The evolution of the supply chain in a three-region framework and its implications on welfare under economic integration

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Abstract

This paper discusses the evolution of the supply chain and welfare under economic integration in a three-region framework. Economic integration is measured by the reduction of inter-regional trade costs and by the reduction of communication costs between headquarters and plants. Numerical simulations show that freer trade leads to the agglomeration of plants to the core region and, depending on the level of communication costs, to some industry accumulation to the most developed region of the periphery. Welfare increases in all regions. As for the reduction of communication costs, it seems that the most developed region of the periphery can become the core region. Regarding welfare, unlike the reduction of trade costs, the reduction of communication costs is beneficial only to the region gaining industry. Also, the best welfare enhancing policy is to promote free trade together with the development and diffusion of new information and communication technologies that favour the reduction of communication costs.

JEL classification: F15, R13
Keywords: communication costs, industrial relocation, welfare

1 Introduction

The contribution of multinational firms (MFNs) to the world’s GDP is highly recognized: there are more than 50,000 companies worldwide, while the world’s largest MFNs represent about 25% of the world’s GDP and virtually half of total world trade (UNCTAD, 2005). The location decision of such corporations and its implications on the distribution of the economic activity and welfare are of high interest to the new economic geography (NEG) approach. Falling trade barriers and liberalizing capital movements are strong incentives for foreign direct investments (FDI) usually associated to MFNs, thus exploiting the various economic, social… opportunities some regions may offer. Indeed, with trade liberalization, many big companies find interesting to set up production facilities in countries where taxes or labour costs are lower: Nokia is going to set up a factory in Romania, Axa is also preparing a relocation plan to Morocco, Alstom has already set up a plant in Poland and not only, Nike in China… examples are abundant.

In the NEG literature, Fujita and Thisse (2006) model such FDIs based on the low labour cost in some regions. Headquarters remain clustered in a core region (developed regions), while production plants are allowed to set up in the core region, together with the headquarters (integrated firms) or in a developing region (MFNs) where labour cost is lower. They show how liberalizing trade can trigger the relocation of plants to the regions with lower labour costs. They also discuss the impact of lowering the communication costs (between headquarters and plants) incurred by MFNs. They find that below a certain value of communication costs, further reduction of the latter triggers the relocation of plants from the core to the periphery, regardless of the level of trade costs. However, this model discusses the

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location of plants on a two-region basis, which is a rather restrictive hypothesis. The authors themselves admit the importance of integrating a third region to the model. Indeed, today MFNs have the choice between Latin America, Eastern Europe and Asia as locations for their plants as each one of these developing regions offer abundant and low cost labour. Furthermore, besides north-south FDI, south-south FDI is developing: given the high Chinese competition, countries like Mexico in Latin America or Estonia in Eastern Europe begin to lose some of their industry. Consequently, this paper aims at extending competition to a three-region framework.

In the NEG literature, some papers have already presented multi-region models. Puga and Venables (1997) discuss industrial location and preferential trading arrangements (PTA), based on a vertical linkages model (Krugman and Venables, 1995)\(^3\) with three regions. They find that at first, the members of the PTA benefit identically from integration, while industry size and welfare fall outside the liberalizing regions. But then, as integration proceeds, some members of the PTA gain industry at the expense of others. Forslid (2004) discusses industrial location as well as regional policy in a three asymmetric region framework. He finds that, as usual in the NEG literature, economic integration leads to the deindustrialization of the periphery. In this context, the industrialization of the peripheral regions can be fostered by locating government agencies in some regional centres rather than in the absolute periphery, by improving infrastructure between the peripheral regions rather than between the periphery and the core or by subsidies, which are effective for low as well as for high levels of economic integration. A three-region version of the footloose capital model is analyzed by Baldwin et al. (2003) and also of Krugman’s (1991) core-periphery model is analyzed by Fujita, Krugman and Venables (1999).

In this article, the evolution of the supply chain under economic integration will be analyzed in a three-region framework. As in Fujita and Thisse (2006), firms are allowed to decentralize production, in order to take advantage of the low labour cost in developing regions. Headquarters are all located in a developed region, while plants may be located in the same region as the headquarters (integrated firms) or in one of the two developing regions of the model (MFNs). The paper will be organized as follows: section 2 presents the model, section 3 discusses the effects of reducing trade costs on location and welfare in each one of the three regions, section 4 analyzes the impact of reducing communication costs between headquarters and plants and section 5 concludes.

2 The model

This model is based on Fujita and Thisse (2006) who discuss the relocation of plants triggered by differences in labour productivity, in a two-region framework. The present paper analyzes the relocation of plants triggered by differences in labour productivity, in a three-region framework. Hereafter, the regions are called: the North (\(N\)), the South (\(S\)) and the Rest of the World (\(RW\)). The North is an industrialized region, while the South and the Rest of the World are developing regions. Furthermore, the Rest of the World is assumed less developed than the South. One can think of, for instance, Western Europe, Eastern and Central Europe and China. There are two production factors: the skilled workers and the unskilled workers and two sectors. The manufacturing sector is under Dixit-Stiglitz (1997) competition: each firm produces one horizontally different variety under increasing returns to scale, using both skilled and unskilled workers. The agricultural sector is under perfect competition, using only unskilled labour.

\(^3\) Manufacturing firms use as inputs their own production or that of other manufacturing firms. This creates some vertical dependence between manufacturing firms, which acts as an agglomeration force in the model.
Consumers are supposed to be identical in their preferences, with the same Cobb-Douglas utility function:

\[ U = M^\mu Z^{1-\mu}, \quad 0 < \mu < 1 \] and

\[ M = \int_0^{\mu} x_i^{(\sigma-1)/\sigma} di \] \tag{1}

\[ M \] is the consumption of a composite good, standing for all the varieties of manufactured goods, while \( Z \) is the consumption of the agricultural good. \( \mu \) is the share of the expenditure on manufactured goods, \( n \) represents the number of varieties produced in the global economy and also the number of firms (\( n = n_N + n_S + n_{RW} \)), \( x_i \) is the consumption of variety \( i \) and \( \sigma > 1 \) is the elasticity of substitution between the different varieties.

The agricultural sector needs \( a_r \geq 1 \) units of unskilled labour for one unit of output. Furthermore, northern unskilled workers are more productive than southern unskilled workers and southern unskilled workers are more productive than those in the Rest of the World: \( a_N = 1 \), while \( a_{RW} \geq a_S \geq 1 \). The global number of unskilled workers \( L \) is distributed across regions as follows: \( L_N = L_S = L_{RW} / a_{RW} = L / 3 \).

The manufacturing sector is slightly different from what is generally known in economic geography models. Every manufacturing firm has a headquarters (HQ) and a production plant. The HQ uses a fixed amount \( F \) of skilled labour. With \( K_H \) being the world population of skilled workers, the global number of manufacturing firms \( n \) is then \( K_H / F \). It is supposed that all HQs and thus, skilled workers are fully agglomerated in region \( N \), which is called the core (Fujita and Thisse, 2006). The amount of unskilled labour \( L_i \) used by manufacturing firms varies with the level of output and it depends also on the location of the plant. Firms can choose to locate their plant together with their HQ, in the core (integrated firms), or in region \( S \) or \( RW \) (MFNs). MFNs must take into account the communication costs \( C \), which add to the marginal labour requirement \( \beta^4 \). Communication costs are supposed lower in the South than in the Rest of the World.

Inter-regional trade costs for the manufactured goods are “iceberg” type: only \( 1/\tau (\tau > 1) \) of a shipped good arrives at destination. These costs are the same, no matter the bilateral partners: one can imagine the three regions located at the corners of an equilateral triangle, with a transport costs \( \tau \) in each direction (Fujita, Krugman and Venables, 1999). The manufactured goods are freely traded inside regions. It is supposed that the agricultural good is inexpensively traded between and inside regions.

Under the above assumptions, demand and supply side equilibrium equations can be written.

First, the demand side equations will be determined. Maximising the utility under the budget constraint \( (Y = PM + p_Z Z) \), the optimal consumption function for each manufactured variety \( x_i \) and for the agricultural good \( Z \) is found:

\[ x_i = \mu Y p_i^{-\alpha} P^{\sigma - 1} \] and \[ Z = (1 - \mu)Y / p_Z \] \tag{2}

where \( Y \) is consumer income, \( p_i \) is the price of the manufactured variety \( i \), \( P \) is the price index of the composite good and \( p_Z \) is the price of the agricultural good.

\( P \) is given by:

\[ \beta \] decreases with the effectiveness of the services provided by the HQ to its plant, which depends itself on the location of the plant and also on the Marshallian externalities between HQs. For further details, see Fujita and Thisse (2006)
Demand $I-\mu$ for the agricultural good is assumed large enough for it to be produced by the three regions and $p^Z$ is chosen as the numeraire ($p^Z = I$). This allows pinning down the wage rate for the unskilled workers: $w^l_N = 1$, $w^l_S = 1/a_s$, $w^l_{RW} = 1/a_{RW}$.

One can see that the wage rate for the unskilled in region $RW$ is smaller than in region $S$, itself being smaller than in region $N$. Thus firms should tend to relocate their plants in region $S$ or $RW$ in order to minimize their production costs.

The wage rate for the skilled workers $w^K_N$ will be determined by the zero profit condition.

Under these conditions, regional income can be determined:

$$Y_N = K_H w^K_N + L/3, \quad Y_S = L/3 \quad \text{and} \quad Y_{RW} = L/3$$

From (2) and knowing that trade costs must be taken into account into the final price paid by consumers, total demand for variety $i$ produced in region $r$ becomes:

$$x^r_{i,t} = \mu Y_r p^{-\sigma} - p^{\sigma-1} + \mu Y_r (p, \tau)^{-\sigma} - p^{\sigma-1} \tau + \mu Y_r (p, \tau)^{-\sigma} p^{\sigma-1} \tau$$

Secondly, the supply side equations are determined. Given that the agricultural sector is the numeraire, only cost and profit functions for the manufacturing firms are left to be determined. There are two types of costs: the fixed cost, which is the wages paid to the skilled workers working for the HQ and the variable cost, which is the wages paid to the unskilled workers working for the plants. The total cost will be different as firms choose to locate their plant in the same region as their HQ or abroad. Knowing that all the HQs are established in region $N$, the total cost function for an integrated manufacturing firm is given by:

$$TC_N = w^K_N F + w^l_N \beta x_N$$

whereas for a MFN, it will be given by:

$$TC_{NS} = w^K_N F + w^l_S \beta C_s x_s$$

or

$$TC_{NRW} = w^K_N F + w^l_{RW} \beta C_{RW} x_{RW}$$

Accordingly, the profit functions of the integrated firms and MFNs are:

$$\pi_N = p_N x_N - w^K_N F - w^l_N \beta x_N$$

$$\pi_{NS} = p_S x_S - w^K_N F - w^l_S \beta C_s x_S$$

$$\pi_{NRW} = p_{RW} x_{RW} - w^K_N F - w^l_{RW} \beta C_{RW} x_{RW}$$

The equilibrium mill price that maximises profits of integrated firms is found to be:

$$p_N = \frac{\sigma w^l_N \beta}{\sigma - 1}$$

while those of MFNs are:

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5 This is the non-full-specialization condition, see Baldwin et al. (2003) for further details.
with $C_S$ a mnemonic for communication costs in the South and $C_{RW}$ for communication costs in the Rest of the World. So, prices charged by MFNs are higher because of the communication costs.

Given the distribution of labour across regions and the wage rates for unskilled labour, price index $P$ can be re-written as:

$$P_N = \frac{\beta \sigma}{\sigma - 1} n^{-1/(\sigma - 1)} \left[ \gamma_N + \Phi \left( \gamma_S \Phi_s + \gamma_{RW} \Phi_{RW} \right) \right]^{1/(\sigma - 1)}$$

(14)

$$P_S = \frac{\beta \sigma}{\sigma - 1} n^{-1/(\sigma - 1)} \left[ \gamma_S \Phi_s + \Phi \left( \gamma_N + \gamma_{RW} \Phi_{RW} \right) \right]^{1/(\sigma - 1)}$$

(15)

$$P_{RW} = \frac{\beta \sigma}{\sigma - 1} n^{-1/(\sigma - 1)} \left[ \gamma_{RW} \Phi_{RW} + \Phi \left( \gamma_N + \gamma_S \Phi_s \right) \right]^{1/(\sigma - 1)}$$

(16)

where:

- $\gamma_N = n_N / n$ represents the share of integrated firms
- $\gamma_S = n_s / n$ represents the share of MFNs to the South
- $\gamma_{RW} = n_{RW} / n$ represents the share of MFNs in the Rest of the World
- $\Phi_s = \left( \frac{C_S}{a_S} \right)^{1-\sigma}$, freeness of communication in the South (the higher $\Phi_s$, the lower communication costs, $\Phi_s > 0$)
- $\Phi_{RW} = \left( \frac{C_{RW}}{a_{RW}} \right)^{1-\sigma}$, freeness of communication in the Rest of the World (the higher $\Phi_{RW}$, the lower communication costs, $\Phi_{RW} > 0$)
- $\Phi = \tau^{1-\sigma}$, freeness of inter-regional trade ($\Phi = 0$ means prohibitive inter-regional trade costs, $0 < \Phi < 1$)
- $\Phi_s > \Phi_{RW}$

From (5) and (9)… (16), equilibrium profit functions can be re-written as:

$$\pi^* = \frac{\mu F}{\sigma K} \left[ \frac{Y_s}{\gamma_s \Phi_s + \Phi (\gamma_s + \gamma_{RW} \Phi_{RW})} \right] - w_s^* F$$

(17)

$$\pi_{NS}^* = \Phi_s \frac{\mu F}{\sigma K} \left[ \frac{Y_s}{\gamma_s \Phi_s + \Phi (\gamma_s + \gamma_{RW} \Phi_{RW})} \right] - w_s^* F$$

(18)

$$\pi_{NRW}^* = \Phi_{RW} \frac{\mu F}{\sigma K} \left[ \frac{Y_{RW}}{\gamma_{RW} \Phi_{RW} + \Phi (\gamma_N + \gamma_S \Phi_s)} \right] - w_s^* F$$

(19)

As $\pi_N^* = 0$, the skilled workers’ equilibrium wage rate must be:
Thus, all the elements necessary to discuss the impact of economic integration on the relocation of production units and welfare are reunited. Given the complexity of the equations, results could not be obtained analytically, but only through numerical simulations.\(^6\)

### 3 The impact of lowering trade costs on relocation and welfare

First, the impact of a decrease in trade costs measured by a rise in $\Phi$ is analyzed. Intuitively, when trade costs begin to decrease, the reaction of manufacturing firms is expected to be different with the level of communication costs. Depending on whether communication costs are high or low, manufacturing firms will find interesting or not to relocate their production units to one of the peripheral regions $S$ or $RW$ or to the core region $N$. For instance, if communication costs are too high, the reduction of trade costs may not be sufficient for the South and the Rest of the World to gain some industry. On the contrary, MFNs may find interesting to relocate their production units to the North. The decrease of trade costs and the absence of communication costs will allow them to charge lower prices and increase their market shares. If communication costs are very low, the tendency should reverse. Consequently, simulations have been run for high (Figure 1) and low values (Figure 2) of communication costs. All simulations have been run for $\mu = 0.4$ and $\sigma = 4$. For the case of high communication costs, in the case of a small differential between South and the Rest of the World, $\Phi_S = 0.9$ and $\Phi_{RW} = 0.8$ have been chosen and in the case of a high differential, $\Phi_S = 1.1$ and $\Phi_{RW} = 0.9$ have been chosen. As for the case of low communication costs, in the case of a small differential between South and the Rest of the World, $\Phi_S = 1.6$ and $\Phi_{RW} = 1.5$ have been chosen and in the case of a high differential, $\Phi_S = 2.1$ and $\Phi_{RW} = 1.5$ have been chosen.

\(^6\)GAMS numerical simulations
In the case of high communication costs, as trade costs decrease, manufacturing firms relocate their production units from region $S$ and mostly from region $RW$ to the core region $N$ (Figure 1a). Then, depending on the communication costs gap between the South and the Rest of the World, it is possible that some manufacturing firms relocate their production units from region $RW$ to region $S$ (as shown in Figure 1b). In any case, the least developed region $RW$ is losing its industry rather fast, while the North reinforces its status of core region. Unfortunately, given the correlation between communication costs and trade costs, simulations could not be run for very low trade costs (values of $\Phi$ above 0.5). So, the model cannot tell exactly if catastrophic agglomeration is reached, but, if southern communication costs are high enough, there is no reason for the tendency not to be followed until that happens. Also, it clearly shows that before full trade liberalization is reached, the region $RW$ definitely loses all its industry. Then, according to Figure 1a, all plants should relocate to the core region or, according to Figure 1b, all plants should relocate to the North and South, the North remaining the core region.

In the case of low communication costs, the tendency is reversed (Figure 2). Most production units tend to leave the North and relocate to the South or the Rest of the World. Then, if communication costs to the South are low enough compared to the Rest of the World, the South should attract plants from the Rest of the World, too.
Figure 2. The impact of lowering trade costs on the distribution of production units in a context of low communication costs: (a) the case of a small differential of communication costs between region S and region RW; (b) the case of a high differential of communication costs between region S and region RW

As the simulations could not be run for very low values of trade costs, the model cannot predict if catastrophic agglomeration is reached, but there is no reason for the tendency not to be followed until that happens. However, it does show that the North may lose all its production units and the South becomes the core region, even before full trade liberalization is reached.

One can conclude that the impact of reducing trade costs is different as communication costs are high or low. Freer trade in a context of high communication costs leads to the agglomeration of production units to the industrialized region, while freer trade in a context of low communication costs leads to the agglomeration of production units to the developing regions.

Next, welfare is discussed. Unskilled workers’ nominal wages \( w_r^L \) are constant, depending only on \( a_r \). Simulations show that skilled workers’ nominal wage \( w_N^K \) is also constant and independent from trade and communication costs. Consequently, welfare is measured in terms of real wages, which are depending on the price indices. Consider the North first. In the northern market, there is a strong competition effect: prices decrease as competition in the home market increases. Also, in the case where some MFNs relocate their production units from the region \( RW \) to the South, the positive effect of lower trade costs is magnified by lower communication costs. Regarding the southern welfare, there are two effects on prices. On the one hand, there is a positive direct effect: the price of the imported goods decreases. On the other hand, there is an indirect effect, induced by the relocation of the industry. As MFNs relocate their production units to the North, more goods will be imported and southern consumers will have to pay the trade costs for those goods instead of the communication costs. But, if some MFNs relocate their production units from the Rest of the World to the South, there is definitely a positive effect coming from the fact that some goods imported from the region \( RW \) are now manufactured on the domestic market at lower communication costs. As for the Rest of the World, the direct effect on the price of the imported goods stands. Then, if MFNs relocate their production units only to the North, \( RW \) consumers will have to pay more trade costs instead of communication costs. If relocation to the South, then consumers in the \( RW \) region will have to pay the trade costs and the southern communication costs which are lower than in the Rest of the World. Finally, the
overall impact depends on the extent of trade liberalization and on whether the communication costs in the periphery are higher or lower than the trade costs. In any case, simulations show that the overall impact on prices is positive in all regions, regardless of the level of communication costs (Figure 3). So, the positive impact of freer trade offsets the negative impact of losing industry in the peripheral regions. Furthermore, in the South and the Rest of the World the lower the communication costs, the faster the price indices decrease. As for the northern consumers, they gain more when communication costs are high, because in that case, more plants will locate to the North.

![Figure 3](image)

**Figure 3.** The impact of decreasing trade costs on the price indices: (a) the case of high communication costs; (b) the case of low communication costs

4 The impact of lowering communication costs on relocation and welfare

4.1 The reduction of southern communication costs

Intuitively, reducing communication costs to the South should be an incentive for manufacturing firms to relocate their production units to this region. Furthermore, this incentive should be stronger for low trade costs and weaker for high trade costs. Simulations show that reducing communication costs to the South does trigger the relocation of the production plants to the South, regardless of the level of trade costs. Then, it seems that freer trade magnifies the impact of reducing communication costs to the southern region: for lower
levels of trade costs, the South industrializes faster, approaching catastrophic agglomeration (Figure 4). Simulations have been run for $\mu = 0.4$ and $\sigma = 4$. In the case of high trade costs, $\Phi = 0.1$ and $\Phi_{RW} = 1.1$ have been chosen. In the case of low trade costs, $\Phi = 0.6$ and $\Phi_{RW} = 1.06$ have been chosen.

![Figure 4. The impact of lowering communication costs to the South on the distribution of production units: (a) the case of high trade costs; (b) the case of low trade costs](image)

As communication costs to the South decrease, firms producing in this region will be able to charge lower prices as their production costs decrease. Thus, they will increase their market shares at the expense of the integrated firms and those producing in the Rest of the World. Under these circumstances, northern integrated firms and RW MFNs will find interesting to relocate their production units to the South, thus restoring their profits. This relocation phenomenon should occur until profits are restored to 0 across all regions. In the case of high trade costs, simulations could not be run for very low levels of southern communication costs. So, the model cannot tell precisely if catastrophic agglomeration to the South occurs, but there is no reason for the tendency not to be followed until that happens. In the case of low trade costs, one can see that the South becomes the core region rather fast, while the North becomes the periphery and the Rest of the World keeps its status of periphery of the periphery.
Regarding welfare, simulations show that prices tend to increase in the regions losing their industry (the North and the Rest of the World) and decrease in the region gaining industry (the South), regardless of the level of trade costs. This is illustrated in Figure 5 below. However, once full agglomeration to the South is attained, further reduction in southern communication costs makes prices decrease in all regions.

![Graph showing the impact of reducing southern communication costs on welfare.](a)

**Figure 5.** The impact of reducing southern communication costs on welfare: (a) the case of high trade costs; (b) the case of low trade costs

Regardless of the level of trade costs, the northern price index increases as communication costs to South decrease. Indeed, in this context, more integrated northern firms find interesting to relocate their production units to the South. Thus, more goods will have to be imported and northern consumers will have to pay additional trade and communication costs on these goods. This negative effect offsets the positive effect of paying smaller prices on manufactured goods that were already imported from the South. Furthermore, the higher the trade costs, the faster the price index increases. Consequently, in order to minimize the negative effects of reducing communication costs to South on northern welfare, the decrease of the southern communication costs should be accompanied by measures of trade liberalization. A similar analysis stands for welfare in the Rest of the World as well. Regarding welfare in the South, consumers in this region are gaining twice. On the one hand, attracting industry from the North and the Rest of World leads to the competition effect: prices decrease as competition in the southern market increases. Furthermore, goods that used to be manufactured in the Rest of the World are now manufactured in the domestic.
market at lower communication costs. On the other hand, the price of the goods manufactured on the domestic market decreases as a direct effect of decreasing southern communication costs.

One can conclude that reducing communication costs to the South triggers the relocation of the production units to this region, while the other two regions lose all their industry. Regarding welfare, unlike the positive impact of reducing trade costs, the decrease of communication costs to the South makes workers in the regions losing industry worse off and workers in the region attracting industry better off. Reducing southern communication costs begin to be beneficial to consumers in all regions only with full agglomeration to the South.

4.2 The reduction of communication costs in the Rest of the World

One expects the effects of lowering communication costs in the Rest of the World on relocation and welfare to be similar to those of lowering communication costs to the South (Figure 6). Simulations have been run for \( \mu = 0.4 \) and \( \sigma = 4 \). In the case of high trade costs, \( \Phi = 0.1 \) and \( \Phi_{RW} = 0.9 \) have been chosen. In the case of low trade costs, \( \Phi = 0.6 \) and \( \Phi_{RW} = 1.02 \) have been chosen.

![Figure 6. The impact of lowering communication costs in the Rest of the World on relocation: (a) the case of high trade costs; (b) the case of low trade costs](image-url)
Indeed, the effects of lowering communication costs in the Rest of the World are similar to those discussed in the previous section. MFNs having production units in the Rest of the World become more competitive, as their production costs decrease. Consequently, they charge lower prices and gain market shares at the expense of the firms producing to the North and South. So, the manufacturing firms from the other two regions find interesting to relocate their production units to the Rest of the World in order to restore their profits. This relocation process should continue until profits are restored to 0 across all regions. But, in the model, it is assumed that communication costs to the South are always lower than in the Rest of World. Consequently, simulations have been run until the communication costs in the Rest of the World catch up the communication costs to the South. At this point, the North keeps its status of core region and the remaining of the industry ends up equally distributed between the South and the Rest of the World. Simulations show that if the level of the communication costs in the Rest of the World becomes lower than in the South, firms will relocate their production units to the former. RW becomes the core region, while the North loses all its industry.

Regarding welfare, the evolution of the price indices is similar to the previous section. In the region attracting industry (RW), prices decrease. This is a direct consequence of the decreasing communication costs: the unit production cost decreases, so the prices fall. Furthermore, there is the rising competition effect: as manufacturing firms relocate their production units to the RW region, competition on this market increases, which makes prices fall. However, as some manufacturing firms relocate their production units from the South to the Rest of the World, consumers of the latter will have to pay higher communication costs for some goods. Anyway, simulations show that the positive effects offset the negative one. In the North, the price index increases. On the one hand, there is a direct positive effect of decreasing communication costs to the RW region: the price of the goods imported from this region decreases. On the other hand, there is an indirect negative effect: as more firms are leaving the northern region for the RW region, more trade and communication costs must be paid by the northern consumers. Obviously, the negative effect offsets the positive one. A similar analysis prevails for the southern region also. Thus, southern consumers as the northern ones are worse off, while the RW consumers are better off, regardless of the level of trade costs. However, the level of trade costs has an impact on the magnitude of the effects of reducing communication costs in the Rest of the World: the lower the trade costs, the faster prices increase/decrease (Figure 7).
One can conclude that reducing communication costs in the Rest of the World triggers relocation to this region. But given that southern communication costs are always lower than $RW$ communication costs, catastrophic agglomeration will never occur. Regarding welfare, consumers in the Rest of the World are better off, while northern and southern consumers are worse off. In the previous section, simulations have shown that, once catastrophic agglomeration is reached, further economic integration is welfare enhancing for all regions. This means that under the present scenario, economic integration will never be welfare enhancing for northern and southern consumers.

5 Conclusions

This paper analyzed the evolution of the supply chain and welfare under economic integration in a three-region framework. Economic integration has been measured by a decrease in inter-regional trade costs and by a decrease of the communication costs incurred by multinational manufacturing firms having their HQs in an industrialized region and their production plants in one of the two developing regions of the model.

Numerical simulations have shown that economic integration seen as trade liberalization (falling inter-regional trade costs) is welfare enhancing for all regions, although industry tends to concentrate to the industrialized region when communication costs are high. Then, for low levels of communication costs, trade liberalization leads to the emergence of another pattern of industry distribution: the industrialized region loses its status of core region and it becomes the periphery, more precisely it becomes the periphery of the periphery, while the richest developing region becomes the core and the formerly poorest developing region becomes the periphery. Consequently, under this scenario, a fair distribution of the industry is never attained, the only possible outcome being the core-periphery structure. Regarding welfare, consumers are better off in all regions.

Then, economic integration has been discussed as a decrease of the communication costs. In this scenario, one can think of the development of the new information and communication technology that allows multinational firms to better coordinate their HQs and their production units. First, the decrease of communication costs to the South is analyzed. It seems that, regardless of the level of trade costs, firms tend to relocate their production units to this region until it becomes the core region, the North becomes the periphery and the Rest of the World keeps its status of periphery of the periphery. Furthermore, freer trade magnifies
the impact of lowering southern communication costs. The lower the trade costs, the faster the South industrializes. As for the impact on welfare, decreasing communication costs has more controversial effects than trade liberalization. The consumers in the region attracting industry are better off, whereas those living in the regions losing their industry are worse off. Reducing southern communication costs begins to be welfare enhancing for all regions only after full agglomeration to South. Secondly, lowering communication costs in the Rest of the World triggers the relocation of production units to this region. Given that communication costs in the Rest of the World are by assumption higher than those in the South, RW will never become a core region. However, as it catches up the level of communication costs in the South, it keeps attracting industry from the North and the South. If communication costs reach very low levels in both developing regions, all industry will end up in this regions and the North will lose all its production plants. Regarding welfare, consumers in the regions losing their industry are worse off, while consumers in the region attracting industry are better off.

References


