Trade and wage inequalities or equalities?

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Abstract

We develop a simple endogenous growth with two countries -North that innovates-and South. As in Dinopoulos and Segerstrom [1999], trade liberalization raises wage inequalities through stimulating R&D activity. However, the consequences of North-South trade become ambiguous when a service sector protected against international competition is included in the model. Changes in relative wages in North then depend on return to scale in R&D and the weight of services.

Keywords: North-South trade, R&D, personal services, wage inequalities

JEL classification: F1,J3
“[ ] the English workers gaily share the feast of England’s domination of the world market” Friedrich Engels’ letter to Karl Kautsky (London, 12 September, 1882).

1 Introduction

The dramatic decline of the relative wages of less skilled workers in several OECD countries, particularly in the eighties, has been extensively documented (e.g. OECD, 1994).

The most popular explanation of this rise of wage inequalities is linked to the current technological revolution. Information and communication technologies (ICT) should be biased in favor of the most skilled or versatile workers (e.g. Berman et al., 1998). In addition, workplace changes associated to ICT are also biased against low-skilled workers (Caroli and Van Reenen, 2001).

However, the impact of international trade on these evolutions of labor demand is still in debate. The seminal Hecksher-Ohlin-Samuelson mechanism that operates through changes in relative product prices was extensively challenged. But many alternative theoretical and empirical ways that globalization can affect wages have been developed in recent years.

First, the division of labor has increased. Northern firms have moved labor intensive segments of the production process in Asia, Mexico or eastern European countries. These shifts should lead to a durable drop of the employment opportunities for low-skilled workers (e.g. Feenstra and Hanson [1996] or Hummels et al. [2001]). In addition, Slaughter [2001] argues that trade liberalization has affected the bargaining power of workers through for instance the threat of outsourcing.

Second, extensive literature stresses the connections between innovation and international trade. Acemoglu [1999] endogenizes the choice of innovation. If trade increases the relative price of goods intensive in human capital, then innovation complementary to
human capital becomes more profitable; this mechanism leads to a rise of wage inequalities both in North and South. Moreover, the adoption of new biased technologies can be a defensive reaction of firms in North in order to preserve their competitiveness (Wood [1994] or Thoenig and Verdier [2001]). Trade liberalization can also play on wages through the innovative activity of exporters (e.g. Manasse and Turrini, 2001). Dinopoulos and Segerstrom [1999] or Sener [2001] exploit a stimulating endogenous growth modelization with two identical countries and two sectors -the production and the R&D-. They obtain a Schumpeterian version of the Stolper-Samuelson theorem: an increase in the relative price of innovation raises the wage of skilled labor and lowers the wage of unskilled labor under the natural assumption that R&D is the skilled-labor intensive activity. Because North-North trade liberalization raises the price of innovation, it induces increasing wage inequalities without a change in relative product prices.

This paper follows this last line of research. We develop a simple two-countries endogenous growth model based on Romer [1990]. North and South have a manufacturing sector that employs both high-technical-skilled and low-skilled workers; R&D is exclusively located in North and requires high-skills. This model exhibits a North-South version of the “Dinopoulos-Segerstrom” mechanism. However, while manufacturing activities exposed to the international competition have declined in the US or in Europe, low-skilled workers have found in the same time new job opportunities in services especially personal services that are intensive in low-skilled labor. For instance, from 1975 to 2000 in the U.S., manufacturing has dropped from 22% of GDP to only 16%, but the relative GDP weight of hotels and lodging places (respectively of car repair) has increased by 50% (resp. 30%). In order to capture the consequences of economic structure that includes non-tradable services, we introduce in the model a service sector intensive in low-skilled workers. Our main result is that trade liberalization does not necessarily lead to higher
wage inequalities. Intuitively, both high-skilled and low-skilled workers in manufacturing are “victims” of competition from South. But, on the one hand, high-skilled workers find job opportunities in the R&D activity that is stimulated by trade. This is the form of Dinopoulos-Segerstrom mechanism and its scale depends on return to scale in R&D. On the other hand, low-skilled workers are partly protected against international competition because they are also employed in personal services. The net effect of trade on wages thus depends on the relative influences of these three processes. Actually, for some range of parameters, i.e. the weight of services intensive in low-skilled workers in the utility of northern consumers is large enough and/or the returns to scale in R&D are low enough, then North-South trade can reduce wage inequalities. Calibrations suggest that such mechanisms are not unrealistic. Consequently, in addition to standard arguments -North-South trade represents of small share of the GDP of northern countries, international prices have not significantly changed-, we show there can exist theoretical reasons for trade does not raise much wage inequalities: it could even limit the rise of inequalities (induced by other factors such as technological or organizational changes).

The paper is organized as follows. The basic elements of the model are presented in section 2. Section 3 studies the impact of trade liberalization between North and South first for the model without services and second for the model with services; it also gives simple calibrations. The last section concludes.

2 Basic model

We consider two countries: North and South that are engaged in bilateral trade. The variables for South are labeled with a star. The country North has three distinct sectors: innovative R&D sector, manufacturing which produces durable goods or consumption
goods, and (personal) services. South has only a manufacturing sector. This assumption is thus an extreme case of comparative advantage of North in the production of innovation.

The labor market in North is segmented between high-skilled workers and low-skilled workers. Skills mainly refer to technical and scientific competencies. High-skilled jobs thus include engineers, researchers, managers... We assume that services only employ low-skilled workers. The numbers of high-skilled workers and of low-skilled are fixed, respectively, $H$ and $L$ in North.

We detail in the next subsections these sectors and households’ behavior.

### 2.1 The R&D sector in North

The research and development sector produces the designs for durable manufacturing equipments (machine, software...). Let $A$ denote the set of types of equipments and the measure of this set. As in Romer [1990], this quantity can be interpreted as to be technological knowledge. The production of new knowledge only requires high-skilled workers. It takes the following continuous functional form:

$$
\dot{A} = \delta H_A^\epsilon A,
$$

where $H_A$ is the number of high-skilled workers in this sector. Following Jones [1995] or Stockey [1995], we assume that R&D has decreasing return to scale i.e. $\epsilon \leq 1$ (Romer [1990] takes $\epsilon = 1$). Technological knowledge is freeware. Nevertheless, the conception of a new specific product is protected by a patent that a manufacturing firm (in North or South) holds or purchases to produce it. Patents are valid in North and South; there is no imitation. To simplify, we assume patents are infinitely live.

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1 We can assume that there is a service sector in South. For calculus convenience, we disregard this hypothesis which doesn’t modify the results.
2.2 The manufacturing sector

2.2.1 North

The manufacturing sector in North produces both homogeneous consumption goods and durable equipments. We assume that the production functions for making durable inputs and consumption goods are similar.

The total manufacturing production $Y$ depends on three production factors: $L$ low-skilled workers, $H_Y$ high-skilled workers, and $K$ durable equipments. Let $x(a)$ denote the amount of equipment of type $a$ used by firms in North. As in Romer [1990], we take

$$Y = H_Y^\alpha L^\beta \int_A x(a)^\gamma da,$$

where $\alpha + \beta + \gamma = 1$. The production function has thus constant return to scale in the three production factors.

2.2.2 South

Consider the manufacturing firms in South that participate to the exchanges with North. The international trade is free. Southern firms can access to all production goods if they pay for (see Wood [1994] for evidence that support this assumption).

The aggregated production function for these southern firms has the following form

$$Y^* = T^*(1-\gamma) \int_A x^*(a)^\gamma da,$$

where $T^*$ can be for instance function of human capital $H^*$ and labor $L^*$. $x^*(a)$ is the amount of equipment of type $a$ used by firms in South. The parameter $T^*$ can be interpreted as the dimension of South or as the degree of openness of North to South. The hypothesis that the functional form for equipments is similar to the northern one simplifies calculus but is not essential.
2.3 Market structures for manufacturing goods

We will hereafter focus on the long-run balanced-growth paths.

The market for consumption goods is taken perfectly competitive. The market for durable inputs is monopolistically competitive because innovations are protected by patents. By construction, durable equipments play symmetric roles. Particularly, they have the same price. Let $p$ be the rental price charged by the firm. The demand curve for inputs in North is $p = \gamma H_Y^\alpha L^\beta x^{\gamma-1}$; this curve in South is $p = \gamma T^{\ast1-\gamma}x^{\ast\gamma-1}$. Since these two curves exhibit the same constant price elasticity, they can be aggregated:

$$p = (H_Y^\prime L^\prime + T^{\ast1/(1-\gamma)})^{1-\gamma} X^{\gamma-1},$$

where $X = x + x^\ast$ is the global demand and $\alpha' = \alpha/(\alpha + \beta)$ and $\beta' = \beta/(\alpha + \beta)$.

The firm program is to choose a profit-maximizing price, $p$, taking as given the global demand. Since one unit of manufacturing output can be converted into one unit of consumption good or one unit of capital input, the opportunity cost for firms to provide one unit of service from the input is the real interest rate $r$. The optimum price is thus the Chamberlin markup (see Tirole [1988]). Let $X$ denote the global demand associated with this price. The profit $\pi$ is then:

$$\pi = rX(1 - \gamma)/\gamma.$$  

The patent cost $P_A$ is equal to the present value of the whole stream of profits that the firm, which produces the specific durable input, is able to win:

$$P_A = \int_0^\infty \pi e^{-rt} dt,$$

and so (recall that along equilibrium growth paths, the interest rate is constant)

$$P_A = \frac{X(1 - \gamma)}{\gamma}.$$
2.4 Skilled-worker market

We assume labor market for skilled-workers is perfect. Consequently, at the equilibrium, wages in R&D and in manufacturing are similar. In the two sectors, skilled-workers are paid at their marginal productivity. Now

\[
\frac{d}{dH_A} P_A \dot{A} = \frac{d}{dH_A} \delta P_A H_A^\varepsilon A = \varepsilon P_A \delta AH_A^{\varepsilon -1}. \tag{8}
\]

Therefore the equilibrium wage of high-skilled workers \(W_H\) verifies

\[
W_H = \alpha H_Y \varepsilon^{-1} L^\beta A x^\gamma = \varepsilon P_A \delta AH_A^{\varepsilon -1} = \varepsilon \frac{X(1-\gamma)}{\gamma} \delta AH_A^{\varepsilon -1}. \tag{9}
\]

Because the demands for equipments are

\[
x = \left[r H_Y^{-\alpha} L^{-\beta} / \gamma^2 \right]^\frac{1}{1-\gamma}, \tag{10}
\]

and

\[
x^* = \left[r T^* \gamma^{-1} / \gamma^2 \right]^\frac{1}{1-\gamma}, \tag{11}
\]

the equation (9) becomes

\[
r = \Omega H_A^{\varepsilon -1} \{H_Y^{\alpha'} L^{\beta'} + T^* \} \left( \frac{L}{H_Y} \right)^{-\beta'}, \tag{12}
\]

where \(\alpha' = \frac{\alpha}{\alpha + \beta}, \beta' = \frac{\beta}{\alpha + \beta}\) and \(\Omega = \frac{\varepsilon \delta}{\alpha} \gamma (1-\gamma)\).

Recall that \(H = H_A + H_Y\). For \(L\) given, the level of skilled labor in manufacturing or in R&D is then determined by the interest rate \(r\). Because \(\varepsilon - 1 \leq 0\), when \(r\) increases, \(H_A\) declines. Intuitively, higher interest rate reduces the demand for equipment; this leads to a drop of the value of patents; the R&D sector is thus less attractive.

2.5 Services and consumers

Households in North consume both manufacturing goods and (personal) services.
Typically services include activities for individuals that are intensive in low-skilled labor: restaurants, beauty salons, tourism, as well as home employees. Precisely, we assume that low-skilled labor is the unique production factor and that the volume of services is proportional to the number of workers. Let $S$ be the volume of (personal) services. Without loss of generality, the production of services is one to one i.e. the number of low-skilled workers in services is also $S$. Consequently, the price of one unit of services is equal to the wage of low-skilled workers $W_L$.

We assume the demand for personal services has an unitary elasticity to income. Evidences support this assumption. For instance, Summer [1985] finds that the service demand does not depend much on the national income, the elasticity to income being closed to one (0.997). Falvey and Gemmell [1996] extend this analysis; they decompose services into eleven types. Despite that elasticity to income of recreation services is about 1.4 and that domestic services have an income elasticity less than one, the income elasticity of services is generally closed to one and not significantly different from one. Precisely, we take that households have an instantaneous utility Cobb-Douglas:

$$[U(c, s)]^{\frac{1}{1+\theta}} = [cs^\theta]^{\frac{1}{1+\theta}},$$  

where $c$ is the consumption of manufacturing goods and $s$ is the consumption of services. The parameter $\theta$ is the weight of personal services in the utility of households. In addition, the households have a preference for present $\rho$ (discount rate) and an intertemporal elasticity of substitution $\sigma > \theta/(1 + \theta)$. The number of households is finite. The welfare is

$$\int_0^\infty \frac{U(c, s)^{(1-\sigma)}}{1 - \sigma} e^{-\rho t} dt.$$ 

The consumption good is chosen as the numeraire. Let $W_L$ denotes the wages of low-skilled workers in services. Each household maximizes its intertemporal utility under the
income constraint:
\[ \dot{a} = ra + R - c - W_Ls, \]
where \( a \) is the net household asset and \( R \) is the total wages of the members of the household. We do not assume that there is a representative household; households’ compositions can be heterogeneous. The Hamiltonian for this program is thus:
\[ H = \max e^{-\rho t} U(c, s)^{(1-\sigma)} + \lambda [ra + R - c - W_Ls]. \] (16)
The first order conditions for maximization are:
\[ \frac{\partial H}{\partial c} = 0 = U(c, s)^{(1-\sigma)} - \rho c - \lambda, \]
(17)
\[ \frac{\partial H}{\partial s} = 0 = \theta U(c, s)^{(1-\sigma)} - \rho s - \lambda W_L, \]
(18)
and
\[ \frac{\partial H}{\partial D} = -\frac{d\lambda}{dt} = \lambda r. \] (19)
The first two equations give the standard result in static optimization for Cobb-Douglas form:
\[ \theta c = s W_L. \] (20)
Let \( C \) and \( S \) denote the aggregated consumptions of goods and services. Equation (20) states
\[ \theta C = SW_L. \] (21)
Taking the logarithmic differential of equations (17) and (19) drives:
\[ r = \rho - \theta(1 - \sigma) \frac{\dot{s}}{s} + \sigma \frac{\dot{c}}{c}. \] (22)
But the differentiation of (20) gives \( \dot{c}/c = \dot{s}/s + \dot{W}_L/W_L. \) Consequently
\[ r = \rho - \theta(1 - \sigma) \frac{\dot{W}_L}{W_L} + (\sigma - \theta(1 - \sigma)) \frac{\dot{c}}{c}. \] (23)
\[ cr = \rho c - \theta(1 - \sigma) \frac{\dot{W}_L}{W_L} c + (\sigma - \theta(1 - \sigma)) \dot{c}. \]  

(24)

This equation is linear and thus can be aggregated. It holds

\[ Cr = \rho C - \theta(1 - \sigma) \frac{\dot{W}_L}{W_L} C + (\sigma - \theta(1 - \sigma)) \dot{C}. \]  

(25)

Now, because \( \theta C = SW_L \), this drives a generalized Keynes-Ramsey rule:

\[ r = \rho - \theta(1 - \sigma) \frac{\dot{S}}{S} + \sigma \frac{\dot{C}}{C}. \]  

(26)

### 2.6 Equilibrium

On the long-run balanced growth path, labor devoted to services is constant i.e. \( \dot{S} = 0 \). Consequently, the generalized Keynes-Ramsey rule (26) becomes the standard rule

\[ r = \rho + \sigma \frac{\dot{C}}{C}. \]  

(27)

Moreover, the growth of consumption should equal GDP growth i.e. technological growth \( \frac{\dot{A}}{A} = \delta H_A^\varepsilon \). The interest rate thus verifies

\[ r = \rho + \sigma \delta H_A^\varepsilon. \]  

(28)

Using this expression in the demand for skilled-worker demand (12) yields

\[ \rho H_A^{1-\varepsilon} + \sigma \delta H_A = \Omega \{ H_Y + T^* \left( \frac{H_Y}{L} \right)^{\beta'} \}. \]  

(29)

### 3 Services and the impact of trade on relative wages

We study in this section the reaction of the model to an increase of the degree of openness of North to South, i.e. to an increase of \( T^* \). We will assume first as a benchmark that there is no service i.e. \( \theta = 0 \). Second we will take \( \theta > 0 \) and compare this case to the benchmark situation.
3.1 Model without service

Assume that $\theta = 0$. Basically, our model becomes a simplified North-South “Romer” version of the Dinopoulos et al. [1999] Shumpeterian North-North model. Consequently we should find similar properties.

Now, because $\theta = 0$, $S = 0$ and then $L = N$ at the equilibrium. Consequently, equation (29) gives the implicit value of $H_Y$ or $H_A = H - H_Y$ as a function of $T^*$:

$$\rho H_A^{1-\varepsilon} + \sigma \delta H_A = \Omega \{ H_Y + T^* (\frac{H_Y}{N})^{\beta} \}.$$ (30)

When $T^*$ increases, the second term of this equality also increases. Because $1 - \varepsilon \geq 0$ and $1 - \gamma > 0$, $H_A$ is necessarily increasing with $T^*$. The skilled labor in manufacturing $H_Y$ is thus decreasing with $T^*$. But the wages of high-skilled and low-skilled workers verify $\frac{W_L}{W_H} = \frac{\beta H_Y}{\alpha N}$ (the production function is Cobb-Douglas). Therefore the wage inequalities widen when $T^*$ grows. Intuitively, on the one hand, South opens new markets for the northern innovation; the R&D sector can finance more innovations and attract more skilled workers. On the other hand, low-skilled workers are employed in the manufacturing sector that is hurt by the competition of South that exports manufacturing goods to finance its production equipments.

As expected, we have the following proposition that is consistent with the Dinopoulos’ version of the Stolper-Samuelson theorem.

**Proposition 1** *In a northern innovative economy without personal service, the trade openness to South leads to an increase of the relative wages of high-skilled workers.*

3.2 Services and inequality

We will now assume that $\theta > 0$. Low-skilled workers can find a job in the service sector that is national and physically protected against international competition.
$L \neq N$, exactly $L + S = N$. In that framework, the property 1 does not thus necessarily hold. We have to determine the equilibrium of the low-skilled labor market. Let us introduce

$$J = \left( \frac{\alpha L}{\beta H_Y} \right)^{-1} = \frac{W_L}{W_H}$$

the wage of low-skilled workers relative to the wages of skilled workers, i.e. the wage equalities. By definition, the low-skilled labor in manufacturing $L$ verifies

$$L = \frac{\beta}{\alpha} H_Y J^{-1}. \quad (32)$$

Recall that the labor in services is given by $SW_L = \theta C$. Now, consumption of northern households $C$ is equal to the total production of manufacturing goods in North minus the production of equipments goods plus the imports of goods produced in the South. And the equilibrium of international trade gives: South imports = lends paid by southern firms for their equipments. This relation can be rewritten as follows:

**Lemma 2** The consumption of goods in North is

$$C = \frac{Y}{H_Y} \left[ H_Y + \gamma T^* \left( \frac{\beta}{\alpha} \right)^{-\beta^\gamma} J^{\beta^\gamma} - \delta H_A \frac{\gamma^2}{\Omega} \right]. \quad (33)$$

**Proof.** See appendix 1. ■

In addition, the wage of low-skilled workers in the manufacturing sector verifies $W_L L = \beta Y$. Consequently, the labor demand in personal services is

$$S = \frac{\theta}{\alpha J} \left[ H_Y + \gamma T^* \left( \frac{\beta}{\alpha} \right)^{-\beta^\gamma} J^{\beta^\gamma} - \delta H_A \frac{\gamma^2}{\Omega} \right]. \quad (34)$$

Using the previous relations, the total demand for low-skilled labor verifies

$$N = L + S = \frac{1}{\alpha J} \left\{ \beta H_Y + \theta H_Y - \delta H_A \frac{\gamma^2}{\Omega} + \gamma \theta T^* \left( \frac{\beta}{\alpha} \right)^{-\beta^\gamma} J^{\beta^\gamma} \right\}. \quad (35)$$
In addition, recall that the equilibrium of the market for skilled workers drives:

\[
\rho H_A^{1-\varepsilon} + \sigma \delta H_A = \Omega \{ H_Y + T^* \left( \frac{H_Y}{L} \right)^{\beta'} \} = \Omega \{ H_Y + T^* \left( \frac{\beta}{\alpha} \right)^{-\beta'} J^{\beta'} \}.
\] (36)

We have thus a system of two equations with two variables \( J \) and \( H_A \) (or \( H_Y \)). Unfortunately, an explicit resolution is not available for all \( \varepsilon \). Consequently, we use a differential approach to study the reaction of the system when the degree of openness \( T^* \) increases.

Assume that, initially, \( T^* = T^* i \), \( H_A = H_A^i \), \( J = J^i \). Let us consider a marginal increase of \( T^* : dT^* > 0 \). The new values of variables are

\[
T^* = T^* + dT^*,
\] (37)

\[
H_A = H_A^i + dH_A,
\] (38)

\[
J = J^i + dJ.
\] (39)

The differentiation of equation (36) gives

\[
\rho (1 - \varepsilon) (H_A^i)^{-\varepsilon} dH_A + \sigma \delta dH_A = \Omega dH_A + \Omega \left( \frac{\beta}{\alpha} \right)^{-\beta'} d(T^* J^{\beta'}).
\] (40)

Consequently,

\[
dH_A = \Omega \left( \frac{\beta}{\alpha} \right)^{-\beta'} \frac{d(T^* J^{\beta'})}{\Omega + \sigma \delta + \rho (1 - \varepsilon) (H_A^i)^{-\varepsilon}}.
\] (41)

Moreover the differentiation of equation (34) leads to

\[
\alpha N dJ = - (\beta + \theta + \frac{\gamma^2}{\Omega} \delta \theta) dH_A + \gamma \theta \left( \frac{\beta}{\alpha} \right)^{-\beta'} d(T^* J^{\beta'}).
\] (42)

Eliminating \( dH_A \) in these two equations drives a new expression of the equilibrium of the market for low-skilled workers:

\[
\alpha N dJ = \left( \frac{\beta}{\alpha} \right)^{-\beta'} \left\{ - (\beta + \theta + \frac{\gamma^2}{\Omega} \delta \theta) \frac{\Omega}{\Omega + \sigma \delta + \rho (1 - \varepsilon) (H_A^i)^{-\varepsilon}} + \gamma \theta \right\} d(T^* J^{\beta'}).
\] (43)

Let

\[
\xi = \left\{ - (\beta + \theta + \frac{\gamma^2}{\Omega} \delta \theta) \frac{\Omega}{\Omega + \sigma \delta + \rho (1 - \varepsilon) (H_A^i)^{-\varepsilon}} + \gamma \theta \right\} \left( \frac{\beta}{\alpha} \right)^{-\beta'} J^{i(-1+\beta')}. \] (44)
The equation (43) becomes

\[(\alpha N - \xi \beta' T^*)dJ = \xi J^* dT^*\].

(45)

Consequently, if \(\xi < 0\) then, as in proposition 1, the relative wages of low-skilled workers decline when \(T^*\) increases. However, if \(\xi > 0\), it happens the contrary\(^2\): deeper exchanges with South lead to a reduction of wage inequalities between low-skilled and high-skilled workers. Consequently, we have the following proposition:

**Proposition 3** When \(\theta > 0\), the effect of trade on wage inequalities in North is ambiguous.

Therefore, the first proposition is not true for all \(\theta\). The intuition behind this result is hard to see directly with the complex parameter \(\xi\). However, we prove in appendix 2 the following lemma:

**Lemma 4**

1. For \(\varepsilon = 1\), \(\text{sign}(\xi) = \text{sign}(\mu)\), where

\[
\mu = (\gamma - 1)(1 + \frac{\beta}{\theta}) + \sigma \alpha + \gamma \beta.\]

(46)

2. For \(\varepsilon < 1\), \(\text{sign}(\xi) \geq \text{sign}[(\gamma - 1)(1 + \beta/\theta - \gamma)\varepsilon + \sigma \alpha - \gamma \alpha] \geq \text{sign}(\mu)\).

Let us thus first focus on the benchmark case \(\varepsilon = 1\). The first part of lemma 4 drives a straightforward corollary:

**Corollary 5** Assume \(\varepsilon = 1\). **Openness to South reduces** wage inequalities in North if and only if

\[\gamma + \sigma \alpha + \gamma \beta > 1,\]

(H1)

and the weight of services is sufficiently large, exactly

\[\theta > \frac{\beta(1 - \gamma)}{(\gamma + \sigma \alpha + \gamma \beta - 1)}.\]

(H2)

\(^2\)We can prove that the existence of an equilibrium requires that \(\alpha N - \xi \beta T^*\) is non-negative.
Intuitively, the evolution of inequalities when trade increases is a balance between

- The Dinopoulous-Segerstrom-Stolper-Samuelson mechanism
- A protection effect. International trade hurts the manufacturing sector and thus both high-skilled and low-skilled workers. However, adverse consequences for low-skilled workers decline with their opportunities in personal services that are protected against international competition.

If $\theta$ is sufficiently large, the second effect dominates the Dinopoulous effect and we have the result that North-South trade can limit wage inequalities between high-skilled and low-skilled workers. More generally, the second part of lemma 4 leads to the following corollary:

**Corollary 6** 1. For all $\epsilon \leq 1$, under the conditions $(H1)$ and $(H2)$ of corollary 1, openness to South reduces wage inequalities in North.

2. For $\sigma > \gamma$, if the returns to scale in R&D are sufficiently decreasing i.e.

$$\epsilon < \frac{\alpha(\sigma - \gamma)}{(\gamma - 1)^2}, \quad (H1')$$

and the weight of services is sufficiently large, exactly

$$\theta > \frac{\beta \epsilon (1 - \gamma)}{\alpha(\sigma - \gamma) - (\gamma - 1)^2 \epsilon}. \quad (H2')$$

then wage inequalities decline with trade liberalization.

Intuitively, in addition to the mechanisms for $\epsilon = 1$, less $\epsilon$ is, less the Dinopoulous effect is important because the opportunity to invest in R&D is lower when this sector exhibits decreasing return to scale.

### 3.3 A basic calibration

This “surprising” result raises doubts about the relevance of conditions $(H1')$ and $(H2')$ under which openness to South can reduce inequalities in North. In other words, for
standard values of the parameters, can $\xi$ be Positive and thus North-South trade can theoretically reduce wage inequalities?

Basically, $\alpha$, $\beta$ and $\gamma$ are the shares of manufacturing value-added devoted to the remuneration of respectively high-skilled labor, low-skilled labor and capital. According to the national accounts, this last parameter is close to one third in typical northern countries such as the US or France. The values of $\alpha$ and $\beta$ depends on the cutoff that we will choose for the definition of “high” and “low” skills. In our perspective, “high-skilled” workers should be the main production factor of the R&D sector. To determine potential values for $\alpha$ and $\beta$, we use the French labor force survey “Enquête Emploi”. It has the advantage to distinguish workers in production activities in manufacturing and ones in the R&D. We take two cutoffs for skills: a) complete university degree or superior technical degree, b) bachelor degree or more. The table 1 provides the share of high-skilled workers in total wages for manufacturing, R&D and personal services according to these cutoffs.

**Table 1: share of high-skilled workers in the total wage bill in %. France 1998.**

<table>
<thead>
<tr>
<th></th>
<th>a) University degree</th>
<th>b) $\geq$ Bachelor degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>23.9</td>
<td>13.3</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>68.1</td>
<td>56.0</td>
</tr>
<tr>
<td>Personal services +</td>
<td>7.0</td>
<td>2.6</td>
</tr>
<tr>
<td>hostels and restaurants</td>
<td></td>
<td></td>
</tr>
</tbody>
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These data suggest that $\alpha = 1/6$ if we consider definition a) for high-skills and $\alpha = 1/11$ in case b). We verify that, as assumed in the model, personal services are intensive in low-skilled labor. Take a standard value for $\sigma$: 2. Table 2 reports the value of $(-\xi)$ for selected weights of services in consumption and returns to scale in R&D in the case
$\alpha = 1/6$ (and $\beta = 1/2$).

### Table 2: Effect on wage inequalities of increasing trade.

<table>
<thead>
<tr>
<th>Weight of services $\theta$</th>
<th>Return to scale in R&amp;D $\epsilon$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1/6$</td>
<td>?</td>
</tr>
<tr>
<td>$1/3$</td>
<td>-</td>
</tr>
<tr>
<td>$1/2$</td>
<td>-</td>
</tr>
<tr>
<td>$2/3$</td>
<td>-</td>
</tr>
<tr>
<td>$1$</td>
<td>-</td>
</tr>
</tbody>
</table>

- (+) says that wage inequalities decline (increase) when $T$ is larger. ? says that the direction of the impact depends on other characteristics of the economy (e.g. values of $H$ and $L$).

These calibrations show that for reasonable returns to scale ($\epsilon \leq 1/4$) and weight of services ($\theta \geq 1/2$), the model predicts lower wage inequalities when $T$ increases. For example, in France, in 1998, the consumption of households of manufacturing goods (except food and kindred products) was about 180 billions euros and the consumption of services to individuals\(^3\) was about 95 billions euros; this proportion gives $\theta \leq 1/2$.

### 4 Conclusion and perspectives

We have developed a North-South model in an endogenous growth framework. R&D is located in North while northern manufacturing face South competition. Trade liberalization stimulates innovation in North because it opens new markets. Since R&D is intensive in high-skilled workers, this mechanism close to Dinopoulas and Segerstrom [1999] leads to increasing wage inequalities in North. However, the introduction of a service sector that

\(^3\)Social services, education or health services that are mainly non-market are of course not included.
employs low-skilled workers challenges this result. Low-skilled workers are thus partly protected against international competition. In that case, relatives wages depend on both this “protection” effect and the R&D enhancement. Precisely, if the weight of services in the households’ utility is heavy and if R&D has decreasing return to scale, trade can reduce wage inequalities. This finding remains very theoretical. The model should be extended in many ways. For instance, as in Dinopoulos and Segerstrom [1999], the choice of acquiring skills can be endogenized. In addition, despite that an engineer can hardly become a layers or a dental surgeon (high-skilled labor market is segmented), workers with high-technical-skills can also find jobs in sectors also protected against South such as finance. That requires precise calibrations of various components of the economy.
APPENDIX 1: proof of lemma 1

a. Without loss of generality, assume durables are produced only in North. South exports consumption goods to North for a value equivalent to the costs of the rents for using durable equipments. Consequently, the imports are \( \gamma Y^* \) in North. But the demands (10) and (11) lead to

\[
\gamma Y^* = \gamma \frac{T^*}{H^*} \left( \frac{\beta}{\alpha} \right)^{-\beta'} J^\beta Y,
\]

(47)

where \( Y \) denote the Northern production.

b. The production of inputs is \( \dot{K} + \dot{K}^* = AX \), since \( \dot{X} = 0 \) on the equilibrium path. Now, equation (9) leads to

\[
X = \alpha H^\alpha Y L^\beta A x^\gamma \left( \frac{1 - \gamma}{\gamma} \delta A H^\varepsilon - 1 \right)^{-1},
\]

(48)

so,

\[
X = \frac{\gamma^2 Y}{\Omega A H^\gamma H^\delta A^\varepsilon - 1}. \quad (49)
\]

Then

\[
\dot{AX} = \frac{\dot{A}}{A} \frac{\gamma^2 Y}{\Omega A H^\gamma H^\delta A^\varepsilon - 1} = \frac{\gamma^2 \delta Y H_A}{\Omega}. \quad (50)
\]

(51)

c. Recall Northern consumption \( C = \) Northern Production + Imports of consumption goods - Input Production. Using the previous results, this relation becomes:

\[
C = \frac{Y}{H_Y} [H_Y + \gamma T^* (\frac{\beta}{\alpha})^{-\beta'} J^\beta - \delta H_A \gamma^2].
\]

(52)

Q.E.D.
APPENDIX 2: proof of lemma 4

For all $\epsilon$, it holds

$$\text{sign}(\xi) = \text{sign}[-(\beta + \theta + \frac{\gamma^2}{\Omega} \delta\theta) + \frac{\Omega}{\Omega + \sigma\delta + \rho(1 - \epsilon)(H_A') - \epsilon} + \gamma\theta].$$

(53)

1. For $\epsilon = 1$, this relation becomes

$$\text{sign}(\xi) = \text{sign}[-(\beta/\theta + 1 + \frac{\gamma^2}{\Omega} \delta) + \frac{\Omega}{\Omega + \sigma\delta} + \gamma]$$

(54)

$$= \text{sign}[\gamma(\Omega + \sigma\delta) - \frac{\beta}{\theta} \Omega - \gamma^2\delta - \Omega].$$

(55)

Then, because $\Omega = \epsilon(1 - \gamma)\gamma\epsilon\delta/\alpha$ and $\alpha = 1 - \beta - \gamma$, when $\epsilon = 1$,

$$\text{sign}(\xi) = \text{sign}[(\gamma - 1)(1 + \beta/\theta) + \sigma\alpha - \gamma\alpha + \gamma(1 - \gamma)]$$

$$= \text{sign}[(\gamma - 1)(1 + \beta/\theta) + \sigma\alpha + \beta\gamma]$$

$$= \text{sign} \mu$$

Q.E.D.

2. 3. For all $0 \leq \epsilon < 1$,

$$-(\beta + \theta + \frac{\gamma^2}{\Omega} \delta\theta) + \frac{\Omega}{\Omega + \sigma\delta + \rho(1 - \epsilon)(H_A') - \epsilon} + \gamma\theta > -(\beta + \theta + \frac{\gamma^2}{\Omega} \delta\theta) + \frac{\Omega}{\Omega + \sigma\delta} + \gamma\theta.$$  

(56)

Consequently

$$\text{sign}(\xi) \geq \text{sign}[\gamma(\Omega + \sigma\delta) - \frac{\beta}{\theta} \Omega - \gamma^2\delta - \Omega]$$

(57)

$$\geq \text{sign}[(\gamma - 1)(1 + \beta/\theta)\epsilon + \sigma\alpha - \gamma\alpha + \gamma(1 - \gamma)e]$$

(58)

$$\geq \text{sign}[(\gamma - 1)(1 + \beta/\theta - \gamma)e + \sigma\alpha - \gamma\alpha].$$

(59)

But $\gamma < 1$, and thus $(\gamma - 1)(1 + \beta/\theta - \gamma)e > (\gamma - 1)(1 + \beta/\theta - \gamma)$. Therefore

$$\text{sign}(\xi) \geq \text{sign}[(\gamma - 1)(1 + \beta/\theta - \gamma)e + \sigma\alpha - \gamma\alpha]$$

(60)

$$\geq \text{sign}[(\gamma - 1)(1 + \beta/\theta - \gamma) + \sigma\alpha - \gamma\alpha]$$

(61)

$$\geq \text{sign} \mu$$

(62)

Q.E.D.
References


