
Essays on New Economic Geography and International Trade



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Dedicated to

my parents Ioannis and Magdalini, my sister Aggeliki and the memory of my grandma Aggelika[†].

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Abstract

Chapter 1: Globalization, Regional Productivity, Taste Bias and Internal Spatial Distribution

This essay looks at *(i)* globalization, *(ii)* regional heterogeneity in productivity, and *(iii)* taste bias over domestic and foreign goods as key determinants of spatial agglomeration. It is shown that pro-agglomeration effects come from foreign being more important relative to domestic country.

Chapter 2: Foreign Productivity Improvements and Domestic Welfare Effects

This essay looks at the impact of foreign productivity improvements on domestic welfare. First, it shows that under flexible wages, a region's productivity improvement benefits its trading partner. Second, it is shown that a productivity improvement of a developing region benefits the entire economy; it, however, creates losers as well as winners in its trading partner.

Preface

The current thesis is a collection of two essays contributing on the field of New Economic Geography and International Trade. The title of the first essay is "Globalization, Regional Productivity, Taste Bias and Internal Spatial Distribution". The title of the second essay is "Foreign Productivity Improvements and Domestic Welfare Effects". I believe that the current Ph.D. thesis illustrates and sheds light on the role of some fundamental insights for the class of New Economic Geography and International Trade models, in general.

1 Globalization, Regional Productivity, Taste Bias and Internal Spatial Distribution

Abstract

I consider an integrated model consisting of a system of two symmetric regions and the rest of the world that features *(i)* globalization, *(ii)* regional heterogeneity in productivity and *(iii)* taste bias over domestic and foreign goods as key determinants of spatial agglomeration. I show that falling external trade barriers favor internal agglomeration. Moreover, a reduction in relative productivity compensates for the trade barriers between the two symmetric regions and the rest of the world; this also favors internal agglomeration of the mobile factor. In addition, I consider two cases of taste bias namely ethnocentrism and xenocentrism. I find that a shift of consumer preferences in the two symmetric regions with respect to goods that are made in the rest of the world results in internal agglomeration, too. Finally, a shift of consumer preferences in a region with respect to goods that are made in the other region results *(i)* in internal agglomeration under ethnocentrism, and *(ii)* in internal dispersion under xenocentrism.

1.1 Introduction

New Economic Geography has provided various explanations for the agglomeration or dispersion of economic activities over a geographical space.¹ The present paper contributes to the literature by studying an integrated model that features *(i)* globalization, *(ii)* regional heterogeneity in productivity and *(iii)* taste bias over domestic and foreign goods as key determinants of spatial agglomeration. These three factors have been reported, both empirically and theoretically, to influence the spatial distribution of economic activities and hence I believe that it is imperative to study their interactions in a model that combines them all.

Concerning globalization, several indicators illustrate that economies are becoming more integrated over the years. For instance, the value of trade as a percentage of the world GDP rose from 42% in 1980 to 60% in 2013 (Source: World Bank) and FDI increased from 6.5% of the world GDP in 1980 to 31% in 2006 (Source: IMF). The increased level of integration is mainly due to institutional changes within countries and various trade agreements among countries which led to the abandonment of many trade barriers. Globalization has indeed affected the spatial concentration of economic activities within countries or regions in various ways and hence this relationship has become a major research issue for trade economists. [Monfort and Nicolini \(2000\)](#) study the impact of international economic integration on the agglomeration process with the use of a model with two symmetric countries, each consisting of two regions. They show that a reduction in interregional and/or international trade costs favors regional agglomeration of economic activities. In the same line of research, [Monfort and van Ypersele \(2003\)](#) study how a country's spatial distribution affects the agglomeration forces in its partner country. In contrast to the work of [Monfort and Nicolini \(2000\)](#), they assume that interregional transaction costs are not identical in the two countries. They exhibit that both integration and agglomeration in one country make agglomeration in the partner country less likely. [Krugman and Livas-Elizondo \(1996\)](#) show that openness to international trade leads to internal dispersion of economic activities when rent and commuting costs are present. [Brühlhart et al. \(2004\)](#) study the impact of improved external market access on the internal geography of a trading bloc consisting of two symmetric regions. Without providing analytical expressions for market's centrifugal and centripetal forces, their work suggests that improved external market access results in internal agglomeration of the mobile factor.

The assumption that regions are heterogeneous with respect to their productivity is of high importance as many parts of the world, that recently became more integrated, have a higher productivity growth rate than the rest of the world. For instance, over the last twenty years, the Chinese average annual productivity growth rate was approximately 8.9% whereas that of the EU and the US was around 1.5%. During the same period of time, India achieved an average productivity growth rate of 5.4% per year. This is greater than that of South Korea (approximately 3.9%), which is, according to the data of World Bank, the country with the highest productivity growth rate among developed countries.

Moreover, due to the process of integration and the development of technology, there exist

¹ The interested reader should consult [Fujita and Krugman \(2004\)](#) for an introduction to the topic.

transmissions of ideas and values around the world. As a result, worldwide consumer preferences are updated and some groups of consumers develop a xenocentric attitude as they put a higher value on foreign made products, styles or ideas rather than those of their own country (Johnson, 2000). At the same time, other consumers develop an ethnocentric attitude as they believe that buying foreign products is unpatriotic and can harm the domestic economy (Balabanis et al. (2002); Klein (2002)). Ethnocentrism still exists in the EU although its people tend to be less ethnocentric than those in developing and emerging countries (Lindquist et al. (2001); Sharma et al. (1995)).

In the present work, I extend the framework of Brülhart et al. (2004) counting for technological differences and biased preferences in order to further explore the impact of globalization on the internal distribution of a trading bloc's economic activity. More specifically, I consider a model with two countries, labeled Foreign country and Domestic country, which is a union of two regions. In this setup, technological differences concern the regional heterogeneity in labor productivity and biased preferences deal with the idiosyncrasies in the consumer taste.

The results in this paper complement very well several existing ones. First of all, my results confirm those of Brülhart et al. (2004) by showing that falling external transportation costs favor internal agglomeration. They also clarify conceptually and analytically why this must be the case. A decrease in relative productivity has an identical impact as the one that comes from falling external trade barriers. Intuitively, a reduction in relative productivity compensates the effect that comes from the trade barriers between Domestic country and Foreign country, and this favors internal agglomeration of the mobile factor. It should be noted that these results are derived under the quasi-linearity assumption, which means that the income effect has been eliminated. In order to study the robustness of the model, I relax this assumption (Section 1.2.5) by considering a Cobb-Douglas utility function. My findings exhibit that the model is fully robust, as falling external trade barriers result again in internal agglomeration of the economic activity.

Furthermore, I compare the distribution of the mobile factor between the market equilibrium allocation and the socially optimal allocation. My results show that the market level of internal agglomeration is higher than the socially preferred level for some values of the internal freeness of trade. For high and low values of the internal freeness of trade, both solutions coincide with respect to the distribution of the mobile factor. This result is in line with the literature, as Ottaviano and Thisse (2001), Tabuschi and Thisse (2002), Charlot et al. (2006), Pflüger and Südekum (2008) also conclude that the market equilibrium outcome differs from the social optimum with respect to the distribution of the mobile factor. My welfare analysis also enhances the existing literature in a key aspect. I calculate the threshold value of the internal freeness of trade that determines the efficiency of the market equilibrium outcome and I show how this value is affected by trade policies and technological interventions.

Finally, concerning the effects of taste bias, I show that a shift of consumer preferences in Domestic country with respect to goods that are made in Foreign country results in internal agglomeration because this behavior compensates for the trade barriers between Domestic country

and Foreign country. In Domestic country, a shift of consumer preferences in a region with respect to goods that are made in its partner region results (i) in internal agglomeration in the case of ethnocentrism, and (ii) in internal dispersion in the case of xenocentrism. The model also shows that in the case of ethnocentrism, internal agglomeration is favored for intermediate and high values of the internal freeness of trade, whereas in the case of xenocentrism, internal agglomeration takes place only for intermediate values of the internal freeness of trade.

The remainder of the paper is organized as follows. Section 1.2 presents the model and characterizes the location patterns of the market equilibrium under regional heterogeneity in labor productivity. It also studies the robustness of the results. Section 1.3 derives the socially optimal spatial pattern. Section 1.4 introduces taste bias across consumers and specifies the location patterns of the market equilibrium under consumer taste bias. Finally, Section 1.5 concludes and summarizes the main findings of the model.

1.2 The Model

1.2.1 Set up

Based on [Brülhart et al. \(2004\)](#) the economy consists of two countries named Domestic and Foreign. Domestic country is a union of two regions labeled North and South, respectively. In each country there exist two types of household supplying unskilled and skilled labor. Both of them inelastically supply one-factor unit each. In Domestic country unskilled labor is immobile and equally distributed across regions. The total mass of unskilled labor in each region is ρ . Skilled labor is interregionally mobile. I normalize the total mass of skilled labor to one. A proportion λ of skilled households is located in North and the rest $(1 - \lambda)$ is located in South. In Foreign country there exist ρ immobile unskilled households and n immobile skilled households. Each household derives utility from an aggregate of manufacturing varieties and an agricultural good.

In each country there exist two production sectors called agricultural and manufacturing sector, respectively. The agricultural sector produces a homogeneous good in a perfectly competitive environment under constant returns with unskilled labor as input. There is no transport cost for the agricultural goods; the agricultural sector is sufficiently large to guarantee positive output; the agricultural good also serves as the numeraire.

In addition, there exists a Dixit-Stiglitz manufacturing sector that produces a large variety of differentiated products. Each variety is produced using both unskilled and skilled labor. Unskilled labor is the variable input and skilled labor enters as fixed cost. Manufacturing goods are tradable with iceberg trade costs. The cost mark-up factor is denoted by $\tau_u > 1$ for trade between the regions of Domestic country and by $\tau_f > \tau_u$ for trade of each region of Domestic country with Foreign country. Trade of manufacturing varieties within each region and within Foreign country is free.

Both countries are symmetric in terms of technology in the agricultural sector. However, the labor productivity differs across countries in the manufacturing sector with the one in Domestic

country being higher than that in Foreign country. Without loss of generality, I normalize the labor productivity in Domestic country to be equal to one. In Foreign country the labor productivity is $0 < \delta < 1$. The production of a manufacturing variety in Domestic country requires one unit of unskilled labor as marginal cost and one unit of skilled labor as fixed cost. In Foreign country, a manufacturing variety is produced using $1/\delta$ units of unskilled labor as marginal cost and one unit of skilled labor as fixed cost.

1.2.2 Preferences and Demand

Household preferences are characterized by a quasi-linear utility function with CES sub-utility over manufacturing varieties. In this kind of models, the quasi-linearity assumption is proposed by Pflüger (2004) and also used in other works such as Pflüger and Südekum (2008). The quasi-linear preferences make the calculations simpler although do not take into account the income effect. Let the utility of a typical household located in region i be

$$U_i = \alpha \ln C_X^i + C_A^i \quad (1.1)$$

with,

$$C_X^i = \left(\int_V l_i(v)^{\frac{\sigma-1}{\sigma}} dv \right)^{\frac{\sigma}{\sigma-1}}, \quad i = n, s, f, \quad (1.2)$$

where $0 < \alpha < 1$ and $\alpha < \kappa = \min\{R_n, R_s, R_f\}$; $\sigma > 1$ and $V = V_n \cup V_s \cup V_f$.

C_X^i is the consumption of the manufacturing aggregate and C_A^i denotes the consumption of the agricultural good. Per capita consumption of a household located in region i is denoted by l_i . V_n , V_s and V_f are the numbers of varieties that are produced in North, South and Foreign country, respectively. σ expresses the elasticity of substitution between any two manufacturing varieties. α is the expenditure on manufacturing products. R_n , R_s and R_f are the wages of skilled labor paid in North, South and Foreign country, respectively. The budget constraint of a representative household is given by

$$P_i C_X^i + C_A^i = Y_i, \quad i = n, s, f. \quad (1.3)$$

Y_i denotes the household's income located in region i . P_n is the perfect CES-price index for the manufacturing aggregate in North,

$$P_n = \left[\int_{V_n} p_n(v)^{1-\sigma} dv + \int_{V_s} (\tau_u p_s(v))^{1-\sigma} dv + \int_{V_f} (\tau_f p_f(v))^{1-\sigma} dv \right]^{\frac{1}{1-\sigma}}, \quad (1.4)$$

and P_s is the perfect CES-price index in South,

$$P_s = \left[\int_{V_s} p_s(v)^{1-\sigma} dv + \int_{V_n} (\tau_u p_n(v))^{1-\sigma} dv + \int_{V_f} (\tau_f p_f(v))^{1-\sigma} dv \right]^{\frac{1}{1-\sigma}}. \quad (1.5)$$

Similarly, the CES-price index for Foreign country is

$$P_f = \left[\int_{V_n} (\tau_f p_n(v))^{1-\sigma} dv + \int_{V_s} (\tau_f p_s(v))^{1-\sigma} dv + \int_{V_f} p_f(v)^{1-\sigma} dv \right]^{\frac{1}{1-\sigma}} \quad (1.6)$$

with $\tau_f > \tau_u > 1$.

p_n , p_s , and p_f denote the producer prices for a variety that is produced in North, South and Foreign country, respectively. Iceberg trade costs are formalized by the parameters τ_u and τ_f . Iceberg trade cost implies that only $\frac{1}{\tau}$ of a unit of a variety shipped arrives at its destination. It also implies that the consumer price of an imported variety is $p\tau$, where p is the price of this variety at its region of origin.

Each household maximizes its utility subject to its budget constraint. It derives the demand functions for the manufacturing aggregate and the agricultural good as

$$C_X^i = \frac{\alpha}{P_i}, \quad C_A^i = Y_i - \alpha, \quad i = n, s, f. \quad (1.7)$$

Moreover, the demand functions of a representative household located in North for manufacturing varieties are obtained as

$$x_{nn} = \alpha p_n^{-\sigma} P_n^{\sigma-1}, \quad x_{ns} = \alpha (\tau_u p_s)^{-\sigma} P_n^{\sigma-1}, \quad x_{nf} = \alpha (\tau_f p_f)^{-\sigma} P_n^{\sigma-1}. \quad (1.8)$$

x_{nn} denotes the demand of a representative household located in North for varieties that are produced in North; x_{ns} is the demand of the same household for varieties that are produced in South; x_{nf} denotes the demand for varieties that are imported from Foreign country. Similarly, demand functions

$$x_{sn} = \alpha (\tau_u p_n)^{-\sigma} P_s^{\sigma-1}, \quad x_{ss} = \alpha p_s^{-\sigma} P_s^{\sigma-1}, \quad x_{sf} = \alpha (\tau_f p_f)^{-\sigma} P_s^{\sigma-1} \quad (1.9)$$

are obtained for a typical household located in South. x_{sn} denotes the demand of a household located in South for varieties that are produced in North; x_{ss} is the demand for varieties that are produced in South; x_{sf} denotes the demand of the same household for varieties that are produced in Foreign country. Finally, the demand functions of a representative household located in Foreign country are

$$x_{fn} = \alpha (\tau_f p_n)^{-\sigma} P_f^{\sigma-1}, \quad x_{fs} = \alpha (\tau_f p_s)^{-\sigma} P_f^{\sigma-1}, \quad x_{ff} = \alpha p_f^{-\sigma} P_f^{\sigma-1}. \quad (1.10)$$

x_{fn} is the demand of a typical household located in Foreign country for varieties that are produced in North; x_{fs} denotes the demand of the same household for varieties that are produced in South; x_{ff} is the demand for varieties that are produced in Foreign country.

The indirect utility is given by

$$I_i = Y_i - \alpha \ln P_i, \quad i = n, s, f. \quad (1.11)$$

1.2.3 Production and Short-run Market Equilibrium

The agricultural good is produced in a perfectly competitive environment under constant returns with a unit input requirement of unskilled labor. Perfect competition enforces marginal cost pricing. Costless trade equalizes prices within Domestic country, and also between Domestic and Foreign country. This indirectly makes the wage rates of unskilled labor equal to one in both countries since the agricultural good serves as the numeraire.

Turning to the industrial sector, each manufacturing variety is supplied by a single firm. The market clearing condition for a variety requires that the total production is equal to the total demand for this variety. Thus, the market clearing condition for a variety that is produced in North is

$$X_n = (\rho + \lambda)x_{nn} + (\rho + 1 - \lambda)\tau_u x_{sn} + (\rho + n)\tau_f x_{fn}. \quad (1.12)$$

A part of the demand is caused by transport losses. Similarly, the market clearing condition for a variety that is produced in South is

$$X_s = (\rho + \lambda)\tau_u x_{ns} + (\rho + 1 - \lambda)x_{ss} + (\rho + n)\tau_f x_{fs}. \quad (1.13)$$

Also, the market clearing condition for a variety that is produced in Foreign country is

$$X_f = (\rho + \lambda)\tau_f x_{nf} + (\rho + 1 - \lambda)\tau_f x_{sf} + (\rho + n)x_{ff}. \quad (1.14)$$

I assume that all firms within a region have access to the same technology. Moreover, the labor productivity in Domestic country is higher than that in Foreign country. Thus, the profits of a representative firm located either in North or in South are

$$\pi_i = (p_i - 1)X_i - R_i, \quad i = n, s. \quad (1.15)$$

Similarly, the profits of a representative firm located in Foreign country are

$$\pi_f = (p_f - \frac{1}{\delta})X_f - R_f. \quad (1.16)$$

Imposing the Chamberlinian large group assumption, each producer perceives an elasticity of demand equal to σ . Thus, profit-maximizing prices are constant mark-ups over marginal costs. Then,

$$p_n = p_s = \frac{\sigma}{\sigma - 1} = \bar{p}, \quad p_f = \left(\frac{\sigma}{\sigma - 1}\right)\frac{1}{\delta} = \bar{p}\frac{1}{\delta}. \quad (1.17)$$

In order to simplify the notation, I define $\xi = \delta^{\sigma-1}$. As a result, the CES-price indices for the manufacturing goods in the three regions can be derived as

$$P_n = \bar{p} \left(\lambda + (1 - \lambda)\phi_u + n\phi_f\xi \right)^{\frac{1}{1-\sigma}}, \quad P_s = \bar{p} \left(\lambda\phi_u + (1 - \lambda) + n\phi_f\xi \right)^{\frac{1}{1-\sigma}}, \quad (1.18)$$

and

$$P_f = \bar{p} (\phi_f + n\xi)^{\frac{1}{1-\sigma}}. \quad (1.19)$$

where $\phi_f < \phi_u \equiv \tau_u^{1-\sigma} \leq 1$ and $\phi_f \equiv \tau_f^{1-\sigma}$ are parameters which are inversely related to trade costs. The two parameters capture the freeness of trade within the union and between the regions of the union and Foreign country.

Moreover, the wage rate of skilled workers is adjusted in order to ensure zero profits. Therefore, the zero profit condition implies that

$$X_i = (\sigma - 1)R_i, \quad i = n, s, \quad (1.20)$$

and

$$X_f = \delta(\sigma - 1)R_f. \quad (1.21)$$

Finally, imposing the condition of zero profits along with the aggregate demand functions (1.12), (1.13), (1.14) and the price indices and optimal firm prices, the equilibrium skilled wages in every region (i.e. R_n , R_s and R_f) are obtained as

$$R_n = \frac{\alpha}{\sigma} \left[\frac{\rho + \lambda}{\lambda + (1 - \lambda)\phi_u + n\phi_f\xi} + \frac{\phi_u(\rho + (1 - \lambda))}{\lambda\phi_u + (1 - \lambda) + n\phi_f\xi} + \frac{\phi_f(\rho + n)}{\phi_f + n\xi} \right] \quad (1.22)$$

and

$$R_s = \frac{\alpha}{\sigma} \left[\frac{\phi_u(\rho + \lambda)}{\lambda + (1 - \lambda)\phi_u + n\phi_f\xi} + \frac{\rho + (1 - \lambda)}{\lambda\phi_u + (1 - \lambda) + n\phi_f\xi} + \frac{\phi_f(\rho + n)}{\phi_f + n\xi} \right] \quad (1.23)$$

and

$$R_f = \frac{\alpha\xi}{\sigma} \left[\frac{\phi_f(\rho + \lambda)}{\lambda + (1 - \lambda)\phi_u + n\phi_f\xi} + \frac{\phi_f(\rho + (1 - \lambda))}{\lambda\phi_u + (1 - \lambda) + n\phi_f\xi} + \frac{\rho + n}{\phi_f + n\xi} \right]. \quad (1.24)$$

The short-run equilibrium wages depend on the productivity parameter, the allocation of skilled and unskilled households, the internal and external freeness of trade and the elasticity of substitution between varieties.

1.2.4 Market Equilibrium in the Long-run

In the long-run skilled workers are allowed to move across regions within the union in response to differences in indirect utilities. This adjustment process over time t is governed by the differential equation

$$\frac{d\lambda}{dt} \equiv \dot{\lambda} = (V_n - V_s)\lambda(1 - \lambda). \quad (1.25)$$

The differential utility for skilled workers is

$$V_n - V_s = (R_n - R_s) - \alpha \ln \left(\frac{P_n}{P_s} \right). \quad (1.26)$$

It can be expressed in an analytical form for general trade costs as

$$\begin{aligned}
V_n - V_s &= \frac{\alpha}{\sigma} \left[\frac{(\rho + \lambda)(1 - \phi_u)}{(\lambda + (1 - \lambda)\phi_u + n\phi_f\xi)} - \frac{(\rho + 1 - \lambda)(1 - \phi_u)}{((1 - \lambda) + \lambda\phi_u + n\phi_f\xi)} \right] \\
&\quad - \alpha \ln \left(\frac{(\lambda + (1 - \lambda)\phi_u + n\phi_f\xi)}{((1 - \lambda) + \lambda\phi_u + n\phi_f\xi)} \right)^{\frac{1}{1-\sigma}} = \\
&= \frac{\alpha(1 - \phi_u)}{\sigma} \left(\frac{M_n}{Q_n} - \frac{M_s}{Q_s} \right) - \frac{\alpha}{1 - \sigma} \ln \left(\frac{Q_n}{Q_s} \right),
\end{aligned} \tag{1.27}$$

with market sizes

$$M_n = \rho + \lambda, \quad M_s = \rho + 1 - \lambda, \tag{1.28}$$

and potentials

$$Q_n = \lambda + (1 - \lambda)\phi_u + n\phi_f\xi, \quad Q_s = (1 - \lambda) + \lambda\phi_u + n\phi_f\xi. \tag{1.29}$$

In equation (1.27), the external freeness of trade (ϕ_f), the productivity parameter (ξ) and the number of skilled workers located in Foreign country (n) can be merged into a new parameter $C = n\xi\phi_f$. In this case, equation (1.27) is algebraically identical to that in a framework without considering regional heterogeneity in labor productivity such as in Brühlhart et al. (2004). The interesting part is the economic interpretation of the relative productivity as well as the analytical specification of all agglomeration and dispersion forces in the market.

A symmetric allocation of the mobile factor, i.e. $\lambda = \frac{1}{2}$, is always a long-run equilibrium in this model. It can be easily seen that $\lambda = \frac{1}{2}$ always leads to a long-run equilibrium since $V_n - V_s = 0$. However, due to the agglomeration forces, this equilibrium is not necessarily stable. In order to evaluate the stability of the symmetric allocation, I evaluate the sign of the derivative

$$\Delta V' = \left[\frac{d(V_n - V_s)}{d\lambda} \right]_{\lambda=1/2} = SL + DL - CE. \tag{1.30}$$

The outcome of the derivative in (1.30) can be split into three different market forces: the supply and the demand linkage (agglomeration forces), and the competition effect (dispersion force). One of the main contributions of the current work is the analytical specification and determination of the agglomeration and dispersion forces in the market. The supply linkage (SL) says that the region with the higher share of skilled workers has a large manufacturing sector. As a result, the price index of the manufacturing aggregate is lower in that region. I obtain the SL evaluating the derivative of the logarithmic ratio of price indices between South and North with respect to the size of skilled workers in North at the symmetric allocation. Let $\bar{M} = M_n |_{\lambda=1/2} = M_s |_{\lambda=1/2} = \rho + 1/2$ and $\bar{Q} = Q_n |_{\lambda=1/2} = Q_s |_{\lambda=1/2} = 1/2(1 + \phi_u) + C$. Then,

$$\begin{aligned}
SL &= \left[\frac{d[\alpha \ln(P_s/P_n)]}{d\lambda} \right]_{\lambda=1/2} = \\
&= \frac{2\alpha(1-\phi_u)}{(\sigma-1)\bar{Q}} = \frac{4\alpha(1-\phi_u)}{(\sigma-1)((1+\phi_u)+2C)}.
\end{aligned} \tag{1.31}$$

The demand linkage (DL) says that an increase in the share of skilled workers located in North implies a large local market. Therefore, the relative profitability in this market increases. This implies that the wage differential between North and South (i.e. $R_n - R_s$) rises. I obtain the demand linkage evaluating the derivative of the wage differential with respect to λ at the symmetric allocation keeping the market potentials constant, in order to isolate the market size effect. Thus,

$$\begin{aligned}
DL &= \left[\frac{d(R_n(M_n, M_s, Q_n, Q_s) - R_s(M_n, M_s, Q_n, Q_s))}{d\lambda} \right]_{\lambda=1/2; (Q_n, Q_s \text{ fixed})} = \\
&= \frac{2\alpha(1-\phi_u)}{\sigma\bar{Q}} = \frac{4\alpha(1-\phi_u)}{\sigma((1+\phi_u)+2C)}.
\end{aligned} \tag{1.32}$$

Finally, the competition effect (CE) comes from the fact that a movement of firms from South to North increases competition on products that are produced in North for given expenditures. I obtain the competition effect evaluating the derivative of the wage differential with respect to λ at the symmetric allocation, keeping the market sizes constant. Thus,

$$\begin{aligned}
CE &= \left[\frac{d(R_n(M_n, M_s, Q_n, Q_s) - R_s(M_n, M_s, Q_n, Q_s))}{d\lambda} \right]_{\lambda=1/2; (M_n, M_s \text{ fixed})} = \\
&= \frac{2\alpha(1-\phi_u)^2\bar{M}}{\sigma\bar{Q}^2} = \frac{4\alpha(1+2\rho)(1-\phi_u)^2}{\sigma((1+\phi_u)+2C)^2}.
\end{aligned} \tag{1.33}$$

The symmetric allocation constitutes a stable long-run equilibrium when (1.30) is negative. I consider the absolute value of all agglomeration and dispersion forces although they have different impacts on the stability of the long-run equilibrium. More specifically, both supply and demand linkages force the symmetric allocation to become an unstable long-run equilibrium while the competition effect is the stabilizing effect, being responsible for the stability of the symmetric allocation in the model.

Falling external trade barriers increase the market potentials (i.e. \bar{Q} goes up); this has a negative impact on all market forces, according to equations (1.31), (1.32) and (1.33). Moreover, as ξ goes up Foreign market becomes more productive. All agglomeration and dispersion forces decline in absolute terms. A decrease in relative productivity has an identical impact on the market forces as the one that comes from falling external trade barriers. Since an increase in the composed parameter C has a negative impact on all market forces, it is interesting to study which effect dominates and why. In order to simplify the analysis, I consider the following monotonic transformations of the three market forces. Let $\tilde{S}L = SLf$, $\tilde{D}L = DLf$ and $\tilde{C}E = CEf$, with

$f = \sigma \bar{Q} / [2\alpha(1 - \phi_u)] > 0$. Then, the agglomeration effect (AE) is given as

$$AE = \tilde{S}L + \tilde{D}L = \frac{2\sigma - 1}{\sigma - 1}, \quad (1.34)$$

and the dispersion effect (DE) is given as

$$DE = \tilde{C}E = \frac{(1 - \phi_u)(1 + 2\rho)}{1 + \phi_u + 2C}. \quad (1.35)$$

Obviously, the agglomeration effect (AE) depends on σ , and the dispersion effect (DE) depends on all other parameters of interest. The AE is strictly decreasing in σ (i.e. $\frac{dAE}{d\sigma} < 0$). The DE is strictly decreasing in ϕ_u and C ; it also increases in ρ . Thus, an increase in ϕ_u and/or C results in internal agglomeration since it reduces the DE without affecting the AE. Additionally, an increase in σ and/or ρ favors internal dispersion since the former reduces the AE, and the latter increases the DE. Finally, the dependence of C on σ is neglected since an increase in σ reduces C . This adds another dispersing effect, enhancing the initial effect of σ .

In order to study where the symmetric allocation constitutes a long-run stable equilibrium, I evaluate the sign of expression (1.30). Figure 1.1 illustrates the magnitude of all agglomeration and dispersion forces for different values of the internal and external freeness of trade. I am interested in specifying the two critical levels of the internal freeness of trade for which the derivative in (1.30) becomes zero. At those two break points, the agglomeration forces (i.e. SL and DL) are canceled out by the dispersion force (i.e. CE).

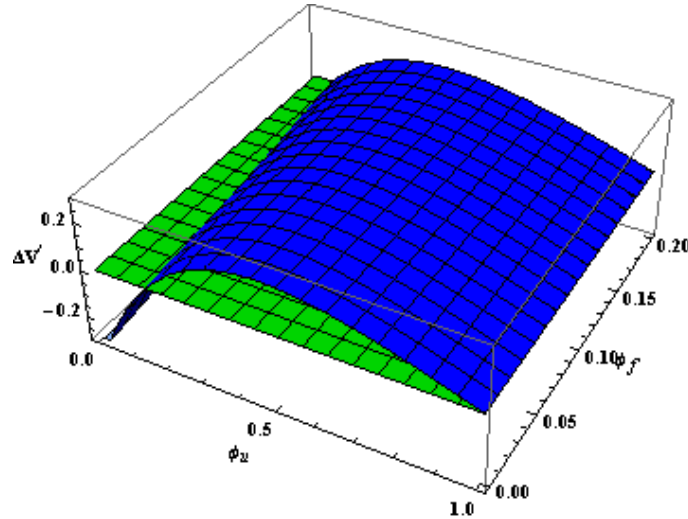


Figure 1.1: Magnitude of Agglomeration and Dispersion Forces

For values between these two break points, expression (1.30) is positive. This implies that the agglomeration forces dominate the dispersion force. As a result, the economic activity within the union is concentrated in one region. Between the autarky point and the first break point, the dispersion force dominates the agglomeration forces. Therefore, (1.30) is negative and thus

dispersion of skilled workers takes place within the union.

It can be seen graphically that these two critical levels of the internal freeness of trade are obtained by the intersection of the blue curve with the level where expression (1.30) is equal to zero. After obtaining those two break points, I study how they depend on the rest of the parameters mainly focusing on the external freeness of trade and the relative productivity. The first break point is trivial since it is constant and equal to one. The second break point is the interesting one since it depends on the parameters of interest. The analytical expressions are

$$\phi_{tr} = 1, \quad (1.36)$$

and

$$\phi_{cr} = \frac{(2\rho - 4C - 1)\sigma + 2(C - \rho)}{(3 + 2\rho)\sigma - 2(1 + \rho)}. \quad (1.37)$$

It can be seen that the numerator of ϕ_{cr} is always lower than its denominator since $\sigma > 1$. This implies that ϕ_{cr} is always smaller than one. Let N and D denote the numerator and denominator of ϕ_{cr} , respectively. Obviously, the denominator is positive. In addition, $D - N = 3\sigma - 2 + 4C\sigma + \sigma - 2C > 0 \Leftrightarrow 4\sigma > 2$ which holds since $\sigma > 1$. Thus, the numerator is smaller than the denominator, possibly even negative. In order to avoid the "black hole" case where ϕ_{cr} is negative and only concentration takes place, the numerator must be positive too.

Lemma 1.1: *NBH ("no black hole") holds if and only if the two conditions (α): $2\rho > 1 + 4C$ and (β): $\sigma > \frac{2(\rho-C)}{2\rho-4C-1}$ hold simultaneously.*

Proof. If $\sigma > \frac{2(\rho-C)}{2\rho-4C-1}$ and $2\rho > 1 + 4C$, then $N > 0$. Now, let the NBH condition hold. Then,

$$\sigma(2\rho - 4C - 1) > 2(\rho - C) \quad (1.38)$$

Let $\rho < C$, then $2\rho - 4C - 1 < 2\rho - 2C < 0$. Thus, (1.38) is violated. Thus, $\rho \geq C$, and hence $2\rho - 4C - 1 > 0$. But then (1.38) implies β . \square

The first condition implies that the "black hole" case is avoided when the composite parameter C does not take high values. This can happen in two cases. First, in the case where the trade between the regions of the union and Foreign country is not completely free; second, when the relative productivity is not very small (i.e. the union is significantly more productive than Foreign country). The second condition implies that the elasticity of substitution between varieties should be above a particular threshold. This means that individuals should not have very high preferences for diversity. The following proposition summarizes how a change in the composed C , the proportion of unskilled workers ρ , and the elasticity of substitution affects the critical break point ϕ_{cr} .

Proposition 1.1: *The critical break point ϕ_{cr}*

1. *decreases in the composed parameter C ,*

2. increases in the proportion of unskilled workers ρ and the elasticity of substitution σ .

Proof.

i.
$$\frac{d\phi_{cr}}{dC} = \frac{2 - 4\sigma}{\sigma(3 + 2\rho) - 2(1 + \rho)} < 0. \quad (1.39)$$

The numerator is negative and the denominator is positive. Thus, the sign of the derivative is negative.

ii.
$$\frac{d\phi_{cr}}{d\rho} = \frac{2(\sigma - 1)(D - N)}{D^2} > 0. \quad (1.40)$$

Expression (1.40) is positive since $D > N$.

Now, let $r = 2\rho - 4C - 1 > 0$. Then $\frac{d\phi_{cr}}{d\sigma} > 0$ iff:

$$[r - 2C'(\sigma)(2\sigma - 1)][\sigma(2\rho + 3) - 2(\rho + 1)] > (2\rho + 3)r(\sigma - \underline{\sigma}), \quad (1.41)$$

with $\underline{\sigma} = \frac{2(\rho - C)}{r} > 1$.

The productivity of the union is greater than that of Foreign country by assumption (i.e. $0 < \delta < 1$). This implies $C'(\sigma) < 0$. Then,

$$[r - 2C'(\sigma)(2\sigma - 1)][\sigma(2\rho + 3) - 2(\rho + 1)] > r[\sigma(2\rho + 3) - 2(\rho + 1)]. \quad (1.42)$$

Now,

$$r[\sigma(2\rho + 3) - 2(\rho + 1)] > (2\rho + 3)r(\sigma - \underline{\sigma}), \quad (1.43)$$

which holds. Thus, (1.42) and (1.43) implies (1.41) and hence $\frac{d\phi_{cr}}{d\sigma} > 0$.

□

Falling external trade barriers reduce all market forces and, according to proposition 1.1, decrease the critical break point, too. This implies that the dispersion force (i.e. CE) falls faster than the agglomeration forces (i.e. SL and DL). Thus, skilled workers are concentrated in one region within the union. The impact that comes from a decrease in relative productivity is identical to the one that comes from falling external trade barriers. More specifically, a reduction in relative productivity favors internal agglomeration of the mobile factor. The same impact evolves when the size of skilled workers located in Foreign country goes up. Intuitively, a decrease in relative productivity compensates for the trade barriers between the regions of the union and Foreign country.

Finally, an increase in the elasticity of substitution between varieties implies low preferences for diversity. This leads to weaker economies of scale at the firm level ($\frac{1}{\sigma}$). As a result, less

agglomeration of skilled workers within the union takes place. Equations (1.31), (1.32) and (1.33) show that the number of unskilled immobile workers affects only the competition effect. Thus, an increase of unskilled immobile workers raises the CE in absolute terms. This leads to dispersion of skilled labor within the union.

1.2.5 Robustness

1.2.5.1 Short-run Market Equilibrium

The quasi-linearity assumption is used for computational reasons. In fact, this choice does not take into account the income effect. In this section, I study the importance of the income effect by considering a Cobb-Douglas utility function. Let the preferences of a typical household located in region i be

$$U_i = C_X^i C_A^i{}^{1-\alpha}, \quad i = n, s, f. \quad (1.44)$$

Each household maximizes its utility subject to its budget constraint (1.3). It derives the new demand functions for the manufacturing aggregate and the agricultural good as

$$C_X^i = \frac{\alpha Y_i}{P_i}, \quad C_A^i = (1 - \alpha) Y_i, \quad i = n, s, f. \quad (1.45)$$

The indirect utility is given by

$$\omega_i = \beta \frac{Y_i}{P_i^\alpha}, \quad \beta = \alpha^\alpha (1 - \alpha)^{1-\alpha}, \quad i = n, s, f. \quad (1.46)$$

Moreover, the new demand functions of a representative household located in North for manufacturing varieties are obtained as

$$x'_{nn} = \alpha p_n^{-\sigma} P_n^{\sigma-1} Y_n, \quad x'_{ns} = \alpha (\tau_u p_s)^{-\sigma} P_n^{\sigma-1} Y_n, \quad x'_{nf} = \alpha (\tau_f p_f)^{-\sigma} P_n^{\sigma-1} Y_n. \quad (1.47)$$

Similarly, demand functions

$$x'_{sn} = \alpha (\tau_u p_n)^{-\sigma} P_s^{\sigma-1} Y_s, \quad x'_{ss} = \alpha p_s^{-\sigma} P_s^{\sigma-1} Y_s, \quad x'_{sf} = \alpha (\tau_f p_f)^{-\sigma} P_s^{\sigma-1} Y_s \quad (1.48)$$

are obtained for a typical household located in South. Finally, the new demand functions of a representative household located in Foreign country are

$$x'_{fn} = \alpha (\tau_f p_n)^{-\sigma} P_f^{\sigma-1} Y_f, \quad x'_{fs} = \alpha (\tau_f p_s)^{-\sigma} P_f^{\sigma-1} Y_f, \quad x'_{ff} = \alpha p_f^{-\sigma} P_f^{\sigma-1} Y_f. \quad (1.49)$$

Combining the new aggregate demand functions together with the price indices and optimal firm prices (See Section 1.2.3), the new short-run equilibrium skilled wages in every region (i.e. R'_n , R'_s and R'_f) are obtained after solving the following system of equations for R'_n , R'_s and R'_f , respec-

tively.

$$R'_n = \frac{\alpha}{\sigma} \left[\frac{\rho + \lambda R'_n}{\lambda + (1 - \lambda)\phi_u + n\phi_f\xi} + \frac{\phi_u(\rho + (1 - \lambda)R'_s)}{\lambda\phi_u + (1 - \lambda) + n\phi_f\xi} + \frac{\phi_f(\rho + nR'_f)}{\phi_f + n\xi} \right] \quad (1.50)$$

and

$$R'_s = \frac{\alpha}{\sigma} \left[\frac{\phi_u(\rho + \lambda R'_n)}{\lambda + (1 - \lambda)\phi_u + n\phi_f\xi} + \frac{\rho + (1 - \lambda)R'_s}{\lambda\phi_u + (1 - \lambda) + n\phi_f\xi} + \frac{\phi_f(\rho + nR'_f)}{\phi_f + n\xi} \right] \quad (1.51)$$

and

$$R'_f = \frac{\alpha\xi}{\sigma} \left[\frac{\phi_f(\rho + \lambda R'_n)}{\lambda + (1 - \lambda)\phi_u + n\phi_f\xi} + \frac{\phi_f(\rho + (1 - \lambda)R'_s)}{\lambda\phi_u + (1 - \lambda) + n\phi_f\xi} + \frac{\rho + nR'_f}{\phi_f + n\xi} \right]. \quad (1.52)$$

1.2.5.2 Long-run Market Equilibrium

In the long-run skilled workers are allowed to move within the union in response to their utility differences. Instead of considering the utility differential, it is more convenient to consider the ratio of the indirect utilities. Thus,

$$\frac{\omega_n}{\omega_s} = \frac{R_n}{R_s} \left(\frac{P_s}{P_n} \right)^\alpha. \quad (1.53)$$

The symmetric allocation remains a long-run equilibrium in this model since it can be shown that $\frac{\omega_n}{\omega_s} = 1$ at $\lambda = \frac{1}{2}$. However, the symmetry can be either a stable or an unstable equilibrium. In order to study the stability of the symmetric equilibrium, I evaluate the sign of the derivative

$$\Delta\omega' = \left[\frac{d\left(\frac{\omega_n}{\omega_s}\right)}{d\lambda} \right]_{\lambda=1/2} = \left[\frac{d\left(\frac{R_n}{R_s}\right)}{d\lambda} \right]_{\lambda=1/2} + \left[\frac{d\left(\frac{P_s}{P_n}\right)^\alpha}{d\lambda} \right]_{\lambda=1/2}. \quad (1.54)$$

In the current version of the model, the market potentials are identical to those given by equation (1.29). However, the new market sizes depend on the skilled nominal wage rates. They are defined as

$$M'_n = \rho + \lambda R'_n, \quad M'_s = \rho + (1 - \lambda)R'_s, \quad M'_f = \rho + nR'_f, \quad (1.55)$$

for North, South and Foreign country, respectively. In equation (1.54), the first term on the right hand side denotes the demand linkage and the competition effect together. The second term is the supply linkage. It is the same as the one given by equation (1.31). In the current model, the demand linkage is slightly different. It is given by

$$DL = \frac{4\alpha(1 - \phi_u)}{(\sigma - \alpha) + (\sigma + \alpha)\phi_u + 2n\phi_f\xi}. \quad (1.56)$$

In addition, the absolute value of the competition effect is given by

$$CE = DL \frac{\sigma(1 - \phi_u)(2n\xi(\sigma - \alpha) + (\alpha + 2\sigma)\phi_f)}{\alpha(2n\xi(\sigma - \alpha)(1 + \phi_u) + 3\sigma(1 + \phi_u)\phi_f + 2n\xi(2\alpha + \sigma)\phi_f^2)}. \quad (1.57)$$

The next proposition summarizes how the market forces change as the external freeness of trade improves.

Proposition 1.2: *All market forces decrease in the external freeness of trade ϕ_f .*

Proof. From (1.31), it follows that $\frac{dSL}{d\phi_f} < 0$. Similarly, from (1.56) it is obvious that $\frac{dDL}{d\phi_f} < 0$. Let, $A = 2n\xi(\sigma - \alpha)$, $B = (\alpha + 2\sigma)$, $\Gamma = 2n\xi(\sigma - \alpha)(1 + \phi_u)$, $\Delta = 3\sigma(1 + \phi_u)$ and $E = 2n\xi(2\alpha + \sigma)$. Then, I consider the first derivative of the following monotonic transformation with respect to ϕ_f as

$$\frac{d\left(\frac{\alpha CE}{\sigma(1-\phi_u)}\right)}{d\phi_f} = \frac{dDL}{d\phi_f} \frac{A + B\phi_f}{\Gamma + \Delta\phi_f + E\phi_f^2} + DL \frac{-BE\phi_f^2 - 2AE\phi_f + B\Gamma - A\Delta}{(\Gamma + \Delta\phi_f + E\phi_f^2)^2} < 0, \quad (1.58)$$

since $B\Gamma - A\Delta < 0$ and $\frac{dDL}{d\phi_f} < 0$. □

Proposition 1.2 shows that an improvement in the external freeness of trade reduces all market forces. The reduction of both SL and DL tends to make the symmetry a stable long-run equilibrium while the reduction of CE forces the symmetry to become an unstable long-run equilibrium. Due to the complexity of the equations that describe the market forces, I cannot show which force dominates. When the agglomeration forces dominate the dispersion force, the symmetric allocation is not a stable long-run equilibrium. On the contrary, when the dispersion force dominates the agglomeration forces, the symmetry constitutes a stable long-run equilibrium. I study this case numerically considering different values for the basic parameters of the model (i.e. α, σ, n, ξ).

The selection of the parameter values is based on the work of [Head and Mayer \(2004\)](#). More specifically, when the industrial sector stands for all tradable goods in the economy, estimations of σ vary between 3 and 5, whereas α takes values between 0.5 and 0.8. By contrast, when this sector is a specific industry, σ sharply rises because varieties are now much better substitutes than in the aggregate level. A value of σ close to 7 is then acceptable. In that case, α typically takes a value lower than 0.2, which approximately corresponds to the share of the manufactured good in a developed economy. The productivity parameter ξ takes values between 0 and 1. Also, n is arbitrarily chosen between 1 and 5.

I consider the effect of reducing the external trade barriers on the spatial distribution of the union's economic activity. For given values of the parameters α, σ, n, ξ , I set (1.54) equal to zero and solve it numerically for the values of the critical break point over a range of values of $\phi_f \in [0, 1]$. The results are obtained for a specific parameter profile. In particular, I consider that $\sigma \in \{4, 7\}$, $\alpha \in \{0.2, 0.6\}$, $\xi \in \{0.3, 0.5, 0.9\}$ and $n \in \{1, 3, 5\}$. After taking into account all 36 possible combinations of the parameter profile, I find that the results in Section 1.2.4 are robust, as falling external trade barriers lead to internal agglomeration of the economic activity. For example, Figure 1.2 shows how the critical break point changes with respect to the external freeness of trade for $\sigma = 4$, $\alpha = 0.6$, $n = 1$ and $\xi = 1/2$.

After considering the income effect, I show that the critical break point falls as long as the external freeness of trade increases. This result implies that in the Cobb-Douglas case, falling external trade barriers lead to internal agglomeration of the economic activity. This result is in accordance with the prediction of the model under the quasi-linearity assumption.

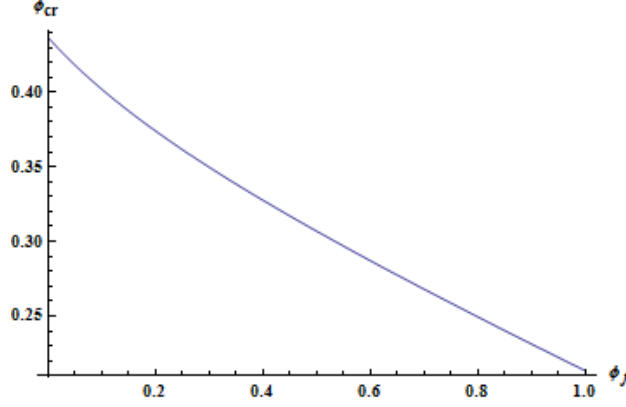


Figure 1.2: ϕ_{cr} and External Freeness of Trade

1.3 Welfare

In this section, I conduct a welfare analysis considering a Utilitarian concept where a social planner is assumed to maximize the un-weighted sum of individual indirect utilities. I use a Utilitarian approach due to the fact that under the assumption of quasi-linear preferences, the marginal utility of income for all agents in the economy is equal to one. This implies that income redistributions do not affect the aggregate welfare.

Let I_n^u , I_s^u and I_f^u denote the indirect utility of an unskilled immobile worker in North, South and Foreign country, respectively. Similarly, I_n^s and I_s^s denote the indirect utility of a skilled mobile worker located in North and South. I_f^s is the indirect utility of a skilled immobile worker located in Foreign country. Therefore, I define the Utilitarian social welfare function as

$$\Omega(\lambda) = \lambda I_n^s + (1 - \lambda) I_s^s + n I_f^s + \rho(I_n^u + I_s^u + I_f^u). \quad (1.59)$$

There are two sources of inefficiency in the model. The first comes from the fact that the manufacturing sector is a monopolistic Dixit-Stiglitz sector. As a result, firms have market power and their mill prices are not equal to their marginal costs. A constant mark-up is added, which depends on the elasticity of substitution between varieties. The second source comes from the decision of a skilled worker whether to migrate or not, without considering the effects of his decision on market prices. As a result, a change in market prices influences the welfare of all other agents in the economy.

In order to compute the optimal social allocation, I replace the analytical expressions for I_n^s , I_s^s , I_f^s , I_n^u , I_s^u and I_f^u into the social welfare function (1.59) above. Then, it can be shown that the first derivative of the social welfare function with respect to the share of skilled workers in North (i.e. $\frac{d\Omega}{d\lambda}$) is equal to zero at $\lambda = \frac{1}{2}$. Note that $\lambda = \frac{1}{2}$ can be either a welfare maximum or a minimum. Furthermore, it is possible that the social welfare function can have more extrema for different values of λ .

Following the work of [Pflüger and Südekum \(2008\)](#), it is enough to calculate the second deriva-

tive of Ω with respect to λ and evaluate it at $\lambda = \frac{1}{2}$. This is going to show us when the social planner chooses either the symmetric allocation ($\lambda = \frac{1}{2}$) or the (full or partial) agglomeration. Thus,

$$\Omega'' = \left[\frac{d^2\Omega}{d\lambda^2} \right]_{\lambda=\frac{1}{2}} = \frac{4\alpha(1-\phi_u)((1-2\rho+(3+2\rho)\phi_u)+4C)}{(\sigma-1)((1+\phi_u)+2C)^2}. \quad (1.60)$$

The symmetric allocation constitutes a global maximum when $\Omega'' < 0$. The (full or partial) agglomeration, however, is chosen when $\Omega'' > 0$. Setting expression (1.60) equal to zero and solving for ϕ_u , two critical values are obtained as

$$\phi_{ir}^{sc} = 1, \quad (1.61)$$

and

$$\phi_{cr}^{sc} = \frac{2\rho - 4C - 1}{3 + 2\rho}. \quad (1.62)$$

I call the bifurcation point ϕ_{cr}^{sc} social break point, which occurs at the level of the internal free-ness of trade, at which the symmetry $\lambda = \frac{1}{2}$ is no longer the social optimum outcome. From lemma 1.1 it holds that $2\rho > 1 + 4C$. This implies that the social break point is greater than zero. It can also be shown that the denominator of ϕ_{cr}^{sc} is larger than its numerator. Hence, ϕ_{cr}^{sc} is always smaller than one. The next proposition summarizes how the market equilibrium outcome deviates from the social optimal outcome.

Proposition 1.3: *The market critical break point is lower than the social break point i.e. $\phi_{cr} < \phi_{cr}^{sc}$.*

Proof. It follows from subtracting the social break point from the market critical break point as given by (1.62) and (1.37). Thus,

$$\phi_{cr} - \phi_{cr}^{sc} = -\frac{2(1+C)(1+2\rho)}{(3+2\rho)((3+2\rho)\sigma - 2(\rho+1))} < 0, \quad (1.63)$$

because $(3+2\rho)((3+2\rho)\sigma - 2(\rho+1)) > 0$ since $\sigma > 1$. \square

The fact that the social break point is lower than the market critical break point means that less agglomeration of skilled workers within the union is socially preferred. For $\phi_u \in (\phi_{cr}, \phi_{cr}^{sc})$ the market equilibrium outcome favors internal agglomeration although internal dispersion is socially preferred. For $\phi_u < \phi_{cr}$ and $\phi_u > \phi_{cr}^{sc}$ the equilibrium outcome coincides with the social optimal outcome. Both market and social forces are illustrated in Figure 1.3. The red curve depicts the social outcome forces and the blue curve represents all market equilibrium forces. Dispersion of skilled workers within the union is socially preferred between the autarky point and the social break point. Between ϕ_{cr}^{sc} and ϕ_{ir}^{sc} expression (1.60) is positive. This implies that agglomeration of the economic activity within the union is socially preferred.

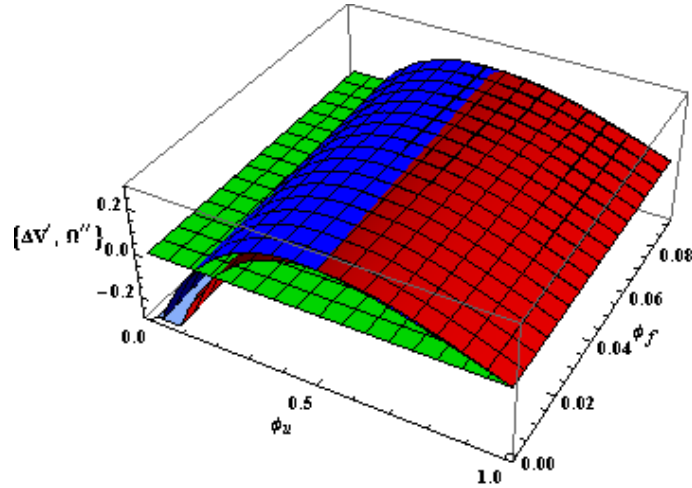


Figure 1.3: Market and Social Outcome Forces

Regarding the change of the social break point with respect to the remaining parameters C , ρ and σ , the results are qualitatively the same as those in proposition 1.1. More specifically, it can be shown that $\frac{d\phi_{cr}^{sc}}{dC} = -\frac{4}{D} < 0$, $\frac{d\phi_{cr}^{sc}}{d\rho} = -\frac{2(D-N)}{D^2} > 0$ and $\frac{d\phi_{cr}^{sc}}{d\sigma} = \phi_C C_\sigma > 0$. Therefore, the comparative static analysis for the point ϕ_{cr}^{sc} is qualitatively the same as the one for the point ϕ_{cr} and the basic intuitions still hold. The mobility of skilled workers within the union affects (i) the skilled wage rates in the entire economy, and (ii) the price indices in the union. The price index in Foreign country, however, is not affected. As a result, with constant wages and unchanged price index, the indirect utility of unskilled workers located in Foreign country is not affected by any relocation of skilled workers within the union.

1.4 Consumer Taste Bias

As a matter of fact, there are broader cultural, traditional and political dimensions of globalization. In this section, I study the multidimensional bias of household taste that mainly comes from the different culture, religious, political and traditional aspects across regions. Due to these differences, in some cases, individuals have the tendency to put more value on products that are produced in their home region. In other cases, individuals put more value on goods, services and other cultural elements which come from another region. In order to take these idiosyncratic differences in consumer taste into account, I rewrite the CES utility in (1.2) for a typical household located in North as

$$C_X^n = \left[\int_{V_n} (A_h l_n(v))^{\frac{\sigma-1}{\sigma}} dv + \int_{V_s} (A_p l_n(v))^{\frac{\sigma-1}{\sigma}} dv + \int_{V_f} (A_f l_n(v))^{\frac{\sigma-1}{\sigma}} dv \right]^{\frac{\sigma}{\sigma-1}}, \quad (1.64)$$

where A_i is a utility shifter ("attractiveness") and can be interpreted as a monadic quality shifter. In particular, A_h is the "attractiveness" of all products that are produced in the home region, A_p

denotes the "attractiveness" of all products that are produced in the other region of the union called partner region, and A_f is the quality shifter of the products that are produced in the other country. Similarly, the CES utility of a typical household located in South is

$$C_X^s = \left[\int_{V_n} (A_p l_s(v))^{\frac{\sigma-1}{\sigma}} dv + \int_{V_s} (A_h l_s(v))^{\frac{\sigma-1}{\sigma}} dv + \int_{V_f} (A_f l_s(v))^{\frac{\sigma-1}{\sigma}} dv \right]^{\frac{\sigma}{\sigma-1}}. \quad (1.65)$$

Finally, for a typical household located in Foreign country the CES utility is

$$C_X^f = \left[\int_{V_n \cup V_s} (A_f l_f(v))^{\frac{\sigma-1}{\sigma}} dv + \int_{V_f} (A_h l_f(v))^{\frac{\sigma-1}{\sigma}} dv \right]^{\frac{\sigma}{\sigma-1}}. \quad (1.66)$$

In the light of isomorphism, the wage differential in (1.27) can be rewritten for the new values $\tilde{\phi}_u = \frac{\psi_p}{\psi_h} \phi_u$ and $\tilde{\phi}_f = \frac{\psi_f}{\psi_h} \phi_f$ with $\psi_h = A_h^{\sigma-1}$, $\psi_p = A_p^{\sigma-1}$ and $\psi_f = A_f^{\sigma-1}$. The symmetric allocation of skilled mobile workers ($\lambda = \frac{1}{2}$) is a long-run equilibrium in this model. I study the stability of the symmetric allocation following the same procedure as in Section 1.2.4. The new break points are obtained as

$$\phi_{cr1} = \frac{1}{\Psi_p}, \quad (1.67)$$

and

$$\phi_{cr2} = \frac{(2\rho - 4\Gamma - 1)\sigma + 2(\Gamma - \rho)}{\Psi_p((3 + 2\rho)\sigma - 2(1 + \rho))}, \quad (1.68)$$

where $\Psi_p = \frac{\psi_p}{\psi_h}$ and $\Gamma = n\Psi_f\phi_f$, with $\Psi_f = \frac{\psi_f}{\psi_h}$.

The first break point ϕ_{cr1} is positive. Based on lemma 1.1, a modified NBH holds if and only if (α): $2\rho > 1 + 4\Gamma$ and (β): $\sigma > \frac{2(\rho-\Gamma)}{2\rho-4\Gamma-1}$ hold simultaneously. Thus, under these two conditions, ϕ_{cr2} is also greater than zero. Let $\tilde{\phi}_{cr}$ be the critical break point in a model with neither taste bias nor productivity differences. Then, in the light of isomorphism, $\phi_{cr2} = \frac{\psi_h}{\psi_p} \tilde{\phi}_{cr}$. Therefore, it is enough $\tilde{\phi}_{cr} < \frac{\psi_p}{\psi_h} = \Psi_p$ for ϕ_{cr2} being less than one.

The ratio $\Psi_f = \frac{\psi_f}{\psi_h}$ shows the relative taste bias between the home region and Foreign country. Similarly, the ratio $\Psi_p = \frac{\psi_p}{\psi_h}$ denotes the taste bias between the two regions of the union. The comparative static analysis for the critical break point ϕ_{cr2} is qualitatively the same as the one for ϕ_{cr} , in proposition 1.1. Therefore, it can be shown that $\frac{d\phi_{cr2}}{d\Gamma} < 0$, $\frac{d\phi_{cr2}}{d\rho} > 0$ and $\frac{d\phi_{cr2}}{d\sigma} > 0$. Moreover, both ϕ_{cr1} and ϕ_{cr2} are strictly decreasing in the composed parameter Ψ_p (i.e. $\frac{d\phi_{cr1}}{d\Psi_p} < 0$ and $\frac{d\phi_{cr2}}{d\Psi_p} < 0$). The impact of Ψ_f on the critical break point ϕ_{cr2} is identical to the impact of ϕ_f on ϕ_{cr2} , all else equal; Ψ_f does not affect ϕ_{cr1} . I consider two cases of taste bias, namely ethnocentrism and xenocentrism. Ethnocentrism underscores the belief that buying foreign made products is unpatriotic. It can harm the domestic economy and this implies that $A_h > A_p > A_f$. On the contrary, xenocentrism is the preference for foreign made products, styles or ideas. This implies that $A_h < A_p$ and $A_h < A_f$.

The critical break point ϕ_{cr2} belongs to the relevant interval of ϕ_u . In the case of ethnocentrism, $\Psi_p < 1$. This implies that ϕ_{cr1} is greater than one. The symmetric allocation is stable between the

autarky point and the critical point ϕ_{cr2} . In the interval between the two break points, the symmetry is no longer stable. Thus, the mobile factor agglomerates within the union. Figure 1.4(a) shows the magnitude of all agglomeration and dispersion forces in the case of ethnocentrism. Intuitively, an increase in Ψ_f compensates for the trade barriers between the home region and Foreign country. This shifts the critical break point ϕ_{cr2} to the left. Therefore, a shift of consumer preferences in the union with respect to goods that are produced in Foreign country results in internal agglomeration of the economic activity. Similarly, an increase in Ψ_p shifts ϕ_{cr2} to the left. This also results in internal agglomeration.

An interesting result comes from the case of xenocentrism since $\Psi_p > 1$. Thus, the critical break point ϕ_{cr1} is lower than one. The symmetry constitutes still an unstable long-run equilibrium in the interval between the two break points. It, however, becomes stable (i) between the autarky point and ϕ_{cr2} , and (ii) between ϕ_{cr1} and the completely free trade point. To see this, let $\Delta V'_*$ be the counterpart of equation (1.30) in a model with taste bias. Then, it can be shown that $\left[\frac{d\Delta V'_*}{d\phi_u} \right]_{\phi_u=\phi_{cr1}} = \frac{2\alpha\Psi_p(1-2\sigma)}{(\Gamma+1)(\sigma-1)\sigma} < 0$ since $\sigma > 1$. This is a stability proof implying that, for $\phi_u > \phi_{cr1}$, the symmetric allocation constitutes a stable long-run equilibrium in this model. Figure 1.4(b) shows the magnitude of all agglomeration and dispersion forces in the case of xenocentrism. Dispersion of the mobile factor takes place within the union for small and high values of the internal freeness of trade. For intermediate values of ϕ_u the symmetry is unstable. Thus, agglomeration of the economic activity occurs within the union. Finally, an increase in Ψ_p shifts both ϕ_{cr1} and ϕ_{cr2} to the left. It can be shown that $\frac{d\phi_{cr2}}{d\Psi_p} > \frac{d\phi_{cr1}}{d\Psi_p}$. This implies that ϕ_{cr1} declines more than ϕ_{cr2} . Therefore, an increase in Ψ_p results in internal dispersion of the mobile factor.

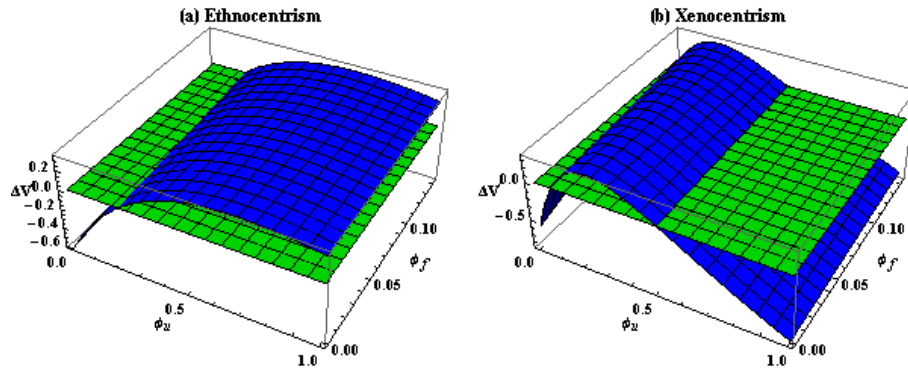


Figure 1.4: Market Equilibrium Outcome: Ethnocentrism Vs Xenocentrism

1.5 Conclusion

The results of the current paper contribute to the existing literature showing that pro-agglomeration effects come from Foreign country being more important relative to Domestic country. I show that falling external trade barriers favor internal agglomeration. I clarify conceptually and analytically

why this must be the case. Moreover, I find that the impact that comes from a decrease in relative productivity is identical to the one that comes from falling external trade barriers. More specifically, a reduction in relative productivity favors internal agglomeration of the mobile factor. Falling internal trade barriers also result in internal agglomeration; the same impact comes when the size of skilled workers located in Foreign country goes up. In addition, the model shows that a shift of consumer preferences in Domestic country with respect to goods that are made in Foreign country compensates for the trade barriers between Domestic country and Foreign country. This also results in internal agglomeration of the mobile factor. In Domestic country, a shift of consumer preferences in a region with respect to goods that are made in its partner region results (i) in internal agglomeration in the case of ethnocentrism, and (ii) in internal dispersion in the case of xenocentrism. Also, an increase either in σ or/and ρ leads to internal dispersion of skilled workers within Domestic country. Finally, the welfare analysis suggests that, for some values of the internal freeness of trade, the market level of internal agglomeration is higher than the socially preferred level. For high and low values of the internal freeness of trade, both the market equilibrium allocation and the socially optimal allocation coincide with respect to the distribution of the mobile factor. This result complements the one that comes from a model consisting of two symmetric regions, which also shows that less agglomeration of the mobile factor is socially preferred for some values of the freeness of trade.

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2 Foreign Productivity Improvements and Domestic Welfare Effects

Abstract

With the use of two models, I study whether a country's productivity improvement is harmful or beneficial for its trading partner. First, I apply a two-region, two-factor, one-sector general equilibrium model that takes into account how factor prices respond to changes in relative productivity. The consideration of factor price responses offers further insights into the impacts of productivity improvements on welfare. I show that a region's productivity improvement is beneficial for the region itself as well as for its trading partner. Second, I use a two-region, two-sector monopolistic competition model with regional differences in labor productivity, and two production factors named skilled and unskilled labor. I show that a productivity improvement in a developing region (*i*) is beneficial for the entire economy, (*ii*) benefits all unskilled workers in the economy and skilled workers in the developing region, and (*iii*) hurts skilled workers in the developing region's trading partner.

2.1 Introduction

The current paper studies whether a country's productivity improvement can be beneficial or harmful for its trading partners. A part of the world, that recently became more integrated, has a higher productivity growth rate than the rest of the world. For example, between 1995 and 2015, the Chinese average annual productivity growth rate was approximately 8.9% far greater than that of the US and the EU which was around 1.5% per year. During the same period of time, India achieved an average annual productivity growth rate of 5.4%. This is greater than that of South Korea (approximately 3.9%), which is, according to the data of World Bank, the country with the highest productivity growth rate among developed countries.

Foreign productivity improvements have indeed affected domestic economy in various ways and hence this relationship has become a major research issue for trade economists. The standard models of international trade, such as Ricardian and Heckscher-Ohlin, show that the growth's nature determines the direction of the terms of trade effects. More specifically, an export-biased growth tends to worsen a growing country's terms of trade and benefits the rest of the world; an import-biased growth, however, improves a growing country's terms of trade and hurts the rest of the world. In this manner, a country's productivity change affects its trading partner's welfare.

For instance, [Dornbusch et al. \(1977\)](#) develop a static Ricardian model with a continuum of goods and show that a country's uniform technological progress, caused by a uniform proportional reduction in unit labor requirements, increases its trading partner's welfare. It is also beneficial for the growing country itself. However, [Samuelson \(2004\)](#) shows that a technological improvement in developing and emerging countries can be harmful for advanced countries. The conclusion of his analysis is that a growth in the rest of the world can hurt a country if it takes place in sectors that compete with the country's exports. Moreover, a technological progress may harm the growing country itself. This possibility is referred in the literature as immiserizing growth and was first introduced by [Bhagwati \(1958a,b\)](#) and generalized by [Bhagwati \(1968\)](#). Bhagwati shows that an economic expansion increases a country's output, but it might lead to a deterioration in the country's terms of trade and this can offset all the beneficial effects of the economic growth.

Monopolistic competition models with increasing returns to scale and heterogeneous firms provide additional adjustment channels, offering further insights into the impacts of trade and productivity (See [Krugman \(1980\)](#); [Helpman and Krugman \(1985\)](#); [Melitz \(2003\)](#)). In these models, a country's productivity improvement increases market size, which results (i) in the reduction of price indices for manufacturing products, and (ii) in a larger variety of products offered. Through this channel, a country's productivity improvement raises welfare in a trading partner. For reasons unrelated to adverse terms of trade effects, [Deminova \(2008\)](#) shows that a country's productivity improvement decreases its trading partner's welfare. She considers a monopolistic competition model with heterogeneous firms and technological asymmetries. She shows that an average domestic productivity improvement results in more entrants in domestic market while it discourages foreign entries in the industry. Through this channel, domestic welfare goes up and foreign welfare falls.

The effects of foreign productivity improvements on domestic welfare constitute a central research issue in several empirical studies, too. Using a multi-country, multi-industry general equilibrium model of international trade, [Hsieh and Ossa \(2016\)](#) find that an increase in China's productivity growth during 1995-2007 raises the worldwide welfare by approximately 3%. However, the effects on individual regions' welfare in their sample range between -1.2% and 3.6% . Using a Ricardian-Heckscher-Ohlin model, [di Giovanni et al. \(2014\)](#) show that the improvement of Chinese productivity has different significant effects on the welfare across regions. In particular, for a large number of Asian countries, the welfare effects are positive while some Latin American countries exhibit negative welfare effects. Both studies conclude that the rise of China's productivity affects different regions in different ways.

In the present work, I study how a country's productivity improvement can affect its trading partner's welfare. I contribute to the existing literature in two key aspects. First, I apply a two-region, two-factor, one-sector general equilibrium model with flexible wages, abandoning Deminova's uniform wage assumption. The uniform wage assumption switches off a channel that shows how factor prices respond to changes in relative productivity. Therefore, the consideration of flexible wages is of high importance as it offers further insights into the impacts of productivity improvements on welfare. I show that a country's productivity improvement is beneficial for the country itself as well as for its trading partner. Second, I use a two-region, two-factor, two-sector monopolistic competition model, relaxing the single-factor (labor) assumption which is used in other works (See [Deminova \(2008\)](#); [Hsieh and Ossa \(2016\)](#)). Under the single-factor assumption, foreign productivity changes do not have any impact on domestic income distribution. In reality, however, any productivity change between countries creates losers as well as winners within each country. Hence, I believe that it is imperative to study how benefits or losses that come from foreign productivity changes are distributed between domestic production factors. More specifically, I consider a model consisting of two regions that are asymmetric in terms of labor productivity, with the one being a developed and the other being a developing region. There are two sectors and two production factors named skilled and unskilled labor. Skilled labor is a specific factor since it is employed in manufacturing sector. Unskilled labor is a non-specific factor, being freely mobile across sectors. I show that a productivity improvement in the developing region *(i)* benefits the entire economy, *(ii)* benefits all unskilled workers in the economy and skilled workers in the developing region, and *(iii)* hurts skilled workers in the developed region.

The remainder of the paper is organized as follows. Section 2.2 presents the one-sector, two-factor model. It characterizes the market equilibrium and contains the welfare analysis. Section 2.3 introduces the two-sector, two-factor model. It determines the analytical expressions for the market equilibrium. It also contains the welfare analysis and studies the robustness of the model. Finally, Section 2.4 concludes and summarizes the main findings of the paper.

2.2 One-Sector, Two-Factor Model

2.2.1 Set up

I consider a model where the global economy consists of two regions, labeled North and South. In each region there exist two types of household supplying unskilled and skilled labor, respectively. Both of them inelastically supply one-factor unit each. Each household derives utility from an aggregate of manufacturing varieties. I normalize the total mass of each skilled and unskilled labor to one in the entire economy. A proportion θ of skilled households is located in North and the rest $(1 - \theta)$ is located in South. Moreover, a proportion ϵ of unskilled households is located in North and the rest $(1 - \epsilon)$ is located in South.

In each region, there exists a Dixit-Stiglitz industry. It produces a large variety of differentiated products using both skilled and unskilled labor. Each variety is produced using unskilled labor as variable input and skilled labor as fixed cost. Manufacturing goods are tradable with iceberg costs. The cost mark-up factor is denoted by $\tau > 1$ for trade between North and South. Trade of manufacturing varieties within each region is free.

Finally, I assume that the labor productivity differs across regions with the one in North being higher than that in South. Without loss of generality, I normalize the productivity of both skilled and unskilled labor in North to be equal to one. In South, unskilled labor has productivity $0 < \delta \leq 1$ and skilled labor has productivity $0 < \alpha \leq 1$. The production of a manufacturing variety in North requires one unit of unskilled labor as marginal cost and one unit of skilled labor as fixed cost. In South a manufacturing variety is produced using $1/\delta$ units of unskilled labor as marginal cost and $1/\alpha$ units of skilled labor as fixed cost, respectively.

2.2.2 Demand Side

Household preferences are defined over a continuum of differentiated varieties. Consumers in both regions derive utility from consuming a manufacturing aggregate. Let the utility of a typical household located in region i be

$$C_i = \left(\int_V l_i(v)^{\frac{\sigma-1}{\sigma}} dv \right)^{\frac{\sigma}{\sigma-1}}, \quad i = n, s, \quad (2.1)$$

with $\sigma > 1$ and $V = V_n \cup V_s$.

Per capita consumption of a consumer located in region i is denoted by l_i . V_n and V_s are the numbers of varieties that are produced in North and South, respectively. The parameter σ expresses the elasticity of substitution between any two manufacturing varieties. The budget constraint of a representative household is given by

$$P_i C_i = y_i, \quad i = n, s, \quad (2.2)$$

where y_i denotes the household's income located in region i . P_n is the perfect CES-price index for the manufacturing aggregate in North,

$$P_n = \left[\int_{V_n} p_n(v)^{1-\sigma} dv + \int_{V_s} (\tau p_s(v))^{1-\sigma} dv \right]^{\frac{1}{1-\sigma}}. \quad (2.3)$$

Similarly, P_s is the perfect CES-price index for the manufacturing aggregate in South,

$$P_s = \left[\int_{V_s} p_s(v)^{1-\sigma} dv + \int_{V_n} (\tau p_n(v))^{1-\sigma} dv \right]^{\frac{1}{1-\sigma}}. \quad (2.4)$$

p_n denotes the producer price for a variety that is produced in North and p_s is the producer price for a variety that is produced in South. The iceberg trade cost implies that only $\frac{1}{\tau}$ of a unit of a variety shipped arrives at its destination. It also implies that the consumer price of an imported variety from South to North is τp_s . Similarly, the consumer price of an imported variety from North to South is τp_n .

Maximizing the utility subject to the budget constraint (2.2), the demand functions of a typical household located in North are obtained as

$$x_{nn} = p_n^{-\sigma} P_n^{\sigma-1} y_n, \quad x_{ns} = (\tau p_s)^{-\sigma} P_n^{\sigma-1} y_n. \quad (2.5)$$

x_{nn} denotes the demand of a representative household located in North for varieties that are produced in North; x_{ns} is the demand of the same household for varieties that are produced in South. Similarly, demand functions

$$x_{sn} = (\tau p_n)^{-\sigma} P_s^{\sigma-1} y_s, \quad x_{ss} = p_s^{-\sigma} P_s^{\sigma-1} y_s, \quad (2.6)$$

are obtained for a typical household located in South. x_{sn} denotes the demand of a representative household located in South for varieties that are produced in North; x_{ss} is the demand of the same household for varieties that are produced in South.

The indirect utility is given by

$$I_i = \frac{y_i}{P_i}, \quad i = n, s. \quad (2.7)$$

2.2.3 Supply Side

Firms are monopolistically competitive and employ both skilled and unskilled labor under increasing returns to scale. Product differentiation ensures that one firm produces a single variety. The productivity level differs between North and South, where North is more efficient. I assume that all firms within a region have access to the same technology. Thus, the profits of a North-based representative firm are given by

$$\pi_n = (p_n - w_n)X_n - R_n, \quad (2.8)$$

where w_n denotes the unskilled wage rate and R_n is the skilled wage rate paid in North. X_n is the total demand for a variety that is produced by a North-based firm.

Similarly, the profits of a South-based representative firm are given by

$$\pi_s = (p_s - \frac{1}{\delta}w_s)X_s - \frac{1}{\alpha}R_s. \quad (2.9)$$

w_s denotes the unskilled wage rate and R_s is the skilled wage rate paid in South. X_s is the total demand for a variety that is produced by a South-based firm. In South a productivity improvement of unskilled labor reduces the marginal cost. This leads to a reduction of the mill consumer price in South. Moreover, a productivity improvement of skilled labor increases the number of manufacturing varieties that are produced in South. This can be seen by the skilled labor market clearing condition which implies that in equilibrium the number of firms in each market is given by

$$n_n = \theta, \quad n_s = (1 - \theta)\alpha. \quad (2.10)$$

n_n and n_s are the numbers of manufacturing firms in North and South, respectively.

Following the standard approach, the profit-maximizing consumer price is a constant mark-up of marginal cost. Thus,

$$p_n = \frac{\sigma}{\sigma - 1}w_n = \bar{p}w_n, \quad p_s = \frac{\sigma}{\sigma - 1}\delta^{-1}w_s = \bar{p}\delta^{-1}w_s. \quad (2.11)$$

Furthermore, due to the fact that the elasticity of substitution between varieties is constant, the income of skilled labor is a proportion of the total revenue. In the case of North the total income is

$$Y_n = \bar{p}\epsilon w_n. \quad (2.12)$$

Similarly, the total income in South is given as

$$Y_s = \bar{p}(1 - \epsilon)w_s. \quad (2.13)$$

Equations (2.12) and (2.13) express the value of total supply in North and South, respectively.

2.2.4 Equilibrium

In South a productivity improvement of skilled labor decreases the CES-price indices; the same impact comes from a productivity improvement of unskilled labor. Therefore, both productivity parameters can be merged into one parameter. In order to further simplify the notation, I define $\xi = \alpha\delta^{\sigma-1}$. As a result, the CES-price indices for manufacturing varieties in both regions can be derived as

$$P_n = \bar{p} \left(\theta w_n^{1-\sigma} + (1 - \theta)\xi\phi w_s^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \quad P_s = \bar{p} \left(\theta\phi w_n^{1-\sigma} + (1 - \theta)\xi w_s^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \quad (2.14)$$

where $\phi \equiv \tau^{1-\sigma} \leq 1$ is a parameter which is inversely related to trade costs. It captures the freeness of trade between North and South. The equilibrium equations for both markets are obtained by setting demand equal to supply in each region. Both total demand and supply in each region are expressed in value terms. Thus, for North

$$Y_n = \theta \left[\left(\frac{P_n}{P_n} \right)^{1-\sigma} Y_n + \left(\frac{P_n}{P_s} \right)^{1-\sigma} \phi Y_s \right]. \quad (2.15)$$

Similarly for South

$$Y_s = (1 - \theta) \left[\left(\frac{P_s}{P_n} \right)^{1-\sigma} \phi Y_n + \left(\frac{P_s}{P_s} \right)^{1-\sigma} Y_s \right]. \quad (2.16)$$

Using demand functions (2.5), (2.6), the price indices and optimal firm prices along with equations (2.12), (2.13) and (2.15), (2.16), the equilibrium equations are obtained as

$$w_n^\sigma = \left(\frac{\theta}{\epsilon} \right) \left[\frac{\epsilon w_n}{\theta w_n^{1-\sigma} + (1 - \theta)\xi\phi w_s^{1-\sigma}} + \frac{(1 - \epsilon)\phi w_s}{\theta\phi w_n^{1-\sigma} + (1 - \theta)\xi w_s^{1-\sigma}} \right], \quad (2.17)$$

and

$$w_s^\sigma = \left(\frac{(1 - \theta)\xi}{(1 - \epsilon)} \right) \left[\frac{\epsilon\phi w_n}{\theta w_n^{1-\sigma} + (1 - \theta)\xi\phi w_s^{1-\sigma}} + \frac{(1 - \epsilon)w_s}{\theta\phi w_n^{1-\sigma} + (1 - \theta)\xi w_s^{1-\sigma}} \right]. \quad (2.18)$$

The equilibrium equations depend on the productivity parameters, the allocation of skilled and unskilled households, the freeness of trade between North and South, and the elasticity of substitution between varieties.

2.2.5 Welfare Analysis

In this section, I conduct a welfare analysis in order to study how a productivity improvement in South affects (i) the welfare in North, and (ii) the welfare in South. For each region, equations (2.12) and (2.13) show that a productivity change in South has no impact on the income distribution between skilled and unskilled households. Thus, a region's income distribution is fixed as long as the number of unskilled households remains constant. As a result, a welfare analysis can be conducted by looking at the aggregate real income in each region. Given Warlas' law, the markets clear when the total production in one region is equal to the total demand for varieties that are produced in this region. Without loss of generality, I fix the unskilled wage in North to one. Thus, I obtain the general equilibrium equation for the entire economy as

$$1 = \left(\frac{\theta}{\epsilon} \right) \left[\frac{\epsilon}{\theta + (1 - \theta)\xi\phi w_s^{1-\sigma}} + \frac{(1 - \epsilon)\phi w_s}{\theta\phi + (1 - \theta)\xi w_s^{1-\sigma}} \right]. \quad (2.19)$$

The idea is to express the unskilled wage rate in South (i.e. w_s) in terms of the welfare in North (i.e. V_n). In order to do this, I use the North's indirect utility (2.7) along with equation (2.12), which gives the total income expressed in units of the unskilled wage rate in North. Therefore, the

total welfare in North can be written as

$$V_n = \frac{Y_n}{P_n} = \frac{\epsilon w_n}{\left(\theta w_n^{1-\sigma} + (1-\theta)\xi\phi w_s^{1-\sigma}\right)^{\frac{1}{1-\sigma}}}. \quad (2.20)$$

Since $w_n = 1$, equation (2.20) can be rewritten as

$$\left(\frac{\epsilon}{V_n}\right)^{1-\sigma} = \theta + (1-\theta)\xi\phi w_s^{1-\sigma}. \quad (2.21)$$

Let $u_n = (1-\theta)\xi\phi w_s^{1-\sigma}$ be a monotone transformation of the welfare in North (i.e. V_n). Then, it can be immediately shown that $\frac{dw_s}{du_n} < 0$ and $\frac{dw_s}{d\xi} > 0$. Using (2.21) and the definition of u_n , the equilibrium equation (2.19) can be rewritten as a function of the welfare in North and the productivity parameters. Hence,

$$1 = F(\xi, u_n) = \left(\frac{\theta}{\epsilon}\right) \left[\frac{\epsilon}{\theta + u_n} + \frac{(1-\epsilon)w_s(\xi, u_n)}{\theta\phi + \frac{u_n}{\phi}} \right]. \quad (2.22)$$

In order to study the impact of a productivity change in South on the welfare in North, I consider the total differential of equation (2.22) as

$$0 = F_\xi d\xi + F_{u_n} du_n, \quad (2.23)$$

where F_ξ and F_{u_n} are the derivatives of $F(\cdot)$ with respect to ξ and u_n , respectively. The goal is to determine the sign of

$$\frac{du_n}{d\xi} = -\frac{F_\xi}{F_{u_n}}. \quad (2.24)$$

After conducting a comparative static analysis, the next proposition summarizes how a productivity improvement in South affects the welfare in North.

Proposition 2.1: *A skilled or unskilled labor productivity improvement in South has a positive impact on the welfare in North.*

Proof. From equation (2.22) with $\frac{dw_s}{du_n} < 0$ and $\frac{dw_s}{d\xi} > 0$, it can be seen that $F_{u_n} < 0$ and $F_\xi > 0$. Thus, $\frac{du_n}{d\xi} > 0$. \square

On the one hand, a productivity improvement of unskilled labor in South reduces the marginal cost of production. Thus, it reduces the consumer price of varieties that are produced in South. Therefore, the price indices in both regions go down. This has a positive impact on the welfare of both regions as long as the wage in South does not respond. On the other hand, taking into account the wage response in South, an increase in ξ has a positive impact on the unskilled wage rate in South. As a result, the price indices in both regions increase. This has a negative impact on the welfare in North, all else equal. The total income in South increases since the unskilled

wage rate in South goes up. Thus, households located in South become richer. This has a positive impact on the demand for varieties that are produced in North. Also, given the fixed unskilled wage rate in North, the total income in North is constant. Proposition 2.1 shows that after taking into account all possible effects, the welfare in North increases when the productivity of unskilled labor in South improves.

Moreover, a productivity improvement of skilled labor in South has the same impact on the welfare in North as the one of unskilled labor. The adjustment mechanism, however, differs. A productivity change of skilled labor in South does not affect the consumer price of varieties that are produced in South. From equation (2.10) it can be seen that an improvement in the productivity of skilled labor in South increases the number of varieties that are produced in South. As a result, the price indices in both regions go down. With falling price indices and fixed total income, the welfare of both skilled and unskilled households in North increases.

In the following part, I extend the welfare analysis in order to study the impact of productivity changes in South on its welfare. I use Warlas' law and fix the unskilled wage in South to one. Therefore, the equilibrium equation for the entire economy is given by

$$1 = \left(\frac{(1-\theta)\xi}{(1-\epsilon)} \right) \left[\frac{\epsilon\phi w_n}{\theta w_n^{1-\sigma} + (1-\theta)\xi\phi} + \frac{(1-\epsilon)}{\theta\phi w_n^{1-\sigma} + (1-\theta)\xi} \right]. \quad (2.25)$$

The equilibrium equation depends on the productivity parameters, the market sizes, the freeness of trade between North and South, and the elasticity of substitution between varieties. As in the case of North, I apply the same idea in order to express the unskilled wage rate in North (i.e. w_s) in terms of the welfare in South (i.e. V_s). Then,

$$\begin{aligned} V_s &= \frac{Y_s}{P_s} = \frac{(1-\epsilon)}{(\theta\phi w_n^{1-\sigma} + (1-\theta)\xi)^{\frac{1}{1-\sigma}}} \Leftrightarrow \\ &\Leftrightarrow \frac{u_s - (1-\theta)\xi}{\phi\theta} = w_n^{1-\sigma}, \end{aligned} \quad (2.26)$$

with $u_s = \left(\frac{V_s}{1-\epsilon} \right)^{\sigma-1}$. Thus, it immediately follows that $\frac{dw_n^{1-\sigma}}{du_s} > 0$ and $\frac{dw_n^{1-\sigma}}{d\xi} = -\frac{(1-\theta)}{\phi\theta} < 0$. Equation (2.26) is derived by using the expression of the total income (2.13), along with the price index in South and normalizing the unskilled wage rate in South to one. Replacing equation (2.26) back in equation (2.25), the equilibrium equation can be written as a function of the productivity parameters and the welfare in South. Thus,

$$1 = G(w_n(u_s, \xi), \xi). \quad (2.27)$$

In order to study the impact of a productivity change in South on its welfare, I consider the total differential of the expression (2.27) as

$$0 = G_\xi d\xi + G_{u_s} du_s, \quad (2.28)$$

with G_ξ and G_{u_s} being the derivatives of $G(\cdot)$ with respect to ξ and u_s , respectively. The goal is to determine the sign of $\frac{du_s}{d\xi} = -\frac{G_\xi}{G_{u_s}}$. The next proposition summarizes how a productivity improvement in South affects the welfare in South.

Proposition 2.2: *A skilled or unskilled labor productivity improvement in South has a positive impact on the welfare in South.*

Proof. From equation (2.27) it can be seen that $\frac{dG}{dw_n} > 0$. With $\frac{dw_n^{1-\sigma}}{du_s} > 0$ and $\frac{dw_n^{1-\sigma}}{d\xi} < 0$, it can be seen that $G_{u_s} < 0$ and $G_\xi > 0$. Thus, $\frac{du_s}{d\xi} > 0$. \square

The model predicts that a productivity improvement in South is beneficial for the region itself since its total welfare goes up. Due to the fact that the income distribution is fixed, the gains from a productivity improvement in South accrue to all consumers in this region. Therefore, the welfare of both skilled and unskilled households increases.

2.3 Two-Sector, Two-Factor Model

2.3.1 Set up

I obtain the previous results under the assumption of a Dixit-Stiglitz manufacturing industry. Under this assumption, any change in productivity between regions does not have any impact on income distribution within each region. In reality, however, benefits or losses that come from a region's productivity improvement are often distributed unevenly between the factors of production. As a result, any change in productivity between regions creates losers as well as winners within each region.

In this section, based on [Krugman \(1980\)](#), I consider a two-region, two-sector, two-factor monopolistic competition model, in order to study the impact of a relative productivity improvement on overall social welfare. Moreover, I use this set up for conducting a group-wise welfare analysis, studying how a productivity improvement in South affects the welfare of each production factor, in each region. More specifically, I assume that an agricultural sector and a manufacturing Dixit-Stiglitz sector exist in the economy. Also, there are two types of household supplying unskilled and skilled labor, respectively. Skilled labor is a specific factor since it is employed in the manufacturing industry. Unskilled labor is a non-specific factor, being freely mobile between sectors.

In order to keep the model analytically tractable, I use two simplifying assumptions. First, I assume that the identical consumer preferences are characterized by a quasi-linear utility function. Second, I keep the agricultural sector as simple as possible, assuming that it produces a costless tradable homogeneous good using only unskilled labor under perfect competition and constant returns to scale. This ensures that the wage of unskilled labor is equalized between sectors and also across regions. Intuitively, under flexible wages a productivity improvement in South increases the wage of unskilled labor in South and this reduces the price indices less than under uniform wages.

As a result, the positive impact on welfare of both regions that comes from the reduction of the price indices is smaller under the assumption of flexible wages than that of uniform wages.

Finally, since both skilled and unskilled productivity parameters α and δ can be merged into one parameter, I assume that the productivity of skilled labor is the same across regions. Only the productivity of unskilled labor differs with the one in North being higher than that in South.

2.3.2 Demand Side

Household preferences are characterized by a quasi-linear utility function with CES sub-utility over manufacturing varieties. Let the utility of a typical household located in region i be

$$U_i = \mu \ln C_X^i + C_A^i, \quad i = n, s, \quad (2.29)$$

where $0 < \mu < 1$ and $\mu < r = \min\{R_n, R_s\}$. The parameter μ expresses the expenditure on manufacturing products. C_X^i is the consumption of the manufacturing aggregate and C_A^i denotes the consumption of the agricultural good. The budget constraint of a representative household is given by

$$P_i C_X^i + C_A^i = y_i, \quad i = n, s. \quad (2.30)$$

y_i denotes the household's income. Each household maximizes its utility subject to its budget constraint. One obtains the demand functions for the manufacturing aggregate and the agricultural good as

$$C_X^i = \frac{\mu}{P_i}, \quad C_A^i = y_i - \mu, \quad i = n, s. \quad (2.31)$$

Moreover, the demand functions of a representative household located in North for manufacturing varieties are obtained as

$$x_{nm} = \mu p_n^{-\sigma} P_n^{\sigma-1}, \quad x_{ns} = \mu (\tau p_s)^{-\sigma} P_n^{\sigma-1}. \quad (2.32)$$

Similarly, the demand functions of a representative household located in South are

$$x_{sn} = \mu (\tau p_n)^{-\sigma} P_s^{\sigma-1}, \quad x_{ss} = \mu p_s^{-\sigma} P_s^{\sigma-1}. \quad (2.33)$$

Finally, the indirect utility is given by

$$\Omega_i = y_i - \mu \ln P_i, \quad i = n, s. \quad (2.34)$$

2.3.3 Supply Side and Market Equilibrium

The agricultural good serves as the numeraire. It is produced in a perfectly competitive environment under constant returns with a unit input requirement of unskilled labor. Perfect competition enforces marginal cost pricing. Costless trade equalizes prices between North and South. This indirectly makes the wage rates of unskilled labor equal to one in both regions.

Turning to the industrial sector, I assume that the productivity of skilled labor is the same across regions and equal to one. In addition, the productivity of unskilled labor in North is higher than that in South. Thus, the relative productivity of North compare to South is denoted by $1/\delta > 1$. The profits of a representative North-based firm are given by

$$\pi_n = (p_n - 1)X_n - R_n. \quad (2.35)$$

Similarly, the profits of a representative South-based firm are given by

$$\pi_s = (p_s - \frac{1}{\delta})X_s - R_s. \quad (2.36)$$

A typical firm acts as if it is a monopolist facing a demand curve with constant elasticity equal to σ . Following the standard approach, the profit-maximizing consumer price is

$$p_n = \frac{\sigma}{\sigma - 1} = \bar{p}, \quad p_s = \frac{\sigma}{\sigma - 1} \delta^{-1} = \bar{p} \delta^{-1}. \quad (2.37)$$

In order to simplify the notation, I define $\lambda = \delta^{\sigma-1} \leq 1$. As a result, the CES-price indices for the manufacturing varieties in both regions can be derived as

$$P_n = \bar{p} (\theta + (1 - \theta)\phi\lambda)^{\frac{1}{1-\sigma}}, \quad P_s = \bar{p} (\theta\phi + (1 - \theta)\lambda)^{\frac{1}{1-\sigma}}. \quad (2.38)$$

The zero profit condition requires that the wage rate of skilled labor must be equal to the operating profit. Thus,

$$X_n = (\sigma - 1)R_n, \quad X_s = \delta(\sigma - 1)R_s \quad (2.39)$$

Imposing the condition of zero profits along with the aggregate demand functions (2.32), (2.33) and the price indices and optimal firm prices, the equilibrium skilled wages in every region (i.e. R_n and R_s) are obtained as

$$\begin{aligned} R_n &= \frac{\mu}{\sigma} \left[\frac{(\epsilon + \theta)}{\theta + (1 - \theta)\phi\lambda} + \frac{\phi((1 - \epsilon) + (1 - \theta))}{\theta\phi + (1 - \theta)\lambda} \right] \\ &= \frac{\mu}{\sigma} \left[\frac{M_n}{Q_n} + \frac{\phi M_s}{Q_s} \right], \end{aligned} \quad (2.40)$$

and

$$\begin{aligned} R_s &= \frac{\mu\lambda}{\sigma} \left[\frac{\phi(\epsilon + \theta)}{\theta + (1 - \theta)\phi\lambda} + \frac{((1 - \epsilon) + (1 - \theta))}{\theta\phi + (1 - \theta)\lambda} \right] \\ &= \frac{\mu\lambda}{\sigma} \left[\frac{\phi M_n}{Q_n} + \frac{M_s}{Q_s} \right], \end{aligned} \quad (2.41)$$

with market sizes

$$M_n = \epsilon + \theta, \quad M_s = (1 - \epsilon) + (1 - \theta), \quad (2.42)$$

and potentials

$$Q_n = \theta + (1 - \theta)\phi\lambda, \quad Q_s = \theta\phi + (1 - \theta)\lambda. \quad (2.43)$$

A productivity improvement in South (i.e. λ goes up) increases the market potentials Q_n and Q_s , respectively. The price indices fall in both regions. Thus, the skilled nominal wage rate in North R_n , goes down. In South, an increase in λ has two opposite effects on the skilled nominal wage rate R_s . On the one hand, an increase in the market potentials leads to a decrease of the skilled nominal wage rate in South. On the other hand, South-based firms become more efficient. Thus, they can pay higher wage rate to skilled labor. The first impact can be seen by keeping the numerator of (2.41) fixed. An improvement in λ increases both, Q_n and Q_s ; this implies that R_s goes down. To see the second impact, the market potentials in (2.41) are kept fixed. A productivity improvement in South increases its skilled nominal wage rate. The next proposition summarizes the impact of a productivity change in South on the skilled nominal wage rates R_n and R_s , respectively.

Proposition 2.3: *The skilled nominal wage rate in North R_n decreases in λ ; the skilled nominal wage rate in South R_s , however, increases in λ .*

Proof.

$$\frac{dR_n}{d\lambda} = -\frac{\mu(1 - \theta)\phi}{\sigma} \left(\frac{M_n}{Q_n^2} + \frac{M_s}{Q_s^2} \right) < 0 \quad (2.44)$$

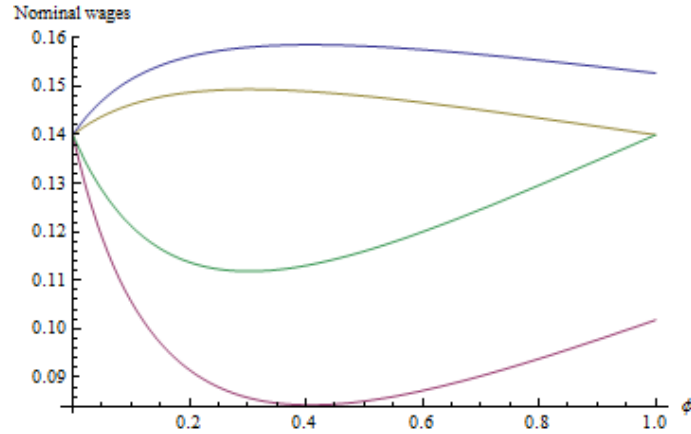
and

$$\begin{aligned} \frac{dR_s}{d\lambda} &= \frac{\mu}{\sigma} \left(\frac{\phi M_n}{Q_n} + \frac{M_s}{Q_s} \right) - \frac{\mu\lambda}{\sigma} \left(\frac{\phi^2 M_n(1 - \theta)}{Q_n^2} + \frac{M_s(1 - \theta)}{Q_s^2} \right) = \\ &= \frac{\mu\theta\phi}{\sigma} \left(\frac{M_n}{Q_n^2} + \frac{M_s}{Q_s^2} \right) > 0. \end{aligned} \quad (2.45)$$

□

Proposition 2.3 shows that a productivity improvement in South increases its skilled nominal wage rate; it, however, reduces the skilled nominal wage rate in North. Figure 2.1 illustrates both R_n and R_s for different values of the freeness of trade ϕ . Starting from the benchmark case, the middle two lines show how the skilled nominal wage rates change with respect to ϕ , when the productivity is equal across regions. The yellow line depicts the skilled nominal wage rate in North; the green line depicts the skilled nominal wage rate in South. We observe that both nominal wage rates are not monotone. They are equalized in the case of autarky (i.e. $\phi = 0$) and in the case of completely free trade (i.e. $\phi = 1$).

Moreover, the upper line (i.e. blue) and the lower line (i.e. red) show how the skilled nominal wage rates change with respect to ϕ , when the productivity differs across regions. Both R_n and R_s are still not monotone. They are equalized in the case of autarky (i.e. $\phi = 0$), but not in the case of completely free trade (i.e. $\phi = 1$).

Figure 2.1: R_n , R_s and Freeness of Trade ϕ

2.3.4 Welfare Analysis

In order to study the impact of a change in relative productivity on the overall social welfare, I consider a Utilitarian concept. Under quasi-linearity, the marginal utility of income for all agents is equal to one. Thus, income redistributions do not affect the aggregate welfare. Therefore, the Kaldor and Hicks compensation criteria are all the same. Both criteria allow for potential Pareto improvements since people that are made better off can in principle compensate those that are made worse off using the appropriate transfers, without affecting the aggregate welfare. This allows us to use an aggregate utility criterion, considering the un-weighted sum of individual utilities.

A productivity improvement in South increases the market potentials Q_n and Q_s , respectively. As a result, the price indices go down in both regions. Since the unskilled wage rates are constant, it can be easily seen that the total income in the entire economy is constant, too. With constant elasticity of substitution between varieties, the income of skilled labor is a proportion of the total revenue which is equal to the total expenditure on the manufacturing products. Under quasi-linearity, the total expenditure on the manufacturing products is equal to 2μ . Thus, the entire income of skilled labor is equal to $2\mu/\sigma$. Also, the entire income of unskilled labor is equal to 1. Hence, the total income in the economy is equal to $2\mu/\sigma + 1$. With constant labor income and falling price indices, the entire Utilitarian welfare increases. Therefore, under the scope of quasi-linearity, a productivity improvement in South is always beneficial for the entire economy.

In addition, I conduct a group-wise welfare analysis, in order to study how a productivity improvement in South affects the welfare of each group of households, in each region. Since individuals are group-wisely identical, it is enough to study the impact of λ on the indirect utility of a single individual. In the case of an unskilled worker, a reduction in the price indices increases his welfare since his income is constant. Thus, a productivity improvement in South is beneficial for all unskilled workers in the economy. Moreover, according to proposition 2.3, an increase in λ has a positive impact on the skilled nominal wage rate in South. Therefore, with falling price indices and increasing income, the welfare of skilled workers located in South increases, too. Hence,

the only interesting question is how the welfare of skilled workers located in North responds to productivity changes in South.

Thus, I consider the derivative of Ω_n with respect to λ using (2.34), (2.38) and (2.44), this, up to positive constants, leads to

$$\Omega'_n = -\omega \left(\frac{\epsilon + \theta}{Q_n^2} + \frac{(1 - \epsilon) + (1 - \theta)}{Q_s^2} \right) + \frac{1}{Q_n}, \quad (2.46)$$

with $\omega = \frac{\sigma-1}{\sigma}$.

ω is monotonously increasing in σ , and $\omega \in (0, 1)$. Let us call Ω'_n the Welfare Effect (WE), the left term the Income Effect (IE) and the right term the Price Effect (PE). Proposition 2.3 shows that IE is negative and PE is positive. Thus, WE is negative if and only if IE dominates. Moreover, if ω is close enough to zero implying σ being close enough to one, PE dominates and thus WE is positive. Intuitively, when individuals in North have high preferences for diversity, a productivity improvement in South increases the welfare of individuals located in North since PE dominates IE. The effect of λ can go both ways and the challenge is to separate the parameter space into subspaces where WE is positive or negative, respectively.

I consider the case where both regions are symmetric in terms of the population size, i.e., $\epsilon = \frac{1}{2}$ and $\theta = \frac{1}{2}$. Then,

$$\Omega'_{n|\theta=\epsilon=\frac{1}{2}} = -\omega \left(\frac{1}{Q_n^2} + \frac{1}{Q_s^2} \right) + \frac{1}{Q_n}. \quad (2.47)$$

More conveniently, I study the sign of $W'(\lambda, \phi, \omega) = Q_n Q_s \Omega'_n$, which is the same as the sign of Ω'_n . Let $z(\lambda, \phi) = \frac{Q_n}{Q_s}$, then

$$W'(\lambda, \phi, \omega) = -\omega \left(\frac{1}{z(\lambda, \phi)} + z(\lambda, \phi) \right) + Q_s, \quad (2.48)$$

with $z(0, \phi) = \frac{1}{\phi}$, $z(1, \phi) = z(\lambda, 1) = 1$, $z(\lambda, 0) = \frac{1}{\lambda}$, $z_\lambda < 0$ and $z_\phi < 0$ being the derivatives of $z(\lambda, \phi)$ with respect to λ and ϕ , respectively.

$D = \{(\lambda, \phi, \omega) \mid W'(\lambda, \phi, \omega) = 0\}$ defines a manifold in \mathbb{R}^3 separating domains with positive from those with negative WE. In order to characterize D , I need the derivatives W'_ω , W'_λ and W'_ϕ of W' with respect to ω , λ and ϕ , respectively. Thus,

$$W'_\omega = - \left(\frac{1}{z(\lambda, \phi)} + z(\lambda, \phi) \right) < 0, \quad (2.49)$$

and

$$W'_\lambda = -\omega z_\lambda \left(1 - \frac{1}{z^2(\lambda, \phi)} \right) + \frac{1}{2} > 0, \quad (2.50)$$

and

$$W'_\phi = -\omega z_\phi \left(1 - \frac{1}{z^2(\lambda, \phi)} \right) + \frac{1}{2} > 0. \quad (2.51)$$

Since $\lambda \leq 1$ it is implied that $z(\lambda, \phi) \geq 1$ and thus the parenthesis $\left(1 - \frac{1}{z^2(\lambda, \phi)} \right)$ is non-negative. From (2.49), (2.50) and (2.51) it is shown that D is monotone with respect to the parameters of interest.

Therefore, D is an increasing curve in the parameter space \mathbb{R}^3 with λ and ϕ on the horizontal axes and ω on the vertical axis. Inserting into $W'(\lambda, \phi, \omega)$ it is immediate that $W'(0, \phi, \underline{\omega}) = W'(1, \phi, \bar{\omega}) = W'(\lambda, 0, \underline{\tilde{\omega}}) = W'(\lambda, 1, \tilde{\tilde{\omega}}) = 0$ with

$$0 < \underline{\omega} = \frac{\phi^2}{2(1 + \phi^2)} < \omega < \bar{\omega} = \frac{\phi + 1}{4} < 1, \quad (2.52)$$

and

$$0 < \underline{\tilde{\omega}} = \frac{\lambda^2}{2(1 + \lambda^2)} < \omega < \tilde{\tilde{\omega}} = \frac{\lambda + 1}{4} < 1. \quad (2.53)$$

D defines implicitly a function $\omega(\lambda, \phi)$ such that WE is negative above and positive below. Then, (2.52) and (2.53) give us the margin curves $\omega(0, \phi)$, $\omega(1, \phi)$, $\omega(\lambda, 0)$ and $\omega(\lambda, 1)$ of D . Since ω , ϕ and λ are all between 0 and 1, they can be placed in the axes of a cube with side length 1, with ω on the vertical axis (ordinate), λ on the horizontal axis (abscissa), and ϕ on the applicate. Then, (2.52) and (2.53) fully characterize the end points of a monotone continuous manifold within the cube, with its corner points being $\omega(0, 0) = 0$, $\omega(0, 1) = \omega(1, 0) = 1/4$ and $\omega(1, 1) = 1/2$. The next figure shows the manifold that separates the parameter space into two subspaces where WE is negative on the domain above and positive on the domain below the manifold.

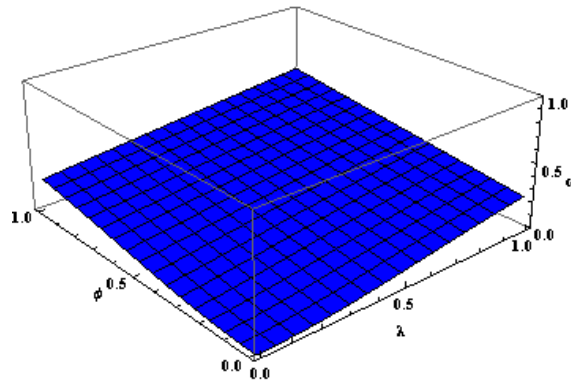


Figure 2.2: Manifold

Intuitively, North region, which is relatively more efficient in the manufacturing sector, is a net exporter of manufacturing varieties and a net importer of agricultural goods. South region, which is relatively less productive in the manufacturing sector, is a net exporter of agricultural goods and a net importer of manufacturing products. The inter-industry pattern of trade is determined by the cross-region difference in relative labor productivity, just as in a Ricardian model. Therefore, a productivity improvement in South is an import-biased growth from the point of view of South. An import-biased growth tends to improve a growing region's terms of trade and to harm its trading partner.

Due to the fall of price indices in both regions, the impact of a productivity change in South on the welfare of skilled workers located in North is ambiguous. It depends on the elasticity of

substitution between varieties, the freeness of trade between North and South, and the productivity in South. When ω is small then σ is small; this implies that individuals have high preferences for diversity. A productivity improvement in South decreases (i) the skilled nominal wage rate in North and (ii) the price indices in both regions. For small values of ω , PE dominates IE since consumers located in North are willing to buy more and cheaper varieties from South. Thus, the welfare of skilled workers located in North goes up. Additionally, keeping ω constant, larger freeness of trade increases the market potentials and thus the price indices fall. This has a positive impact on the welfare of skilled workers located in North, too.

Moreover, for given values of ω and ϕ , a larger λ reduces the skilled nominal wage rate in North but, at the same time, it makes the varieties that are produced in South cheaper. The higher λ the cheaper the varieties that are produced in South, and the lower the price indices in both regions. The impact of given changes of λ depends on whether λ is large or small. As long as ω and ϕ are constant, productivity improvements in South have negative effects on the welfare of skilled workers in North for small values of λ . However, for larger values of λ there are cases where PE dominates IE. Thus, the welfare of skilled workers located in North increases when the productivity improves in South.

Finally, it is interesting to study empirically which side of the cube is the most likely one. Based on the work of [Head and Mayer \(2004\)](#), the estimations of σ vary between 3 and 5 when the industrial sector stands for all tradable goods in the economy. By contrast, when this sector is a specific industry, σ sharply rises because varieties are now much better substitutes than in the aggregate level; a value of σ close to 7 is then acceptable. Therefore, ω varies between $2/3$ and $4/5$ when σ is between 3 and 5, respectively; ω is $6/7$ when σ is equal to 7. The minimum value of ω (i.e. $\omega = 2/3$) is larger than the maximum corner point (i.e. $\omega(1, 1) = 1/2$) of the manifold. As a result, no matter what the rest parameter values are (i.e. ϕ and λ), empirically the sub-space above the manifold is the most likely one. This implies that IE dominates PE. Therefore, a productivity improvement in South is harmful for skilled households located in North since it reduces their welfare.

2.3.5 Robustness

I use the quasi-linearity assumption for computational reasons. In fact, this choice does not take into account the income effect, although it makes the calculations simpler and the model analytically tractable. In this section, I relax this assumption, studying the importance of the income effect by considering a Cobb-Douglas utility function. More specifically, I numerically study the impact of a productivity improvement in South on the welfare of both North-based and South-based skilled workers, considering different values for the basic parameters of the model, i.e., $\mu, \sigma, \phi, \lambda$.

The selection of the parameter values is based on the work of [Head and Mayer \(2004\)](#). I use the same values for σ as in Section 2.3.4; μ takes values between 0.5 and 0.8, when the industrial sector stands for all tradable goods in the economy. When the manufacturing sector is a specific

industry, μ typically takes a value lower than 0.2, which approximately corresponds to the share of the manufactured good in a developed economy. Finally, both λ and ϕ take values between 0 and 1.

For given values of μ , σ and ϕ , I plot the indirect utility of both North-based and South-based skilled workers over a range of values of $\lambda \in [0, 1]$. The results are obtained for a particular parameter profile, i.e., $\sigma \in \{4, 7\}$, $\mu \in \{0.2, 0.6\}$, and $\phi \in \{1/3, 1/2, 2/3\}$. After considering all 12 possible parameter combinations, I find that the results in Section 2.3.4 regarding the impact of productivity improvements in South on the welfare of skilled workers are robust; a productivity improvement in South decreases the welfare of skilled workers located in North while it increases the welfare of skilled workers located in South. For example, the next figure shows how the welfare of a North-based and a South-based skilled worker changes with respect to λ for $\sigma = 4$, $\mu = 0.6$ and $\phi = 1/3$.

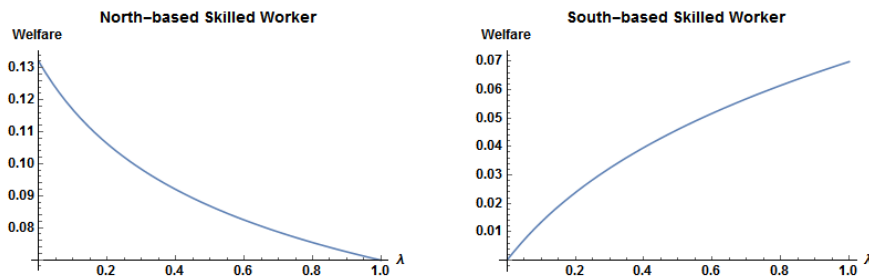


Figure 2.3: Welfare of a Skilled Worker

2.4 Conclusion

I apply a general equilibrium model that takes into account how factor prices respond to changes in relative productivity. It consists of two regions, a manufacturing Dixit-Stiglitz sector and two production factors. I show that a region's productivity improvement is beneficial for the region itself as well as for its trading partner. Moreover, I study how benefits or losses that come from foreign productivity changes are distributed between domestic production factors. To do this, I use a two-region, two-sector, two-factor monopolistic competition model, relaxing the single-factor assumption which is used in other works. I show that a developing region's productivity improvement is beneficial for the entire economy. I also find that a developing region's productivity improvement benefits all unskilled workers in the economy and skilled workers in the developing region; it, however, hurts skilled workers in the developed region. The results of the second model are derived under the quasi-linearity assumption, which means that the income effect has been eliminated. In order to study the robustness of the model, I relax this assumption (Section 2.3.5) by considering a Cobb-Douglas utility function. My findings exhibit that the model is fully robust for a specific parameter profile.

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Affirmation

I hereby affirm that I have completed my doctoral thesis entitled, "Essays on New Economic Geography and International Trade" entirely on my own and unassisted, and that I have specially marked all of the quotes I have used from other authors as well as those passages in my work that are extremely close to the thoughts presented by other authors, and listed the sources in accordance with the regulations I have been given.

Kiel, November 14, 2017

Dionysios Karavidas