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Trading Tasks and Skill Premia

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Abstract

The 2x2x2 Heckscher-Ohlin model predicts that trade openness causes the skill premium to increase in the skill abundant developed countries, and to decrease in the skill scarce developing countries, after trade openness. Empirical evidence, however, shows that the skill premium declined in some developing countries, while others experienced an increase in wage inequality. This paper develops a North-South model, where firms produce a low-skilled and a high-skilled intensive good. The production of a unit of either good involves a continuum of L-tasks and H-tasks. The L-tasks can be performed by low-skilled workers only, and the H-tasks can be performed by high-skilled workers only. The Northern firms can produce the task in their headquarters, or offshore the task to the South. The results suggest there is a threshold skill abundance level in the South, above which countries experience an increase in the skill premium after an improvement in the offshoring technology, and below which countries experience a decrease in the skill premium. In this context, the North offshores the H-tasks to countries that are relatively more abundant in high-skilled labor, and L-tasks to countries that are relatively more abundant in low-skilled labor. Therefore, countries that become the hosts of L-tasks experience a decrease in the skill premium, because there will be higher demand for their low-skilled workers, while those that become the hosts of the H-tasks will experience an increase in the skill premium, because there will be higher demand for their high-skilled workers. This accounts for the asymmetric patterns of skill premia in the South.

JEL Classifications: F16, J31, O34

Keywords: trading tasks, skill premium, labor market

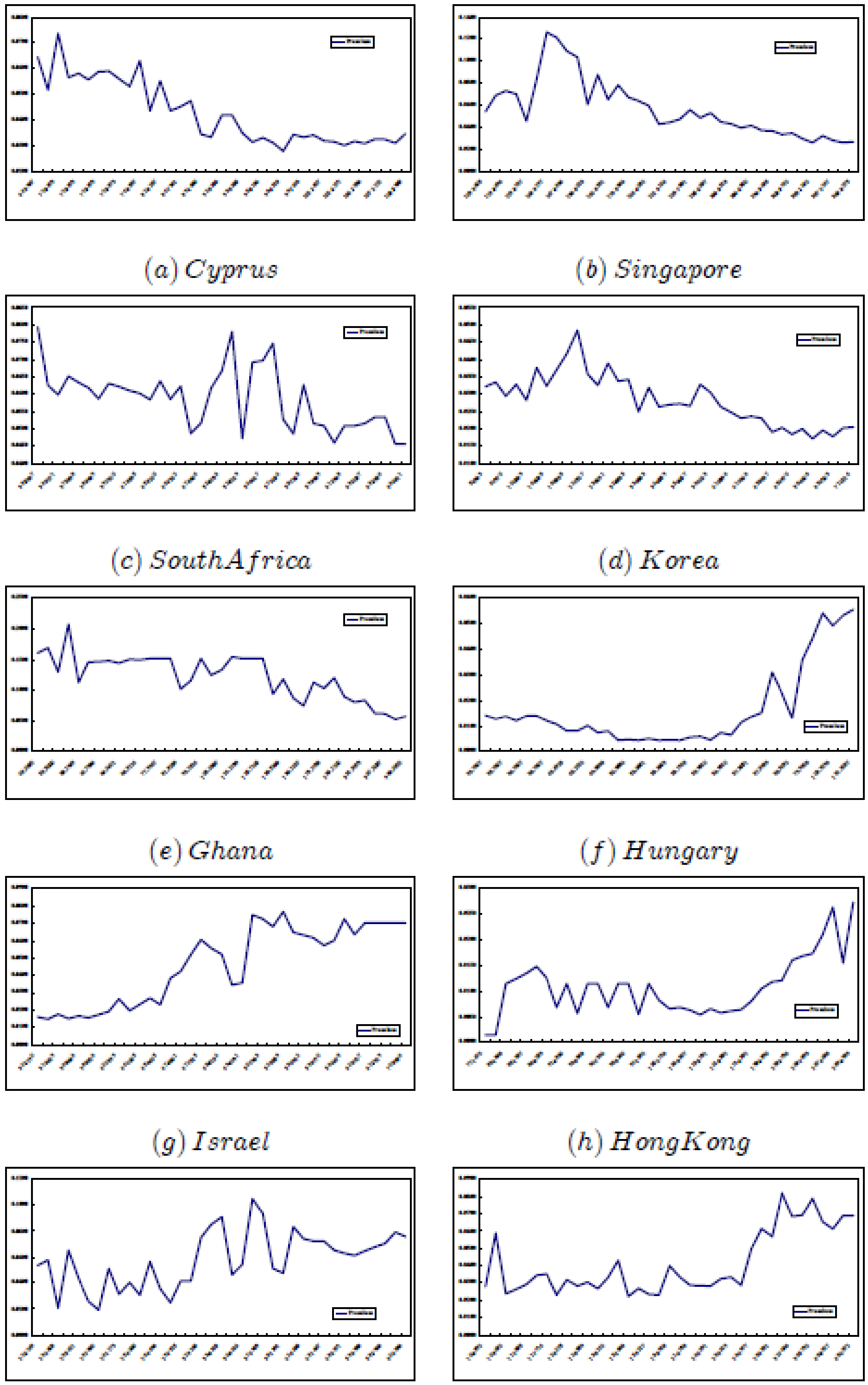
1. Introduction

The 2x2x2 Heckscher-Ohlin model predicts that trade openness induces countries to export the good that intensively uses the relatively abundant factor of production, and import the good that intensively uses the relatively scarce factor of production. Accordingly, skill abundant developed countries are expected to export the good that intensively uses high-skilled workers. This leads to an increase in the relative price of the high-skilled intensive good, a rise in the relative demand for high-skilled workers, and consequently an increase in the skill premium. On the other hand, skill scarce developing countries are expected to export the good that intensively uses low-skilled workers. This leads to an increase in the relative price of the low-skilled intensive good, a rise in the relative demand for low-skilled workers, and consequently a decrease in the skill premium. Theoretical predictions, however, are not supported by the observed empirical evidence. Some developing countries experienced an increase in the skill premium, while others witnessed a decline after trade openness. Evidence as to the asymmetric patterns of skill premia in the developing countries is documented by Freeman and Oostendorp (2001), Hanson and Harrison (1995), Robbins (1996), Wood (1997), and Goldberg and Pavcnik (2004). Figure 1 shows the premium decreasing with openness in some countries, and the premium increasing with openness in other countries.

As this poses a challenge to trade theorists, some studies attempted to address this puzzle in order to resolve the discrepancy between the predictions of the theory and the empirical evidence. This paper, however, builds on the contribution of Grossman and Rossi-Hansberg (2006, 2008, & 2012). In their paper, they focus on the impact of offshoring on wages in the North. The significance of international offshoring and fragmentation of production has been growing around the world in recent years. Firms are subcontracting an ever-increasing proportion of their activities, such as the production of intermediate inputs, services, and most recently - specific tasks. The flourishing ease with which hundreds of diverse activities and tasks could be offshored to a distant location nowadays, has prompted amplifying research in domestic and international outsourcing issues. One important aspect of these new trends in globalization, is the impact on the skill premia in both the country-source of offshoring, and the country-host. The major part of current research has focused on the consequences of outsourcing activities in various parts of the world, including developing countries endowed with predominantly cheap labor, upon the labor in developed countries. The patterns of skill premia in the diverse developing world have attracted relatively less attention. The purpose of our research is to complement the current discussion by looking into the effects of globalization on labor markets in the South.

Our paper develops a model of trading tasks between two countries: the North and the South. The North is more skill-abundant compared to the South. Firms in both countries produce a low-skilled intensive good and a high-skilled intensive good. There are two factors of production: low-skilled workers and high-skilled workers. The production of a unit of either good involves a continuum of $L-$ tasks and a continuum of $H-$ tasks. The $L-$ tasks can be performed by low-skilled workers only, and the $H-$ tasks can be performed by high-skilled workers only. If a task is performed offshore, the firm bears an extra cost of coordinating production and communicating with distant workers. This cost varies by task, as some require face-to-face contact or interaction between workers, while others are easier to perform from a distance. In this context, there exists a threshold $L-$ task and a threshold $H-$ task in every industry, below which all tasks are offshored to the South, and above which all tasks are produced in the headquarters in the North. In the South, some of the high-skilled and low-skilled workers supply their labor to the firms that serve as an external provider of a task to the Northern firms. The wages of the high-skilled and the low-skilled workers are a weighted average of the higher wage of those working in the offshoring firms, and of the lower wage of those hired by local producers in the South. The assumption that the wages of those employed in firms engaged in offshoring are higher than the wages of those working in local firms is justified by empirical evidence as in Aitken, Harrison, and Lipsey (1996), and Sethupathy (2013).

The results suggest that the skill premium in the North increases with an improvement in the technology of offshoring, under certain conditions. On the other hand, there is a threshold skill abundance level in the South. Countries with skill abundance above this threshold, are relatively more endowed with high-skilled workers. The Northern firms offshore their $H-$ tasks to these countries to benefit from the relatively lower labor cost. This means that a higher proportion of the high-skilled workers in the South will be earning the higher wage, and the increase in their proportion will cause an increase in the weighted average wage of the high-skilled workers, and accordingly an increase in the skill premium. Countries with skill abundance below this threshold, are relatively more endowed with low-skilled workers. The Northern firms offshore their $L-$ tasks to these countries to benefit from the relatively lower labor cost. Therefore, a higher proportion of the low-skilled workers in the South will be earning the higher wage, and the increase in their proportion will cause an increase in the weighted average wage of the low-skilled workers, and accordingly a decrease in the skill premium.



(a) Cyprus (b) Singapore

(c) SouthAfrica (d) Korea

(e) Ghana (f) Hungary

(g) Israel (h) HongKong

(i) Chile (j) Turkey

Figure 1. Openness and skill premium in developing countries

Consequently, in the South, countries that are more (less) skill abundant, will have a lower (higher) cost of offshoring services for skilled tasks. The North offshores the high-skilled tasks to countries that are relatively more abundant in high-skilled workers, and low-skilled tasks to countries that are relatively more abundant in low-skilled workers. As a result, countries that become the hosts of low-skilled tasks will have a decrease in the skill premium, while those that become the hosts of the high-skilled tasks will have an increase in their skill premium, after an improvement in the offshoring technology. This provides a possible explanation to the asymmetric patterns of skill premia in the South.

Khalifa and Mengova (2010) test empirically the predictions of the model in this paper utilizing the threshold estimation techniques developed in Hansen (1999). The remainder of the paper is organized as follows: section 2 includes the literature review, section 3 presents the model, section 4 includes the conclusion, section 5 includes the proofs appendices. References are included thereafter.

2. Literature Review

The first stream attributes the increase in the skill premium in the South to outsourcing and technology transfer. For instance, Feenstra and Hanson (1996) argue that outsourcing shifts a portion of input production from the North to the South. This portion is the most skilled-intensive in the South, and the most unskilled-intensive in the North. Hence, outsourcing increases relative skill demand and wage inequality in both countries. Similarly, Zhu (2004), and Zhu and Trefler (2005) argue that if the North loses competitiveness in unskilled-intensive products, a process of technology transfer is induced, where the production of unskilled-intensive goods is relocated to the South. The relocated goods are the most skilled-intensive by Southern standards. This Southern catching-up raises the relative demand for skilled workers and thus exacerbates wage inequality. Yeaple (2003) demonstrates that in skill-scarce labor host countries, the flows of foreign direct investment by U.S.-based multinational companies are concentrated in low-skilled industries, whereas in skill-abundant labor host countries, the flows of foreign direct investment are concentrated in high-skilled industries. This can cause the skill premium to decrease in the former and to increase in the latter.

Xu (2003) shows that in a framework, where there are non-traded goods whose range is endogenously determined by the level of trade barriers, a tariff reduction causes an expansion in the South's import range, which increases the demand for skilled workers in the North. This causes an increase in the North's skilled labor cost, which leads the South to expand its export range as well. The increase in the export ranges of both countries leads to an increase in skill demand and wage inequality. In addition, Beaulieu, Benarroch, and Gaisford (2004) present a model in which a reduction of trade barriers within the high-tech sector can raise the demand for these products in both countries, increase the demand for skilled labor, and thus increase wage inequality.

Other studies argue that trade induces skill-biased technological change. Acemoglu (2002, 2003) shows that trade creates a tendency for the relative price of skill-intensive goods to increase in the North. This makes the technologies used in the production of these goods more profitable to develop and encourages skill-biased technological change, which contributes to the increase in wage inequality. Since the South imitates the Northern technologies that are becoming more skill-biased, it experiences an increase in the skill premium as well. Thoenig and Verdier (2003) argue that when globalization triggers an increased threat of technological leapfrogging, firms respond by biasing the direction of their innovations towards skill-intensive technologies. In a model where only the North innovates and the South imitates, openness causes defensive skill-biased technical change in the North, and technical upgrading in the production of the imitated goods in the South to more skill-intensive ones. This generates an increase in wage inequality in both the North and the South.

Nevertheless, as much as these studies provide insights on the factors generating an increase in the skill premium in both the North and the South, they do not address the asymmetry of the response of the skill premium to trade openness among developing countries. The purpose of this paper is to provide an alternative explanation for the asymmetric patterns of skill premia observed, using the theory of task trade. In this context, Grossman and Rossi-Hansberg (2006, 2008, & 2012) argue that advances in communication and information technologies have enabled the break-up of the production process into tasks, where the performance of these tasks is spread across the world. Antras, Garicano, and Rossi-Hansberg (2006) investigate the impact of offshoring in a global economy with heterogeneous agents, where skilled workers specialize in problem solving, and unskilled workers specialize in production, and find that team formation across countries increases wage inequality within unskilled workers in the South, but not in the North. Therefore, international trade is becoming less a matter of countries' specialization in particular industries, and more about their specialization in particular tasks.

3. Model

This model builds on the contribution of Grossman and Rossi-Hansberg (2006, 2008, & 2012). In their paper, they focus on the impact of offshoring on wages in the North. However, we extend their framework to consider the impact on wage inequality in the South. Our model presents two countries: the North and the South. Firms in the two countries produce a low-skilled intensive good and a high-skilled intensive good using two factors of production: low-skilled workers and high-skilled workers. The North is more skill abundant compared to the South, or $\left(\frac{H}{L}\right) > \left(\frac{H^*}{L^*}\right)$, where H is the supply of high-skilled workers in the North, while L is the supply of low-skilled workers in the North. Similarly, H^* is the supply of high-skilled workers in the South, while L^* is the supply of low-skilled workers in the South.

3.1. The North

In the North, firms can produce two goods, X and Y, with constant returns to scale. The production of a unit of either good involves a continuum of $L-$ tasks and a continuum of $H-$ tasks. We normalize the measure of tasks in each industry to one. The $L-$ tasks can be performed by low-skilled workers only, and the $H-$ tasks can be performed by high-skilled workers only. In any industry, the task that can be performed by a given factor requires similar amounts of that factor when performed at home. Industries may differ in their factor intensities. If a production technology allows no substitution between factors or tasks, each task must be performed at a fixed intensity in order to produce a unit of output. In industry X, a firm needs a_{LX} units of the low-skilled workers to perform a typical $L-$ task once, and a_{HX} units of the high-skilled workers to perform a typical $H-$ task once. Since the measure of $L-$ tasks and $H-$ tasks is normalized to one, a_{LX} is the total amount of low-skilled workers and a_{HX} is the total amount of high-skilled workers, that would be needed to produce a unit of good X in the absence of any offshoring. In industry Y, a firm needs a_{LY} units of the low-skilled workers to perform a typical $L-$ task once, and a_{HY} units of the high-skilled workers to perform a typical $H-$ task once. Since the measure of $L-$ tasks and $H-$ tasks is normalized to one, a_{LY} is the total amount of low-skilled workers and a_{HY} is the total amount of high-skilled workers, that would be needed to produce a unit of good Y in the absence of any offshoring. We will assume that industry X is more skill intensive compared to Y, which means $\frac{a_{HX}}{a_{LX}} > \frac{a_{HY}}{a_{LY}}$.

Firms can undertake these tasks in the North, or offshore them to be performed in the South. Since some tasks are more difficult to offshore than others, we recognize the differences in terms of input requirements. A firm producing good j that offshores the f - task i abroad requires $\beta_{fj} a_{fj} t_{fj}(i)$ units of labor in the South, $\forall fj \in (LX, HX, LY, HY)$. β_{fj} is a parameter that reflects the technology of offshoring. A decline in β_{fj} represents the ease to offshore a given task abroad, and is equivalent to a decrease in the cost of offshoring. $t_{fj}(i)$ is a parameter that reflects improvements in the technology of offshoring that differs across the i tasks. We assume that $t_{fj}(i)$ is continuously differentiable and that $\beta_{fj} a_{fj} t_{fj}(i) \geq 1, \forall fj$, and $t'_{fj}(i) > 0$.

Let w and w^* be the wages of low-skilled workers in the North and in the South, respectively. Let s and s^* be the wages of high-skilled workers in the North and in the South, respectively. We also assume that $w > \beta_{LX} t_{LX}(0) w^*$, $w > \beta_{LY} t_{LY}(0) w^*$, $s > \beta_{HX} t_{HX}(0) s^*$ and $s > \beta_{HY} t_{HY}(0) s^*$, such that it is profitable for the North to conduct some tasks in the South. Thus, the Northern firms offshore tasks in order to take advantage of the lower wages in the South. In each industry, the marginal task performed in the North is determined by the condition that the savings in the wage costs just balance the offshoring costs as follows

$$w = \beta_{LX} t_{LX}(I_{LX}) w^* \quad (1)$$

$$w = \beta_{LY} t_{LY}(I_{LY}) w^* \quad (2)$$

$$s = \beta_{HX} t_{HX}(I_{HX}) s^* \quad (3)$$

$$s = \beta_{HY} t_{HY}(I_{HY}) s^* \quad (4)$$

where I_{fj} is the threshold task, below which all $f-$ tasks in the production of good j are offshored to the South, and above which all $f-$ tasks are produced in the headquarters in the North, as shown in the following figures 2 and 3.

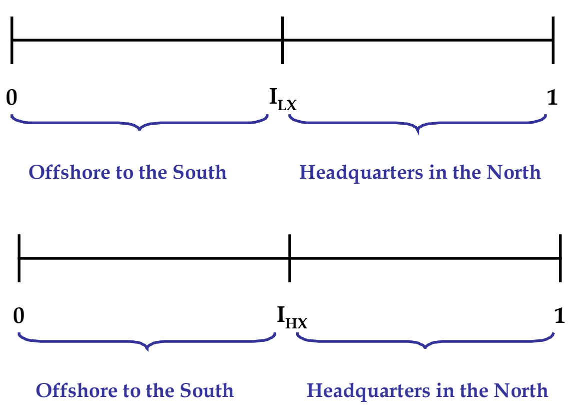


Figure 2. The threshold L-task and H-task in the X-industry in the North

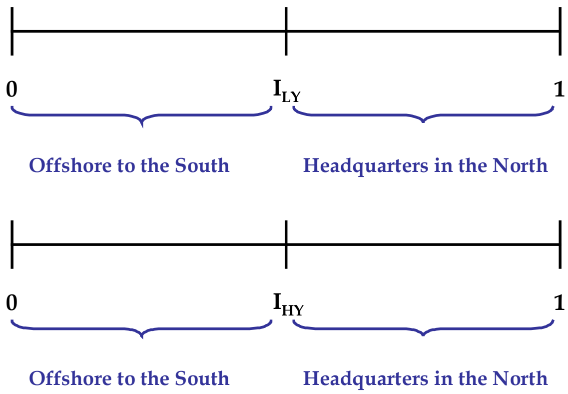


Figure 3. The threshold L-task and H-task in the Y-industry in the North

In a competitive economy, the price of any good is less than or equal to the unit cost of production, with equality whenever a positive quantity of the good is produced. The unit cost of good j is the sum of the wages paid to the Northern low-skilled and high-skilled workers, and the wages paid to the Southern low-skilled and high-skilled workers. Accordingly, the price of good X is given by

$$P_X = wa_{LX}\left(1-I_{LX}\right)+w^*a_{LX}\int_0^{I_{LX}}\beta_{LX}t_{LX}\left(i\right)di+sa_{HX}\left(1-I_{HX}\right)+s^*a_{HX}\int_0^{I_{HX}}\beta_{HX}t_{HX}\left(i\right)di \tag{5}$$

Similarly, the price of good Y is given by

$$P_Y = wa_{LY}\left(1-I_{LY}\right)+w^*a_{LY}\int_0^{I_{LY}}\beta_{LY}t_{LY}\left(i\right)di+sa_{HY}\left(1-I_{HY}\right)+s^*a_{HY}\int_0^{I_{HY}}\beta_{HY}t_{HY}\left(i\right)di \tag{6}$$

where the first term in both equations is the labor cost of the low-skilled workers performing $L-$ tasks in the headquarters in the North, the second term is the labor cost of the low-skilled workers performing offshored $L-$ tasks in the South, the third term is the labor cost of the high-skilled workers performing $H-$ tasks in the headquarters in the North, and finally the fourth term is the labor cost of the high-skilled workers performing offshored $H-$ tasks in the South. Substituting (1) and (3) into (5) yields

$$P_X = wa_{LX}\Omega_{LX} + sa_{HX}\Omega_{HX} \tag{7}$$

where $\Omega_{LX} = 1-I_{LX}+\frac{\int_0^{I_{LX}}t_{LX}(i)di}{t_{LX}(I_{LX})}$, and $\Omega_{HX} = 1-I_{HX}+\frac{\int_0^{I_{HX}}t_{HX}(i)di}{t_{HX}(I_{HX})}$. Similarly, substituting (2) and (4) into (6) yields

$$P_Y = wa_{LY}\Omega_{LY} + sa_{HY}\Omega_{HY} \tag{8}$$

where $\Omega_{LY} = 1-I_{LY}+\frac{\int_0^{I_{LY}}t_{LY}(i)di}{t_{LY}(I_{LY})}$, and $\Omega_{HY} = 1-I_{HY}+\frac{\int_0^{I_{HY}}t_{HY}(i)di}{t_{HY}(I_{HY})}$.

The assumption that $t_{fj}^{'}\left(i\right)>0$ for all $i\in\left[0,1\right]$ implies that $\Omega_{fj}\left(I_{fj}\right)<1$ for $I_{fj}>0$, which means that offshoring reduces the wage bill in proportion to the cost of performing the $f-$ tasks at home, as long as some tasks are performed abroad. The improvement in the offshoring technology of the $f-$ task in industry j is reflected in the decline of β_{fj}, or $d\beta_{fj} < 0$. This causes a decline in the growth rate of Ω_{fj}, which is referred to as the "productivity gain", as it is reflected in a boost to labor productivity[1]. According to Grossman and Rossi-Hansberg (2008), "a firm's cost savings are proportional to its payment to workers. These savings are much the same as would result from an economy-wide increase in labor productivity. The boost in productivity raises firms' demand for workers, which tends to inflate their wages, much as would labor-augmenting technological progress." Therefore, the productivity gain works to the benefit of the factor whose tasks are being moved offshore.

Next, we consider the factor markets in the North. The markets for low-skilled and high-skilled labor clear when employment by the two industries in the tasks performed in the North exhausts the factor supply. The labor market clearing conditions in the North are given by

$$a_{LX}\left(1-I_{LX}\right)X + a_{LY}\left(1-I_{LY}\right)Y = L \tag{9}$$

$$a_{HX}\left(1-I_{HX}\right)X + a_{HY}\left(1-I_{HY}\right)Y = H \tag{10}$$

where X and Y denote the outputs of the two industries, respectively. The condition under which the skill premium increases in the North as a response to improvements in the offshoring technology is captured in the following proposition.

Proposition 1

The skill premium in the North, $\omega^N = \frac{s}{w}$ *, increases with an improvement in the technology of offshoring, when* $d\beta_{fj} < 0$, $\forall fj$ *, if and only if* $\left(1 > w\theta_{LX}\right)$*, and the productivity gain in the* $L-$ *tasks in the high-skilled intensive industry is larger than that in the low-skilled intensive industry, and if and only if the productivity gain in the* $H-$ *tasks in the high-skilled intensive industry is larger than that in the low-skilled intensive industry.*

Proof included in appendix 1.

This proposition states that the improvement in the technology of offshoring the $L-$ tasks causes a productivity gain that works to the benefit of the low-skilled workers in the North, and that the improvement in the technology of offshoring the $H-$ tasks causes a productivity gain that works to the benefit of the high-skilled workers in the North. However, if the productivity gain in the high-skilled intensive industry is larger than in the low-skilled intensive industry for all $f-$ tasks, then these gains work to the benefit of the high-skilled workers relatively more than to the benefit of the low-skilled workers, and accordingly the skill premium increases. The following proposition considers the conditions under which the skill premium increases in the North with an improvement in the offshoring technology of the $f-$ task.

Proposition 2

The skill premium in the North, ω^N*, increases with an improvement in the technology of offshoring* $H-$*tasks, when* $d\beta_H < 0$ *only, and decreases with an improvement in the technology of offshoring* $L-$ *tasks, when* $d\beta_L < 0$ *only.*

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[1]The inclusion of the price effect due to an improvement in the offshoring technology does not change the qualitative results of the analysis.

Proof included in appendix 2.

This proposition states that the improvement in the technology of offshoring $H-$ tasks brings a productivity gain that works to the benefit of the high-skilled workers whose tasks are being moved offshore. This causes the wage of the high-skilled to increase, and accordingly induces the skill premium to increase as well. Alternatively, the improvement in the technology of offshoring $L-$ tasks causes a productivity gain that works to the benefit of the low-skilled workers whose tasks are being moved offshore. This causes the wage of the low-skilled to increase, and accordingly induces the skill premium to decrease.

3.2. The South

We assume that $w\beta_{LX}t_{LX}(0) > w^*$, $w\beta_{HX}t_{HX}(0) > w^*$, $s\beta_{LY}t_{LY}(0) > s^*$ and $s\beta_{HY}t_{HY}(0) > s^*$, which guarantee that the South does not offshore to the North, as it would be too expensive for the South to pay the Northern wages. Taking into consideration the offshoring decisions made by firms in the North, the number of the Southern low-skilled workers engaged in local production in the South, ℓ^*, is given by

$$\ell^* = L^* - \left[\int_0^{I_{LX}} \beta_{LX}t_{LX}(i)a_{LX}di + \int_0^{I_{LY}} \beta_{LY}t_{LY}(i)a_{LY}di\right] \tag{11}$$

Similarly, the number of the Southern high-skilled workers engaged in local production in the South, $\hbar^*$, is given by

$$\hbar^* = H^* - \left[\int_0^{I_{HX}} \beta_{HX}t_{HX}(i)a_{HX}di + \int_0^{I_{HY}} \beta_{HY}t_{HY}(i)a_{HY}di\right] \tag{12}$$

where $\left(L^* - \ell^*\right)$ is the number of Southern low-skilled workers performing the offshored $L-$ tasks for Northern firms, and $\left(H^* - \hbar^*\right)$ is the number of Southern high-skilled workers performing the offshored $H-$ tasks for Northern firms. The following figures 4 and 5 show the division of low-skilled and high-skilled labor in the South between those engaged in local production in Southern firms, and those performing offshored tasks for Northern firms.

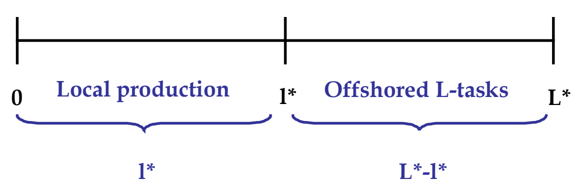

Figure 4. Division of low-skilled labor in the South between ℓ^* engaging in local production in the South, and ($L^* - \ell^*$) performing offshored L-tasks for Northern firms

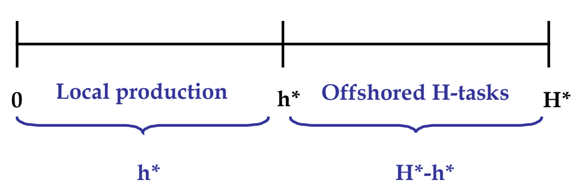

Figure 5. Division of high-skilled labor in the South between $\hbar^*$ engaging in local production in the South, and $\left(H^* - \hbar^*\right)$ performing o ff shored H-tasks for Northern firms

As in Grossman and Rossi-Hansberg (2012), firms in the South must pay a small extra cost to acquire the capability to serve as an external provider of a task. In equilibrium, no firm has an incentive to pay this cost. However, we assume that firms in the North are willing to cover this cost as long as their total cost of procuring the task from the South is less than their total cost of producing it in their headquarters in the North. This provides an incentive for firms in the South to perform offshoring services to Northern firms. If this payment is reflected in an increase in the wage of the workers who are producing these tasks in the South on behalf of the firms in the North, then we have an incentive for workers in the South to supply their labor to Southern firms providing offshoring services. Assume the wage of the low-skilled workers hired to perform offshored $L-$ tasks in these firms is w^*, while that of the remaining low-skilled workers engaged in local production in the South is w^{**}, where $w^* > w^{**}$ [2], then the weighted average wage of the low-skilled workers, w_L^S, is given by

$$w_L^S = \frac{\ell^* w^{**} + \left(L^* - \ell^*\right) w^*}{L^*} = \left(\frac{\ell^*}{L^*}\right) w^{**} + \left(1 - \frac{\ell^*}{L^*}\right) w^* \tag{13}$$

Similarly, assume the wage of the high-skilled workers hired to perform offshored $H-$ tasks in these firms[3] is s^*, while that of the remaining high-skilled workers engaged in local production is s^{**}, where $s^* > s^{**}$, then the weighted average wage of the high-skilled workers, w_H^S, is given by

$$w_H^S = \frac{\hbar^* s^{**} + \left(H^* - \hbar^*\right) s^*}{H^*} = \left(\frac{\hbar^*}{H^*}\right) s^{**} + \left(1 - \frac{\hbar^*}{H^*}\right) s^* \tag{14}$$

In this context, the skill premium in the South is given by

$$\omega^S = \frac{w_H^S}{w_L^S} = \frac{\left(\frac{\hbar^*}{H^*}\right) s^{**} + \left(1 - \frac{\hbar^*}{H^*}\right) s^*}{\left(\frac{\ell^*}{L^*}\right) w^{**} + \left(1 - \frac{\ell^*}{L^*}\right) w^*} \tag{15}$$

Proposition 3

$\exists$ *a threshold skill abundance in the South,* $\left(\frac{H^*}{L^*}\right)^T$*, below which an improvement in the technology of*

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[2] The assumption that the wages of those employed in firms engaged in offshoring are higher than the wages of those working in local firms is justified by the empirical evidence shown in Aitken *et al*. (1996) that Southern workers employed in multinational corporations earn higher wages on average compared to workers employed by domestic firms. This assumption is also based on the findings in Sethupathy (2013) who shows that "following a new offshoring opportunity, offshoring firms increase their productivity and profitability at the expense of non-offshoring firms. This channel leads to higher domestic wages at offshoring firms and lower domestic wages at non-offshoring firms."

[3] Developed countries offshore $H-$ tasks to developing countries, to take advantage of relatively lower wages of the high-skilled workers. Due to capital-skill complementarity, the productivity of high-skilled workers is higher in developed countries that are relatively more capital-abundant. Thus, the wages of high-skilled workers are higher in developed countries.

offshoring $(d\beta < 0)$ *causes a decrease in the skill premium in the South, and above which the improvement in the technology of offshoring* $(d\beta < 0)$ *causes an increase in the skill premium in the South.*

Proof included in appendix 3.

This result provides a possible explanation for the asymmetric patterns of skill premia after trade openness among developing countries. The threshold skill abundance is displayed in the following figure 6.

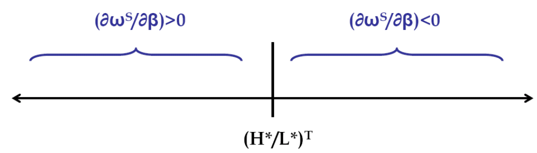

Figure 6. Threshold skill abundance in the South

The intuition for the existence of this threshold is straightforward. Developed countries offshore their $H-$ tasks to developing countries that are high-skilled abundant to benefit from the relatively lower labor cost. This means that more high-skilled workers in the South will be involved in performing offshored $H-$ tasks for firms in the North. As their wage is higher than the wage of the remaining high-skilled workers in the South, the increase in the proportion of the high-skilled workers performing offshored tasks leads to an increase in their weighted average wage, and accordingly an increase in the skill premium. On the other hand, developed countries offshore their $L-$ tasks to developing countries that are low-skilled abundant to benefit from the relatively lower labor cost. This means that more low-skilled workers in the South will be involved in performing offshored $L-$ tasks for firms in the North. As their wage is higher than the wage of the remaining low-skilled workers in the South, the increase in the proportion of the low-skilled workers performing offshored tasks leads to an increase in their weighted average wage, and accordingly a decrease in the skill premium.

Proposition 4

(1) $\exists$ *a threshold skill abundance* $\left(\frac{H^*}{L^*}\right)^{TX}$, *below which the skill premium in the South decreases with an improvement in the technology of offshoring all tasks in the high-skilled intensive* $X-$ *industry, when* $d\beta_X < 0$, *and above which the skill premium increases in the South.* (2) $\exists$ *another threshold skill abundance* $\left(\frac{H^*}{L^*}\right)^{TY}$, *below which the skill premium in the South decreases with an improvement in the technology of offshoring all tasks in the low-skilled intensive* $Y-$ *industry, when* $d\beta_Y < 0$, *and above which the skill premium increases in the South.* (3) *We have* $\left(\frac{H^*}{L^*}\right)^{TX} > \left(\frac{H^*}{L^*}\right)^{TY}$.

Proof included in appendix 4.

This result is intuitive as well. An improvement in the offshoring technology of the high-skilled intensive $X-$ industry, leads the North to offshore more $H-$ tasks to produce good X to the developing countries that are relatively high-skilled abundant, and offshore more $L-$ tasks to produce good X to the developing countries that are relatively low-skilled abundant. Therefore, the relative increase in the demand for high-skilled workers in the former will cause an increase in the skill premium, while the relative increase in the demand for low-skilled workers in the latter will cause a decrease in the skill premium. The same scenario takes place with an improvement in the offshoring technology of all tasks in the low-skilled intensive $Y-$ industry. However, the threshold in the last case is smaller than in the first case. This is because the increase in the proportion of the high-skilled workers performing offshored tasks in the $Y-$ industry relative to the increase in the proportion of the low-skilled workers performing offshored tasks in the $Y-$ industry is smaller than that in the $X-$ industry. This follows from the assumption that the $X-$ industry is more skill intensive than the $Y-$ industry, and that the relative labor requirement of high-skilled workers performing offshored $H-$ tasks to that of the low-skilled workers performing offshored $L-$ tasks in the $Y-$ industry, $\frac{\int_0^{I_{HY}} t_{HY}(i)di}{\int_0^{I_{LY}} t_{LY}(i)di}$, is less than that in the $X-$ industry, $\frac{\int_0^{I_{HX}} t_{HX}(i)di}{\int_0^{I_{LX}} t_{LX}(i)di}$. This means that developing countries whose skill abundance is lower than the threshold $\left(\frac{H^*}{L^*}\right)^{TX}$, will experience a decline in the skill premium after an improvement in the technology of offshoring all tasks in the $X-$ industry, while those above the threshold $\left(\frac{H^*}{L^*}\right)^{TX}$ will experience an increase in the skill premium. Similarly, developing countries whose skill abundance is lower than the threshold $\left(\frac{H^*}{L^*}\right)^{TY}$, will experience a decrease in the skill premium after an improvement in the technology of offshoring all tasks in the $Y-$ industry, while those above the threshold $\left(\frac{H^*}{L^*}\right)^{TY}$ will experience an increase in the skill premium. This also means that developing countries whose skill abundance is between $\left(\frac{H^*}{L^*}\right)^{TX}$ and $\left(\frac{H^*}{L^*}\right)^{TY}$ will experience a decrease in the skill premium after an improvement in the offshoring technology of all tasks in the $X-$ industry, but will experience an increase in the skill premium after an improvement in the offshoring technology of all tasks in the $Y-$ industry, as shown in the following figure 7.

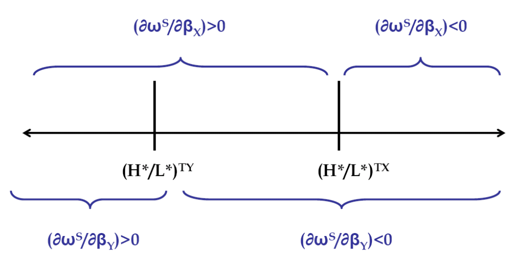

Figure 7. Threshold skill abundance in the South with an improvement in the technology of o ff shoring tasks in the X − industry and the Y − industry

This is because the $Y-$ industry has a lower relative high-skilled to low-skilled labor requirement for offshoring as opposed to the $X-$ industry. Therefore, countries with a relatively lower skill abundance can attract more $H-$ tasks with an improvement in the offshoring of all tasks in the $Y-$ industry than with an improvement in the offshoring of all tasks in the $X-$ industry. This explains the smaller threshold in the case of an improvement in the technology of offshoring tasks in the low-skilled intensive industry compared to the case of an improvement in the technology of offshoring tasks in the high-skilled intensive industry.

Proposition 5

The skill premium in the South, ω^S, increases with an improvement in the technology of offshoring H-tasks, $\left(d\beta_{Hj} < 0\right)$ for one or all j, and decreases with an improvement in the technology of offshoring L-tasks, $\left(d\beta_{Lj} < 0\right)$ for one or all j.

Proof included in appendix 5.

The intuition is straightforward. If the technology of offshoring $H-$ tasks in either the high-skilled intensive or the low-skilled intensive sector, or both, improves, there are more $H-$ tasks offshored to the South by Northern firms. Thus, there are more high-skilled workers in the South involved in performing $H-$ tasks for Northern firms. Accordingly, the weighted average wage of the high-skilled increases, while that of the low-skilled does not change, leading to an increase in the skill premium. Alternatively, if the technology of offshoring $L-$ tasks in either the high-skilled intensive or the low-skilled intensive sector, or both, improves, there are more $L-$ tasks offshored to the South by Northern firms. Thus, there are more low-skilled workers in the South involved in performing $L-$ tasks for Northern firms. Accordingly, the weighted average wage of the low-skilled increases, while that of the high-skilled does not change, leading to a decrease in the skill premium.

4. Conclusion

The 2x2x2 Heckscher-Ohlin model predicts that trade openness induces countries to export the good that intensively uses the relatively abundant factor of production, and import the good that intensively uses the relatively scarce factor of production. Accordingly, skill abundant developed countries are expected to export the good that intensively uses high-skilled workers. This leads to an increase in the relative price of the high-skilled intensive good, a rise in the relative demand for high-skilled workers, and consequently an increase in the skill premium. On the other hand, skill scarce developing countries are expected to export the good that intensively uses low-skilled workers. This leads to an increase in the relative price of the low-skilled intensive good, a rise in the relative demand for low-skilled workers, and consequently a decrease in the skill premium. Empirical evidence, however, demonstrates that although some developing countries have witnessed a declining skill premium, others have experienced a widening wage gap after trade liberalization.

This paper develops a model of trading tasks between two countries: the North and the South. The North is more skill-abundant compared to the South. Firms produce a low-skilled intensive good and a high-skilled intensive good. There are two factors of production: low-skilled workers and high-skilled workers. The production of a unit of either good involves a continuum of $L-$ tasks and a continuum of $H-$ tasks. The $L-$ tasks can be performed by low-skilled workers only, and the $H-$ tasks can be performed by high-skilled workers only.

The results suggest that the skill premium in the North increases with an improvement in the technology of offshoring, under certain conditions. On the other hand, the North offshores the high-skilled tasks to countries that are relatively more abundant in high-skilled workers, and low-skilled tasks to countries that are relatively more abundant in low-skilled workers. As a result, countries that become the hosts of low-skilled tasks will have a decrease in the skill premium, while those that become the hosts of the high-skilled tasks will have an increase in their skill premium, after an improvement in the offshoring technology. This provides a possible explanation to the asymmetric patterns of skill premia in the South.

Acknowledgements

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References

[1] Acemoglu, D. (2002). Directed technical change. *Review of Economic Studies*, *69*(4), 781-809.

[2] Acemoglu, D. (2003). Patterns of skill premia. *Review of Economic Studies*, *70*(2), 199-230.

[3] Aitken, B., Harrison, A., & Lipsey, R. E. (1996). Wages and foreign ownership: A comparative study of Mexico, Venezuela, and the United States. *Journal of International Economics, 40*(3-4), 345-371.

[4] Antras, P., Garicano, L., & Rossi-Hansberg, E. (2006). Offshoring in a knowledge economy. *The Quarterly Journal of Economics, 121*(1), 31-77.

[5] Beaulieu, E., Benarroch, M., & Gaisford, J. (2004). Trade barriers and wage inequality in a north-south model with technology-driven intra-industry trade. *Journal of Development Economics*, *75*(1), 113-136.

[6] Feenstra, R. C., & Hanson, G. H. (1996). Foreign investment, outsourcing and relative wages. In R. C. Feenstra, G. M. Grossman, & D. A. Irwin (Eds.), *The political economy of trade policy: Papers in honor of Jagdish Bhaghwati* (pp.89-128). Cambridge, MA.: MIT Press.

[7] Freeman, R. B., & Oostendorp, R. H. (2001). *Wages around the world: Pay across occupations and countries* (Working Paper No. 8058). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w8058.

[8] Goldberg, P. K., & Pavcnik, N. (2004). *Trade, inequality and poverty: What do we know? Evidence from recent trade liberalization episodes in developing countries* (Working Paper No. 10593). National Bureau of Economic Research Retrieved from http://www.nber.org/papers/w10593.

[9] Grossman, G. M., & Rossi-Hansberg, E. (2006). *The rise of offshoring: It's not wine for cloth anymore*. Paper presented at the Federal Reserve Bank of Kansas City on "The New Economic Geography: Effects and Policy Implications"—Jackson Hole Symposium. Retrieved from https://www.princeton.edu/~pcglobal/research/papers/grossman_rise_offshoring_0602.pdf.

[10] Grossman, G. M., & Rossi-Hansberg, E. (2008). Trading tasks: A simple theory of offshoring. *American Economic Review*, *98*(5), 1978-1997.

[11] Grossman, G. M., & Rossi-Hansberg, E. (2012). Task trade between similar countries. *Econometrica*, *80*(2), 593-629.

[12] Hansen, B. E. (1999). Threshold effects in non-dynamic panels: estimation, testing, and inference. *Journal of Econometrics*, *93*(2), 345-368.

[13] Hanson, G. H., & Harrison, A. (1995). *Trade, technology and wage inequality* (Working Paper No. 5110). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w5110.

[14] Khalifa, S., & Mengova, E. (2010). Offshoring and wage inequality in developing countries. *Journal of Economic Development*, *35*(3), 1-42.

[15] Robbins, D. J. (1996). *Evidence on trade and wages in the developing world* (Working Papers No. 119). OECD Development Centre. http://dx.doi.org/10.1787/113347174747.

[16] Sethupathy, G. (2013). Offshoring, Wages, and Employment: Theory and Evidence. *European Economic Review, 62*, 73-97.

[17] Thoenig, M., & Verdier, T. (2003). A theory of defensive skill-biased innovation and globalization. *American Economic Review*, *93*(3), 709-728.

[18] Wood, A. (1997). Openness and Wage Inequality in Developing Countries: The Latin American Challenge to East Asian Conventional Wisdom. *The World Bank Economic Review*, *11*(1), 33-57.

[19] Xu, B. (2003). Trade Liberalization, Wage Inequality and Endogenously Determined Nontraded Goods. Journal of International Economics, *60*(2), 417-431.

[20] Yeaple, S. (2003). The role of skill endowments in the structure of U.S. outward foreign direct investment. *Review of Economics and Statistics*, *85*(3), 726-734.

[21] Zhu, S. C. (2004). Trade, product cycles and inequality within and between countries. *Canadian Journal of Economics*, *37*(4), 1042-1060.

[22] Zhu, S. C., & Trefler, D. (2005). Trade and inequality in developing countries: A general equilibrium analysis. *Journal of International Economics*, *65*(1), 21-48.

Appendix

1. Proof of Proposition 1

Equations (7) and (8) can be rewritten as:

$$1 - wa_{LX}\Omega_{LX} - sa_{HX}\Omega_{HX} = 0$$

$$P - wa_{LY}\Omega_{LY} - sa_{HY}\Omega_{HY} = 0$$

where we normalize $P_X = 1$, and $P = \frac{P_Y}{P_X}$. Solving the first equation for s yields

$$s = \frac{1 - wa_{LX}\Omega_{LX}}{a_{HX}\Omega_{HX}}$$

Substitute this into the second equation to get

$$P - wa_{LY}\Omega_{LY} - \left[\frac{1 - wa_{LX}\Omega_{LX}}{a_{HX}\Omega_{HX}}\right]a_{HY}\Omega_{HY} = 0$$

This can be rearranged to

$$P - wa_{LY}\Omega_{LY} - \frac{a_{HY}\Omega_{HY}}{a_{HX}\Omega_{HX}} + \frac{wa_{LX}\Omega_{LX}a_{HY}\Omega_{HY}}{a_{HX}\Omega_{HX}} = 0$$

This can be rewritten as

$$wa_{LY}\Omega_{LY} - w\left(\frac{a_{LX}\Omega_{LX}a_{HY}\Omega_{HY}}{a_{HX}\Omega_{HX}}\right) = P - \left(\frac{a_{HY}\Omega_{HY}}{a_{HX}\Omega_{HX}}\right)$$

Taking the total differential yields

$$\left(a_{LY}\Omega_{LY}\right)dw+\left(wa_{LY}\right)d\Omega_{LY}-\left(\frac{a_{LX}\Omega_{LX}a_{HY}\Omega_{HY}}{a_{HX}\Omega_{HX}}\right)dw-\left(w\frac{a_{LX}\Omega_{LX}a_{HY}}{a_{HX}\Omega_{HX}}\right)d\Omega_{HY}$$
$$-\left(w\frac{a_{LX}a_{HY}\Omega_{HY}}{a_{HX}\Omega_{HX}}\right)d\Omega_{LX}+\left(w\frac{a_{LX}\Omega_{LX}a_{HY}\Omega_{HY}}{a_{HX}}\right)\left(\Omega_{HX}\right)^{-2}d\Omega_{HX}$$
$$=-\left(\frac{a_{HY}}{a_{HX}\Omega_{HX}}\right)d\Omega_{HY}+\left(\frac{a_{HY}\Omega_{HY}}{a_{HX}}\right)\left(\Omega_{HX}\right)^{-2}d\Omega_{HX}$$

Simplifying yields

$$dw\left[\left(a_{LY}\Omega_{LY}\right)-\left(\frac{a_{LX}\Omega_{LX}a_{HY}\Omega_{HY}}{a_{HX}\Omega_{HX}}\right)\right]$$
$$=-\left(wa_{LY}\right)d\Omega_{LY}+\left(w\frac{a_{LX}a_{HY}\Omega_{HY}}{a_{HX}\Omega_{HX}}\right)d\Omega_{LX}$$
$$+d\Omega_{HY}\left[\left(w\frac{a_{LX}\Omega_{LX}a_{HY}}{a_{HX}\Omega_{HX}}\right)-\left(\frac{a_{HY}}{a_{HX}\Omega_{HX}}\right)\right]$$
$$+d\Omega_{HX}\left[\left(\frac{a_{HY}\Omega_{HY}}{a_{HX}}\right)\left(\Omega_{HX}\right)^{-2}-\left(w\frac{a_{LX}\Omega_{LX}a_{HY}\Omega_{HY}}{a_{HX}}\right)\left(\Omega_{HX}\right)^{-2}\right]$$

Substituting $\theta_{fj}=a_{fj}\Omega_{fj}$ as the cost share of the $f-$ tasks in industry j, we have

$$dw\left[\theta_{LY}-\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\right]=-\left(wa_{LY}\right)d\Omega_{LY}+\left(w\frac{a_{LX}\theta_{HY}}{\theta_{HX}}\right)d\Omega_{LX}$$
$$+d\Omega_{HY}\left[\left(w\frac{\theta_{LX}a_{HY}}{\theta_{HX}}\right)-\left(\frac{a_{HY}}{\theta_{HX}}\right)\right]$$
$$+d\Omega_{HX}\left[\left(\frac{\theta_{HY}}{\theta_{HX}}\right)\left(\frac{1}{\Omega_{HX}}\right)-\left(w\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\left(\frac{1}{\Omega_{HX}}\right)\right]$$

Divide both sides by w to get

$$\frac{dw}{w}\left[\theta_{LY}-\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\right]=-a_{LY}d\Omega_{LY}+\left(\frac{a_{LX}\theta_{HY}}{\theta_{HX}}\right)d\Omega_{LX}$$
$$+d\Omega_{HY}\left[\left(\frac{\theta_{LX}a_{HY}}{\theta_{HX}}\right)-\left(\frac{a_{HY}}{w\theta_{HX}}\right)\right]$$
$$+d\Omega_{HX}\left[\left(\frac{\theta_{HY}}{w\theta_{HX}}\right)\left(\frac{1}{\Omega_{HX}}\right)-\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\left(\frac{1}{\Omega_{HX}}\right)\right]$$

This can be simplified further to

$$\frac{dw}{w}\left[\theta_{LY}-\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\right]=-a_{LY}\frac{\Omega_{LY}}{\Omega_{LY}}d\Omega_{LY}+\left(\frac{a_{LX}\theta_{HY}}{\theta_{HX}}\right)\left(\frac{\Omega_{LX}}{\Omega_{LX}}\right)d\Omega_{LX}$$
$$+d\Omega_{HY}\left[\left(\frac{\theta_{LX}a_{HY}}{\theta_{HX}}\right)-\left(\frac{a_{HY}}{w\theta_{HX}}\right)\right]\left(\frac{\Omega_{HY}}{\Omega_{HY}}\right)$$
$$+d\Omega_{HX}\left[\left(\frac{\theta_{HY}}{w\theta_{HX}}\right)\left(\frac{1}{\Omega_{HX}}\right)-\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\left(\frac{1}{\Omega_{HX}}\right)\right]$$

Which can be rearranged to

$$\frac{dw}{w}\left[\theta_{LY}-\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\right]=-\theta_{LY}\frac{d\Omega_{LY}}{\Omega_{LY}}+\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\frac{d\Omega_{LX}}{\Omega_{LX}}$$
$$+\left[\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)-\left(\frac{\theta_{HY}}{w\theta_{HX}}\right)\right]\frac{d\Omega_{HY}}{\Omega_{HY}}$$
$$+\left[\left(\frac{\theta_{HY}}{w\theta_{HX}}\right)-\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\right]\frac{d\Omega_{HX}}{\Omega_{HX}}$$

This can be further rearranged to

$$\frac{dw}{w}\left(\frac{\theta_{LY}\theta_{HX}-\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)=-\theta_{LY}\frac{d\Omega_{LY}}{\Omega_{LY}}+\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{HX}}\right)\frac{d\Omega_{LX}}{\Omega_{LX}}$$
$$+\left(\frac{w\theta_{LX}\theta_{HY}-\theta_{HY}}{w\theta_{HX}}\right)\frac{d\Omega_{HY}}{\Omega_{HY}}$$
$$+\left(\frac{\theta_{HY}-w\theta_{LX}\theta_{HY}}{w\theta_{HX}}\right)\frac{d\Omega_{HX}}{\Omega_{HX}}$$

Solving for the percentage change in w, $\frac{dw}{w}$, yields

$$\frac{dw}{w}=-\left(\frac{\theta_{LY}\theta_{HX}}{\theta_{LY}\theta_{HX}-\theta_{LX}\theta_{HY}}\right)\frac{d\Omega_{LY}}{\Omega_{LY}}+\left(\frac{\theta_{LX}\theta_{HY}}{\theta_{LY}\theta_{HX}-\theta_{LX}\theta_{HY}}\right)\frac{d\Omega_{LX}}{\Omega_{LX}}$$
$$+\left(\frac{w\theta_{LX}\theta_{HY}-\theta_{HY}}{\theta_{LY}\theta_{HX}-\theta_{LX}\theta_{HY}}\right)\left(\frac{1}{w}\right)\frac{d\Omega_{HY}}{\Omega_{HY}}$$
$$+\left(\frac{\theta_{HY}-w\theta_{LX}\theta_{HY}}{\theta_{LY}\theta_{HX}-\theta_{LX}\theta_{HY}}\right)\left(\frac{1}{w}\right)\frac{d\Omega_{HX}}{\Omega_{HX}}$$

This can be further simplified to

$$\widehat{w}=\left[\frac{(\theta_{LY}\theta_{HX})\left(-\widehat{\Omega}_{LY}\right)-(\theta_{LX}\theta_{HY})\left(-\widehat{\Omega}_{LX}\right)}{\theta_{LY}\theta_{HX}-\theta_{LX}\theta_{HY}}\right]$$
$$+\frac{(\theta_{HY}-w\theta_{LX}\theta_{HY})\left[\left(-\widehat{\Omega}_{HY}\right)-\left(-\widehat{\Omega}_{HX}\right)\right]}{w(\theta_{LY}\theta_{HX}-\theta_{LX}\theta_{HY})}$$

where $\widehat{z}=\frac{dz}{z}$ denotes the growth rate of a variable z. This can be simplified to

$$\widehat{w} = \left[\frac{\left(\frac{\theta_{LY}\theta_{HX}}{\theta_{LX}}\right)\left(-\widehat{\Omega}_{LY}\right) - \left(\theta_{HY}\right)\left(-\widehat{\Omega}_{LX}\right)}{\left(\frac{\theta_{LY}\theta_{HX}}{\theta_{LX}}\right) - \theta_{HY}}\right] + \frac{\left(\theta_{HY} - w\theta_{LX}\theta_{HY}\right)\left[\left(-\widehat{\Omega}_{HY}\right) - \left(-\widehat{\Omega}_{HX}\right)\right]}{w\left(\theta_{LY}\theta_{HX} - \theta_{LX}\theta_{HY}\right)}$$

This can be simplified further to

$$\widehat{w} = \left[\frac{\left(\frac{\theta_{HX}}{\theta_{LX}}\right)\left(-\widehat{\Omega}_{LY}\right) - \left(\frac{\theta_{HY}}{\theta_{LY}}\right)\left(-\widehat{\Omega}_{LX}\right)}{\left(\frac{\theta_{HX}}{\theta_{LX}}\right) - \left(\frac{\theta_{HY}}{\theta_{LY}}\right)}\right] + \frac{\left(\theta_{HY} - w\theta_{LX}\theta_{HY}\right)\left[\left(-\widehat{\Omega}_{HY}\right) - \left(-\widehat{\Omega}_{HX}\right)\right]}{w\left(\theta_{LY}\theta_{HX} - \theta_{LX}\theta_{HY}\right)}$$

Since we assumed that industry X is relatively more high-skilled intensive compared to industry Y, then we have $\left(\frac{\theta_{HX}}{\theta_{LX}}\right) > \left(\frac{\theta_{HY}}{\theta_{LY}}\right)$. Any improvement in offshoring is reflected in a decline in β_{fj}, such that $d\beta_{fj} < 0$, $\forall\ fj$. In this context, $d\beta_{fj}$ has an impact on $\widehat{\Omega}_{fj}$, since $\frac{dI_{fj}}{d\beta_{fj}} < 0$, as the lower the cost of offshoring, the broader the range of tasks to be offshored. We also have $\frac{d\Omega_{fj}}{dI_{fj}} = \frac{\int_0^{I_{fj}} t_{fj}(i)\,di}{\left[t_{fj}(I_{fj})\right]^2}\left(t_{fj}^{'}(i)\right) < 0$. Therefore, $\frac{d\Omega_{fj}}{d\beta_{fj}} = \left(\frac{d\Omega_{fj}}{dI_{fj}}\right)\left(\frac{dI_{fj}}{d\beta_{fj}}\right) > 0$, which gives us the productivity effect as in Grossman and Rossi-Hansberg (2008). This means that $\widehat{w} > 0$ if both the first term and the second term are positive, when $d\beta_{fj} < 0$, and $\widehat{\Omega}_{fj} < 0$, $\forall fj$. The first term is positive if and only if the productivity gain in the $L-$ tasks in the low-skilled intensive industry is larger than that in the high-skilled intensive industry, or $\left(-\widehat{\Omega}_{LY}\right) > \left(-\widehat{\Omega}_{LX}\right)$, since $\left(\frac{\theta_{HX}}{\theta_{LX}}\right) > \left(\frac{\theta_{HY}}{\theta_{LY}}\right)$ by assumption. On the other hand, we know that the denominator is positive in the second term as $\left(\frac{\theta_{HX}}{\theta_{LX}}\right) > \left(\frac{\theta_{HY}}{\theta_{LY}}\right)$. Then if $\left(1 > w\theta_{LX}\right)$, the second term is positive if and only if the productivity gain in the $H-$ tasks in the low-skilled intensive industry is larger than that in the high-skilled intensive industry, or $\left(-\widehat{\Omega}_{HY}\right) > \left(-\widehat{\Omega}_{HX}\right)$. In summary, the wage of the low-skilled workers in the North increases if the productivity gain for both types of tasks is larger in the low-skilled intensive industry compared to the high-skilled intensive industry. To solve for the percentage change in the wage of the high-skilled workers in the North, s, we have

$$s = \frac{1 - wa_{LX}\Omega_{LX}}{a_{HX}\Omega_{HX}}$$

This can be rewritten as

$$sa_{HX}\Omega_{HX} = 1 - wa_{LX}\Omega_{LX}$$

Taking the total differential yields

$$a_{HX}\Omega_{HX}ds + sa_{HX}d\Omega_{HX} = -a_{LX}\Omega_{LX}dw - wa_{LX}d\Omega_{LX}$$

This can be rearranged to

$$\theta_{HX}ds + sa_{HX}d\Omega_{HX} = -\theta_{LX}dw - wa_{LX}d\Omega_{LX}$$

Divide both sides by $\frac{1}{sw}$ to get

$$\frac{\theta_{HX}}{w}\frac{ds}{s} = -\frac{\theta_{LX}}{s}\frac{dw}{w} - \frac{a_{HX}}{w}d\Omega_{HX}\left(\frac{\Omega_{HX}}{\Omega_{HX}}\right) - \frac{a_{LX}}{s}d\Omega_{LX}\left(\frac{\Omega_{LX}}{\Omega_{LX}}\right)$$

This can be rewritten as

$$\frac{\theta_{HX}}{w}\widehat{s} = -\frac{\theta_{LX}}{s}\widehat{w} - \frac{\theta_{HX}}{w}\widehat{\Omega}_{HX} - \frac{\theta_{LX}}{s}\widehat{\Omega}_{LX}$$

Solving for $\widehat{s}$ yields

$$\widehat{s} = -\left(\frac{w\theta_{LX}}{s\theta_{HX}}\right)\widehat{w} - \widehat{\Omega}_{HX} - \left(\frac{w\theta_{LX}}{s\theta_{HX}}\right)\widehat{\Omega}_{LX}$$

Therefore, since the skill premium in the North is given by $\frac{s}{w}$, the percentage change in the skill premium is given by

$$\widehat{\omega}^N = \widehat{s} - \widehat{w}$$

Substituting $\widehat{s}$ and $\widehat{w}$ into $\widehat{\omega}^N$ yields

$$\begin{aligned}\widehat{\omega}^N &= -\widehat{w}\left[\left(\frac{\theta_{LX}}{\theta_{HX}}\right)\left(\frac{w}{s}\right)+1\right] - \widehat{\Omega}_{HX} - \left(\frac{w\theta_{LX}}{s\theta_{HX}}\right)\widehat{\Omega}_{LX} \\ &= -\left[\left(\frac{\theta_{LX}}{\theta_{HX}}\right)\left(\frac{w}{s}\right)+1\right] \\ &\left[\frac{\left(\frac{\theta_{HX}}{\theta_{LX}}\right)\left(-\widehat{\Omega}_{LY}\right) - \left(\frac{\theta_{HY}}{\theta_{LY}}\right)\left(-\widehat{\Omega}_{LX}\right)}{\left(\frac{\theta_{HX}}{\theta_{LX}}\right) - \left(\frac{\theta_{HY}}{\theta_{LY}}\right)} + \frac{\left(\theta_{HY} - w\theta_{LX}\theta_{HY}\right)\left[\left(-\widehat{\Omega}_{HY}\right) - \left(-\widehat{\Omega}_{HX}\right)\right]}{w\left(\theta_{LY}\theta_{HX} - \theta_{LX}\theta_{HY}\right)}\right] \\ &-\widehat{\Omega}_{HX} - \left(\frac{w\theta_{LX}}{s\theta_{HX}}\right)\widehat{\Omega}_{LX}\end{aligned}$$

This means that $\widehat{\omega}^N > 0$ if both the first term and the second term of $\widehat{w}$ are negative when $d\beta_{fj} < 0$, and $\widehat{\Omega}_{fj} < 0 \quad \forall fj$. The first term is negative if and only if the productivity gain in the $L-$ tasks in the high skilled-intensive industry is larger than that in the low-skilled intensive industry, or $\left(-\widehat{\Omega}_{LX}\right) > \left(-\widehat{\Omega}_{LY}\right)$. On the other hand, if $\left(\theta_{HY} - w\theta_{LX}\theta_{HY}\right) > 0$, which is the equivalent of $1 > w\theta_{LX}$, the second term is negative if and only if the productivity gain in the $H-$ tasks in the high-skilled intensive industry is larger than that in the low-skilled intensive industry, or $\left(-\widehat{\Omega}_{HX}\right) > \left(-\widehat{\Omega}_{HY}\right)$.

2. Proof of Proposition 2

Assume that $\beta_{LX} = \beta_{LY} = \beta_L$, and $\beta_{HX} = \beta_{HY} = \beta_H$. In this case, the prices of goods X and Y are given by

$$1 = wa_{LX}\Omega_L + sa_{HX}\Omega_H$$

$$P = wa_{LY}\Omega_L + sa_{HY}\Omega_H$$

where $\Omega_L = 1 - I_L + \frac{\int_0^{I_L} t_L(i)di}{t_L(I_L)}$, and $\Omega_H = 1 - I_H + \frac{\int_0^{I_H} t_H(i)di}{t_H(I_H)}$. Solving the first equation for s yields

$$s = \frac{1 - wa_{LX}\Omega_L}{a_{HX}\Omega_H}$$

Substituting s into the second equation gives

$$w = \frac{P - \left(\frac{a_{HY}}{a_{HX}}\right)}{\Omega_L\left[a_{LY} - \left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)\right]}$$

This can be simplified further to

$$w\Omega_L a_{LY} - w\Omega_L\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right) = P - \left(\frac{a_{HY}}{a_{HX}}\right)$$

Taking the total differential yields

$$\Omega_L a_{LY}dw + wa_{LY}d\Omega_L - \Omega_L\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)dw - w\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)d\Omega_L = 0$$

This can be rearranged to

$$dw\left[\Omega_L a_{LY} - \Omega_L\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)\right] = -d\Omega_L\left[wa_{LY} - w\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)\right]$$

Divide both sides by $\frac{1}{w\Omega_L}$ to get

$$\frac{dw}{w}\left[a_{LY} - \left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)\right] = -\frac{d\Omega_L}{\Omega_L}\left[a_{LY} - \left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)\right]$$

This yields

$$\widehat{w} = -\widehat{\Omega}_L$$

We also have $s = \frac{1 - wa_{LX}\Omega_L}{a_{HX}\Omega_H}$, which after replacing w can be rewritten as

$$s=\frac{1}{a_{HX}\Omega_H}-\left[\frac{P-\left(\frac{a_{HY}}{a_{HX}}\right)}{\Omega_L\left[a_{LY}-\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)\right]}\right]\frac{a_{LX}\Omega_L}{a_{HX}\Omega_H}$$

$$=\frac{1}{a_{HX}\Omega_H}-\left[\frac{P-\left(\frac{a_{HY}}{a_{HX}}\right)}{a_{LY}-\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)}\right]\frac{a_{LX}}{a_{HX}\Omega_H}$$

$$=\frac{1}{a_{HX}\Omega_H}\left[1-a_{LX}\frac{P-\left(\frac{a_{HY}}{a_{HX}}\right)}{a_{LY}-\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)}\right]$$

This can be rewritten as

$$sa_{HX}\Omega_H=1-a_{LX}\left[\frac{P-\left(\frac{a_{HY}}{a_{HX}}\right)}{a_{LY}-\left(\frac{a_{HY}a_{LX}}{a_{HX}}\right)}\right]$$

Taking the total differential yields

$$a_{HX}\Omega_H ds+sa_{HX}d\Omega_H=0$$

Dividing both sides by $\frac{1}{s\Omega_H}$ and rearranging yields

$$\widehat{s}=-\widehat{\Omega}_H$$

The skill premium in the North is thus given by

$$\widehat{\omega}^N=\widehat{s}-\widehat{w}=\left(-\widehat{\Omega}_H\right)-\left(-\widehat{\Omega}_L\right)$$

Therefore, an improvement in the offshoring of the $H-$ tasks only, when $d\beta_H<0$, would affect positively the productivity of the high-skilled workers, reflected in an increase in $\left(-\widehat{\Omega}_H\right)$, and therefore causes an increase the skill premium in the North, $\widehat{\omega}^N$. On the other hand, an improvement in the offshoring of the $L-$ tasks only, when $d\beta_L<0$, would affect positively the productivity of the low-skilled workers, reflected in an increase in $\left(-\widehat{\Omega}_L\right)$, and therefore causes a decrease in the skill premium in the North, $\widehat{\omega}^N$.

3. Proof of Proposition 3

The skill premium in the South is given by

$$\omega^S=\frac{\left(\frac{\hbar^*}{H^*}\right)s^{**}+\left(1-\frac{\hbar^*}{H^*}\right)s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**}+\left(1-\frac{\ell^*}{L^*}\right)w^*}$$

Assume that $\beta_{LX}=\beta_{LY}=\beta_{HX}=\beta_{HY}=\beta$. Taking the derivative of ω^S with respect to β yields

$$\frac{\partial\omega^S}{\partial\beta}=\left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**}+\left(1-\frac{\ell^*}{L^*}\right)w^*}\right]\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial\beta}\right]$$
$$-\frac{\left[\left(\frac{\hbar^*}{H^*}\right)s^{**}+\left(1-\frac{\hbar^*}{H^*}\right)s^*\right]w^*}{\left[\left(\frac{\ell^*}{L^*}\right)w^{**}+\left(1-\frac{\ell^*}{L^*}\right)w^*\right]^2}\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial\beta}\right]$$

If $\frac{\partial\omega^S}{\partial\beta}>0$, this means that as the offshoring technology improves $(d\beta<0)$, the skill premium in the South declines. This derivative is positive if and only if

$$\left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**}+\left(1-\frac{\ell^*}{L^*}\right)w^*}\right]\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial\beta}\right]$$
$$>\frac{\left[\left(\frac{\hbar^*}{H^*}\right)s^{**}+\left(1-\frac{\hbar^*}{H^*}\right)s^*\right]w^*}{\left[\left(\frac{\ell^*}{L^*}\right)w^{**}+\left(1-\frac{\ell^*}{L^*}\right)w^*\right]^2}\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial\beta}\right]$$

which can be simplified to

$$s^*\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial\beta}\right]>\frac{\left[\left(\frac{\hbar^*}{H^*}\right)s^{**}+\left(1-\frac{\hbar^*}{H^*}\right)s^*\right]w^*}{\left[\left(\frac{\ell^*}{L^*}\right)w^{**}+\left(1-\frac{\ell^*}{L^*}\right)w^*\right]}\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial\beta}\right]$$

which can be rearranged to

$$\frac{s^*}{w^*}>\omega^S\frac{\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial\beta}\right]}{\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial\beta}\right]}$$

This also means that $\frac{\partial\omega^S}{\partial\beta}<0$ if and only if

$$\frac{s^*}{w^*}<\omega^S\frac{\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial\beta}\right]}{\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial\beta}\right]}$$

The left-hand side of (9) is independent of $\left(\frac{H^*}{L^*}\right)$. On the other hand, the right-hand side is a function of the skill abundance in the South $\left(\frac{H^*}{L^*}\right)$. It remains to determine the sign of the derivative of the right-hand side with respect to $\left(\frac{H^*}{L^*}\right)$. First, the skill premium in the South can be rewritten as

$$\omega^S = \left[\frac{\left(\frac{\hbar^*}{L^*}\right)\left(s^{**}-s^*\right)+\left(\frac{H^*}{L^*}\right)s^*}{\left(\frac{\ell^*}{L^*}\right)\left(w^{**}-w^*\right)+w^*}\right]\left(\frac{H^*}{L^*}\right)^{-1}$$

Thus, the derivative of the skill premium with respect to skill abundance $\left(\frac{H^*}{L^*}\right)$ is given by

$$\frac{\partial\omega^S}{\partial\left(\frac{H^*}{L^*}\right)} = -\left[\frac{\left(\frac{\hbar^*}{L^*}\right)\left(s^{**}-s^*\right)+\left(\frac{H^*}{L^*}\right)s^*}{\left(\frac{\ell^*}{L^*}\right)\left(w^{**}-w^*\right)+w^*}\right]\left(\frac{H^*}{L^*}\right)^{-2}+\left(\frac{H^*}{L^*}\right)^{-1}\left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right)\left(w^{**}-w^*\right)+w^*}\right]$$

This is positive if and only if

$$\left(\frac{H^*}{L^*}\right)^{-1}\left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right)\left(w^{**}-w^*\right)+w^*}\right] > \left[\frac{\left(\frac{\hbar^*}{L^*}\right)\left(s^{**}-s^*\right)+\left(\frac{H^*}{L^*}\right)s^*}{\left(\frac{\ell^*}{L^*}\right)\left(w^{**}-w^*\right)+w^*}\right]\left(\frac{H^*}{L^*}\right)^{-2}$$

This can be simplified to

$$\left(\frac{H^*}{L^*}\right)s^* > \left(\frac{\hbar^*}{L^*}\right)\left(s^{**}-s^*\right)+\left(\frac{H^*}{L^*}\right)s^*$$

Which can be further simplified to

$$\left(\frac{\hbar^*}{L^*}\right)s^* > \left(\frac{\hbar^*}{L^*}\right)s^{**}$$

which is true since we assumed $s^* > s^{**}$. Therefore, the skill premium increases with skill abundance. In addition, we also have $\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial\beta}\right] < 0$, and $\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial\beta}\right] < 0$, because the improvement in offshoring technology increases offshoring to the South, and accordingly increases the proportion of the low-skilled and the high-skilled workers in the South performing tasks for Northern firms. This means that the right-hand side of (9) is increasing in $\left(\frac{H^*}{L^*}\right)$. Therefore, since the left-hand side is independent of $\left(\frac{H^*}{L^*}\right)$, there exists a threshold, $\left(\frac{H^*}{L^*}\right)^T$, that satisfies

$$\frac{s^*}{w^*} = \omega^S \frac{\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial\beta}\right]}{\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial\beta}\right]}$$

Below this threshold, skill abundance is lower than the threshold, and accordingly the right-hand side is lower than the left-hand side, and the condition (9) is satisfied, such that $\frac{\partial\omega^S}{\partial\beta} > 0$, and an improvement in the offshoring technology causes a decrease in the skill premium. Above the threshold, skill abundance is higher than the threshold and accordingly the right-hand side is higher than the left-hand side, and the condition (10) is satisfied, such that $\frac{\partial \omega^S}{\partial \beta} < 0$, and an improvement in the offshoring technology causes an increase in the skill premium.

4. Proof of Proposition 4

The skill premium in the South is given by

$$\omega^S = \frac{\left(\frac{\hbar^*}{H^*}\right)s^{**} + \left(1 - \frac{\hbar^*}{H^*}\right)s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1 - \frac{\ell^*}{L^*}\right)w^*}$$

Assume that $\beta_{LX} = \beta_{HX} = \beta_X$, and $\beta_{LY} = \beta_{HY} = \beta_Y$. The derivative of ω^S with respect to β_X is given by

$$\frac{\partial \omega^S}{\partial \beta_X} = \left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1 - \frac{\ell^*}{L^*}\right)w^*}\right]\left[\frac{\partial\left(1 - \frac{\hbar^*}{H^*}\right)}{\partial \beta_X}\right] - \frac{\left[\left(\frac{\hbar^*}{H^*}\right)s^{**} + \left(1 - \frac{\hbar^*}{H^*}\right)s^*\right]w^*}{\left[\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1 - \frac{\ell^*}{L^*}\right)w^*\right]^2}\left[\frac{\partial\left(1 - \frac{\ell^*}{L^*}\right)}{\partial \beta_X}\right]$$

If $\frac{\partial \omega^S}{\partial \beta_X} > 0$, this means that as the offshoring technology of the high-skilled intensive industry improves $\left(d\beta_X < 0\right)$, the skill premium in the South declines. This derivative is positive if and only if

$$\left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1 - \frac{\ell^*}{L^*}\right)w^*}\right]\left[\frac{\partial\left(1 - \frac{\hbar^*}{H^*}\right)}{\partial \beta_X}\right] > \frac{\left[\left(\frac{\hbar^*}{H^*}\right)s^{**} + \left(1 - \frac{\hbar^*}{H^*}\right)s^*\right]w^*}{\left[\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1 - \frac{\ell^*}{L^*}\right)w^*\right]^2}\left[\frac{\partial\left(1 - \frac{\ell^*}{L^*}\right)}{\partial \beta_X}\right]$$

which can be simplified to

$$\frac{s^*}{w^*} > \omega^S \frac{\left[\frac{\partial\left(1 - \frac{\ell^*}{L^*}\right)}{\partial \beta_X}\right]}{\left[\frac{\partial\left(1 - \frac{\hbar^*}{H^*}\right)}{\partial \beta_X}\right]} = \omega^S \left[\left(\frac{a_{LX}}{a_{HX}}\right)\frac{\int_0^{I_{LX}} t_{LX}(i)\,di}{\int_0^{I_{HX}} t_{HX}(i)\,di}\right]$$

As in proposition 3, this implies that there is a threshold skill abundance $\left(\frac{H^*}{L^*}\right)^{TX}$, below which the skill premium in the South declines with an improvement in the technology of offshoring all tasks in the high-skilled intensive industry, and above which the skill premium increases. Similarly, the derivative of ω^S with respect to β_Y is given by

$$\frac{\partial \omega^S}{\partial \beta_Y} = \left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1-\frac{\ell^*}{L^*}\right)w^*}\right]\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial \beta_Y}\right] - \frac{\left[\left(\frac{\hbar^*}{H^*}\right)s^{**} + \left(1-\frac{\hbar^*}{H^*}\right)s^*\right]w^*}{\left[\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1-\frac{\ell^*}{L^*}\right)w^*\right]^2}\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial \beta_Y}\right]$$

If $\frac{\partial \omega^S}{\partial \beta_Y} > 0$, this means that as the offshoring technology of the low-skilled intensive industry improves $\left(d\beta_Y < 0\right)$, the skill premium in the South declines. This derivative is positive if and only if

$$\left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1-\frac{\ell^*}{L^*}\right)w^*}\right]\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial \beta_Y}\right] > \frac{\left[\left(\frac{\hbar^*}{H^*}\right)s^{**} + \left(1-\frac{\hbar^*}{H^*}\right)s^*\right]w^*}{\left[\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1-\frac{\ell^*}{L^*}\right)w^*\right]^2}\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial \beta Y}\right]$$

which can be simplified to

$$\frac{s^*}{w^*} > \omega^S \frac{\left[\frac{\partial\left(1-\frac{\ell^*}{L^*}\right)}{\partial \beta_Y}\right]}{\left[\frac{\partial\left(1-\frac{\hbar^*}{H^*}\right)}{\partial \beta_Y}\right]} = \omega^S \left[\left(\frac{a_{LY}}{a_{HY}}\right)\frac{\int_0^{I_{LY}} t_{LY}(i)\,di}{\int_0^{I_{HY}} t_{HY}(i)\,di}\right]$$

As in proposition 3, this implies that there is a threshold skill abundance $\left(\frac{H^*}{L^*}\right)^{TY}$, below which the skill premium in the South declines with an improvement in the technology of offshoring all tasks in the high-skilled intensive industry, and above which the skill premium increases.

We assumed that $\frac{a_{HX}}{a_{LX}} > \frac{a_{HY}}{a_{LY}}$, and that $\frac{\int_0^{I_{LX}} t_{LX}(i)\,di}{\int_0^{I_{HX}} t_{HX}(i)\,di} < \frac{\int_0^{I_{LY}} t_{LY}(i)\,di}{\int_0^{I_{HY}} t_{HY}(i)\,di}$, which means that the gap between the labor requirement for all $H-$ tasks and all $L-$ tasks in the high-skilled intensive industry is higher than that in the low-skilled intensive industry. This means that the second term in the right-hand side in (11) is smaller than that in the right-hand side in (12). This also means that the equalities that determine the two thresholds imply that $\left(\frac{H^*}{L^*}\right)^{TX} > \left(\frac{H^*}{L^*}\right)^{TY}$, since $\frac{\partial \omega^S}{\partial\left(\frac{H^*}{L^*}\right)} > 0$.

5. Proof of Proposition 5

The skill premium in the South is given by

$$\omega^S = \frac{\left(\frac{\hbar^*}{H^*}\right)s^{**} + \left(1-\frac{\hbar^*}{H^*}\right)s^*}{\left(\frac{\ell^*}{L^*}\right)w^{**} + \left(1-\frac{\ell^*}{L^*}\right)w^*}$$

Assume that $\beta_{LX} = \beta_{LY} = \beta_L$, and $\beta_{HX} = \beta_{HY} = \beta_H$. This means that the number of Southern low-skilled workers performing offshored $L-$ tasks for Northern firms is given by

$$L^* - \ell^* = \left[\int_0^{I_L} \beta_L t_L(i) a_{LX} di + \int_0^{I_L} \beta_L t_L(i) a_{LY} di \right]$$

Similarly, the number of Southern high-skilled workers performing offshored $H-$ tasks for Northern firms is given by

$$H^* - \hbar^* = \left[\int_0^{I_H} \beta_H t_H(i) a_{HX} di + \int_0^{I_H} \beta_H t_H(i) a_{HY} di \right]$$

Taking the derivative of the skill premium with respect to β_H yields

$$\frac{\partial \omega^S}{\partial \beta_H} = \left[\frac{s^*}{\left(\frac{\ell^*}{L^*}\right) w^{**} + \left(1 - \frac{\ell^*}{L^*}\right) w^*} \right] \left[\frac{\partial \left(1 - \frac{\hbar^*}{H^*}\right)}{\partial \beta_H} \right] < 0$$

This derivative is negative because $\left[\frac{\partial \left(1 - \frac{\hbar^*}{H^*}\right)}{\partial \beta_H} \right] < 0$. Accordingly, as β_H declines, reflecting an improvement in the technology of offshoring $H-$ tasks, the skill premium increases. On the other hand, taking the derivative of the skill premium with respect to β_L yields

$$\frac{\partial \omega^S}{\partial \beta_L} = -\frac{\left[\left(\frac{\hbar^*}{H^*}\right) s^{**} + \left(1 - \frac{\hbar^*}{H^*}\right) s^* \right] w^*}{\left[\left(\frac{\ell^*}{L^*}\right) w^{**} + \left(1 - \frac{\ell^*}{L^*}\right) w^* \right]^2} \left[\frac{\partial \left(1 - \frac{\ell^*}{L^*}\right)}{\partial \beta_L} \right] > 0$$

This derivative is positive because $\left[\frac{\partial \left(1 - \frac{\ell^*}{L^*}\right)}{\partial \beta_L} \right] < 0$. Accordingly, as β_L declines reflecting an improvement in the technology of offshoring technology of $L-$ tasks, the skill premium decreases.

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