector contracts;
(c) The rural wage rate falls; and,
(d) The unemployment rate rises.

Corollary 3.1 *In the limiting case of constant returns (as* $\alpha \to 1$*), as a result of a foreign capital inflow:*
(a) The urban final output sector expands;
(b) The intermediate input sector contracts; and
(c) Rural wage rate and unemployment rate remain unchanged.

To illustrate the mechanism behind the above result I proceed in the same manner as the stability analysis and derive a demand curve for the intermediate input X, with the modification that now I allow for the capital stock, $\overline{K}$ to change.
Log-differentiating both sides of equation 3.10 I have

$$\gamma_{LZ}\left(-\frac{\gamma_{KX}}{\gamma_{KZ}}\widehat{n}+\frac{\widehat{\overline{K}}}{\gamma_{KZ}}\right)+\gamma_{LX}\frac{\widehat{X}}{\alpha}-\frac{L_U}{\overline{L}}(1+\lambda)\left(-\frac{\theta_{XY}}{\theta_{LY}}\widehat{P}\right)+\left(\frac{L_R}{\overline{L}}\right)\widehat{X}=$$
$$-\left(\frac{L_R}{\overline{L}}\right)(\sigma_Y(\widehat{P}-\widehat{w_r}))$$
$$\Rightarrow\left(-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}}+\gamma_{LX}\right)\left(\frac{\widehat{X}}{\alpha}\right)-\frac{L_U}{\overline{L}}(1+\lambda)\left(-\frac{\theta_{XY}}{\theta_{LY}}\widehat{P}\right)+\left(\frac{L_R}{\overline{L}}\right)\widehat{X}=$$
$$-\left(\frac{L_R}{\overline{L}}\right)\left(\frac{\sigma_Y}{\theta_{LY}}\right)\widehat{P}-\frac{\gamma_{LZ}}{\gamma_{KZ}}\widehat{\overline{K}}$$
$$\Rightarrow\left[-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}\alpha}+\frac{\gamma_{LX}}{\alpha}+\frac{L_R}{\overline{L}}\right]\widehat{X}=$$
$$-\left[\frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}+\left(\frac{L_R}{\overline{L}}\right)\left(\frac{\sigma_Y}{\theta_{LY}}\right)\right]\widehat{P}-\frac{\gamma_{LZ}}{\gamma_{KZ}}\widehat{\overline{K}}$$
$$\Rightarrow\widehat{X}=-\frac{\left[\frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}+\left(\frac{L_R}{\overline{L}}\right)\left(\frac{\sigma_Y}{\theta_{LY}}\right)\right]}{\frac{1}{\alpha}\left[\gamma_{LX}-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}}+\alpha\frac{L_R}{\overline{L}}\right]}\widehat{P}-\frac{\gamma_{LZ}}{\frac{\gamma_{KZ}}{\alpha}\left[\gamma_{LX}-\frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}}+\alpha\frac{L_R}{\overline{L}}\right]}\widehat{\overline{K}}$$

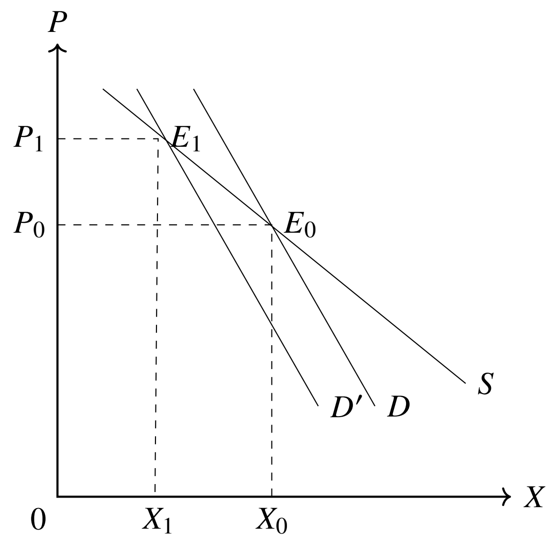

Figure 3.2: Demand Curve Shift due to Capital Inflow

From the Marshall stability condition (equation 3.15) we know that the demand curve cuts the supply curve from above which implies that the demand curve must necessarily be negatively sloped[7]. Hence in the above equation the coefficient of $\widehat{P}$ is negative, implying the denominator in the said coefficient is positive. This implies that the coefficient of $\widehat{\overline{K}}$ is negative, meaning that as a result of a foreign capital inflow, for every P the value of X along the new (shifted) demand curve is smaller. Thus the demand curve shifts to the left. This is explained with the help of figure 3.2. Initial equilibrium is attained at point E_0 with X at X_0 and P at P_0. Now, as a result of a capital inflow, according to Marshall stability there is a leftward shift of the demand curve while the supply curve remains the same. Thus the new equilibrium is established at E_1 with the price index $P_1 > P_0$ and the intermediate good output $X_1 < X_0$. With firm scale constant in the variety sector, this implies a decrease in specialization. Also an increase in the price index results in a fall in the rural wage due to average cost pricing in the rural sector, which in turn, results in an increase in the rate of urban unemployment.

To understand the employment effects of a foreign capital inflow, firstly we see from the definition of L_U that

[7]Note that from equation 3.17 that we have a downward sloping supply curve for X.

$$
\begin{aligned}
\frac{\widehat{L_U}}{\widehat{\overline{K}}} &= \frac{a_{LZ}Z}{L_U}\frac{\widehat{a_{LZ}Z}}{\widehat{\overline{K}}} + \frac{a_{LX}nx}{L_U}\frac{\widehat{a_{LX}nx}}{\widehat{\overline{K}}} \\
&= \frac{a_{LZ}Z(1+\lambda)}{\overline{L}}\frac{\overline{L}}{(1+\lambda)L_U}\frac{\widehat{Z}}{\widehat{\overline{K}}} + \frac{a_{LX}nx(1+\lambda)}{\overline{L}}\frac{\overline{L}}{(1+\lambda)L_U}\frac{\widehat{n}}{\widehat{\overline{K}}} \\
&= \frac{\overline{L}}{(1+\lambda)L_U}\frac{\gamma_{LZ}\widehat{Z}+\gamma_{LX}\widehat{n}}{\widehat{\overline{K}}} \\
&= \frac{\overline{L}}{\Delta(1+\lambda)L_U}\left[\gamma_{LZ}\gamma_{LX} - \gamma_{LZ}\frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1)\right. \\
&\left. +\gamma_{LZ}\left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right) - \gamma_{LX}\gamma_{LZ}\right] \\
&= \frac{\gamma_{LZ}\overline{L}}{\Delta(1+\lambda)L_U}\left[\left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right) - \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1)\right] \\
&= -\frac{\gamma_{LZ}\overline{L}}{\Delta(1+\lambda)L_U}\left[\frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) - \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha-1)\right)\right]
\end{aligned}
$$

Similarly the effect of a capital inflow on rural employment is derived as:

$$
\begin{aligned}
\frac{\widehat{L_R}}{\widehat{\overline{K}}} &= \frac{\widehat{a_{LY}}+\widehat{Y}}{\widehat{\overline{K}}} \\
&= \frac{\widehat{a_{LY}}-\widehat{a_{XY}}+\widehat{X}}{\widehat{\overline{K}}} \\
&= \frac{\sigma_Y}{\theta_{LY}}\frac{\widehat{P}}{\widehat{\overline{K}}} + \alpha\frac{\widehat{n}}{\widehat{\overline{K}}} \\
&= \frac{\sigma_Y}{\theta_{LY}}(1-\alpha)\frac{\widehat{n}}{\widehat{\overline{K}}} + \alpha\frac{\widehat{n}}{\widehat{\overline{K}}} \\
&= \left[\alpha - (\alpha-1)\frac{\sigma_Y}{\theta_{LY}}\right]\frac{\widehat{n}}{\widehat{\overline{K}}}
\end{aligned}
$$

From the above analysis it is clear that as α limitingly approaches 1, in the case of constant returns, urban employment rises ($\frac{\widehat{L_U}}{\widehat{\overline{K}}} > 0$) and rural employment falls ($\frac{\widehat{L_R}}{\widehat{\overline{K}}} < 0$). And as I have shown that an inflow of foreign capital does not affect the rate of unemployment under constant returns, the change in the level of unemployment due to a capital inflow is given by: $\frac{\widehat{U}}{\widehat{\overline{K}}} = \frac{(\widehat{\lambda}+\widehat{L_U})}{\widehat{\overline{K}}} > 0$, that is, the level of unemployment rises under constant returns.

The intuition for this result comes not from the Rcybzynski effect but from Marshall stability. An inflow of foreign capital expands the urban final output sector and contracts the intermediate input sector, ultimately raising urban employment. As the output of the intermediate input is totally used in the rural sector, the latter contracts and releases labor. These rural workers migrate to the urban sector at the same expected wage. But the rise in urban employment at the same unemployment rate implies a proportional rise in the level of unemployment.

The unambiguity of the result under constant returns vanishes as increasing returns are brought into the picture. Specifically, for $\alpha > 1$,

$$\frac{\widehat{L_U}}{\widehat{\overline{K}}} \gtrless 0 \text{ iff } A \lesseqgtr 0$$

$$\frac{\widehat{L_R}}{\widehat{\overline{K}}} \gtrless 0 \text{ iff } \alpha \lesseqgtr (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}$$

I now derive, under the general case of increasing returns, the effect of a foreign capital inflow on aggregate employment.

$$\begin{aligned}
\frac{\widehat{L_U + L_R}}{\widehat{\overline{K}}} &= \frac{L_U}{L_U + L_R}\frac{\widehat{L_U}}{\widehat{\overline{K}}} + \frac{L_R}{L_U + L_R}\frac{\widehat{L_R}}{\widehat{\overline{K}}} \\
&= \frac{L_U}{L_U + L_R}\left[-\frac{\gamma_{LZ}\overline{L}}{\Delta(1+\lambda)L_U}\left[\frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha - 1) - \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - (\frac{\sigma_Y}{\theta_{LY}})(\alpha - 1)\right)\right]\right] \\
&+ \frac{L_R}{L_U + L_R}\left(-\frac{\gamma_{LZ}}{\Delta}\right)\left[\alpha - (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}\right] \\
&= -\frac{\gamma_{LZ}}{\Delta}\left[\frac{L_U}{L_U + L_R}\frac{\overline{L}}{(1+\lambda)L_U}\left(\frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha - 1) - \frac{L_R}{\overline{L}}\left(\alpha - (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}\right)\right)\right. \\
&\left. + \frac{L_R}{L_U + L_R}\left(\alpha - (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}\right)\right] \\
&= -\frac{\gamma_{LZ}}{\Delta}\left[\frac{L_U}{L_U + L_R}\frac{\theta_{XY}}{\theta_{LY}}(\alpha - 1) + \left(\alpha - (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}\right)\left(\frac{L_R}{L_U + L_R} - \frac{L_R}{(1+\lambda)(L_U + L_R)}\right)\right] \\
&= -\frac{\gamma_{LZ}}{\Delta}\left[\frac{L_U}{L_U + L_R}\frac{\theta_{XY}}{\theta_{LY}}(\alpha - 1) + \left(\alpha - (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}\right)\left(\frac{L_R}{L_U + L_R}\right)\left(\frac{\lambda}{1+\lambda}\right)\right]
\end{aligned}$$

The change in total employment due to an inflow of foreign capital is, in general, ambiguous.

The employment effects can be summarized in the following Proposition and Corollary:

Proposition 3.2 *As a result of a foreign capital inflow:*
(a) Urban employment rises(falls) iff A is less(greater) than zero;
(b) Rural employment rises(falls) iff α is less(greater) than $(\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}$; and,
(c) A sufficient condition for aggregate employment to fall is $\alpha > (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}$.

Corollary 3.2 *In the limiting case of constant returns (as $\alpha \to 1$), as a result of a foreign capital inflow:*
(a) Urban employment rises;
(b) Rural employment falls; and,
(c) Aggregate employment falls.

3.4.2 Welfare Effect

In this subsection I calculate the welfare change due to a foreign capital inflow. First I assume that the exportable Y is numeraire. Then as total expenditure in the economy must equal the total factor income accruing to domestic residents, we have

$$(1+t)\overline{p_Z}D_Z + D_Y = \overline{w}L_U + w_R L_R + rK_h + t\overline{p_Z}M$$

where M is the quantity of imports. By manipulating equation 3.12 we get the celebrated property of the H-T model that total wage bill is the product of the rural wage and the total labor endowment in the economy. Then I can rewrite the above equation as

$$(1+t)\overline{p_Z}D_Z + D_Y = w_R\overline{L} + rK_h + t\overline{p_Z}M \tag{3.26}$$

where D_Z and D_Y are domestic demands for goods Z and Y respectively, and M is the quantity of imports of Z.

Brecher and Diaz Alejandro 1977 show in a two sector model that a foreign capital inflow into a protected sector, with the profit income being repatriated, is welfare reducing if the protected sector is capital intensive. This is because the capital inflow expands the import competing sector which leads to crowding out of cheaper imports and thus welfare falls. In order to present our results in comparison with Brecher and Diaz Alejandro 1977 I assume that the entire profit income is repatriated and the domestic capital stock is zero.

Taking total differential on both sides of equation 3.26 we have

$$\begin{aligned} &dD_Y + (1+t)\overline{p_Z}dD_Z + D_Z d((1+t)\overline{p_Z}) = \overline{L}dw_R + t\overline{p_Z}dM \\ &\Rightarrow dD_Y + (1+t)\overline{p_Z}dD_Z = \overline{L}dw_R + t\overline{p_Z}dM \end{aligned}$$

The change in welfare which I denote by dy (for details see Ronald W. Jones 1967), is the change in domestic real income measured in units of the exportable Y. This is nothing but the price-weighted change in domestic demands of the two goods derived in the previous equation. Thus I can write

$$\begin{aligned} dy &= \overline{L}dw_R + t\overline{p_Z}dM \\ &= \overline{L}dw_R + t\overline{p_Z}(dD_Z - dZ) \\ &= \overline{L}dw_R - t\overline{p_Z}dZ + t\overline{p_Z}dD_Z \\ &= \overline{L}dw_R - t\overline{p_Z}dZ + t\frac{\overline{p_Z}}{p_Z}p_Z\frac{\partial D_z}{\partial y}dy \\ &= \overline{L}dw_R - t\overline{p_Z}dZ + \frac{t}{1+t}m_Z dy \end{aligned}$$

where $0 < m_Z = p_Z\frac{\partial D_z}{\partial y} < 1$, the marginal propensity to consume good Z, assuming non-inferiority of both final goods, and p_Z is the price faced by consumers.

$$\Rightarrow \left[1 - \frac{m_Z t}{1+t}\right] dy = \overline{L}dw_R - t\overline{p_Z}dZ \tag{3.27}$$

From equation 3.27 we see that irrespective of the factor intensity ranking between the urban sector goods, an inflow of foreign capital always decreases welfare. The first term on the R.H.S. of equation 3.27 is negative (see equation 3.25) and shows the increase in aggregate factor income due to an inflow of foreign capital. As the reward to capital is not affected by a capital inflow, it boils down to change in labor income. Under increasing returns this term is negative while under constant returns it vanishes. The second term on the R.H.S. of equation 3.27 is the tariff distortion effect which is negative (see equation 3.23) as the protected sector expands following from the Marshal stability condition. It should be noted that the second effect does not depend on any factor intensity condition in the urban sector and thus will hold even if the protected sector is labor intensive.
The above discussion is summarized in the Proposition and Corollary below.

Proposition 3.3 *As a result of a foreign capital inflow, welfare always decreases.*

Corollary 3.3 *In the limiting case of constant returns (as $\alpha \to 1$), as a result of a foreign capital inflow, welfare falls even if the protected sector is labor intensive, contrary to the Brecher and Diaz Alejandro 1977 result.*

3.5 Protection

In section 3.4 I discussed the effects of a foreign capital inflow on sectoral outputs, sectoral employment levels, total employment level and welfare. Now I turn to the effect on increased tariff on these same variables.
Let $(1 + t) = T$. Since I am analyzing the impact of an increase in tariff protection we have, $\widehat{T} > 0$.

3.5.1 Output and Employment Effects

From equation 3.8 we have

$$\widehat{T} = \theta_{KZ}\widehat{r} \tag{3.28}$$

And from equation 3.3 we have

$$\begin{aligned}\widehat{p} &= \theta_{KX}\widehat{r} \\ &= \frac{\theta_{KX}}{\theta_{KZ}}\widehat{T}\end{aligned}$$

Hence from equations 3.7 and 3.4 we get

$$\begin{aligned}\widehat{P} &= (1-\alpha)\widehat{n} + \widehat{q} \\ &= (1-\alpha)\widehat{n} + \frac{\theta_{KX}}{\theta_{KZ}}\widehat{T}\end{aligned}$$

Now from equation 3.11 we get

$$\begin{aligned}\gamma_{KZ}\widehat{Z} + \gamma_{KX}\widehat{n} &= 0 - \gamma_{KZ}\widehat{a_{KZ}} - \gamma_{KX}\widehat{a_{KX}} \\ &= \gamma_{KZ}\theta_{LZ}\sigma_Z\widehat{r} + \gamma_{KX}\theta_{LX}\sigma_X\widehat{r}\end{aligned}$$

$$\Rightarrow \gamma_{KZ}\widehat{Z} + \gamma_{KX}\widehat{n} = \frac{\widehat{T}}{\theta_{KZ}}(\gamma_{KX}\theta_{LX}\sigma_X + \gamma_{KZ}\theta_{LZ}\sigma_Z) \tag{3.29}$$

And from equation 3.10 we have

$$\begin{aligned}
&\gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} + \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}\left[(1-\alpha)\widehat{n} + \frac{\theta_{KX}}{\theta_{KZ}}\widehat{T}\right] + \left(\frac{L_R}{\overline{L}}\right)\alpha\widehat{n} = \\
&-\gamma_{LZ}\widehat{a_{LZ}} - \gamma_{LX}\widehat{a_{LX}} - \left(\frac{L_R}{\overline{L}}\right)(\widehat{a_{LY}} - \widehat{a_{XY}}) \\
&\Rightarrow \gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} + \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}\left[\frac{\theta_{KX}}{\theta_{KZ}}\widehat{T} - (\alpha-1)\widehat{n}\right] + \left(\frac{L_R}{\overline{L}}\right)\alpha\widehat{n} = \\
&-\gamma_{LZ}\theta_{KZ}\sigma_Z\widehat{r} - \gamma_{LX}\theta_{KX}\sigma_X\widehat{r} - \left(\frac{L_R}{\overline{L}}\right)\frac{\sigma_Y}{\theta_{LY}}\left[(1-\alpha)\widehat{n} + \frac{\theta_{KX}}{\theta_{KZ}}\widehat{T}\right] \\
&\Rightarrow \gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n} - \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1)\widehat{n} + \left(\frac{L_R}{\overline{L}}\right)\alpha\widehat{n} - \left(\frac{L_R}{\overline{L}}\right)\frac{\sigma_Y}{\theta_{LY}}(\alpha-1)\widehat{n} \\
&= -\frac{\widehat{T}}{\theta_{KZ}}(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X) - \widehat{T}\left[\left(\frac{L_R}{\overline{L}}\right)\frac{\sigma_Y}{\theta_{LY}}\frac{\theta_{KX}}{\theta_{KZ}} + \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}\frac{\theta_{KX}}{\theta_{KZ}}\right]
\end{aligned}$$

$$\begin{aligned}
&\Rightarrow \gamma_{LZ}\widehat{Z} + \left[\gamma_{LX} - \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - \frac{\sigma_Y}{\theta_{LY}}(\alpha-1)\right)\right]\widehat{n} \\
&= -\widehat{T}\left[\frac{(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X)}{\theta_{KZ}} + \left(\left(\frac{L_R}{\overline{L}}\right)\frac{\sigma_Y}{\theta_{LY}} + \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}\right)\frac{\theta_{KX}}{\theta_{KZ}}\right]
\end{aligned} \tag{3.30}$$

Applying Cramer's rule to equations 3.29 and 3.30 we get

$$\widehat{Z} = \frac{\begin{vmatrix} \frac{\widehat{T}}{\theta_{KZ}}\Omega_1 & \gamma_{KX} \\ -\widehat{T}\Omega_3 & \Omega_2 \end{vmatrix}}{\Delta}$$

where

$$\begin{aligned}\Delta &= \begin{vmatrix} \gamma_{KZ} & \gamma_{KX} \\ \gamma_{LZ} & \left[\gamma_{LX} - \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - \sigma_Y(\frac{1}{\theta_{LY}})(\alpha-1)\right)\right] \end{vmatrix} \\ &= \gamma_{KZ}\left[\gamma_{LX} - \frac{L_U}{\overline{L}}(1+\lambda)\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - \sigma_Y(\frac{1}{\theta_{LY}})(\alpha-1)\right)\right] \\ &- \gamma_{LZ}\gamma_{KX}\end{aligned}$$

$\Omega_1 = (\gamma_{KX}\theta_{LX}\sigma_X + \gamma_{KZ}\theta_{LZ}\sigma_Z) > 0$,
$\Omega_2 = \left[\gamma_{LX} - \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}(\alpha-1) + \left(\frac{L_R}{\overline{L}}\right)\left(\alpha - \frac{\sigma_Y}{\theta_{LY}}(\alpha-1)\right)\right]$ and
$\Omega_3 = \left[\frac{(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X)}{\theta_{KZ}} + \left(\left(\frac{L_R}{\overline{L}}\right)\frac{\sigma_Y}{\theta_{LY}} + \frac{(1+\lambda)L_U}{\overline{L}}\frac{\theta_{XY}}{\theta_{LY}}\right)\frac{\theta_{KX}}{\theta_{KZ}}\right] > 0$.
From equation 3.20, we have $\Omega_2 > \frac{\gamma_{KX}\gamma_{LZ}}{\gamma_{KZ}} > 0$.

This implies that

$$\frac{\widehat{Z}}{\widehat{T}} = \frac{\frac{\Omega_1\Omega_2}{\theta_{KZ}} + \gamma_{KX}\Omega_3}{\Delta} > 0 \tag{3.31}$$

Also we have

$$\widehat{n} = \frac{\begin{vmatrix} \gamma_{KZ} & \frac{\widehat{T}}{\theta_{KZ}}\Omega_1 \\ \gamma_{LZ} & -\widehat{T}\Omega_3 \end{vmatrix}}{\Delta}$$

$$\Rightarrow \frac{\widehat{n}}{\widehat{T}} = -\frac{\gamma_{KZ}\Omega_3 + \frac{\gamma_{LZ}}{\theta_{KZ}}\Omega_1}{\Delta} < 0 \tag{3.32}$$

The change in the price index is

$$\begin{aligned}\frac{\widehat{P}}{\widehat{T}} &= (1-\alpha)\frac{\widehat{n}}{\widehat{T}} + \frac{\theta_{KX}}{\theta_{KZ}} \\ &= \frac{\theta_{KX}}{\theta_{KZ}} + (\alpha-1)\frac{\gamma_{KZ}\Omega_3 + \frac{\gamma_{LZ}}{\theta_{KZ}}\Omega_1}{\Delta}\end{aligned}$$

Hence

$$\frac{\widehat{P}}{\widehat{T}} > 0$$

which in turn, implies

$$\frac{\widehat{w_R}}{\widehat{T}} = -\frac{\theta_{XY}}{\theta_{LY}}\frac{\widehat{P}}{\widehat{T}} < 0 \tag{3.33}$$

and

$$\frac{\widehat{\lambda}}{\widehat{T}} = -\frac{1+\lambda}{\lambda}\frac{\widehat{w_R}}{\widehat{T}} > 0$$

.

I have thus proved the following Proposition.

Proposition 3.4 *As a result of an increase in tariff protection:*
(a) The final output sector expands,
(b) The intermediate input sector contracts, and
(c) Rural wage rate falls and unemployment rate rises.

Like in the previous section a graphical analysis is suitable to explain the intuition behind these results. As a result of an increase in tariff protection the demand curve is unaffected. But an increase in tariff increases the rental rate from equation 3.8, which in turn, increases p from equation 3.3. As a result, by equation 3.4 the price of a variety rises which increases the supply price of the intermediate input in the rural sector for every X. Hence the new (rightward shifted) supply curve can be derived as:

$$\begin{aligned}\widehat{P} &= (1-\alpha)\widehat{n} + \widehat{q} \\ &= (1-\alpha)\widehat{n} + \widehat{p} \\ &= (1-\alpha)\frac{\widehat{X}}{\alpha} + \frac{\theta_{KX}}{\theta_{KZ}}\widehat{T}\end{aligned} \tag{3.34}$$

In Figure 3.3 I start with the same initial equilibrium at E_0. As the supply curve shifts to S', P rises to P_1 and X falls to X_1.

The change in urban employment levels is calculated in the following equations:

$$\begin{aligned}\widehat{L_U} &= \frac{\overline{L}}{(1+\lambda)L_U}\left(\gamma_{LZ}\widehat{Z} + \gamma_{LX}\widehat{n}\right) + \gamma_{LZ}\widehat{a_{LZ}} + \gamma_{LX}\widehat{a_{LX}} \\ &= \frac{\overline{L}}{(1+\lambda)L_U}\left[\frac{\gamma_{LZ}}{\Delta}\widehat{T}\left(\frac{\Omega_1\Omega_2}{\theta_{KZ}} + \gamma_{KX}\Omega_3\right) - \frac{\gamma_{LX}}{\Delta}\widehat{T}\left(\gamma_{KZ}\Omega_3 + \frac{\gamma_{LZ}}{\theta_{KZ}}\Omega_1\right)\right] \\ &+ \frac{\widehat{T}}{\theta_{KZ}}(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X) \\ &= \frac{\overline{L}}{(1+\lambda)L_U\Delta}\widehat{T}\left[\frac{\gamma_{LZ}}{\theta_{KZ}}\Omega_1\Omega_2 + \gamma_{LZ}\gamma_{KX}\Omega_3 - \gamma_{LX}\gamma_{KZ}\Omega_3 - \frac{\gamma_{LX}\gamma_{LZ}}{\theta_{KZ}}\Omega_1\right] \\ &+ \frac{\widehat{T}}{\theta_{KZ}}(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X)\end{aligned}$$

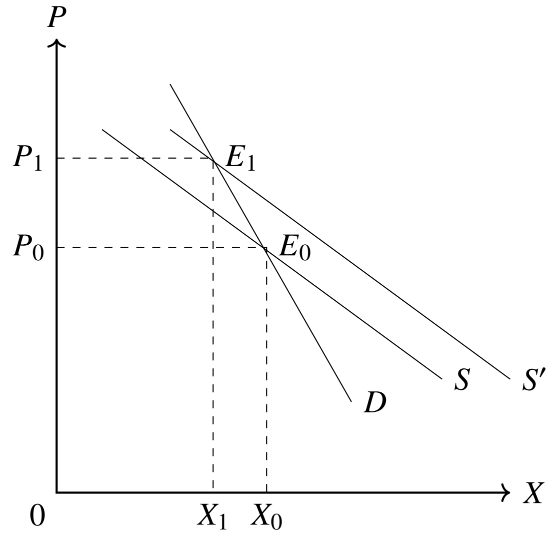

Figure 3.3: Supply Curve Shift due to Tariff Protection

$$\Rightarrow \frac{\widehat{L_U}}{\widehat{T}} = \frac{\overline{L}}{(1+\lambda)L_U\Delta}\left[\frac{\gamma_{LZ}}{\theta_{KZ}}\Omega_1(\Omega_2-\gamma_{LX}) - \Omega_3\gamma_{KZ}\left(\gamma_{LX}-\frac{\gamma_{LZ}\gamma_{KX}}{\gamma_{KZ}}\right)\right] + \frac{1}{\theta_{KZ}}(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X)$$
$$= \frac{\overline{L}}{(1+\lambda)L_U\Delta}\left[\frac{\gamma_{LZ}}{\theta_{KZ}}\Omega_1(-A) + \Omega_3\gamma_{KZ}(-B)\right] + \frac{1}{\theta_{KZ}}(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X)$$

Here, as $\alpha \to 1$, and the model converges to that of Beladi and Marjit 1996, a comparison of the tariff-induced employment changes in this model and theirs seems reasonable. In the current model, in the limiting case of constant returns, $-A = \frac{L_R}{\overline{L}} > 0$, hence urban employment would rise as a result of tariff protection if $B < 0$ (i.e., if the intermediate input sector is capital intensive). But irrespective of the degree of increasing returns, the sign of B is ambiguous. In contrast to this, Beladi and Marjit 1996 find that a tariff causes urban employment to fall if the intermediate input sector is labor intensive (Proposition 1 in their paper).

Now,

$$\widehat{L_R} = \frac{\sigma_Y}{\theta_{LY}}\left[(1-\alpha)\widehat{n} + \frac{\theta_{KX}}{\theta_{KZ}}\widehat{T}\right] + \alpha\widehat{n}$$
$$\Rightarrow \frac{\widehat{L_R}}{\widehat{T}} = \left[\alpha - (\alpha-1)\frac{\sigma_Y}{\theta_{LY}}\right]\frac{\widehat{n}}{\widehat{T}} + \frac{\sigma_Y}{\theta_{LY}}\frac{\theta_{KX}}{\theta_{KZ}}$$

Then the effect on total employment can be derived as

$$\begin{aligned}
\frac{\widehat{L_U + L_R}}{\widehat{T}} &= \frac{L_U}{L_U + L_R}\frac{\widehat{L_U}}{\widehat{T}} + \frac{L_R}{L_U + L_R}\frac{\widehat{L_R}}{\widehat{T}} \\
&= \frac{L_U}{L_U + L_R}\left[\frac{\overline{L}}{(1+\lambda)L_U\Delta}\left(\frac{\gamma_{LZ}}{\theta_{KZ}}\Omega_1(-A) + \Omega_3\gamma_{KZ}(-B)\right) + \right. \\
&\left. \frac{1}{\theta_{KZ}}(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X)\right] \\
&+ \frac{L_R}{L_U + L_R}\left[\left(\alpha - (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}\right)\left(-\frac{\gamma_{KZ}\Omega_3 + \frac{\gamma_{LZ}}{\theta_{KZ}}\Omega_1}{\Delta}\right) + \frac{\sigma_Y}{\theta_{LY}}\frac{\theta_{KX}}{\theta_{KZ}}\right] \\
&= [...] - \frac{\gamma_{LZ}}{\theta_{KZ}\Delta}\Omega_1\left(\frac{\overline{L}}{(L_U + L_R)(1+\lambda)}A + \frac{L_R}{L_U + L_R}\left(\alpha - (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}\right)\right) \\
&- \frac{\Omega_3\gamma_{KZ}}{\Delta}\left[\frac{\overline{L}}{(L_U + L_R)(1+\lambda)}B + \frac{L_R}{L_U + L_R}\left(\alpha - (\alpha - 1)\frac{\sigma_Y}{\theta_{LY}}\right)\right]
\end{aligned}$$

where $[...] = \frac{L_U}{(L_U+L_R)\theta_{KZ}}(\gamma_{LZ}\theta_{KZ}\sigma_Z + \gamma_{LX}\theta_{KX}\sigma_X) + \frac{L_R}{L_U+L_R}\frac{\sigma_Y}{\theta_{LY}}\frac{\theta_{KX}}{\theta_{KZ}} > 0$.
Beladi and Marjit 1996 conclude that a tariff will reduce total employment if the determinant of the coefficient matrix from the two resource constraints, is negative (Proposition 2 in their paper). In the current paper the same determinant is assured positive by Marshall stability. In the limiting case of constant returns the change in total employment is ambiguous (note that this result does not depend on the sign of Δ).

Proposition 3 of Beladi and Marjit 1996 states that a tariff can reduce total employment even if the urban final output is labor intensive. Our analysis allows for this case as Marshall stability is compatible with the situation where $0 < B < A$. Here the final output sector is labor intensive and a tariff can reduce aggregate employment.
The following Proposition is thus immediate.

Proposition 3.5 *In the limiting case of constant returns (as $\alpha \to 1$), as a result of an increase in tariff protection:*
(a) Urban employment may rise or fall; and,
(b) Rural employment may rise or fall.

3.5.2 Welfare Effect

Similar to the case of capital inflow, the change in welfare can be calculated as follows

$$\begin{aligned} dy &= \overline{L}dw_R + K^h dr - D_Z dp_Z + \overline{p_Z}(Mdt + tdM) \\ &= \overline{L}dw_R + K^h dr - D_Z\overline{p_Z}dt + \overline{p_Z}(D_Z - Z)dt + t\overline{p_Z}(dD_Z - dZ) \\ &= \overline{L}dw_R + K^h dr - D_Z\overline{p_Z}dt + \overline{p_Z}D_Z dt - \overline{p_Z}Zdt - t\overline{p_Z}dZ + t\overline{p_Z}\left[\frac{\partial D_Z}{\partial p_Z}dp_Z + \frac{\partial D_Z}{\partial y}dy\right] \\ &= \overline{L}dw_R + K^h dr - \overline{p_Z}Zdt - t\overline{p_Z}dZ + t\overline{p_Z}^2\frac{\partial D_Z}{\partial p_Z}dt + t\frac{\overline{p_Z}}{p_Z}p_Z\frac{\partial D_Z}{\partial y}dy \\ &= \overline{L}dw_R + K^h dr - \overline{p_Z}\left[\left(Z - t\overline{p_Z}\frac{\partial D_Z}{\partial p_Z}\right)dt + tdZ\right] + \frac{t}{1+t}m_Z dy \end{aligned}$$

$$\Rightarrow \left[1 - \frac{m_Z t}{1+t}\right]dy = \overline{L}dw_R + K^h dr - \overline{p_Z}\left[\left(Z - t\overline{p_Z}\frac{\partial D_Z}{\partial p_Z}\right)dt + tdZ\right] \quad (3.35)$$

The first two terms on the R.H.S. of equation 3.35 show the fall in wage income (see equation 3.33) and rise in capital income (3.28) accruing to the economy respectively, resultant to an increase in tariff protection. The third term is the combined terms of trade effect and the tariff distortion effect. As $\frac{\partial D_Z}{\partial p_Z} < 0$ and the output of the urban final good increases (see equation 3.31), this third term is negative. The total change in welfare, in general ambiguous, depends on the relative strengths of these effects. This analysis gives the following Proposition.

Proposition 3.6 *In the limiting case of constant returns (as $\alpha \to 1$), as a result of an increase in tariff protection, welfare change is ambiguous.*

3.6 Conclusion

For a dual economy struggling with unemployment the conventional wisdom regarding policies to curb urban unemployment comes from the Harris-Todaro model. It is argued that rural development policies would work in reducing unemployment and job-seeking migration while urban development policies will have little to no effect. Developing countries are also keen on implementing policies to raise real income levels. As virtually no country today is under total autarky yet protection of import competing sectors with trade barriers is a common phenomenon especially among poorer countries, such developmental policies should be evaluated in an international context. The standard result regarding investment liberalization when there are trade barriers in the import-competing sector, is given by the Brecher and Diaz Alejandro 1977 result which states that a foreign capital inflow into a tariff protected capital intensive sector is immiserizing. Such conventional wisdom is based on models with perfectly competitive production structures where goods are produced under constant returns.

This paper incorporates increasing returns and agriculture-industry linkage in the H-T framework and evaluates the impacts of foreign capital inflow and tariff protection on unemployment and welfare. A foreign capital inflow is found to be welfare reducing always, irrespective of the relative factor intensity of the protected sector and the degree of economies of scale. Under increasing returns an inflow of foreign capital reduces the rural wage rate thereby increasing the rate of unemployment. An increase in tariff protection raises the reward to capital and decreases the rural wage rate. The employment effects of a tariff are ambiguous.

Chapter 4

SECTOR-SPECIFIC TARIFF AND INDUSTRIAL RELOCATION: HOME MARKET EFFECT AND UNEMPLOYMENT

4.1 Introduction

Recently there has been a noticeable shift in the world trade regime towards a more protectionist policy stance on trade by governments throughout the world (see Colantone, Ottaviano, and Stanig 2022 for a survey). Protectionist trade policy was a pillar of the electoral manifesto of the winning candidate in the 2016 and the 2024 US presidential elections. The economic argument put forward was thus: in the face of rising unemployment, protection of domestic industry will lead to relocation of production to the domestic country and thus also bring jobs. Such relocation of industrial production as a result of protectionist measures has a theoretical background (Helpman and Krugman 1989, Ch. 4), though with some caveats, but a question remains still: What is the impact of such protectionist measures in industries that are not protected? This question becomes one of vital importance if the unprotected industry in question consumes valuable resources that are better used elsewhere.

The current paper studies the impact of a tariff on industrial relocation in both protected and unprotected sectors and employment, when there is costless trade in homogeneous agriculture goods but costly trade in varieties of two distinct industrial goods. I find that the movement of output in the two industries occurs in tandem, implying that an expansion or contraction of one industry (protected industry) leads to the same in the other industry (unprotected industry). Hence, as a tariff expands the protected sector in the tariff imposing country and contracts the same sector in its trading partner, the same behaviour is observed also in the unprotected differentiated goods sector in the two countries. This leads to an increase in the real wage in the tariff imposing country and a decrease of the same in its trading counterpart. This mechanism, in conjunction with an efficiency-wage modeling of unemployment (along the lines of Shapiro and Stiglitz 1984), leads to rise in employment in one country (tariff imposing) and fall in employment in the other.

The literature on the co-movement of sectoral outputs of two or more industries is sparse although the issue is an important part of realistic general equilibrium models. Using competitive production structures Ronald W Jones and Scheinkman 1977 and Ronald W Jones and Marjit 1992 generalize the traditional "2×2" model to several sectors and factors, and they find that a rise in the output of one sector may lead to rise in the output of another sector. Marjit and Beladi 1996 show that an expansion in the protected sector results in an expansion in the import demand for the similar product. Matsuyama 1995, building on Matsuyama 1993, surveys the literature showing that complementarities are an equilibrium outcome in models of monopolistic competition. Matsuyama 1995 focuses on the inherent features in monopolistic competition models that give rise to processes of circular causation generating from complementarities in the structure. Another study featuring increasing returns and monopolistic competition where complementarity arises in Chakraborty 2009. Combining complementarity in production with increasing returns to scale, Chakraborty 2009 points out that the results of the Specific Factor Model may not hold when increasing returns are brought into the picture. The current paper contributes to this literature by incorporating the impact of a unilateral tariff on industrial relocation and unemployment in an expanding variety model with two increasing returns sectors. This paper shows that the industrial relocation occurring in one sector can spill over to other sectors under a plausible assumption (relating to stability).

This paper is also related to the rather vast literature on the effects of liberalization and trade policy on involuntary unemployment. Two of the more popular kinds of labor market distortions used in this literature are search-matching and efficiency wages. Among the different kinds of efficiency wage models, Shapiro and Stiglitz 1984 has been frequently used to theoretically examine the impact of trade on unemployment. Hoon 2001 incorporates Shapiro and Stiglitz 1984 type unemployment in a Ricardian set-up and shows a positive impact of trade on employment. In one of the first studies incorporating Shapiro and Stiglitz 1984 type unemployment in a model of increasing returns and proliferation of varieties, Matusz 1996 finds that liberalization decreases the price index in both trading partners and thereby increases real wages and consequently employment in both countries.

The papers cited above assume liberalization for all trading partners. There have been only a few studies that assess the impact of unilateral trade policy on equilibrium unemployment modeled along the lines of Shapiro and Stiglitz 1984. Biswas and Shubham 2018 consider a small open economy facing a given price of imports. An import tariff levied by such an economy may lead to fall in its imports. Chakraborty 2024 evaluates the impact of a unilateral tariff imposed by a large country in presence of transport cost. Chakraborty 2024 finds that a tariff causes entry (exit) in the tariff-imposing country (trading partner) leading to a decrease (increase) in the price index of the tariff-imposing country (trading partner) and thus an increase (decrease) in employment in the tariff-imposing country (trading partner). Our paper contributes to this literature by building on Chakraborty 2024 in the way of adding another increasing returns sector which is not protected. I show that the results in Chakraborty 2024 still hold because the outputs of the two increasing returns sectors move together and so the effects of protection are similar for both of these two sectors in any country, even if only one sector is protected.

Lastly, there is a small literature studying the locational distribution of industries across countries that may differ in size. Here the industries within a country may differ in the elasticity of demand, factor intensity of production, trade cost and the degree of firm heterogeneity. A change in trade cost in this setting can interact with the differences in industry characteristics at the country level and give rise to novel patterns in the distribution of industry across industries.

Amiti 1998 studies the relationship between the size of a country and the characteristics of the goods it produces and trades. In her paper, there are two imperfectly competitive industries that may differ in demand elasticity, factor intensity of production and transport cost. The patterns of trade and specialization depend on the interaction between the market access effect and the production cost effect. In a contemporary paper, Ricci 1999 also models two imperfectly competitive industries with Ricardian comparative cost differences, in two countries of different sizes. He also considers (like the current paper) a homogeneous good industry and shows that agglomeration in a country brought about by a fall in transport cost, reduces its specialization within the manufacturing industry. Laussel and Paul 2007 build a two-country, two-sector and one factor model with monopolistic competition and find that if the size differential between the countries is significant and if the demand elasticity differs across industries then the larger country is always a net exporter of the less differentiated goods.

Firm heterogeneity is also considered in this vein of literature. Bernard, S. Redding, and Schott 2007 consider a factor-proportions driven model of intra-industry trade between two countries where each nation has two monopolistically competitive industries populated by heterogeneous firms and the two industries differ in factor intensity. They show that falling trade costs result in reallocation of factors both within and across industries in both countries, leading to aggregate productivity gain. Xu and Zhou 2023 study how industries differing in firm heterogeneity distribute across countries. They consider a model with one constant returns to scale, homogeneous good sector and two industrial sectors (one with homogeneous firms and another with firm heterogeneity), and find that if trade costs are high(low) then the larger country is more specialized in the industry with heterogeneous(homogeneous) firms.

The current model, like Ricci 1999, assumes a two-country, three-sector and one factor model of inter and intra-industry trade and allows for the two imperfectly competitive sectors to differ in their cost parameters and the two countries to differ in size. In contrast to the previous studies mentioned, I study the impact of a unilateral change in variable trade cost in one sector on the distribution patterns of both industries.

4.2 Model

Consider a two-country world, consisting of two countries-Home (h) and Foreign (f), indexed by $k = h, f$. The two countries trade (costlessly) in a homogeneous good (Y) and (with variable trade cost) in the intermediate varieties of two differentiated goods X_j where $j = A, B$. The individuals in each country k, when employed, can choose to shirk while working or give full effort $e_k, \quad k = h, f$. The representative consumer in country k faces the following utility function:

$$U_k = (Y_k)^{1-\delta}(X_{Ak}^{\gamma} X_{Bk}^{(1-\gamma)})^{\delta} - e_k, \quad k = h, f; \quad 0 < \delta, \gamma < 1 \tag{4.1}$$

where it is assumed that work-effort creates disutility by an equal amount. Let c_{ijh}^k and c_{ljf}^k be the consumption by a k-country consumer of the ith and lth variety respectively of Home and Foreign produced goods of sector j where $j = A, B$. Then the consumption of varieties is aggregated into a CES bundle as follows:

$$X_j^k = [\sum_{i=1}^{n_j^h}(c_{ijh}^k)^{\rho} + \sum_{l=1}^{n_j^f}(c_{ljf}^k)^{\rho}]^{\frac{1}{\rho}}, \qquad 0 < \rho < 1 \tag{4.2}$$

for countries $k = h, f$ and sectors $j = A, B$. Here n_j^h and n_j^f are varieties produced in Home and Foreign respectively of sector j good.

I assume Y good is the numeraire, produced under constant returns to scale in both countries, both before and after the imposition of tariff. I further assume that Y requires one unit of labor per unit of output and since it is freely traded–implying that its price is equalized across the countries–the wage rate in both countries is unity because of average cost pricing in this sector.

Turning now to the cost structure, I assume that all differentiated goods have the same cost function where the parameters may vary across sectors and countries.

The cost of producing x_{mjk} of variety m, sector j in country k is

$$C(x_{mjk}) = (\alpha_{jk} + \beta_{jk} x_{mjk}) w_k$$

where w_k is the wage rate in country k and, since it equals unity, is henceforth omitted. As the average cost is falling in output each variety will be produced by one and only one firm.

The differentiated good sectors are characterized by monopolistic competition so each firm considers itself small in the market and thus there are no strategic interactions between any two firms. Consequently the profit-maximization exercise of each producer gives the following mark-up pricing rule:

$$p_{mjk} \left(1 - \frac{1}{\sigma}\right) = \beta_{jk}$$

where $\sigma = \frac{1}{1-\rho} > 1$ is the price elasticity of demand and the elasticity of substitution between any two varieties. This implies,

$$p_{mjk} = \frac{\beta_{jk}}{\rho} \tag{4.3}$$

So all firms in a given sector charge the same price ($p_{mjk} = p_{jk}$), hence the variety subscript is dropped henceforth. Also note that with a fixed wage rate the price of each variety is constant.

Free entry and exit imply zero profits in equilibrium which means that the operating surplus of a firm must equal its fixed cost of production.

$$p_{jk} \frac{x_{mjk}}{\sigma} = \alpha_{jk} \tag{4.4}$$

This implies that all firms in a sector in a country produce the same (constant) amount of output which is:

$$x_{mjk} = x_{jk} = \frac{\alpha_{jk}\sigma}{p_{jk}} = \frac{\alpha_{jk}\sigma\rho}{\beta_{jk}} = \frac{\alpha_{jk}\rho}{\beta_{jk}(1-\rho)} \tag{4.5}$$

The labor market clearing condition is given by the equality of labor demand by the three sectors and the labor employed:

$$(\alpha_{Ak} + \beta_{Ak} x_{Ak}) n_{Ak} + (\alpha_{Bk} + \beta_{Bk} x_{Bk}) n_{Bk} + Y_k = \theta_k \overline{L_k}, \qquad k = h, f \tag{4.6}$$

where θ_k and $\overline{L_k}$ are respectively the rate of employment and the total labor stock in country k.

The four price indices in total faced by the consumers of each of the two countries for each of the two differentiated good sectors are given below:

$$P_{Ah}^{1-\sigma} = n_{Ah} p_{Ah}^{1-\sigma} + n_{Af} \left(\frac{p_{Af}}{\tau} (1+t) \right)^{1-\sigma} \tag{4.7}$$

$$P_{Bh}^{1-\sigma} = n_{Bh} p_{Bh}^{1-\sigma} + n_{Bf} \left(\frac{p_{Bf}}{\tau} \right)^{1-\sigma} \tag{4.8}$$

$$P_{Af}^{1-\sigma} = n_{Ah} \left(\frac{p_{Ah}}{\tau} \right)^{1-\sigma} + n_{Af} p_{Af}^{1-\sigma} \tag{4.9}$$

$$P_{Bf}^{1-\sigma} = n_{Bh} \left(\frac{p_{Bh}}{\tau} \right)^{1-\sigma} + n_{Bf} p_{Bf}^{1-\sigma} \tag{4.10}$$

where $0 < \tau < 1$ is the variable cost of export modeled in the iceberg fashion, implying that if one unit of a good is shipped out then τ unit reaches the marketplace; and, since we are interested in sector-specific unilateral liberalization, only Home faces the tariff-inclusive price of varieties in only one sector (A), that is to say, the price is multiplied by a factor $(1+t)$ where t is the amount of tariff imposed.
The consumer's demand for a Home and Foreign variety is derived from their utility maximization exercise. This gives the market clearing for the varieties of both sectors in both countries as follows:

$$x_{Ah} = \frac{p_{Ah}^{-\sigma}}{P_{Ah}^{1-\sigma}} \delta\gamma \left(\theta_h \bar{L_h} + t n_{Af} p_{Af} \frac{c_{Af}^h}{\tau} \right) + \frac{\frac{1}{\tau}(\frac{p_{Ah}}{\tau})^{-\sigma}}{P_{Af}^{1-\sigma}} \delta\gamma(\theta_f \bar{L_f}) \tag{4.11}$$

$$x_{Af} = \frac{\frac{1}{\tau}(\frac{p_{Af}}{\tau}(1+t))^{-\sigma}}{P_{Ah}^{1-\sigma}} \delta\gamma \left(\theta_h \bar{L_h} + t n_{Af} p_{Af} \frac{c_{Af}^h}{\tau} \right) + \frac{p_{Af}^{-\sigma}}{P_{Af}^{1-\sigma}} \delta\gamma(\theta_f \bar{L_f}) \tag{4.12}$$

$$x_{Bh} = \frac{p_{Bh}^{-\sigma}}{P_{Bh}^{1-\sigma}} \delta(1-\gamma) \left(\theta_h \bar{L_h} + t n_{Af} p_{Af} \frac{c_{Af}^h}{\tau} \right) + \frac{\frac{1}{\tau}(\frac{p_{Bh}}{\tau})^{-\sigma}}{P_{Bf}^{1-\sigma}} \delta(1-\gamma)(\theta_f \bar{L_f}) \tag{4.13}$$

$$x_{Bf} = \frac{\frac{1}{\tau}(\frac{p_{Bf}}{\tau})^{-\sigma}}{P_{Bh}^{1-\sigma}} \delta(1-\gamma) \left(\theta_h \bar{L_h} + t n_{Af} p_{Af} \frac{c_{Af}^h}{\tau} \right) + \frac{p_{Bf}^{-\sigma}}{P_{Bf}^{1-\sigma}} \delta(1-\gamma)(\theta_f \bar{L_f}) \tag{4.14}$$

where $t n_{Af} p_{Af} \frac{c_{Af}^h}{\tau}$ is the tariff revenue.

4.3 Labor Market

The labor market is characterized by equilibrium unemployment as in Shapiro and Stiglitz 1984[1]. Workers, if employed, can exert full effort, $e = \bar{e}$ or shirk,

[1]This way of modeling unemployment gives a positive relation between the employment rate and the real wage. Such a relation can also be obtained in the case of classical labor supply. In such a framework, the results on varieties and price indices of the differentiated goods will still hold. However, in the modeling framework of classical labor supply, the results on involuntary unemployment derived in our framework cannot be obtained.

$e = 0$. Since worker effort creates disutility, workers have motive to shirk, but if caught doing so, they will be fired and thus lose the wage income. Firms offer efficiency wages (wages higher than the market clearing wage) to prevent shirking, thus causing involuntary unemployment. It is involuntary because in equilibrium the state of employment gives a worker strictly higher utility than unemployment. In this framework workers cannot credibly commit to exert effort at any wage less than the prevailing wage and so cannot bid down the wage rate. This is why unemployment persists.

The entire tariff revenue in Home is divided equally and redistributed among the residents as a lump-sum transfer. Let z_k be the per capita transfer amount in country k. The workers can at any point in time be in one of three states: E (state where she is employed and exerting full effort), S (state where she is employed and shirking) and U (state where she is unemployed). For a worker in state E her instantaneous utility is given by

$$U_k = \frac{w_k + z_k}{\mu P_k^{\delta}} - e_k$$

where $\mu \equiv \delta^{-\delta}(1-\delta)^{-(1-\delta)}$ is a positive constant and $P_k^{\delta} = [P_{Ak}^{\delta\gamma} P_{Bk}^{\delta(1-\gamma)}]$.
Denoting by $v_k = \frac{1}{\mu[P_{Ak}^{\delta\gamma} P_{Bk}^{\delta(1-\gamma)}]}, \quad k = h, f$ the real wage in country k, we get

$$U_k = v_k + \frac{z_k}{\mu[P_{Ak}^{\delta\gamma} P_{Bk}^{\delta(1-\gamma)}]} - e_k \tag{4.15}$$

I assume that individuals are risk neutral and they maximize the expected value of their lifetime utility over an infinite horizon. Let r be the discount factor. Then subject to an intertemporal budget constraint the worker in country k maximizes the expected value of

$$\int_{t=0}^{\infty} U_k e^{-rt}\, dt$$

An employed non-shirker can lose her job at an exogeneous probability of $b > 0$ per unit of time. For a shirker the probability of losing her job is $b + q$ per unit of time where q is the hazard rate of her getting caught and fired. Denoting by V_{Ek} and V_{Sk} the expected lifetime utility of an employed non-shirker and an employed shirker respectively, I can write their fundamental asset equations as follows:

$$rV_{Ek} = \left(v_k + \frac{z_k}{\mu P_k^{\delta}} - \bar{e}\right) - b(V_{Ek} - V_{Uk}) \tag{4.16}$$

$$rV_{Sk} = \left(v_k + \frac{z_k}{\mu P_k^{\delta}}\right) - (b + q)(V_{Sk} - V_{Uk}) \tag{4.17}$$

where V_{Uk} is the expected lifetime utility of an unemployed individual. The first term in equations 4.16 and 4.17 is the flow real wage benefits of an employed non-shirker and an employed shirker respectively. The former is lesser than the latter by the amount of work effort. The second term in equations 4.16 and 4.17 is the expected loss due to job break up.

For an unemployed individual her only source of income is the governmental transfer of tariff revenue. Her fundamental asset equation is

$$rV_{Uk} = \frac{z_k}{\mu P_k^{\delta}} + a(V_{Ek} - V_{Uk}) \tag{4.18}$$

where the unemployed individual finds a new job with the probability of a per unit of time.

Adopting a "carrot and stick" policy, firms will offer wages to ensure that no worker has an incentive to shirk, which implies the following No-Shirking Condition:

$$V_{Ek} \geq V_{Sk} \tag{4.19}$$

Due to cost minimization by firms constraint 4.19 will be satisfied with equality:

$$V_{Ek} = V_{Sk} \tag{4.20}$$

Invoking equations 4.16 and 4.17 we can rewrite equation 4.19 as

$$V_{Ek} - V_{Uk} = \frac{\bar{e}}{q} \tag{4.21}$$

Equation 4.16 can be rewritten as

$$(r + b)(V_{Ek} - V_{Uk}) = (v_k + \frac{z_k}{\mu P_k^{\delta}} - \bar{e}) - rV_{Uk}$$

which, using equation 4.18, can be rewritten as

$$(r + b + a)(V_{Ek} - V_{Uk}) = (v_k + \frac{z_k}{\mu P_k^{\delta}} - \bar{e}) - \frac{z_k}{\mu P_k^{\delta}}$$

Finally using equation 4.21 to plug the value of $(V_{Ek} - V_{Uk})$ we get

$$v_k = \bar{e}\left(1 + \frac{a + b + r}{q}\right) \tag{4.22}$$

Per unit of time $b\theta_k \bar{L_k}$ number of workers join the unemployment pool and $a(\bar{L_k} - \theta_k \bar{L_k})$ number of workers find new jobs, hence exit the unemployment pool. So in steady state we have the following condition

$$b\theta_k \bar{L_k} = a\bar{L_k}(1 - \theta_k)$$

which implies,

$$a = \frac{b\theta_k}{1-\theta_k} \tag{4.23}$$

From equations 4.23 and 4.22 we get

$$v_k = \bar{e}\left(1 + \frac{r + b + \frac{b}{1-\theta_k}}{q}\right) \tag{4.24}$$

The L.H.S. of equation 4.24 is increasing in θ_k so we can write the inverse of equation 4.24 as

$$\theta_k = f(v_k); \quad f'(v_k) > 0 \tag{4.25}$$

Equation 4.25 implies that the employment rate is an increasing function of the country's real wage.

4.4 Stability

In what follows '$\widehat{\ }$' denotes proportional change. Log-differentiating equation 4.25 we get

$$\widehat{\theta_k} = m(v_k)\widehat{v_k}; \quad m(v_k) = \frac{v_k f'(v_k)}{f(v_k)} > 0, \quad k = h, f$$

which can be rewritten, using the definition of v_k as

$$\widehat{\theta_k} = -m(v_k)\delta[\gamma\widehat{P_{Ak}} + (1-\gamma)\widehat{P_{Bk}}], \quad k = h, f \tag{4.26}$$

Log-differentiating equations 4.7-4.10 we have:

$$(1-\sigma)\widehat{P_{Ah}} = s^h_{Ah}\widehat{n_{Ah}} + s^f_{Ah}\left(\widehat{n_{Af}} + (1-\sigma)\frac{dt}{(1+t)}\right) \tag{4.27}$$

$$(1-\sigma)\widehat{P_{Bh}} = s^h_{Bh}\widehat{n_{Bh}} + s^f_{Bh}\widehat{n_{Bf}} \tag{4.28}$$

$$(1-\sigma)\widehat{P_{Af}} = s^h_{Af}\widehat{n_{Ah}} + s^f_{Af}\widehat{n_{Af}} \tag{4.29}$$

$$(1-\sigma)\widehat{P_{Bf}} = s^h_{Bf}\widehat{n_{Bh}} + s^f_{Bf}\widehat{n_{Bf}} \tag{4.30}$$

where the shares are defined as $s^h_{Ah} = \frac{n_{Ah}p^{1-\sigma}_{Ah}}{P^{1-\sigma}_{Ah}}$, and so on. Here s^i_{jk} is the share of country k's expenditure in industry j going towards goods produced in country i. Note, for any industry j, we have

$$\frac{s^h_{jh}}{s^f_{jh}} = \frac{\frac{n_{jh}p^{1-\sigma}_{jh}}{P^{1-\sigma}_{jh}}}{\frac{n_{jf}\left(\frac{p_{jf}}{\tau}\right)^{-\sigma}}{P^{1-\sigma}_{jh}}} = \frac{n_{jh}}{n_{jf}}\left(\frac{p_{jh}}{p_{jf}}\right)^{1-\sigma}\tau^{1-\sigma}$$

And

$$\frac{s_{jf}^h}{s_{jf}^f} = \frac{\frac{n_{jh}\left(\frac{p_{jh}}{\tau}\right)^{1-\sigma}}{P_{jf}^{1-\sigma}}}{\frac{n_{jf}p_{jf}^{1-\sigma}}{P_{jf}^{1-\sigma}}} = \frac{n_{jh}}{n_{jf}}\left(\frac{p_{jh}}{p_{jf}}\right)^{1-\sigma}\tau^{\sigma-1}$$

Hence, as $0 < \tau < 1$ we have

$$\frac{s_{jh}^h}{s_{jh}^f} > \frac{s_{jf}^h}{s_{jf}^f} \Rightarrow s_j \equiv s_{jh}^h s_{jf}^f - s_{jh}^f s_{jf}^h > 0, \quad j = A, B$$

The stability conditions of the model are derived from the entry/exit mechanism of the monopolistically competitive firms. I assume that firms make zero profits only in the long run equilibrium. In the short run the firms may make profits or incur losses. The former case leads to entry in the market whereas the latter case results in firm exit. In this way the long run equilibrium is reached. Based on this logic I propose the following reasonable adjustment rule

$$\dot{n_{Ah}} = \epsilon_{Ah}\left(\frac{\frac{p_{Ah}x_{Ah}}{\sigma}}{\alpha_{Ah}} - 1\right) \tag{4.31}$$

$$\dot{n_{Af}} = \epsilon_{Af}\left(\frac{\frac{p_{Af}x_{Af}}{\sigma}}{\alpha_{Af}} - 1\right) \tag{4.32}$$

$$\dot{n_{Bh}} = \epsilon_{Bh}\left(\frac{\frac{p_{Bh}x_{Bh}}{\sigma}}{\alpha_{Bh}} - 1\right) \tag{4.33}$$

$$\dot{n_{Bf}} = \epsilon_{Bf}\left(\frac{\frac{p_{Bf}x_{Bf}}{\sigma}}{\alpha_{Bf}} - 1\right) \tag{4.34}$$

where a dot over a variable represents time derivative and ϵ_{jk} is the speed of adjustment in sector j in country k.

While linearizing equations 4.31-4.32 around the steady-state we note that

$$\frac{\frac{p_{jk}x_{jk}}{\sigma}}{\alpha_{jk}} - 1 = 0$$

Hence we get:

$$\begin{aligned}\dot{n}_{Ah} = {} & \frac{\epsilon_{Ah}}{n^*_{Ah}} \frac{\partial \log \left(\frac{\frac{p_{Ah} x_{Ah}}{\sigma}}{\alpha_{Ah}} - 1 \right)}{\partial \log n_{Ah}} (n_{Ah} - n^*_{Ah}) + \frac{\epsilon_{Ah}}{n^*_{Af}} \frac{\partial \log \left(\frac{\frac{p_{Ah} x_{Ah}}{\sigma}}{\alpha_{Ah}} - 1 \right)}{\partial \log n_{Af}} (n_{Af} - n^*_{Af}) \\ & + \frac{\epsilon_{Ah}}{n^*_{Bh}} \frac{\partial \log \left(\frac{\frac{p_{Ah} x_{Ah}}{\sigma}}{\alpha_{Ah}} - 1 \right)}{\partial \log n_{Bh}} (n_{Bh} - n^*_{Bh}) + \frac{\epsilon_{Ah}}{n^*_{Bf}} \frac{\partial \log \left(\frac{\frac{p_{Ah} x_{Ah}}{\sigma}}{\alpha_{Ah}} - 1 \right)}{\partial \log n_{Bf}} (n_{Bf} - n^*_{Bf})\end{aligned} \tag{4.35}$$

$$\begin{aligned}\dot{n}_{Af} = {} & \frac{\epsilon_{Af}}{n^*_{Ah}} \frac{\partial \log \left(\frac{\frac{p_{Af} x_{Af}}{\sigma}}{\alpha_{Af}} - 1 \right)}{\partial \log n_{Ah}} (n_{Ah} - n^*_{Ah}) + \frac{\epsilon_{Af}}{n^*_{Af}} \frac{\partial \log \left(\frac{\frac{p_{Af} x_{Af}}{\sigma}}{\alpha_{Af}} - 1 \right)}{\partial \log n_{Af}} (n_{Af} - n^*_{Af}) \\ & + \frac{\epsilon_{Af}}{n^*_{Bh}} \frac{\partial \log \left(\frac{\frac{p_{Af} x_{Af}}{\sigma}}{\alpha_{Af}} - 1 \right)}{\partial \log n_{Bh}} (n_{Bh} - n^*_{Bh}) + \frac{\epsilon_{Af}}{n^*_{Bf}} \frac{\partial \log \left(\frac{\frac{p_{Af} x_{Af}}{\sigma}}{\alpha_{Af}} - 1 \right)}{\partial \log n_{Bf}} (n_{Bf} - n^*_{Bf})\end{aligned} \tag{4.36}$$

$$\begin{aligned}\dot{n}_{Bh} = {} & \frac{\epsilon_{Bh}}{n^*_{Ah}} \frac{\partial \log \left(\frac{\frac{p_{Bh} x_{Bh}}{\sigma}}{\alpha_{Bh}} - 1 \right)}{\partial \log n_{Ah}} (n_{Ah} - n^*_{Ah}) + \frac{\epsilon_{Bh}}{n^*_{Af}} \frac{\partial \log \left(\frac{\frac{p_{Bh} x_{Bh}}{\sigma}}{\alpha_{Bh}} - 1 \right)}{\partial \log n_{Af}} (n_{Af} - n^*_{Af}) \\ & + \frac{\epsilon_{Bh}}{n^*_{Bh}} \frac{\partial \log \left(\frac{\frac{p_{Bh} x_{Bh}}{\sigma}}{\alpha_{Bh}} - 1 \right)}{\partial \log n_{Bh}} (n_{Bh} - n^*_{Bh}) + \frac{\epsilon_{Bh}}{n^*_{Bf}} \frac{\partial \log \left(\frac{\frac{p_{Bh} x_{Bh}}{\sigma}}{\alpha_{Bh}} - 1 \right)}{\partial \log n_{Bf}} (n_{Bf} - n^*_{Bf})\end{aligned} \tag{4.37}$$

$$\begin{aligned}\dot{n}_{Bf} = {} & \frac{\epsilon_{Ah}}{n^*_{Bf}} \frac{\partial \log (\left(\frac{\frac{p_{Bf} x_{Bf}}{\sigma}}{\alpha_{Bf}} - 1 \right)}{\partial \log n_{Ah}} (n_{Ah} - n^*_{Ah}) + \frac{\epsilon_{Bf}}{n^*_{Af}} \frac{\partial \log \left(\frac{\frac{p_{Bf} x_{Bf}}{\sigma}}{\alpha_{Bf}} - 1 \right)}{\partial \log n_{Af}} (n_{Af} - n^*_{Af}) \\ & + \frac{\epsilon_{Bf}}{n^*_{Bh}} \frac{\partial \log \left(\frac{\frac{p_{Bf} x_{Bf}}{\sigma}}{\alpha_{Bf}} - 1 \right)}{\partial \log n_{Bh}} (n_{Bh} - n^*_{Bh}) + \frac{\epsilon_{Bf}}{n^*_{Bf}} \frac{\partial \log \left(\frac{\frac{p_{Bf} x_{Bf}}{\sigma}}{\alpha_{Bf}} - 1 \right)}{\partial \log n_{Bf}} (n_{Bf} - n^*_{Bf})\end{aligned} \tag{4.38}$$

Noting that the price of a variety is constant, the above equations reduce to

$$\begin{aligned}\dot{n}_{Ah} &= \frac{\epsilon_{Ah}}{n^*_{Ah}}\frac{\partial(\log x_{Ah})}{\partial(\log n_{Ah})}(n_{Ah}-n^*_{Ah}) + \frac{\epsilon_{Ah}}{n^*_{Af}}\frac{\partial(\log x_{Ah})}{\partial(\log n_{Af})}(n_{Ah}-n^*_{Ah}) \\ &+ \frac{\epsilon_{Ah}}{n^*_{Bh}}\frac{\partial(\log x_{Ah})}{\partial(\log n_{Bh})}(n_{Bh}-n^*_{Bh}) + \frac{\epsilon_{Ah}}{n^*_{Bf}}\frac{\partial(\log x_{Ah})}{\partial(\log n_{Bf})}(n_{Bf}-n^*_{Bf})\end{aligned} \tag{4.39}$$

$$\begin{aligned}\dot{n}_{Af} &= \frac{\epsilon_{Af}}{n^*_{Ah}}\frac{\partial(\log x_{Af})}{\partial(\log n_{Ah})}(n_{Ah}-n^*_{Ah}) + \frac{\epsilon_{Af}}{n^*_{Af}}\frac{\partial(\log x_{Af})}{\partial(\log n_{Af})}(n_{Af}-n^*_{Af}) \\ &+ \frac{\epsilon_{Af}}{n^*_{Bh}}\frac{\partial(\log x_{Af})}{\partial(\log n_{Bh})}(n_{Bh}-n^*_{Bh}) + \frac{\epsilon_{Af}}{n^*_{Bf}}\frac{\partial(\log x_{Af})}{\partial(\log n_{Bf})}(n_{Bf}-n^*_{Bf})\end{aligned} \tag{4.40}$$

$$\begin{aligned}\dot{n}_{Bh} &= \frac{\epsilon_{Bh}}{n^*_{Ah}}\frac{\partial(\log x_{Bh})}{\partial(\log n_{Ah})}(n_{Ah}-n^*_{Ah}) + \frac{\epsilon_{Bh}}{n^*_{Af}}\frac{\partial(\log x_{Bh})}{\partial(log n_{Af})}(n_{Ah}-n^*_{Ah}) \\ &+ \frac{\epsilon_{Bh}}{n^*_{Bh}}\frac{\partial(\log x_{Bh})}{\partial(\log n_{Bh})}(n_{Bh}-n^*_{Bh}) + \frac{\epsilon_{Bh}}{n^*_{Bf}}\frac{\partial(\log x_{Bh})}{\partial(\log n_{Bf})}(n_{Bf}-n^*_{Bf})\end{aligned} \tag{4.41}$$

$$\begin{aligned}\dot{n}_{Bf} &= \frac{\epsilon_{Bf}}{n^*_{Ah}}\frac{\partial(\log x_{Bf})}{\partial(\log n_{Ah})}(n_{Ah}-n^*_{Ah}) + \frac{\epsilon_{Bf}}{n^*_{Af}}\frac{\partial(\log x_{Bf})}{\partial(\log n_{Af})}(n_{Af}-n^*_{Af}) \\ &+ \frac{\epsilon_{Bf}}{n^*_{Bh}}\frac{\partial(\log x_{Bf})}{\partial(\log n_{Bh})}(n_{Bh}-n^*_{Bh}) + \frac{\epsilon_{Bf}}{n^*_{Bf}}\frac{\partial(\log x_{Bf})}{\partial(\log n_{Bf})}(n_{Bf}-n^*_{Bf})\end{aligned} \tag{4.42}$$

As firm output adjusts to reach the new equilibrium, we have:

$$\begin{aligned}\widehat{x_{Ah}} &= A[\widehat{P^{\sigma-1}_{Ah}\theta_h}] + B[\widehat{P^{\sigma-1}_{Af}\theta_f}] \\ &= A[(\sigma-1)\widehat{P_{Ah}} - m(v_h)\delta[\gamma\widehat{P_{Ah}} + (1-\gamma)\widehat{P_{Bh}}]] \\ &\quad +B[(\sigma-1)\widehat{P_{Af}} - m(v_f)\delta[\gamma\widehat{P_{Af}} + (1-\gamma)\widehat{P_{Bf}}]]\end{aligned} \tag{4.43}$$

$$\begin{aligned}\widehat{x_{Af}} &= C[\widehat{P^{\sigma-1}_{Ah}\theta_h}] + D[\widehat{P^{\sigma-1}_{Af}\theta_f}] \\ &= C[(\sigma-1)\widehat{P_{Ah}} - m(v_h)\delta[\gamma\widehat{P_{Ah}} + (1-\gamma)\widehat{P_{Bh}}]] \\ &\quad +D[(\sigma-1)\widehat{P_{Af}} - m(v_f)\delta[\gamma\widehat{P_{Af}} + (1-\gamma)\widehat{P_{Bf}}]]\end{aligned} \tag{4.44}$$

$$\begin{aligned}\widehat{x_{Bh}} &= A'[\widehat{P^{\sigma-1}_{Bh}\theta_h}] + B'[\widehat{P^{\sigma-1}_{Bf}\theta_f}] \\ &= A'[(\sigma-1)\widehat{P_{Bh}} - m(v_h)\delta[\gamma\widehat{P_{Ah}} + (1-\gamma)\widehat{P_{Bh}}]] \\ &\quad +B'[(\sigma-1)\widehat{P_{Bf}} - m(v_f)\delta[\gamma\widehat{P_{Af}} + (1-\gamma)\widehat{P_{Bf}}]]\end{aligned} \tag{4.45}$$

$$\begin{aligned}\widehat{x_{Bf}} &= C'[\widehat{P^{\sigma-1}_{Bh}\theta_h}] + D'[\widehat{P^{\sigma-1}_{Bf}\theta_f}] \\ &= C'[(\sigma-1)\widehat{P_{Bh}} - m(v_h)\delta[\gamma\widehat{P_{Ah}} + (1-\gamma)\widehat{P_{Bh}}]] \\ &\quad +D'[(\sigma-1)\widehat{P_{Bf}} - m(v_f)\delta[\gamma\widehat{P_{Af}} + (1-\gamma)\widehat{P_{Bf}}]]\end{aligned} \tag{4.46}$$

where

$$A = \frac{p_{Ah}^{-\sigma}}{x_{Ah} P_{Ah}^{1-\sigma}} \delta\gamma(\theta_h \bar{L_h}) > 0; \quad B = \frac{\frac{1}{\tau}(\frac{p_{Ah}}{\tau})^{-\sigma}}{x_{Ah} P_{Af}^{1-\sigma}} \delta\gamma(\theta_f \bar{L_f}) > 0;$$

$$C = \frac{\frac{1}{\tau}(\frac{p_{Af}}{\tau}(1+t))^{-\sigma}}{x_{Af} P_{Ah}^{1-\sigma}} \delta\gamma(\theta_h \bar{L_h}) > 0; \quad D = \frac{p_{Af}^{-\sigma}}{x_{Af} P_{Af}^{1-\sigma}} \delta\gamma(\theta_f \bar{L_f}) > 0;$$

$$A' = \frac{p_{Bh}^{-\sigma}}{x_{Bh} P_{Bh}^{1-\sigma}} \delta(1-\gamma)(\theta_h \bar{L_h}) > 0; \quad B' = \frac{\frac{1}{\tau}(\frac{p_{Bh}}{\tau})^{-\sigma}}{x_{Bh} P_{Bf}^{1-\sigma}} \delta(1-\gamma)(\theta_f \bar{L_f}) > 0;$$

$$C' = \frac{\frac{1}{\tau}(\frac{p_{Bf}}{\tau}(1+t))^{-\sigma}}{x_{Bf} P_{Bh}^{1-\sigma}} \delta(1-\gamma)(\theta_h \bar{L_h}) > 0; \quad D' = \frac{p_{Bf}^{-\sigma}}{x_{Bf} P_{Bf}^{1-\sigma}} \delta(1-\gamma)(\theta_f \bar{L_f}) > 0.$$

Let $[(\sigma - 1) - m(v_k)\delta\gamma] = L_k, \quad m(v_k)\delta(1-\gamma) = l_k, \quad k = h, f;$
$X_1 = AD - BC, \quad X_2 = A'D' - B'C'.$
By definition,

$$AD - BC = \frac{p_{Ah}^{-\sigma} p_{Af}^{-\sigma} (\delta\gamma)^2 (\theta_h \bar{L_h})(\theta_f \bar{L_f})}{x_{Ah} P_{Ah}^{1-\sigma} x_{Af} P_{Af}^{1-\sigma}} (1 - \tau^{-2(1-\sigma)})$$

Hence, as $0 < \tau < 1$, $X_1 > 0$. Proceeding in a similar way we can prove that $X_2 > 0$. Using the notations defined above, the equations 4.43-4.46 can be rewritten as

$$\widehat{x_{Ah}} = A[L_h \widehat{P_{Ah}} - l_h \widehat{P_{Bh}}] + B[L_f \widehat{P_{Af}} - l_f \widehat{P_{Bf}}] \tag{4.47}$$

$$\widehat{x_{Bh}} = A'[L_h \widehat{P_{Bh}} - l_h \widehat{P_{Ah}}] + B'[L_f \widehat{P_{Bf}} - l_f \widehat{P_{Af}}] \tag{4.48}$$

$$\widehat{x_{Af}} = C[L_h \widehat{P_{Ah}} - l_h \widehat{P_{Bh}}] + D[L_f \widehat{P_{Af}} - l_f \widehat{P_{Bf}}] \tag{4.49}$$

$$\widehat{x_{Bf}} = C'[L_h \widehat{P_{Bh}} - l_h \widehat{P_{Ah}}] + D'[L_f \widehat{P_{Bf}} - l_f \widehat{P_{Af}}] \tag{4.50}$$

Using equations 4.27-4.30 we get:

$$\begin{aligned}\widehat{x_{Ah}} =& A[L_h(\frac{s^h_{Ah}\widehat{n_{Ah}} + s^f_{Ah}\widehat{n_{Af}}}{1-\sigma}) - l_h(\frac{s^h_{Bh}\widehat{n_{Bh}} + s^f_{Bh}\widehat{n_{Bf}}}{1-\sigma})] \\ &+ B[L_f(\frac{s^h_{Af}\widehat{n_{Ah}} + s^f_{Af}\widehat{n_{Af}}}{1-\sigma}) - l_f(\frac{s^h_{Bf}\widehat{n_{Bh}} + s^f_{Bf}\widehat{n_{Bf}}}{1-\sigma})]\end{aligned} \tag{4.51}$$

$$\begin{aligned}\widehat{x_{Bh}} =& A'[L_h(\frac{s^h_{Bh}\widehat{n_{Bh}} + s^f_{Bh}\widehat{n_{Bf}}}{1-\sigma}) - l_h(\frac{s^h_{Ah}\widehat{n_{Ah}} + s^f_{Ah}\widehat{n_{Af}}}{1-\sigma})] \\ &+ B'[L_f(\frac{s^h_{Bf}\widehat{n_{Bh}} + s^f_{Bf}\widehat{n_{Bf}}}{1-\sigma}) - l_f(\frac{s^h_{Af}\widehat{n_{Ah}} + s^f_{Af}\widehat{n_{Af}}}{1-\sigma})]\end{aligned} \tag{4.52}$$

$$\begin{aligned}\widehat{x_{Af}} =& C[L_h(\frac{s^h_{Ah}\widehat{n_{Ah}} + s^f_{Ah}\widehat{n_{Af}}}{1-\sigma}) - l_h(\frac{s^h_{Bh}\widehat{n_{Bh}} + s^f_{Bh}\widehat{n_{Bf}}}{1-\sigma})] \\ &+ D[L_f(\frac{s^h_{Af}\widehat{n_{Ah}} + s^f_{Af}\widehat{n_{Af}}}{1-\sigma}) - l_f(\frac{s^h_{Bf}\widehat{n_{Bh}} + s^f_{Bf}\widehat{n_{Bf}}}{1-\sigma})]\end{aligned} \tag{4.53}$$

$$\begin{aligned}\widehat{x_{Bf}} =& C'[L_h(\frac{s^h_{Bh}\widehat{n_{Bh}} + s^f_{Bh}\widehat{n_{Bf}}}{1-\sigma}) - l_h(\frac{s^h_{Ah}\widehat{n_{Ah}} + s^f_{Ah}\widehat{n_{Af}}}{1-\sigma})] \\ &+ D'[L_f(\frac{s^h_{Bf}\widehat{n_{Bh}} + s^f_{Bf}\widehat{n_{Bf}}}{1-\sigma}) - l_f(\frac{s^h_{Af}\widehat{n_{Ah}} + s^f_{Af}\widehat{n_{Af}}}{1-\sigma})]\end{aligned} \tag{4.54}$$

Rearranging equations 4.51-4.54 we have:

$$\widehat{x_{Ah}} =[AL_h\frac{s^h_{Ah}}{1-\sigma} + BL_f\frac{s^h_{Af}}{1-\sigma}]\widehat{n_{Ah}} + [AL_h\frac{s^f_{Ah}}{1-\sigma} + BL_f\frac{s^f_{Af}}{1-\sigma}]\widehat{n_{Af}} + [-Al_h\frac{s^h_{Bh}}{1-\sigma} - Bl_f\frac{s^h_{Bf}}{1-\sigma}]\widehat{n_{Bh}} + [-Al_h\frac{s^f_{Bh}}{1-\sigma} - Bl_f\frac{s^f_{Bf}}{1-\sigma}]\widehat{n_{Bf}} \tag{4.55}$$

$$\widehat{x_{Af}} =[CL_h\frac{s^h_{Ah}}{1-\sigma} + DL_f\frac{s^h_{Af}}{1-\sigma}]\widehat{n_{Ah}} + [CL_h\frac{s^f_{Ah}}{1-\sigma} + DL_f\frac{s^f_{Af}}{1-\sigma}]\widehat{n_{Af}} + [-Cl_h\frac{s^h_{Bh}}{1-\sigma} - Dl_f\frac{s^h_{Bf}}{1-\sigma}]\widehat{n_{Bh}} + [-Cl_h\frac{s^f_{Bh}}{1-\sigma} - Dl_f\frac{s^f_{Bf}}{1-\sigma}]\widehat{n_{Bf}} \tag{4.56}$$

$$\widehat{x_{Bh}} =[-A'l_h\frac{s^h_{Ah}}{1-\sigma} - B'l_f\frac{s^h_{Af}}{1-\sigma}]\widehat{n_{Ah}} + [-A'l_h\frac{s^f_{Ah}}{1-\sigma} - B'l_f\frac{s^f_{Af}}{1-\sigma}]\widehat{n_{Af}} + [A'L_h\frac{s^h_{Bh}}{1-\sigma} + B'L_f\frac{s^h_{Bf}}{1-\sigma}]\widehat{n_{Bh}} + [A'L_h\frac{s^f_{Bh}}{1-\sigma} + B'L_f\frac{s^f_{Bf}}{1-\sigma}]\widehat{n_{Bf}} \tag{4.57}$$

$$\widehat{x_{Bf}} =[-C'l_h\frac{s^h_{Ah}}{1-\sigma} - D'l_f\frac{s^h_{Af}}{1-\sigma}]\widehat{n_{Ah}} + [-C'l_h\frac{s^f_{Ah}}{1-\sigma} - D'l_f\frac{s^f_{Af}}{1-\sigma}]\widehat{n_{Af}} + [C'L_h\frac{s^h_{Bh}}{1-\sigma} + D'L_f\frac{s^h_{Bf}}{1-\sigma}]\widehat{n_{Bh}} + [C'L_h\frac{s^f_{B}}{1-\sigma} + D'L_f\frac{s^f_{Bf}}{1-\sigma}]\widehat{n_{Bf}} \tag{4.58}$$

Using equations 4.39-4.42 and 4.55-4.58 we can get the Jacobian Matrix **J** of the dynamic system, which is defined as follows

$$\mathbf{J} = [\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}] \tag{4.59}$$

where the column vectors are

$$\mathbf{a} = \begin{bmatrix} \frac{\epsilon_{Ah}}{n^*_{Ah}(1-\sigma)}[AL_h s^h_{Ah} + BL_f s^h_{Af}] \\ \frac{\epsilon_{Af}}{n^*_{Ah}(1-\sigma)}[CL_h s^h_{Ah} + DL_f s^h_{Af}] \\ \frac{\epsilon_{Bh}}{n^*_{Ah}(1-\sigma)}[-A'l_h s^h_{Ah} - B'l_f s^h_{Af}] \\ \frac{\epsilon_{Bf}}{n^*_{Ah}(1-\sigma)}[-C'l_h s^h_{Ah} - D'l_f s^h_{Af}] \end{bmatrix},$$

$$\mathbf{b} = \begin{bmatrix} \frac{\epsilon_{Ah}}{n^*_{Af}(1-\sigma)}[AL_h s^f_{Ah} + BL_f s^f_{Af}] \\ \frac{\epsilon_{Af}}{n^*_{Af}(1-\sigma)}[CL_h s^f_{Ah} + DL_f s^f_{Af}] \\ \frac{\epsilon_{Bh}}{n^*_{Af}(1-\sigma)}[-A'l_h s^f_{Ah} - B'l_f s^f_{Af}] \\ \frac{\epsilon_{Bf}}{n^*_{Af}(1-\sigma)}[-C'l_h s^f_{Ah} - D'l_f s^f_{Af}] \end{bmatrix},$$

$$\mathbf{c} = \begin{bmatrix} \frac{\epsilon_{Ah}}{n^*_{Bh}(1-\sigma)}[-Al_h s^h_{Bh} - Bl_f s^h_{Bf}] \\ \frac{\epsilon_{Af}}{n^*_{Bh}(1-\sigma)}[-Cl_h s^h_{Bh} - Dl_f s^h_{Bf}] \\ \frac{\epsilon_{Bh}}{n^*_{Bh}(1-\sigma)}[A'L_h s^h_{Bh} + B'L_f s^h_{Bf}] \\ \frac{\epsilon_{Bf}}{n^*_{Bh}(1-\sigma)}[C'L_h s^h_{Bh} + D'L_f s^h_{Bf}] \end{bmatrix},$$

$$\mathbf{d} = \begin{bmatrix} \frac{\epsilon_{Ah}}{n^*_{Bf}(1-\sigma)}[-Al_h s^f_{Bh} - Bl_f s^f_{Bf}] \\ \frac{\epsilon_{Af}}{n^*_{Bf}(1-\sigma)}[-Cl_h s^f_{Bh} - Dl_f s^f_{Bf}] \\ \frac{\epsilon_{Bh}}{n^*_{Bf}(1-\sigma)}[A'L_h s^f_{Bh} + B'L_f s^f_{Bf}] \\ \frac{\epsilon_{Bf}}{n^*_{Bf}(1-\sigma)}[C'L_h s^f_{Bh} + D'L_f s^f_{Bf}] \end{bmatrix}$$

The characteristic equation of **J** is given by:

$$\left|\mathbf{J} - \lambda I\right| = 0 \tag{4.60}$$

where I is an identity matrix of order 4. Expanding the determinant, using MAPLE, equation 4.60 can be rewritten as:

$$\lambda^4 + a_1\lambda^3 + a_2\lambda^2 + a_3\lambda + a_4 = 0. \tag{4.61}$$

where the coefficients are:

$$a_1 = \frac{1}{(\sigma-1)n^*_{Ah}n^*_{Af}n^*_{Bh}n^*_{Bf}}\left[L_h\left(\frac{\epsilon_{Ah}}{n^*_{Ah}}s^h_{Ah}A + \frac{\epsilon_{Bh}}{n^*_{Bh}}s^h_{Bh}A' + \frac{\epsilon_{Af}}{n^*_{Af}}s^f_{Ah}C + \frac{\epsilon_{Bf}}{n^*_{Bf}}s^f_{Bh}C'\right)\right. \tag{4.62}$$

$$\left. +L_f\left(\frac{\epsilon_{Ah}}{n^*_{Ah}}s^h_{Af}B + \frac{\epsilon_{Bh}}{n^*_{Bh}}s^h_{Bf}B' + \frac{\epsilon_{Af}}{n^*_{Af}}s^f_{Af}D + \frac{\epsilon_{Bf}}{n^*_{Bf}}s^f_{Bf}D'\right)\right]$$

$$a_2 = \frac{1}{(\sigma-1)^2n^*_{Ah}n^*_{Af}n^*_{Bh}n^*_{Bf}}[(L_h-l_h)(L_h+l_h)\phi_1\phi_2 + (L_f-l_f)(L_f+l_f)\phi_3\phi_4 \tag{4.63}$$

$$+L_hL_f(\epsilon_{Ah}\epsilon_{Af}n^*_{Bh}n^*_{Bf}s_AX_1 + \epsilon_{Bh}\epsilon_{Bf}n^*_{Ah}n^*_{Af}s_BX_2 + \phi_1\phi_4 + \phi_2\phi_3) - l_hl_f(\phi_1\phi_4 + \phi_2\phi_3)]$$

$$a_3 = \frac{1}{(\sigma-1)^3n^*_{Ah}n^*_{Af}n^*_{Bh}n^*_{Bf}}[L_f(L_h-l_h)(L_h+l_h)(\epsilon_{Bh}\epsilon_{Bf}s_BX_2\phi_1 + \epsilon_{Ah}\epsilon_{Af}s_AX_1\phi_2) \tag{4.64}$$

$$+L_h(L_f-l_f)(L_f+l_f)(\epsilon_{Ah}\epsilon_{Af}s_AX_1\phi_4 + \epsilon_{Bh}\epsilon_{Bf}s_BX_2\phi_3)]$$

$$a_4 = \frac{1}{(\sigma-1)^4n^*_{Ah}n^*_{Af}n^*_{Bh}n^*_{Bf}}[X_1X_2\epsilon_{Ah}\epsilon_{Af}\epsilon_{Bh}\epsilon_{Bf}s_As_B(L_h-l_h)(L_h+l_h)(L_f-l_f)(L_f+l_f)] \tag{4.65}$$

where

$$\phi_1 = (A\epsilon_{Ah}n^*_{Af}s^h_{Ah} + C\epsilon_{Af}n^*_{Ah}s^f_{Ah}) > 0$$
$$\phi_2 = (A'\epsilon_{Bh}n^*_{Bf}s^h_{Bh} + C'\epsilon_{Bf}n^*_{Bh}s^f_{Bh}) > 0$$
$$\phi_3 = (B\epsilon_{Ah}n^*_{Af}s^h_{Af} + D\epsilon_{Af}n^*_{Ah}s^f_{Af}) > 0$$
$$\phi_4 = (B'\epsilon_{Bh}n^*_{Bf}s^h_{Bf} + D'\epsilon_{Bf}n^*_{Bh}s^f_{Bf}) > 0$$

The stability of the system of equations comprising the adjustment rule, requires that all of the real parts of all of the characteristic roots (roots of equation 4.61) are negative. Instead of deriving the values of all characteristic roots I shall use Routh's Theorem (see (Chiang and Wainwright 2005) for details) to find conditions under which all of the real parts of all of the characteristic roots are negative. Routh's theorem (for equation 4.61) states that the real parts of all of the roots of equation 4.61 are negative if and only if the following sequence of determinants

$$\begin{vmatrix} a_1 \end{vmatrix}; \quad \begin{vmatrix} a_1 & a_3 \\ 1 & a_2 \end{vmatrix}; \quad \begin{vmatrix} a_1 & a_3 & 0 \\ 1 & a_2 & a_4 \\ 0 & a_1 & a_3 \end{vmatrix}; \quad \begin{vmatrix} a_1 & a_3 & 0 & 0 \\ 1 & a_2 & a_4 & 0 \\ 0 & a_1 & a_3 & 0 \\ 0 & 1 & a_2 & a_4 \end{vmatrix}$$

are all positive.
Hence we have

$$M_1 = \begin{vmatrix} a_1 \end{vmatrix} > 0 \tag{4.66}$$

$$M_2 = \begin{vmatrix} a_1 & a_3 \\ 1 & a_2 \end{vmatrix} > 0 \tag{4.67}$$

$$M_3 = \begin{vmatrix} a_1 & a_3 & 0 \\ 1 & a_2 & a_4 \\ 0 & a_1 & a_3 \end{vmatrix} > 0 \tag{4.68}$$

$$M_4 = \begin{vmatrix} a_1 & a_3 & 0 & 0 \\ 1 & a_2 & a_4 & 0 \\ 0 & a_1 & a_3 & 0 \\ 0 & 1 & a_2 & a_4 \end{vmatrix} > 0 \tag{4.69}$$

Equation 4.67 implies

$$a_1a_2 - a_3 > 0 \tag{4.70}$$

Equation 4.68 implies

$$a_3M_2 - a_4a_1^2 > 0 \tag{4.71}$$

Equation 4.69 implies

$$a_4 M_3 > 0 \tag{4.72}$$

Using equation 4.68, equation 4.72 implies

$$a_4 > 0 \tag{4.73}$$

Using equation 4.73, equation 4.71 implies

$$a_3 > 0 \tag{4.74}$$

Using equation 4.74, equation 4.70 implies

$$a_2 > 0 \tag{4.75}$$

And from equation 4.66 we have

$$a_1 > 0 \tag{4.76}$$

Hence relations 4.73-4.76 are a necessary condition for the inequalities 4.66-4.69 to hold, which in turn, form a necessary and sufficient condition for all of the real parts of all of the characteristic roots to be negative.

Now I shall demonstrate that $(L_h - l_h) > 0$ and $(L_f - l_f) > 0$ are sufficient for relations 4.73-4.76 to hold. First, note that if $(L_k - l_k) > 0$ for $k = h, f$ then: (a)

$$L_k > 0$$

and thus (b)

$$(L_k + l_k) > 0$$

. From implication (a) we see that inequality 4.76 holds. Rewriting equation 4.63 as

$$a_2 = \frac{1}{(\sigma - 1)^2 n^*_{Ah} n^*_{Af} n^*_{Bh} n^*_{Bf}} [(L_h - l_h)(L_h + l_h)\phi_1\phi_2 + (L_f - l_f)(L_f + l_f)\phi_3\phi_4$$
$$+ (L_h L_f - l_h l_f)(\phi_1\phi_4 + \phi_2\phi_3) + L_h L_f (\epsilon_{Ah}\epsilon_{Af} n^*_{Bh} n^*_{Bf} s_A X_1 + \epsilon_{Bh}\epsilon_{Bf} n^*_{Ah} n^*_{Af} s_B X_2)]$$

we see that relation 4.75 holds using implication (b). Also $(L_k - l_k) > 0$ and its two implications ensure that inequalities 4.74 and 4.73 hold.

4.5 Comparative Statics

This section discusses the consequences a unilateral tariff around free trade in the model described above. I now make the following assumption.

Assumption 1: *For both countries* $k = h, f$, $(L_k - l_k) > 0$.

As shown above, this assumption sufficiently guarantees that a_1, a_2, a_3, a_4 are all positive. This is necessary for the positivity of the determinants M_1, M_2, M_3, M_4, which is a necessary and sufficient condition for all of the real parts of all of the characteristic roots of the dynamic system (equations 4.39-4.42) to be negative.
We are now ready to evaluate the impact of a sector-specific unilateral tariff. I assume Home imposes a tariff on imported varieties in sector A and redistributes the tariff revenue lump-sum to all domestic residents equally.
I shall now log-differentiate equations 4.11-4.14 and evaluate them around free trade. First, let $I = tn_{Af}p_{Af}\frac{c^h_{Af}}{\tau}$ and $Q = P^{\sigma-1}_{Ah}\left(\theta_h\bar{L}_h + tn_{Af}p_{Af}\frac{c^h_{Af}}{\tau}\right)$. Then

$$\begin{aligned}\widehat{Q} &= \frac{P^{\sigma-1}_{Ah}\theta_h\bar{L}_h}{Q}\widehat{P^{\sigma-1}_{Ah}\theta_h\bar{L}_h} + \frac{P^{\sigma-1}_{Ah}I}{Q}\widehat{P^{\sigma-1}_{Ah}I} \\ &= \widehat{P^{\sigma-1}_{Ah}\theta_h\bar{L}_h} + \frac{P^{\sigma-1}_{Ah}I}{Q}\left(\frac{dt}{t} + \widehat{P^{\sigma-1}_{Ah}n_{Af}p_{Af}\frac{c^h_{Af}}{\tau}}\right) \\ &= \widehat{P^{\sigma-1}_{Ah}}\theta_h + \lambda dt\end{aligned}$$

where $\lambda = \frac{n_{Af}p_{Af}\frac{c^h_{Af}}{\tau}}{\theta_h\bar{L}_h} < 1$.
Now, keeping in mind that firm scale is constant, from equations 4.11 and 4.12 we have:

$$0 = A[(\widehat{P^{\sigma-1}_{Ah}\theta_h}) + \lambda dt] + B(\widehat{P^{\sigma-1}_{Af}\theta_f}) \tag{4.77}$$
$$0 = C[(\widehat{P^{\sigma-1}_{Ah}\theta_h}) - \sigma dt + \lambda dt] + D(\widehat{P^{\sigma-1}_{Af}\theta_f}) \tag{4.78}$$

From equations 4.77 and 4.78 we get by Cramer's rule,

$$(\widehat{P^{\sigma-1}_{Ah}\theta_h}) = \frac{[BC(\sigma-\lambda) + AD\lambda]dt}{BC - AD} \tag{4.79}$$
$$(\widehat{P^{\sigma-1}_{Af}\theta_f}) = \frac{-AC\sigma dt}{BC - AD} \tag{4.80}$$

Now, using equation 4.26 we have:

$$(\widehat{P^{\sigma-1}_{Ah}\theta_h}) = (\sigma-1)\widehat{P_{Ah}} - m(v_h)\delta[\gamma\widehat{P_{Ah}} + (1-\gamma)\widehat{P_{Bh}}] \tag{4.81}$$
$$(\widehat{P^{\sigma-1}_{Af}\theta_f}) = (\sigma-1)\widehat{P_{Af}} - m(v_f)\delta[\gamma\widehat{P_{Af}} + (1-\gamma)\widehat{P_{Bf}}] \tag{4.82}$$

Similar to the above analysis we can log-differentiate equations 4.13 and 4.14 to get for sector B

$$0 = A'[(\widehat{P^{\sigma-1}_{Bh}\theta_h}) + \lambda dt] + B'(\widehat{P^{\sigma-1}_{Bf}\theta_f}) \tag{4.83}$$
$$0 = C'[(\widehat{P^{\sigma-1}_{Bh}\theta_h}) + \lambda dt] + D'(\widehat{P^{\sigma-1}_{Bf}\theta_f}) \tag{4.84}$$

Equations 4.83 and 4.84, after solving, give us:

$$(\widehat{P_{Bh}^{\sigma-1}\theta_h}) = \frac{-\lambda A'D'dt + B'C'\lambda dt}{A'D' - B'C'} = -\lambda dt \tag{4.85}$$

$$(\widehat{P_{Bf}^{\sigma-1}\theta_f}) = \frac{A'(-C'\lambda dt) - (-A'\lambda dt)C'}{A'D' - B'C'} = 0 \tag{4.86}$$

Equation 4.85 shows that if the rate of employment rises in Home then P_{Bh} has to fall. And, according to equation 4.86, employment rate and the price index in sector B in Foreign move in opposite directions.
Again, from equation 4.26 we have for sector B:

$$(\widehat{P_{Bh}^{\sigma-1}\theta_h}) = (\sigma-1)\widehat{P_{Bh}} - m(v_h)\delta[\gamma\widehat{P_{Ah}} + (1-\gamma)\widehat{P_{Bh}}] \tag{4.87}$$

$$(\widehat{P_{Bf}^{\sigma-1}\theta_f}) = (\sigma-1)\widehat{P_{Bf}} - m(v_f)\delta[\gamma\widehat{P_{Af}} + (1-\gamma)\widehat{P_{Bf}}] \tag{4.88}$$

Hence from equations 4.85 to 4.88 we get:

$$m(v_h)\delta\gamma\widehat{P_{Ah}} - \lambda dt = [(\sigma-1) - m(v_h)\delta(1-\gamma)]\widehat{P_{Bh}} \tag{4.89}$$

$$m(v_h)\delta\gamma\widehat{P_{Af}} = [(\sigma-1) - m(v_f)\delta(1-\gamma)]\widehat{P_{Bf}} \tag{4.90}$$

From equation 4.89 we can see that if a tariff reduces P_{Ah} then P_{Bh} must fall. Also, from equation 4.90 it is clear that P_{Af} and P_{Bf} move in opposite directions.
Substituting equations 4.89 and 4.90 into equations 4.81 and 4.82 we get:

$$(\widehat{P_{Ah}^{\sigma-1}\theta_h}) = [(\sigma-1) - m(v_h)\delta\gamma]\widehat{P_{Ah}} - m(v_h)\delta(1-\gamma)\frac{m(v_h)\delta\gamma\widehat{P_{Ah}} - \lambda dt}{[(\sigma-1) - m(v_h)\delta(1-\gamma)]} \tag{4.91}$$

$$(\widehat{P_{Af}^{\sigma-1}\theta_f}) = [(\sigma-1) - m(v_f)\delta\gamma]\widehat{P_{Af}} - m(v_f)\delta(1-\gamma)\frac{m(v_f)\delta\gamma}{[(\sigma-1) - m(v_f)\delta(1-\gamma)]}\widehat{P_{Af}} \tag{4.92}$$

Substituting equations 4.79 and 4.80 into equations 4.91 and 4.92 we get:

$$\frac{[BC(\sigma-\lambda) + AD\lambda]dt}{BC - AD} = \left[[(\sigma-1) - m(v_h)\delta\gamma] - \frac{m(v_h)\delta(1-\gamma)m(v_h)\delta\gamma}{[(\sigma-1) - m(v_h)\delta(1-\gamma)]}\right]\widehat{P_{Ah}} + \frac{m(v_h)\delta(1-\gamma)\lambda dt}{[(\sigma-1) - m(v_h)\delta(1-\gamma)]} \tag{4.93}$$

$$\frac{-AC\sigma dt}{BC - AD} = \left[[(\sigma-1) - m(v_f)\delta\gamma] - \frac{m(v_f)\delta(1-\gamma)m(v_f)\delta\gamma}{[(\sigma-1) - m(v_f)\delta(1-\gamma)]}\right]\widehat{P_{Af}} \tag{4.94}$$

Then equations 4.93 and 4.94 can be rewritten as:

$$\frac{[BC(\sigma-\lambda)+AD\lambda]dt}{-X_1} = \left[\frac{(\sigma-1)(L_h-l_h)}{(\sigma-1)-l_h}\right]\widehat{P_{Ah}} + \frac{l_h\lambda dt}{[(\sigma-1)-l_h]} \tag{4.95}$$

$$\frac{AC\sigma dt}{X_1} = \left[\frac{(\sigma-1)(L_f-l_f)}{(\sigma-1)-l_f}\right]\widehat{P_{Af}} \tag{4.96}$$

Assumption 1 states that $(L_h - l_h), (L_f - l_f) > 0$ and $(L_k - l_k) > 0, \quad k = h, f$ is a sufficient condition for $(\sigma - 1) - l_k > 0, \quad k = h, f$. Also, as $X_1 > 0$ and $\sigma > 1 > \lambda$ we have $\frac{\widehat{P_{Ah}}}{dt} < 0$ and $\frac{\widehat{P_{Af}}}{dt} > 0$, implying that for the protected sector, as a result of a small tariff the price index in the tariff imposing country falls while the same rises in its trading partner. The change in the price indices in the unprotected sectors in the two countries can be derived from equations 4.89 and 4.90. Thus we have $\frac{\widehat{P_{Bh}}}{dt} < 0$ and $\frac{\widehat{P_{Bf}}}{dt} > 0$, that is, in the unprotected sectors also the price index in the tariff imposing country falls while the same rises in its trading partner.

The price indices in the tariff imposing country fall and the same rise in the trading partner due to the entry-exit process triggered by a unilateral tariff through its interaction with the home market effect. In the tariff imposing country, in sector A, the number of imported varieties (for which the consumer has to pay extra for transport cost) falls while the number of domestically produced varieties rises. This reduces the price index in sector A. In sector B, though a tariff is not imposed, the same mechanism reduces the price index. In the trading counterpart, the exact opposite happens: in both sectors, the number of domestic varieties falls while the number of imported varieties rises, resulting in a rise in the price index in both sectors.

Next, to show mathematically the entry and exit of firms in the two sectors, I calculate the changes in the number of firms in each industry in each country. From equations 4.7 and 4.9 we see that:

$$\begin{aligned}
\widehat{n_{Ah}} &= \frac{(1-\sigma)}{s_A}\begin{vmatrix}(\widehat{P_{Ah}} - s^f_{Ah}dt) & s^f_{Ah} \\ \widehat{P_{Af}} & s^f_{Af}\end{vmatrix} \\
&= \frac{(1-\sigma)}{s_A}[\widehat{P_{Ah}}s^f_{Af} - s^f_{Af}s^f_{Ah}dt - \widehat{P_{Af}}s^f_{Ah}]
\end{aligned}$$

$$\Rightarrow \frac{\widehat{n_{Ah}}}{dt} > 0$$

$$\begin{aligned}
\widehat{n_{Af}} &= \frac{(1-\sigma)}{s_A}\begin{vmatrix}s^h_{Ah} & (\widehat{P_{Ah}} - s^f_{Ah}dt) \\ s^h_{Af} & \widehat{P_{Af}}\end{vmatrix} \\
&= \frac{(1-\sigma)}{s_A}[\widehat{P_{Af}}s^h_{Ah} - \widehat{P_{Ah}}s^h_{Af} + s^f_{Ah}s^h_{Af}dt]
\end{aligned}$$

$$\Rightarrow \frac{\widehat{n_{Af}}}{dt} < 0$$

So for the protected sector in the tariff-imposing country entry of firms is observed while exit of firms is observed in its trading counterpart.
From equations 4.8 and 4.10 we see that:

$$\widehat{n_{Bh}} = \frac{(1-\sigma)}{s_B} \begin{vmatrix} \widehat{P_{Bh}} & s^f_{Bh} \\ \widehat{P_{Bf}} & s^f_{Bf} \end{vmatrix}$$

$$= \frac{(1-\sigma)}{s_B} [\widehat{P_{Bh}} s^f_{Bf} - \widehat{P_{Bf}} s^f_{Bh}]$$

$$\Rightarrow \frac{\widehat{n_{Bh}}}{dt} > 0$$

$$\widehat{n_{Bf}} = \frac{(1-\sigma)}{s_B} \begin{vmatrix} s^h_{Bh} & \widehat{P_{Bh}} \\ s^h_{Bf} & \widehat{P_{Bf}} \end{vmatrix}$$

$$= \frac{(1-\sigma)}{s_B} [\widehat{P_{Bf}} s^h_{Bh} - \widehat{P_{Bh}} s^h_{Bf}]$$

$$\Rightarrow \frac{\widehat{n_{Bf}}}{dt} < 0$$

Thus in the unprotected sector also there is firm entry in the tariff-imposing country and firm exit in its trading partner.
The results derived above are summarized in the following Proposition.

Proposition 4.1 *In a two county world with free trade in a homogeneous good and costly trade in the varieties of two differentiated goods, in a stable long run with zero profits, a tariff by Home country on imported varieties in one sector:*
(a) in the protected sector, causes entry in Home and exit in Foreign,
(b) in the unprotected sector, causes entry in Home and exit in Foreign, and
(c) increases (decreases) real wage and employment in Home (Foreign).

The intuition for this result can be explained in the following way. A tariff imposed by Home on varieties in sector *A* makes Home a more lucrative location for *A* sector firms to produce as the cost of producing in Foreign and then shipping to Home is now higher. In essence the tariff amplifies the distance from Foreign to Home while keeping the distance from Home to Foreign unchanged. So via the home market effect *A* sector firms exit in Foreign and enter in Home. The same process is observed in sector *B* in the two countries without the imposition of a tariff in this sector.

4.6 Conclusion

This paper develops a two-country model of trade in a homogeneous good and intra-industry trade in the varieties of two distinct goods produced by monopolistically competitive firms. Labor market frictions along the lines of Shapiro and Stiglitz 1984 exist in both countries. I find that as a result of a unilateral, sector-specific tariff, there is entry (exit) in the protected sector in the tariff imposing country (its trading partner), same as in Chakraborty 2024 but the outputs of the two industrial sectors move in tandem, consequently the same process of industrial relocation is observed in the unprotected sector also.

Now-a-days, policy debates around trade are increasingly focusing on the detrimental effects it has on domestic businesses by flooding the markets with cheaper competition. The resultant shutting down of domestic firms and the job loss consequent to that has increased political support for isolationist and protectionist trade policy (See Colantone and Stanig 2018a). This has happened in conjunction with (and perhaps been the main cause of) election of right-wing governments throughout the world (See Colantone and Stanig 2018b). Thus the world trade regime is tilting towards protectionism to support domestic industries and jobs.

This paper suggests caution to policymakers while implementing protectionist measures. A marginal tariff on one or a few crucial industries might deliver the desired relocation of firms but a blanket protection of all industries, even if it is politically appealing, might lead to retaliation thereby nullifying or even reversing the gains accrued through protection.

Chapter 5

FOREIGN CAPITAL INFLOW IN A SMALL OPEN ECONOMY WITH INCREASING RETURNS AND FIRM HETEROGENEITY

5.1 Introduction

Neoclassical theory suggests that financial liberalization (opening up the capital account) will bring capital inflows into capital-scarce developing countries. Since the late twentieth century many developing countries have done just that; they have invited foreign investment to foster capital accumulation and growth. Bonfiglioli 2008 provides evidence that capital inflow causes growth primarily through an increase in Total Factor Productivity (TFP). An increase in TFP can occur in one of two ways: either the firms individually get more productive or there takes place a more efficient allocation of resources across firms. Larrain and Stumpner 2017 emprically show that the latter case is more likely. The current paper gives a theoretical explanation for the same mechanism in an analytically tractable framework.

I model a small open economy exporting a labor intensive final good which also uses in its production a capital intensive intermediate input. This input is a composite of domestically produced varieties (in a production structure similar to M. Melitz 2003) and imported varieties (at a tariff inclusive price). I show that a capital inflow into this economy leads to exit of the least productive domestic firms, thereby increasing the industry efficiency.

This study is related to the literature on how foreign capital inflows impact domestic firms' productivity, sectoral misallocation and welfare. Larrain and Stumpner 2017 study the episode of capital account liberalization in 10 Eastern European countries between 1996 and 2013. They find evidence that foreign capital inflows increase industry efficiency through reallocation of capital towards more productive firms. Bau and Matray 2023 evaluate the impact on Indian manufacturing firms of the deregulation of capital account during the 1990s and 2000s. They find that foreign capital liberalization reduces capital misallocation and increases aggregate productivity for affected industries in India. The present paper shows theoretically that an inflow of foreign capital increases domestic cut-off productivity, resulting in an increase in industry efficiency through the intra-industry reallocation mechanism inherent in firm heterogeneity models following M. Melitz 2003.

There is another strand of literature that studies the welfare impact of foreign capital inflow into a protected sector with full repatriation of profits. Following Brecher and Diaz Alejandro 1977, such a foreign capital inflow is usually found to be welfare reducing under constant returns production. Chakraborty 2001 shows that as the domestic protected sector expands due to a foreign capital inflow, it can raise the imports of foreign intermediate inputs, thereby possibly leading to an increase in welfare. The current paper incorporates Melitz-type firm heterogeneity in the model of Chakraborty 2001 and also finds that an inflow of foreign capital may raise welfare by crowding in cheaper imports.

5.2 Model

Consider a small open economy called Home that trades with the rest of the world called Foreign. There is only one final good Y which is produced under constant returns with inputs: labor and an intermediate input X, according to the following production function

$$Y = X^{\alpha} L_Y^{1-\alpha}, \qquad \alpha < 1. \tag{5.1}$$

X is a CES composite of differentiated varieties and is produced under constant returns by costlessly assembling Home $(x_h(z))$ and Foreign varieties (x_f) according to the production function

$$X = \left[M \int_{z^*}^{\infty} x_h(z)^{\frac{\sigma-1}{\sigma}} \mu(z)\, dz \; + M^* x_f{}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 1 \tag{5.2}$$

where σ is the elasticity of substitution between any two varieties and M is the mass of domestic firms (and also varieties as there is a one-to-one correspondence between firm and variety because of decreasing average costs), among which a firm of productivity z produces $x_h(z)$ with the conditional probability $\mu(z)$, conditional on $z \geq z^*$, the minimum productivity a domestic firm must have in order to produce profitably. It is assumed that Foreign firms of mass M^* provide x_f at a given (tariff inclusive) price $p_f(1+t)$. The Home economy is 'small' in the sense that for Home the mass of Foreign varieties and each of their prices are fixed (See Sen, Ghosh, and Barman 1997 for a similar formulation of a small-open economy). We also assume that the economy exports only the final good and imports only the varieties of the intermediate good and (Foreign) capital alongwith full repatriation of the reward to Foreign capital.

Given equation 5.2 the demand for Home and Foreign varieties are given by

$$x_h(z) = \frac{p_h(z)^{-\sigma}}{P^{1-\sigma}} PX \tag{5.3}$$

$$x_f = \frac{(p_f(1+t))^{-\sigma}}{P^{1-\sigma}} PX \tag{5.4}$$

where

$$P^{1-\sigma} = \left[M^e \int_{z^*}^{\infty} {p_h}^{1-\sigma} g(z)\, dz \; + M^*(p_f(1+t))^{1-\sigma} \right] \tag{5.5}$$

Here P is the composite price index of the varieties and also the price of X, and M^e is the domestic mass of the entrants.

The Home industry for varieties is the same as in M. Melitz 2003. Ex-ante identical firms pay a sunk entry cost of F^e units of capital to enter into the market and get a productivity draw from a given cumulative distribution $G(z)$. Only firms with productivity greater than or equal to a cut-off level z^* can start production, the rest exit the market. Production of a variety requires both a fixed cost of f units of labour and a variable cost of $\frac{1}{z}$ units of labour per unit of output for a firm of productivity z. Hence marginal cost pricing implies

$$p_h(z) = \frac{w}{\rho z} \tag{5.6}$$

where w is the Home wage rate and $\frac{1}{\rho} = \frac{\sigma}{\sigma-1}$ is the mark-up over the marginal cost. The profits of a firm with productivity z, from the variety demand function and the mark-up pricing rule, are given by:

$$\pi(z) = \frac{1}{\sigma}\left(\frac{\rho z}{w}\right)^{\sigma-1} P^{\sigma-1} PX - wf$$

Hence it follows that the profits are monotonically increasing in a firm's productivity. Consequently firms that can cover the fixed cost with their revenue will produce, that is to say, firms with productivity greater than the cut-off level z^* will produce, where z^* is given implicitly by the following equation:

$$\frac{(\frac{w}{\rho z^*})^{1-\sigma}}{P^{1-\sigma}} PX = \sigma w f \tag{5.7}$$

The free entry condition states that the expected profits from entering the market should be equal to the sunk entry cost. That is, the entry cost should equal the probability of success times the average profit per firm. Denoting aggregate profits by Π and the mass of firms by M the free entry condition is

$$[1 - G(z^*)] \frac{\Pi}{M} = rF^e$$

where

$$\Pi = M \int_{z^*}^{\infty} \pi(z) \frac{g(z)}{1 - G(z)}\, dz$$

Invoking the relation between the revenues of any two producing firms, using the definition of profits and the cut-off productivity relation we get

$$J(z^*) w f = r F^e \tag{5.8}$$

where, as in M. Melitz 2003, $J(z^*) = \int_{z^*}^{\infty} [(\frac{z}{z^*})^{\sigma-1} - 1] g(z)\, dz$

As capital is only used to pay the sunk cost by entrants, the capital market equilibrium condition is given by:

$$M^e F^e = K^h + K^f = K \tag{5.9}$$

where K^h is Home capital stock, K^f is Foreign capital invested in Home and K is the total capital stock available in Home.

The total wage bill should equal the sum of the wage payment in the final good sector and the total fixed and variable costs in the variety sector

$$(\sigma - 1) M^e J(z^*) w f + \sigma M^e [1 - G(z^*)] w f + w L_Y = w L \tag{5.10}$$

where L is Home labor force.

Finally, considering the production function of Y it is apparent that α fraction of its revenue is spent on the intermediate input X,

$$\alpha Y = P X$$

and $(1 - \alpha)$ fraction is spent on labor,

$$(1 - \alpha) Y = w L_Y$$

. Thus we have

$$\begin{aligned}
\frac{\alpha}{1-\alpha} w L_Y &= P X \\
&= \text{Total expenditure on Home varieties + Total expenditure on Foreign varieties} \\
&= \sigma M^e [J(z^*) + [1 - G(z^*)]] w f + M^* x_f p_f (1 + t) \\
&= \sigma M^e [J(z^*) + [1 - G(z^*)]] w f + M^* \left(\frac{p_f (1 + t)}{P} \right)^{1-\sigma} \frac{\alpha}{1-\alpha} w L_Y
\end{aligned}$$

where equation 5.4 has been used to derive the last part of the equation.

This implies,

$$\frac{\alpha}{1-\alpha} w L_Y \left[1 - M^* \left(\frac{p_f(1+t)}{P}\right)^{1-\sigma}\right] = \sigma M^e [J(z^*) + [1 - G(z^*)]] w f \quad (5.11)$$

We assume ex-ante firm productivity follows a Pareto distribution

$$G(z) = 1 - (\frac{b}{z})^\beta$$

Here we assume

$$\beta > \sigma - 1$$

so that firm profits are finite. Hence

$$\begin{aligned} J(a) &= (\frac{b}{a})^\beta \frac{(\sigma-1)}{\beta - (\sigma - 1)} \\ &= (\theta - 1)(\frac{b}{a})^\beta \end{aligned}$$

where $\theta = \frac{\beta}{\beta-(\sigma-1)}$. Hence equations 5.8, 5.10 and 5.11 can be rewritten as

$$(\theta - 1) b^\beta (z^*)^{-\beta} w f = r F^e \quad (5.12)$$

$$(\sigma - 1) M^e (\theta - 1) b^\beta (z^*)^{-\beta} f + \sigma M^e b^\beta (z^*)^{-\beta} f + L_Y = L \quad (5.13)$$

$$\frac{\alpha}{1-\alpha} w L_Y [1 - M^* (\frac{p_f(1+t)}{P})^{1-\sigma}] = \sigma \theta M^e b^\beta (z^*)^{-\beta} w f \quad (5.14)$$

Assuming Y to be numeraire we have

$$\frac{P^\alpha w^{1-\alpha}}{(1-\alpha)^{(1-\alpha)} \alpha^\alpha} = 1$$

Let $J = (1-\alpha)^{(1-\alpha)} \alpha^\alpha$. Then we have

$$P = (w)^{\frac{\alpha-1}{\alpha}} J^{\frac{1}{\alpha}} \quad (5.15)$$

5.3 Foreign Capital Inflow

Now we analyze the effects of an inflow of Foreign capital. Let us denote proportional change by $\widehat{x} = \frac{dx}{x}$. Hence an inflow of Foreign capital implies, $\widehat{K^f} > 0$.
Let $A = M^*(p_f(1+t))^{1-\sigma}$. Then equation 5.14 can be rewritten as

$$\frac{\alpha}{1-\alpha} w L_Y [1 - A P^{\sigma-1}] = \sigma \theta M^e b^\beta (z^*)^{-\beta} w f$$

Log-differentiating on both sides we have,

$$\Rightarrow \widehat{w} + \widehat{L_Y} - \frac{AP^{\sigma-1}}{1 - AP^{\sigma-1}} (\sigma - 1) \widehat{P} = \widehat{M^e} + \widehat{w} - \beta \widehat{(z^*)}$$

$$\Rightarrow \widehat{L_Y} + \frac{(\sigma-1)AP^{\sigma-1}}{1 - AP^{\sigma-1}} (\frac{1-\alpha}{\alpha}) \widehat{w} = \widehat{M^e} - \beta \widehat{(z^*)}$$

Using equation 5.9 we have

$$\Rightarrow \widehat{L_Y} + \frac{(\sigma-1)AP^{\sigma-1}}{1-AP^{\sigma-1}}(\frac{1-\alpha}{\alpha})\widehat{w} = \frac{K_f}{K}\widehat{K^f} - \beta\widehat{(z^*)} \tag{5.16}$$

From equations 5.7 and 5.15 we have

$$\frac{w^{1-\sigma}}{(\rho z^*)^{1-\sigma}}(w^{\frac{\alpha-1}{\alpha}}J^{\frac{1}{\alpha}})^{\sigma-1}\frac{\alpha}{1-\alpha}L_Y = \sigma f \qquad [\because \frac{\alpha}{1-\alpha}wL_Y = PX]$$
$$\Rightarrow \widehat{w}[-(\sigma-1)-(\sigma-1)(\frac{1-\alpha}{\alpha})] + (\sigma-1)\widehat{z^*} + \widehat{L_Y} = 0$$
$$\Rightarrow \widehat{w}[(\sigma-1)(\frac{-\alpha-1+\alpha}{\alpha})] + (\sigma-1)\widehat{z^*} + \widehat{L_Y} = 0$$

$$\Rightarrow \widehat{w}(-\frac{\sigma-1}{\alpha}) + (\sigma-1)\widehat{z^*} + \widehat{L_Y} = 0 \tag{5.17}$$

From equation 5.13 we have

$$\lambda_{LX}(-\beta\widehat{z^*} + \widehat{M^e}) + \lambda_{LY}\widehat{L_Y} = 0$$

where $\lambda_{LX} = \frac{(\sigma-1)M^e(\theta-1)b^\beta(z^*)^{-\beta}f + \sigma M^e b^\beta(z^*)^{-\beta}f}{L}$ and $\lambda_{LY} = \frac{L_Y}{L}$ are respectively the share of labor employed in the intermediate input sector and the final output sector. Using equation 5.9 we get

$$\lambda_{LX}(-\beta\widehat{z^*} + \frac{K_f}{K}\widehat{K^f}) + \lambda_{LY}\widehat{L_Y} = 0$$

$$\Rightarrow \frac{K_f}{K}\widehat{K^f} - \beta\widehat{z^*} = -\frac{\lambda_{LY}}{\lambda_{LX}}\widehat{L_Y} \tag{5.18}$$

Equation 5.18 can be rearranged as

$$\widehat{z^*} = \frac{\frac{K_f}{K}\widehat{K^f} + \frac{\lambda_{LY}}{\lambda_{LX}}\widehat{L_Y}}{\beta} \tag{5.19}$$

From equations 5.16 and 5.18 we have

$$\widehat{L_Y} + \frac{(\sigma-1)AP^{\sigma-1}}{1-AP^{\sigma-1}}(\frac{1-\alpha}{\alpha})\widehat{w} = -\frac{\lambda_{LY}}{\lambda_{LX}}\widehat{L_Y}$$
$$\Rightarrow \widehat{L_Y}[1 + \frac{\lambda_{LY}}{\lambda_{LX}}] = -\frac{(\sigma-1)AP^{\sigma-1}}{1-AP^{\sigma-1}}(\frac{1-\alpha}{\alpha})\widehat{w}$$

Using $\lambda_{LX} + \lambda_{LY} = 1$ we get

$$\widehat{L_Y} = -\lambda_{LX}\frac{(\sigma-1)AP^{\sigma-1}}{1-AP^{\sigma-1}}(\frac{1-\alpha}{\alpha})\widehat{w} \tag{5.20}$$

Putting the value of $\widehat{z^*}$ from equation 5.19 in equation 5.17, simplifying, and then putting the value of $\widehat{L_Y}$ from equation 5.20 we get:

$$\widehat{w}(-\frac{\sigma-1}{\alpha}) + (\sigma-1)\left[\frac{\frac{K_f}{K}\widehat{K^f} + \frac{\lambda_{LY}}{\lambda_{LX}}\widehat{L_Y}}{\beta}\right] + \widehat{L_Y} = 0$$

$$\Rightarrow \widehat{w}(-\frac{\sigma-1}{\alpha}) + \frac{(\sigma-1)}{\beta}\frac{K_f}{K}\widehat{K^f} + \left(\frac{(\sigma-1)}{\beta}\frac{\lambda_{LY}}{\lambda_{LX}} + 1\right)\widehat{L_Y} = 0$$

$$\Rightarrow \widehat{w}(-\frac{\sigma-1}{\alpha}) + \left(\frac{(\sigma-1)}{\beta}\frac{\lambda_{LY}}{\lambda_{LX}} + 1\right)\left(-\lambda_{LX}\frac{(\sigma-1)AP^{\sigma-1}}{1-AP^{\sigma-1}}(\frac{1-\alpha}{\alpha})\widehat{w}\right) = -\frac{(\sigma-1)}{\beta}\frac{K_f}{K}\widehat{K^f}$$

$$\Rightarrow \widehat{w}\left[\frac{\sigma-1}{\alpha}\left(1 + \left(\frac{(\sigma-1)}{\beta}\frac{\lambda_{LY}}{\lambda_{LX}} + 1\right)\lambda_{LX}\frac{(1-\alpha)AP^{\sigma-1}}{1-AP^{\sigma-1}}\right)\right] = \frac{(\sigma-1)}{\beta}\frac{K_f}{K}\widehat{K^f}$$

$$\Rightarrow \frac{\widehat{w}}{\widehat{K^f}} = \frac{K_f}{\beta K}\frac{\alpha}{\left[1 + \left(\frac{(\sigma-1)}{\beta}\frac{\lambda_{LY}}{\lambda_{LX}} + 1\right)\lambda_{LX}\frac{(1-\alpha)AP^{\sigma-1}}{1-AP^{\sigma-1}}\right]}$$

$$= \frac{K_f}{\beta K}\frac{\alpha}{\left[1 + \left(\frac{(\sigma-1)\lambda_{LY}+\beta\lambda_{LX}}{\beta\lambda_{LX}}\right)\lambda_{LX}\frac{(1-\alpha)AP^{\sigma-1}}{1-AP^{\sigma-1}}\right]}$$

$$\Rightarrow \frac{\widehat{w}}{\widehat{K^f}} = \frac{K_f}{K}\frac{\alpha(1-AP^{\sigma-1})}{\left[\beta(1-AP^{\sigma-1}) + (1-\alpha)AP^{\sigma-1}((\sigma-1)\lambda_{LY} + \beta\lambda_{LX})\right]} \tag{5.21}$$

Hence, $\frac{\widehat{w}}{\widehat{K^f}} > 0$. Using equations 5.20 and 5.15 this implies, $\frac{\widehat{L_Y}}{\widehat{K^f}} < 0$ and $\frac{\widehat{P}}{\widehat{K^f}} < 0$. Thus the following Proposition is immediate.

Proposition 5.1 *A capital inflow in a tariff protected sector in a small open economy:*
(a) increases the real wage rate,
(b) decreases the price of the intermediate input and decreases the labor employed in the final good sector.

Proof: Proved in the text. ■

An inflow of foreign capital increases the wage rate in our model in contrast to the neo-classical models with perfectly competitive sectors where the factor prices are determined independently of factor endowments. The change in the price index depends on the change in the mass of available varieties (variety effect) and on the change in the wage rate (wage effect). The mass of domestically produced varieties M is the product of the mass of entrants M^e and the fraction of surviving firms $1 - G(z^*)$, which depends negatively on the cut-off productivity z^*. So an increase

in the mass of entrants increases the mass of domestic varieties and thus reduces the price index (entry effect). An increase in the cut-off productivity, on the other hand, decreases the fraction of surviving firms which in turn decreases the mass of varieties thereby increasing the price index (productivity effect). An increase in the wage rate increases the price of each variety that is still being produced and thus increases the price index. We see that the entry effect dominates the other two effects and thus the price index falls due to a foreign capital inflow.
With these results in hand, we can now turn to the productivity effects of a foreign capital inflow.

Proposition 5.2 *An inflow of foreign capital:*
(a) increases the cut-off productivity,
(b) decreases the output of all surviving firms.

Proof: The demand for the marginal firm's variety can be written from equation 5.3 as:

$$x_h(z^*) = \frac{p_h(z^*)^{-\sigma}}{P^{1-\sigma}} PX \tag{5.22}$$

which can be rewritten as

$$x_h(z^*) = (\frac{w}{\rho z^*})^{-\sigma} w^{-(\sigma-1)(\frac{1-\alpha}{\alpha})} J^{\frac{\sigma-1}{\alpha}} \frac{\alpha}{1-\alpha} w L_Y$$

Log-differentiating on both sides and using equation 5.20 we have

$$\begin{aligned}
\widehat{x_h(z^*)} &= -\sigma(\widehat{w} - \widehat{z^*}) - (\sigma-1)\left(\frac{1-\alpha}{\alpha}\right)\widehat{w} + \widehat{w} - \frac{(\sigma-1)AP^{\sigma-1}}{1-AP^{\sigma-1}}\left(\frac{1-\alpha}{\alpha}\right)\lambda_{LX}\widehat{w} \\
&= \widehat{w}\left[1-\sigma-(\sigma-1)\left(\frac{1-\alpha}{\alpha}\right)\left(1+\frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right)\right] + \sigma\widehat{z^*} \\
&= \widehat{w}(\sigma-1)\left[-1-\left(\frac{1-\alpha}{\alpha}\right)\left(1+\frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right)\right] + \sigma\widehat{z^*} \\
&= -\widehat{w}(\sigma-1)\left[1+\left(\frac{1-\alpha}{\alpha}\right)\left(1+\frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right)\right] + \sigma\widehat{z^*}
\end{aligned}$$

The zero profit condition for the marginal firm can be rewritten as:

$$x_h(z^*)p_h(z^*) = \sigma w f \tag{5.23}$$

$$\begin{aligned}
\Rightarrow x_h(z^*) &= \frac{\sigma w f}{p_h(z^*)} \\
&= \sigma w f \frac{\rho z^*}{w} \\
&= \rho\sigma f z^*
\end{aligned}$$

Hence

$$\widehat{x_h(z^*)} = \widehat{z^*}$$

$$\therefore\ \widehat{z^*} = -\widehat{w}(\sigma-1)\left[1+\left(\frac{1-\alpha}{\alpha}\right)\left(1+\frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right)\right]+\sigma\widehat{z^*}$$
$$\Rightarrow (\sigma-1)\widehat{z^*} = \widehat{w}(\sigma-1)\left[1+\left(\frac{1-\alpha}{\alpha}\right)\left(1+\frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right)\right]$$

Since, $\frac{\widehat{w}}{\widehat{K^f}} > 0$ this implies, $\frac{\widehat{z^*}}{\widehat{K^f}} > 0$ and $\frac{\widehat{x_h(z^*)}}{\widehat{K^f}} > 0$.
Now, suppose that as a result of an inflow of foreign capital by the amount $\widehat{K^f}$, z^* rises to z^*_{new}. For firms with productivity draw $z > z^*_{new}$,

$$x_h(z) = z^{\sigma}(z^*)^{-\sigma}x_h(z^*)$$

By log-differentiation on both sides we have

$$\widehat{x_h(z)}|_{z>z^*_{new}} = (1-\sigma)\widehat{x_h(z^*)} < 0. \tag{5.24}$$

■

The productivity effect in our model is similar to that in the firm heterogeneity literature following M. Melitz 2003 and the homogeneous firm case studied in Chakraborty 2001. In the homogeneous firm case presented in Chakraborty 2001 a capital inflow reduces the domestic firm's output and increases the number of varieties. This leads to specialization gains. In our model an inflow of foreign capital increases the mass of entrants and also the cut-off productivity, thereby lowering the probability of survival. The least productive firms exit the market resulting in increased industry efficiency. Domestic firms (those that do not exit) contract in size. Thus an inflow of foreign capital leads to productivity gain.
Bonfiglioli 2008 was one of the first empirical studies to show that there exists a positive effect of capital inflows on industry total factor productivity. Larrain and Stumpner 2017 find that the key driver behind this positive effect is the more efficient allocation of capital across firms. They examine the effects of capital account liberalization and the consequent increase in the ratio of capital inflows to GDP on aggregate productivity. Larrain and Stumpner 2017 show that aggregate total factor productivity rises mainly through a more efficient allocation of resources across firms.
As we have shown, a foreign capital inflow lowers the probability of firm survival alongside increasing the mass of entrants. So naturally the question then arises:

what is the ultimate impact on the mass of domestically produced varieties? We answer this question next.

We assume, similar to Demidova and Rodriguez-Clare 2013, that the probability of firm death is one, implying that all firms die at the end of each period. Hence in steady-state the mass of domestic firms M obeys:

$$\begin{aligned} M &= M^e(1 - G(z^*)) \\ &= M^e b(z^*)^{-\beta} \end{aligned} \tag{5.25}$$

Totally differentiating both sides we have,

$$\begin{aligned} \widehat{M} &= \widehat{M^e} - \beta\widehat{z^*} \\ &= \frac{K_f}{K}\widehat{K^f} - \beta\left[1 + \left(\frac{1-\alpha}{\alpha}\right)\left(1 + \frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right)\right]\widehat{w} \end{aligned}$$

Thus we have

$$\begin{aligned} \frac{\widehat{M}}{\widehat{K^f}} &= \frac{K_f}{K}\left[1 - \frac{\beta\left[1 + \left(\frac{1-\alpha}{\alpha}\right)\left(1 + \frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right)\right]\alpha(1-AP^{\sigma-1})}{\beta(1-AP^{\sigma-1}) + (1-\alpha)AP^{\sigma-1}((\sigma-1)\lambda_{LY} + \beta\lambda_{LX})}\right] \\ &= \frac{K_f}{K}\left[1 - \frac{\beta\left[1 + \frac{(1-\alpha)((1-AP^{\sigma-1})+\lambda_{LX}AP^{\sigma-1})}{\alpha(1-AP^{\sigma-1})}\right]\alpha(1-AP^{\sigma-1})}{\beta(1-AP^{\sigma-1}) + (1-\alpha)AP^{\sigma-1}((\sigma-1)\lambda_{LY} + \beta\lambda_{LX})}\right] \\ &= \frac{K_f}{K}\left[1 - \frac{\beta[\alpha(1-AP^{\sigma-1}) + (1-\alpha)((1-AP^{\sigma-1}) + \lambda_{LX}AP^{\sigma-1})]}{\beta(1-AP^{\sigma-1}) + (1-\alpha)AP^{\sigma-1}((\sigma-1)\lambda_{LY} + \beta\lambda_{LX})}\right] \\ &= \frac{K_f}{K}\left[\frac{(1-\alpha)AP^{\sigma-1}(\sigma-1)\lambda_{LY}}{\beta(1-AP^{\sigma-1}) + (1-\alpha)AP^{\sigma-1}((\sigma-1)\lambda_{LY} + \beta\lambda_{LX})}\right] \end{aligned}$$

Hence we can see that $\frac{\widehat{M}}{\widehat{K^f}} > 0$.

Proposition 5.3 *An inflow of foreign capital increases the mass of domestically produced varieties.*

Proof: Proved in the text. ■

Let us now consider the impact of an inflow of foreign capital on the volume of imports.

Proposition 5.4 *An inflow of foreign capital may result in an increase in the volume of imports, if σ is low enough.*

Proof: From equation 5.4 we have

$$\begin{aligned}\widehat{x_f} &= (\sigma-1)\widehat{P}+\widehat{w}+\widehat{L_Y}\\ &= \widehat{w}\left[(\sigma-1)\left(\frac{\alpha-1}{\alpha}\right)-\left(\frac{\sigma-1}{\alpha}\right)\left(\frac{1-\alpha}{1-AP^{\sigma-1}}\right)\lambda_{LX}AP^{\sigma-1}+1\right]\\ &= \left[-\left(\frac{(\sigma-1)(1-\alpha)}{\alpha}\right)\left[1+\frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right]+1\right]\widehat{w}\end{aligned}$$

As $\frac{\widehat{w}}{\widehat{K^f}} > 0$ the above equation implies that $\frac{\widehat{x_f}}{\widehat{K^f}} > 0$ if

$$\left(\frac{(\sigma-1)(1-\alpha)}{\alpha}\right)\left[1+\frac{\lambda_{LX}AP^{\sigma-1}}{1-AP^{\sigma-1}}\right] < 1 \tag{5.26}$$

Now, relation 5.22 can be rewritten as:

$$\begin{aligned}&\left[1+\frac{\lambda_{LX}AP^{\sigma-1}}{(1-AP^{\sigma-1})}\right] < \left(\frac{\alpha}{(\sigma-1)(1-\alpha)}\right)\\ &\Rightarrow (\sigma-1)\left[1+\frac{\lambda_{LX}AP^{\sigma-1}}{(1-AP^{\sigma-1})}\right] < \frac{\alpha}{(1-\alpha)}\\ &\Rightarrow (\sigma-1) < \frac{\alpha}{(1-\alpha)}\left[\frac{(1-AP^{\sigma-1})}{(1-AP^{\sigma-1})+\lambda_{LX}AP^{\sigma-1}}\right]\\ &\Rightarrow \sigma < 1+\frac{\alpha}{(1-\alpha)}\left[\frac{(1-AP^{\sigma-1})}{(1-AP^{\sigma-1})+\lambda_{LX}AP^{\sigma-1}}\right]\end{aligned}$$

■

Thus a foreign capital inflow into a protected capital intensive sector may not lead to crowding out of imports; the level of imports may rise if σ is low enough. This implies that if the intermediate inputs (domestic and foreign varieties) are sufficiently complementary then as the foreign capital inflow expands the intermediate input sector, the demand for foreign varieties also rises.

Proposition 5.4 is in contrast to the earlier literature following Brecher and Diaz Alejandro 1977 that shows a foreign capital inflow into a protected capital intensive sector to be welfare reducing as it expands the protected sector which results in the crowding out of cheaper imports. We show, along the lines of Chakraborty 2001, that expansion of the protected domestic capital intensive sector may coincide with an increase in imports if the inputs are not highly substitutable.

From equation 5.6 we can get the change in the price charged by the marginal firm as:

$$\begin{aligned}\widehat{p_h(z^*)} &= \widehat{w} - \widehat{z^*} \\ &= \widehat{w}\left[1 - \frac{1}{\alpha}\left(1 + \frac{\lambda_{LX}AP^{\sigma-1}}{1 - AP^{\sigma-1}}\right)\right] \\ &= \widehat{w}\left[\left(1 - \frac{1}{\alpha}\right) - \frac{\lambda_{LX}AP^{\sigma-1}}{\alpha(1 - AP^{\sigma-1})}\right]\end{aligned}$$

So, $\frac{\widehat{p_h(z^*)}}{\widehat{K^f}} < 0$ as $\alpha < 1$.

Again, from equation 5.6 we can see that price charged by any non-marginal firm changes at the same rate as the wage rate:

$$\widehat{p_h(z)} = \widehat{w} \tag{5.27}$$

So that $\frac{\widehat{p_h(z)}}{\widehat{K^f}} > 0$.

Due to an increase in the wage rate consequent upon a capital inflow the marginal cost rises. Since the price of an individual variety is a constant markup over the marginal cost, the price rises proportinately to the wage rate, except for the marginal variety. The marginal variety is now produced by a more productive firm, putting a downward pressure on its price. The productivity effect is strong enough that the price of the marginal variety falls while that of any non-marginal variety rises.

5.4 Impact on Welfare

Since Y is the only final good in the model. the total spending on its consumption in Home is an adequate measure of Home's welfare. The total expenditure on Y in Home, which equals the National Income of Home, Ω is the sum of labor income, return to capital accruing to Home and the tariff revenue.

$$\Omega = wL + rK_h + tM^* p_f x_f \tag{5.28}$$

Since the focus of this paper is not the relative changes in labor income and profit income, we set $K_h = 0$. Also let δ be the share of labor income in welfare. Then by total differentiation we get

$$\begin{aligned}\widehat{\Omega} &= \delta\widehat{w} + (1-\delta)\widehat{x_f} \\ &= \left[\delta + (1-\delta)\left[1 - \left(\frac{(\sigma-1)(1-\alpha)}{\alpha}\right)\left(1 + \frac{\lambda_{LX}AP^{\sigma-1}}{1 - AP^{\sigma-1}}\right)\right]\right]\widehat{w} \\ &= \left[1 - \frac{(1-\delta)(\sigma-1)(1-\alpha)}{\alpha}\left(1 + \frac{\lambda_{LX}AP^{\sigma-1}}{1 - AP^{\sigma-1}}\right)\right]\widehat{w} \\ &= \left[\frac{\alpha(1 - AP^{\sigma-1}) - (1-\delta)(\sigma-1)(1-\alpha)(1 - \lambda_{LY}AP^{\sigma-1})}{\alpha(1 - AP^{\sigma-1})}\right]\widehat{w}\end{aligned}$$

Using equation 5.21 we get

$$\frac{\widehat{\Omega}}{\widehat{K_f}} = \frac{K_f}{K} \frac{\alpha(1 - AP^{\sigma-1}) - (1-\delta)(\sigma-1)(1-\alpha)(1-\lambda_{LY}AP^{\sigma-1})}{\left[\beta(1 - AP^{\sigma-1}) + (1-\alpha)AP^{\sigma-1}((\sigma-1)\lambda_{LY} + \beta\lambda_{LX})\right]} \tag{5.29}$$

We have $\frac{\widehat{\Omega}}{\widehat{K_f}} > 0$ if

$$\Rightarrow \alpha(1 - AP^{\sigma-1}) > (\sigma-1)[(1-\delta)(1-\alpha)(1-\lambda_{LY}AP^{\sigma-1})]$$

$$\Rightarrow (\sigma - 1) < \frac{\alpha(1 - AP^{\sigma-1})}{(1-\delta)(1-\alpha)(1-\lambda_{LY}AP^{\sigma-1})}$$

So an inflow of foreign capital increases welfare if the following inequality holds

$$\sigma < 1 + \frac{\alpha(1 - AP^{\sigma-1})}{(1-\delta)(1-\alpha)(1-\lambda_{LY}AP^{\sigma-1})} \tag{5.30}$$

This analysis proves the following result.

Proposition 5.5 *A foreign capital inflow into a tariff protected, capital intensive sector may increase welfare.*

Due to an inflow of foreign capital, the wage rate rises unambiguously. Hence welfare will rise if a foreign capital inflow increases the tariff revenue. This happens if relation 5.30 is satisfied. For a low enough elasticity of substitution between varieties relation 5.30 is satisfied. This implies that if the Home and Foreign produced inputs are sufficiently complementary then the volume of import rises, which in turn raises the tariff revenue at given world prices.
We have seen that the result of Brecher and Diaz Alejandro 1977 holds for the model in Chapter 3 but it does not hold for the current model. This warrants a discussion. The Brecher and Diaz Alejandro 1977 result states that "in a small open economy, a foreign capital inflow into a tariff-protected capital intensive, import competing sector, with full repatriation of foreign profits, is welfare reducing". Both the models in Chapters 3 and 5 are small open economy models, with the prices of the urban final good and the rural good set to their world price levels in Chapter 3, and the price and mass of foreign varieties exogeneously given in this Chapter. In both models the reward to foreign capital is entirely repatriated. The main difference between the two models is that while in Chapter 3 capital enters both the protected urban final good and the intermediate input, in this Chapter, capital is specific to the protected intermediate input sector whereby a capital inflow increases the mass of domestic varieties and domestic average productivity.

5.5 Conclusion

Considering the growth experience of the East Asian economies, an important policy prescription for economic growth in a developing country is capital account liberalization resulting in foreign capital inflows. Foreign capital inflows arguably contribute to economic growth by fostering capital accumulation and by raising industry productivity. In this paper I develop a model of a small open economy producing (and exporting) a final good with labor and an intermediate input assembled by combining the domestically produced and imported (subject to tariff) differentiated varieties of a capital intensive good. The domestic variety sector comprises firms with heterogeneous productivity. I show that an inflow of foreign capital in this economy leads to a reallocation of resources from less productive firms to more productive ones, thereby increasing aggregate productivity. The least productive firms exit the market and the surviving firms reduce their scale of operation. A foreign capital inflow may also raise the volume of imports, thereby increasing welfare in the economy.

Chapter 6

SUMMARY AND CONCLUSIONS

Twenty-first century world production and trade display significant fragmentation across borders in all product groups but especially in the manufacturing sector, the leading source of scale economies and the engine of growth. As production processes became increasingly complex and fragmented (vertical and horizontal) into stages, the developed countries (or giant multinationals headquartered there) outsourced more and more stages of production (either labor intensive or requiring less skill or a specialized service like customer support) to low-wage developing countries. The developing and emerging economies of today have achieved high degree of GVC participation across a wide variety of product groups, which is positively significant for their growth. But the developing countries continue to suffer from numerous distortions like open urban unemployment and rural-urban migration, tariff protected sectors, low quality of financial and legal institutions, etc. leading to deficiency of credit, imperfect contract enforcement and other similar issues. For raising the growth rates in developing economies the participation in GVCs is found to be a promising avenue. But the liberalization policies that need to be enacted to increase GVC participation in emerging economies are hindered from realizing their full potential because of the presence of these distortions.

The topic of the efficacy of investment and trade liberalization in developing countries is a matter of huge debate and has generated a substantial amount of literature in both trade and development economics. It has been argued that the policies that work usually well in developed countries may give quite different results in developing countries like inviting capital inflow in a tariff protected industry with full repatriation of profits might actually reduce welfare. My dissertation adds to this debate by considering investment and trade liberalization policies in the context of increasing returns to scale, vertical fragmentation and equilibrium unemployment.

In Chapter 2, I study trade between a capital abundant North (Home) and a labor abundant South (Foreign). The two countries trade in a labor intensive final good and the differentiated varieties of a capital intensive intermediate input, where the latter trade is subject to both fixed and variable trade cost. As a country under autarky opens up to free trade, for the capital abundant country the cut-off productivity and hence the aggregate productivity falls, while it rises for the labor abundant country.

Under free trade factor prices are equalized between the two countries and the trade pattern is driven by factor proportions. Under free trade, in the variety sector, the mass of firms rises in the capital abundant country while it falls in the labor abundant country. Under free trade the real wage rate rises in the capital abundant country but the change in the real wage rate in the labor abundant country is ambiguous. As the full costly trade model is analytically intractable, I simulate a bilateral liberalization in case of costly trade, using parameters used in Bernard, S. Redding, and Schott 2007. I find that a fall in the rental-wage ratio leads to stricter selection (in case of Home) and a rise in the rental-wage ratio leads to weaker selection (in case of Foreign). In addition, in Home a rise in rental-wage ratio results in a fall in the labor employed in the final good sector, while the opposite happens in Foreign.

In Chapter 3, I consider a small open economy featuring Harris-Todaro type unemployment and rural-urban migration. The urban sector comprises an import-competing final good sector and an intermediate good sector exhibiting increasing returns. The rural sector produces the exportable using rural labor and the intermediate input. An inflow of foreign capital increases the rate of unemployment and decreases the rural wage. A foreign capital inflow with full repatriation of foreign profits also reduces welfare unconditionally. An increase in tariff protection on the import-competing good decreases the rural wage and increases the rate of unemployment, but its impacts on unemployment and welfare are ambiguous.

Chapter 4 studies a two-country world with Shapiro-Stiglitz type unemployment where trade takes place in one homogeneous, constant returns good (costlessly) and two differentiated goods produced under increasing returns (subject to variable trade cost). In equilibrium, the two differentiated good sectors show a complementarity of supply response. A unilateral tariff in one increasing returns sector leads to firm entry in both variety sectors in the tariff imposing country, while it leads to firm exit in both variety sectors in its trading counterpart. This further leads to an increase in the rate of employment in tariff-imposing country as both industrial sectors expand. In the trading partner both industrial sectors contract, resulting in a fall in the rate of employment.

Turning back to the case of a small open economy, in Chapter 5, I revisit the production structure described in Chapter 2 and assume that the Home country imports a fixed mass of varieties from Foreign at a given price, subject to a tariff. Home exports only the final good and also allows for investment of capital from abroad with full repatriation of profits. In this framework an inflow of foreign capital increases the real wage in the economy, in contrast to the literature with perfectly competitive production sectors. The foreign capital inflow also increases the cut-off productivity and hence the aggregate productivity in the increasing returns sector. Due to an inflow of foreign capital the marginal firm sells more and at a lower price, but all other surviving firms reduce their scale of operation and charge a higher price for their output. If the varieties of the intermediate input are sufficiently complementary, an inflow of foreign capital may lead to an increase in import volume implying higher tariff revenue, which in turn may result in an increase in welfare.

The work done in this dissertation can be extended in several different directions. While in this dissertation I have allowed for foreign capital inflows only in small open economies, in reality there are countries like China with significant share in world trade and a conducive environment for foreign investment. It will be fruitful to develop a heterogeneous firm model like the one presented in Chapter 2 but with mobile capital and analyze trade and investment liberalization by calibrating the model to bilateral trade data. I have studied the efficacy of a unilateral tariff on firm relocation and the consequent complementary supply response in the unprotected industry, while keeping fixed the wage rate. Allowing for this channel of adjustment is important as trade results in measurable and extensive impact on labor markets, especially in developing countries. Regarding foreign capital inflows in small open economies, I have assumed in Chapter 5 that foreign financial capital invested translates one-to-one into domestic physical capital and that capital is not firm-specific. This is clearly a long-run phenomenon and assumes that domestic financial markets work perfectly. An interesting extension would be to model credit market imperfection in this setting or to assume that capital movement between firms faces frictions, at least in the short run.

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