**Two-Way Outsourcing, International Migration,
and Wage Inequality**

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Abstract: This paper develops a general equilibrium model with a vertical production structure to examine the relationship between offshore outsourcing and international migration, especially emphasizing their effects on the wages of skilled and unskilled workers. Two-way outsourcing (simultaneous insourcing and outsourcing) in skilled-labor intensive services arises due to product differentiation and scale economies, and outsourcing in unskilled-labor intensive processing occurs because of factor endowment differences. The tractability of the model allows us to rank outsourcing and migration, according to the wages of both types of workers. Finally, we also analyze under what conditions outsourcing and international migration are complements or substitutes.

1 Introduction

The rapid growth of international trade in business services is a topical issue among the general public as well as economists. Freund and Weinhold (2002) report that, from 1995 to 1999, the expansion of trade in business services has far outpaced the growth of overall goods and services. One driving force is the recent development of communication technology. The Internet makes it possible to access low-cost skills for many types of business services, such as data processing, software consulting, the readings of medical records such as X-ray films, ultra-sound and CT records.[1] As a result, the skilled-labor markets that used to be segmented are being integrated internationally.

The media focuses on the fact that high-tech companies are increasingly outsourcing their business services overseas to cut costs, and alarms that such offshore outsourcing brings adverse effects on home workers (Moran 2003; Roberts 2005). Outsourcing also continues to attract the attention of economists (see for instance, Bhagwati, Panagariya, and Srinivasan 2004 and Blinder 2006). Mankiw and Swagel (2006) state, "As technology develops and global economic integration deepens, more jobs and people will be affected by actual or potential offshore outsourcing....Further development of theoretical models will foster better understanding of the associated welfare impacts."

Meanwhile, international movement of workers is another driving force that integrates labor markets across countries. The United Nations estimates that more than 175 million people in the world live outside their countries of birth in 2002, and almost 1 in 10 people living in the more developed regions is a migrant. Especially in the US, immigrants are everywhere, no matter the industry. Roberts (2005) reports that Wal-Mart is a leading business lobby in Washington D.C., for a more relaxed and tolerant approach to legal immigration, and the IT industry lobbies hard to relax visa restrictions on skilled immigrants from India.

Obviously, the intense debates on outsourcing and migration stem from their effects on income distribution, and especially on the wage inequalities across sectors and the wage gaps across countries. By casual observation, it might seem that outsourcing of produc-

tion/services and migration of workers are two sides of the same coin. Thus in this paper, we ask whether the labor market effects of offshore outsourcing are similar to those of international migration, and if so, in what aspects?

Specifically, we adopt a general equilibrium model with a vertical production structure. There are two countries, each producing a final good with constant-returns-to-scale technology. The production of the final good consists of two stages. In the first stage, differentiated business services are combined and transformed into an aggregate service, which together with unskilled labor, is used to produce the final good in the second stage. Each differentiated individual business service in turn requires skilled labor as input, and is produced with increasing returns to scale technology in monopolistically competitive markets.

We define two types of outsourcing. First, service outsourcing can be regarded as the arm's length trade of individual business services, and it arises due to product differentiation and scale economies. We find that service outsourcing is a two-way phenomenon that consists of both insourcing and outsourcing; that is, countries export and import business services simultaneously. This is in fact an important feature in the U.S. economy, but such a reality is often lost in the outsourcing debate.[2] Second, outsourcing in unskilled-labor intensive processing occurs because of factor endowment differences. We examine how each type of offshore outsourcing and international migration affect the wage income distribution among skilled and unskilled workers, at both the national and international levels.[3]

We identify two wage effects: the productivity effect and the factor abundance effect. In a closed economy, an increase in the number of skilled workers affects wages through two channels. The first is an increase of service input, reducing the skill premium of wages. This can be called *the factor abundance effect*. The second is the expansion of service varieties, leading to higher productivity in final goods production, which in turn raises both the skilled and unskilled wages. We call it *the productivity effect*. When the economy is opened and outsourcing is allowed in both business services and labor processing, we find that skilled workers gain as long as the productivity effect outweighs the factor abundance

effect. When we further allow international migration of workers, multiple equilibria arises. Which equilibrium emerges depends on the relative magnitude of the above two effects. Nonetheless, the wage impacts of outsourcing and migration can be ranked, regardless of which effect is bigger.

We then use the model to examine whether offshore outsourcing and international migration exhibit complementarity or substitutability. On the one hand, outsourcing and migration are substitutes since migration erodes the incentive for outsourcing in unskilled-labor intensive processing. On the other hand, they are complements because skilled-labor migration promotes service outsourcing. These results suggest that the effect of migration on outsourcing depends on which type of workers migrate across country borders.

The literature on the relationship between trade and wages is extensive. Several empirical studies find that growing imports of labor intensive goods from less developed countries help cause the wage gap between the more educated and less educated workers in developed countries (see Wood 1995), while some other studies say that this effect is not important (e.g., Lawrence and Slaughter 1993). Our model is closest and complements Feenstra and Hanson (1996, 1999), who argue that trade expansion in intermediate goods plays an important role in explaining the observed demand increase for skilled workers. In their model, intermediate goods differ in skill intensities, and trade expansion causes a shift of intermediate good production across countries, leading to a rise in the average skill intensity. We show that trade in skilled business services raises service variety and hence the demand for skilled workers in both developed and developing countries due to an increase in their productivity, which is another channel through which trade raises the demand for skilled workers.[4]

Like Ethier (1982), Helpman and Krugman (1985, Ch. 11), Markusen (1989), and Marrewijk et al. (1997) among others, we adapt the Dixit and Stiglitz (1977) model of monopolistic competition to international trade in differentiated intermediate services.[5] However, we adopt a production structure based on a Ricardo-Viner setting, in which each primary factor is specific to a sector, i.e., skilled workers are used for business services and unskilled

workers for final good production. The rationale is that workers with technical skills may be more mobile across countries than across sectors (e.g. Neary 1995), especially in this age of globalization and regional integration. Our approach can be used to analyze in a tractable way the various effects of both outsourcing and migration on income distribution and industrial structure, and these effects can be ranked.

Harris (1998) points out that the Internet can cause "virtual mobility" of workers by reducing trade barriers in services. While he focuses on such mobility across identical regions in a small open economy, our interest is in comparing the virtual mobility and the actual migration of workers between developed and developing countries, by explicitly considering two countries with skilled and unskilled labor, which enables us to examine the labor market effects of migration and outsourcing.[6]

There is voluminous theoretical literature on international trade and migration, such as Ethier (1985), Brecher and Choudhri (1987), Bond and Chen (1987), and Ishikawa (1994) among others. However, none of these papers focuses on outsourcing. Markusen (1988) and Francois (1994) examine migration issues with diversity of intermediate inputs and increasing returns in production. In Francois, differentiated inputs are assembled into a final good without using other primary factors. In our model, final good production requires unskilled labor as well as differentiated services, which enables us to examine the relationship between migration of workers and outsourcing of processing. Markusen (1988) explicitly considers the skill formation of workers, but the skilled wage is always equal to the unskilled wage in the diversified trade equilibrium and hence income inequality cannot be analyzed. In our model, the skill premium is flexible so that we can analyze the effects of migration on the wage inequality. More importantly, the present paper complements the existing literature by clearly demonstrating how the migration equilibrium is similar to or different from the outsourcing equilibrium in their effects on the wage distribution among skilled and unskilled workers, both at the national and international levels.

2 The Two-Sector Closed Economy

We start with the simplest case of one country with two sectors, final good and business service. Business services $(Z_1, Z_2...Z_n)$ are produced under variety-specific increasing returns to scale, and the market for business services is characterized by monopolistic competition. The final good (y) is produced with constant returns to scale technology under perfect competition, using unskilled labor L and a number of differentiated business services $Z_1, ..., Z_n$, in the following form:

$$y = L^\beta S^{1-\beta}, \ 0 < \beta < 1, \tag{1}$$

where S is the index of business services,

$$S = \left[\sum_{i=1}^n Z_i^\delta\right]^{1/\delta}, \ 0 < \delta < 1. \tag{2}$$

Each variety of business services uses only skilled labor H such that the production of z_i units requires h_i units of skilled labor as a fixed cost and a constant marginal cost b:

$$h_i = cz_i + b, \tag{3}$$

where $b, c > 0$. Obviously, without outsourcing, $z_i = Z_i$ in equilibrium.

On the demand side, all consumers have identical preferences, and enjoy utility from the consumption of the final good C_y. We begin with an autarky situation. In the final good market, given good and factor prices, competitive producers choose the index of business services and unskilled labor to maximize their profits,

$$p_y(1 - \beta)L^\beta S^{-\beta} = p_s, \tag{4}$$

$$p_y \beta L^{\beta-1} S^{1-\beta} = w_L, \tag{5}$$

where p_y is the price of the final good, p_s is the price index of business services, and w_L is

the wage of unskilled workers (the unskilled wage). Eq. (4) gives the derived demand for business services in the final good sector.

In the business service sector, each firm takes as given the output of the final good y, factor prices, and prices of other rival firms. Since producers are symmetric, all varieties of business services are sold at the same price p_z. Profit maximization leads to

$$p_z = \frac{cw_H}{\delta}, \tag{6}$$

where w_H is the wage of skilled workers (the skilled wage). Under monopolistic competition, free entry drives profits to zero, and we can derive the output of each firm as

$$z = \frac{\delta b}{c(1-\delta)}. \tag{7}$$

Labor endowment constrains the variety of business services as:

$$n = \frac{(1-\delta)H}{b}. \tag{8}$$

And finally the index of business services S can be obtained as

$$S = (n)^{\frac{1}{\delta}} z. \tag{9}$$

3 Two Countries

Now suppose there are two countries in the world economy, Home and Foreign. They are identical in preferences, technologies, and endowments of unskilled labor, i.e., $L = L^*$.[7] However, Home is more skilled-labor abundant than Foreign, i.e., $H > H^*$.[8] In this section, we examine the wage structures within and across countries in the autarky equilibrium. For notational clarity, we call the international wage difference of the same type of workers the

"wage gap", while the wage difference between skilled and unskilled workers within a country the "wage inequality." We will show that an increase in the size of skilled workers has two effects on the real wages, *the productivity effect* and *the factor abundance effect.* If the former overwhelms the latter, both the skilled and unskilled wages are higher in the skilled-labor abundant country than in the skilled-labor scarce country.

International Wage Gaps

With symmetric firms, the price index of business services for Home is given as $p_s = (n)^{-\frac{1-\delta}{\delta}} p_z$. From (6), it can be rewritten as

$$p_s = (n)^{-\frac{1-\delta}{\delta}} \left(\frac{cw_H}{\delta} \right). \tag{10}$$

Using (4), (9), and (10), we can derive the real skilled wage (i.e., the wage-price ratio),

$$\frac{w_H}{p_y} = (1 - \beta) \left(\frac{\delta}{c} \right) n^{\frac{(1-\delta)(1-\beta)}{\delta}} \left(\frac{L}{nz} \right)^{\beta}. \tag{11}$$

It implies that in equilibrium, the real skilled wage equals the "marginal product" of business services (skilled workers) in the final good sector.

An increase in the number of skilled workers affects the real skilled wage through two channels. First, it raises the total output of business services nz proportionally, which can be easily confirmed since the output of each business service z is constant and the number of business services n is proportional to the size of skilled workers. This in turn negatively affects the real skilled wage due to decreasing marginal productivity in final good production. This effect appears as $(nz)^{-\beta}$ in (11), and we call it "the factor abundance effect".

Second, it also raises the marginal product of business services by increasing the variety of such services. This positively affects the real skilled wage because a rise in the productivity in the final good sector expands the demand for business services. This effect appears as $n^{\frac{(1-\delta)(1-\beta)}{\delta}}$ in (11), and we call it "the productivity effect". If the productivity effect dominates

the factor abundance effect, the real income of skilled workers would be higher in Home than in Foreign.

Using (5) and (9), we can also derive the real unskilled wage,

$$\frac{w_L}{p_y} = \beta n^{\frac{(1-\delta)(1-\beta)}{\delta}} \left(\frac{nz}{L}\right)^{1-\beta}. \tag{12}$$

Clearly, both the factor abundance and productivity effects positively affect the marginal product of unskilled workers. Thus, an increase in the size of skilled workers raises the productivity of unskilled-workers, increasing the real unskilled wage. This implies that the real income of unskilled workers is *necessarily higher* in Home than in Foreign.

These are central properties in our model, and thus we state them in the following lemma.

Lemma 1 *Suppose that Home has a greater size of skilled labor endowment than Foreign and the productivity effect dominates the factor abundance effect. Then, the real wages of skilled and unskilled workers in Home are higher than those in Foreign.*

Proof: From (8), one sees that the number of business services proportionally increases with the size of skilled workers. Thus, (12) immediately gives $\frac{w_L}{p_y} > \frac{w_L^*}{p_y^*}$. As to the real skilled wage, we obtain

$$\frac{d\left(\frac{w_H}{p_y}\right)}{dn} \frac{n}{\frac{w_H}{p_y}} = \frac{(1-\delta)(1-\beta)}{\delta} - \beta. \tag{13}$$

The LHS of condition (13) is positive if and only if

$$1 - \beta > \delta. \tag{14}$$

An increase in H results in a larger S, which decreases the real skilled wage through a reduction in $MP_S = \frac{\partial y}{\partial S} = (1-\beta)\left(\frac{L}{S}\right)^\beta$. Since $\beta = -\left(\frac{\partial MP_S}{\partial S}\right)\left(\frac{S}{MP_S}\right)$, a smaller β implies a smaller factor abundance effect. Also, $1/\delta$ equals the ratio of the average to marginal cost in each business service, and thus δ is the inverse of the degree of scale economies in service production. A greater degree of scale economies $1/\delta$ leads to a larger productivity

effect.[9] Therefore, condition (14) implies that the productivity effect dominates the factor abundance effect.   Q.E.D.

Domestic Wage Inequality

Next, let us look at the domestic inter-sectoral wage inequality. The skilled wage relative to the unskilled wage is derived by taking the ratio of (11) to (12),

$$\frac{w_H}{w_L} = \left(\frac{1-\beta}{\beta}\right)\left(\frac{\delta}{c}\right)\left(\frac{L}{nz}\right). \tag{15}$$

The productivity effect is cancelled out because it affects the real skilled and unskilled wages in the same way. However, the factor abundance effect remains on the RHS. That is, the skilled-labor abundant Home has a lower income inequality than the skilled-labor scarce Foreign, because a greater size of skilled labor implies a higher productivity of unskilled labor.[10]

4 Offshore Outsourcing

Recall that the production process consists of two stages: first, differentiated service inputs are combined and transformed into the service index, and then, the service index and unskilled labor are used to produce the final good. In this section we examine offshore outsourcing, which can exhibit in several forms: that of services, of unskilled-labor processing, and full outsourcing. We examine them sequentially and investigate how such outsourcing affects wages.

Two-way Service Outsourcing

First, we analyze service outsourcing and its wage effects. In the service outsourcing equilibrium, real skilled wage is lower in Home than in Foreign. This does not necessarily imply that skilled workers lose in the skilled-labor abundant Home. In fact, we shall show that service outsourcing can increase the productivity of workers and benefit both skilled

and unskilled workers in both countries.

With service trade, Home final-good producers can use business services produced in both countries. Then, the index of business services becomes

$$S = \left[\sum_{i=1}^{n} Z_i^{\delta} + \sum_{i=1}^{n^*} V_i^{\delta} \right]^{1/\delta}, \quad 0 < \delta < 1, \tag{16}$$

where V_i is the home input of the foreign service. Given the property of the CES function in (16), profit maximization of the final good producers leads to

$$\frac{V + V^*}{Z + Z^*} = \left(\frac{p_z}{p_v^*} \right)^{\frac{1}{1-\delta}}, \tag{17}$$

where p_v^* is the price of the foreign service, and Z^* and V^* are the foreign inputs of the home and foreign services, respectively. The world demand for Foreign relative to Home services depends only on the service price ratio. The market equilibrium condition for services can be written as

$$\frac{V + V^*}{Z + Z^*} = \frac{v^*}{z}, \tag{18}$$

where v^* is the output of the foreign service. Due to the symmetric technologies, the service outputs are equalized across countries, $z = v^* = \delta b / c(1 - b)$. Since the relative demand depends only on the relative price, output equalization implies that each country's service providers charge the same price, i.e., $p_z = p_v^*$, which leads to $Z = V$ and $Z^* = V^*$, i.e., the inputs of the home and foreign services are equal in each country. Then, the service and price indices in Home can be written respectively as

$$S = (n + n^*)^{\frac{1}{\delta}} V, \tag{19}$$

$$p_s = (n + n^*)^{-\frac{1-\delta}{\delta}} p_z \tag{20}$$

Using (4), (19), and (20), we derive the real skilled wage in Home as,

$$\frac{w_H}{p_y} = (1 - \beta) \left(\frac{\delta}{c}\right) (n + n^*)^{\frac{(1-\delta)(1-\beta)}{\delta}} \left[\frac{L}{(n + n^*)V}\right]^{\beta}. \tag{21}$$

Analogously, service outsourcing also occurs from Foreign to Home, and we can obtain a similar expression for the real skilled wage in Foreign, by replacing L and V with L^* and Z^* in the above equation. In other words, outsourcing and insourcing exist simultaneously for each country. Under two-way outsourcing, the same number of business services becomes available in each country, and as a result, the productivity effects that depend on the variety of services are equalized across countries.

Meanwhile, a difference arises in the factor abundance effect. In fact, with the balance of trade equation, $n^* p_v^* V = n p_z Z^*$, and (18), we find that Home has a bigger factor abundance effect than Foreign because

$$V = \frac{nv^*}{n + n^*} > \frac{n^* z}{n + n^*} = Z^*. \tag{22}$$

Since the service input demand increases with the number of services produced domestically, Home enjoys a greater amount of service input than Foreign.

Notice that the scale advantage vanishes in the outsourcing equilibrium. Before service outsourcing arises, Home skilled workers have a higher real income than Foreign counterparts, as long as service production exhibits sufficiently high degree of scale economies. However, outsourcing allows the productivity effects to be equalized between countries, and as a result, Home loses its productivity advantage based on a larger number of skilled workers. Without the productivity advantage, the larger scale of skilled workers generates only a greater factor abundance effect. As a result, a scale *disadvantage* arises for skilled workers in Home. That is, regardless of the degree of scale economies, the skilled wage becomes lower in Home than in Foreign.

As for the home unskilled wage, by using (5) and (19), we derive,

$$\frac{w_L}{p_y} = \beta(n + n^*)^{\frac{(1-\delta)(1-\beta)}{\delta}} \left[\frac{(n + n^*)V}{L}\right]^{1-\beta}. \tag{23}$$

A similar expression can be obtained for the foreign real unskilled wage by replacing V and L with Z^* and L^*, respectively in (23). Again, the productivity effects are the same but the factor abundance effects are different across countries. The larger input of total services results in a higher marginal product of unskilled workers in Home than in Foreign. Theses results are summarized as follows:

Lemma 2 *In the two-way service outsourcing equilibrium, the real skilled wage is lower in Home than in Foreign, but the situation is reversed for the real unskilled wage.*

This result does not mean that service outsourcing adversely affects the welfare of Home skilled workers. Comparing the above with the case of no outsourcing, namely (21) with (11), one sees that service outsourcing benefits skilled workers in Home, too. This arises because outsourcing improves the productivity of both skilled and unskilled workers in both countries. And this productivity effect is strong enough to overcome the loss due to the scale disadvantage. As a result, service outsourcing generates a win-win situation such that:

Lemma 3 *Both skilled and unskilled workers in both countries gain from service outsourcing.*

Also, from Lemmas 1, 2, and 3, we obtain:

Corollary 1 *Foreign skilled workers gain more from service outsourcing than Home skilled workers.*

This result suggests that service outsourcing is more beneficial for the skilled workers in less developed countries than those in more developed countries.

Lastly, it can be shown that service outsourcing does not have any effect on the inter-sectoral wage inequality. This is because the marginal products of both skilled and unskilled

workers increase at the same rate, which suggests that service outsourcing is similar to a Hicks-neutral technical progress.

Outsourcing of Unskilled-Labor Intensive Processing

So far, we have assumed that the final good is not tradable across countries. This assumption implicitly excludes the possibility of outsourcing in unskilled-labor intensive processing. As we have shown, in the service outsourcing equilibrium, the real unskilled wage is higher in the skilled-labor abundant Home. If the final good is tradable, Home would have an incentive to outsource the unskilled-labor intensive stage to Foreign and export the final good produced there back to Home. In this section, we examine how such outsourcing affects the wage of each type of workers.

The price ratio of the Home to Foreign final good can be derived by using (4),

$$\frac{p_y}{p_y^*} = \left(\frac{S}{S^*} \right)^{\beta}, \tag{24}$$

where the service price indices are cancelled out duo to $p_s = p_s^*$. Using (19), we can rewrite (24) as

$$\frac{p_y}{p_y^*} = \left(\frac{V}{Z^*} \right)^{\beta}. \tag{25}$$

As we have shown in (22), the service input demand is proportional to the size of skilled-labor, and thus $V > Z^*$, which leads to $p_y > p_y^*$, i.e., the final good is more expensive in Home than in Foreign. Since the real unskilled wage is higher in the former country, producers there will outsource the unskilled-labor intensive stage to Foreign and export back some outputs to Home. Such outsourcing increases the demand for services in Foreign, but decreases that in Home, and eventually, $V = Z^*$, at which outsourcing is not profitable any more.[11]

In Home, outsourcing of the unskilled-labor intensive stage promotes the exports of business services, which leads to an increase in the demand for skilled-workers. Simultaneously, the reverse importing of the final good reduces its price. These both increase the real skilled

wage. However, the real unskilled wage declines due to a fall in the demand for unskilled workers. And in Foreign, exactly the opposite arises.

Lemma 4 *Outsourcing of unskilled-labor intensive processing provides an additional gain for Home skilled workers and Foreign unskilled workers, but it hurts Home unskilled workers and Foreign skilled workers.*

When unskilled-labor processing is outsourced in addition to business services, the real wages of both types of workers are equalized between countries. We can show that the Home real skilled wage is

$$\frac{w_H}{p_y} = (1 - \beta) \left(\frac{\delta}{c}\right) (n + n^*)^{\frac{(1-\delta)(1-\beta)}{\delta}} \left[\frac{2L}{(n + n^*)z}\right]^{\beta}, \tag{26}$$

by replacing V with $z/2$ in (21). Home skilled workers prefer outsourcing to autarky. Comparing (11) with (26), one sees that since $2n > n + n^* > n$, both the productivity and factor abundance effects are positive on the real skilled wage. On the other hand, in Foreign, the productivity and factor abundance effects are opposite to each other, but the positive productivity effect outweighs the negative factor abundance effect under condition (14). We can confirm this point by using (11) and (26). Skilled workers in Foreign gain if and only if

$$n^{*\frac{1-\beta-\delta}{\delta}} < 2^{\beta} (n + n^*)^{\frac{1-\beta-\delta}{\delta}}. \tag{27}$$

This inequality is satisfied under condition (14), *regardless of* international differences in skilled-labor endowments. That is, if the degree of scale economies in services is sufficiently high, outsourcing necessarily benefits skilled workers in Foreign as well as in Home.

Lemma 5 *Suppose condition (14) holds, i.e., in autarky, both types of workers enjoy higher real wages in Home than in Foreign. Then, skilled workers in both countries benefit from outsourcing in both skilled-labor intensive services and unskilled-labor intensive processing.*

Similarly, by using (23), we can derive the real unskilled wage,

$$\frac{w_L}{p_y} = \beta(n + n^*)^{\frac{(1-\delta)(1-\beta)}{\delta}} \left[\frac{(n + n^*)z}{2L} \right]^{1-\beta}. \qquad (28)$$

In Foreign, unskilled workers necessarily prefer outsourcing to autarky since both the productivity and factor abundance effects are positive. But, in Home, the negative factor abundance effect may overwhelm the positive productivity effect. In fact, by comparing (12) with (28), we find that unskilled workers gain from outsourcing if and only if

$$2^\delta n < n + n^*. \qquad (29)$$

Given the different endowments of skilled-labor, (29) is more likely to arise when condition (14) holds, but less likely to hold as the difference in skilled worker endowments becomes larger. In other words, if service production exhibits sufficiently large scale economies and/or the difference in skilled-labor endowment is not too large, unskilled workers in Home gain as well. We summarize these results as follows:

Lemma 6 *Suppose that condition (29) holds, i.e., the degree of scale economies in services is sufficiently high and/or the difference in skilled-worker endowments is not too large. Then in both countries, unskilled workers benefit from outsourcing in both skilled-labor intensive services and unskilled-labor intensive processing.*

The above results are closely related to those of Krugman (1981), who shows that scarce factors can gain from trade if either scale economies are important or countries are very similar in factor endowments. In his model, depending on the degree of factor endowment differences, a critical level of scale economies determines whether scarce factors gain or not. This critical level needs to be greater as the difference in factor endowments is larger.

In contrast, in our setting, the critical level of scale economies for skilled workers is independent of the difference in factor endowments. If (14) is satisfied, then (27) necessarily

holds as long as $n > n^*$. Thus, skilled workers in unskilled-labor abundant Foreign gain from trade *regardless of* the difference in factor endowments. However, with regard to unskilled workers, we obtain the same result as in Krugman, i.e., the critical level of scale economies depends on the difference in factor endowment ratios.

The above contrasting results arise because, unlike the Krugman model, the present setting assumes that skilled labor is used in the service sector with scale economies but unskilled labor is used only in the final good sector with constant returns to scale.[12] Our results suggest that skilled while workers are more likely to gain from specialization and scale economies, unskilled workers are less likely to gain from the conventional distributional effect.

Wage Inequality

It is worth investigating how outsourcing affects the wage inequality within countries. The ratio of skilled to unskilled wage is derived by using (26) and (28),

$$\frac{w_H}{w_L} = \left(\frac{1-\beta}{\beta}\right)\left(\frac{\delta}{c}\right)\left[\frac{2L}{(n+n^*)z}\right]. \tag{30}$$

Compared to autarky, outsourcing increases Home inter-sectoral wage inequality. This can be confirmed by comparing (15) with (30).[13] Intuitively, since Home is the net exporter of services, which pulls up the demand for skilled workers, increasing the skilled wage. And outsourcing in unskilled-labor intensive processing reduces the demand for unskilled workers, decreasing the unskilled wage.[14] Exactly the opposite effects arise and the wage inequality declines in Foreign.[15]

Lemma 7 *The inter-sectoral wage inequality rises in Home but falls in Foreign due to outsourcing in skilled-labor intensive services and unskilled-labor intensive processing.*

5   International Migration

In this section, we allow international migration of both types of workers instead of out-sourcing. As we have shown in Lemma 1, under condition (14), both skilled and unskilled workers earn a higher real income in Home than in Foreign. This is because the greater number of skilled workers leads to a larger variety of services, increasing the productivity of skilled workers. In this case, both types of workers migrate to Home from Foreign, and it does not stop until all workers have migrated. On the other hand, if (14) is not satisfied, the factor abundance effect dominates and the direction of migration is reversed. Skilled workers migrate to Foreign, until eventually, both countries have the same size of skilled and unskilled workers.

Migration Equilibria

We consider a situation in which either type of workers can migrate across borders. For the moment, assume that both countries are incompletely specialized. In equilibrium, real wages of each type of workers must be equalized across countries. From (11), $\frac{w_H}{p_y} = \frac{w_H^*}{p_y^*}$ iff

$$\frac{L^*}{L} = \left(\frac{n^*}{n}\right)^{-\frac{1-\beta-\delta}{\beta\delta}}. \tag{31}$$

The ratio $\frac{n^*}{n}$ is negatively related to $\frac{L^*}{L}$ if condition (14) is satisfied, i.e., the productivity effect outweighs the factor abundance effect. Since the skilled wage increases with the number of skilled workers, a rise in $\frac{n^*}{n}$ raises the skilled wage in Foreign relative to Home. To offset this increase in the wage gap, $\frac{L^*}{L}$ must decline. However, if (14) does not hold, the factor abundance effect dominates and the skilled wage is negatively related to the number of skilled workers. In this case, there is a positive relation between $\frac{n^*}{n}$ and $\frac{L^*}{L}$.

Similarly, (12) implies that the real unskilled wages are equalized, $\frac{w_L}{p_y} = \frac{w_L^*}{p_y^*}$, iff

$$\frac{L^*}{L} = \left(\frac{n^*}{n}\right)^{\frac{1}{\delta}}. \tag{32}$$

Then $\frac{n^*}{n}$ must be positively related to $\frac{L^*}{L}$. An increase in unskilled immigrants leads to a fall in the unskilled wage. To offset this decline, there must be an increase in skilled immigrants.

Figure 1 depicts the migration equilibria. In panel (a), (31) is illustrated as a downward sloping curve because the productivity effect outweighs the factor abundance effect. At point E, the real wages of each type of workers are equalized across countries. This equilibrium is unstable though, since we are considering a situation in which Home is more skilled-labor abundant than Foreign and the initial condition for factor endowments is given by a point such as A. As shown in Lemma 1, at point A, both types of workers earn a higher real income in Home than in Foreign. If migration is allowed, they both would move to Home. Without any restriction, the outflow of workers does not stop in Foreign. And eventually, the equilibrium is attained at point O in which all workers migrate to Home and Foreign turns out to be a "deserted island".

Meanwhile, panel (b) illustrates the case in which the factor abundance effect overwhelms the productivity effect. Thus, (31) is drawn as an upward sloping curve. In this case, the symmetric equilibrium point E is stable, and this is attained by the migration of skilled workers to Foreign from Home.

6   Outsourcing vs. Migration

It is important to examine whether outsourcing or migration is more desirable in terms of workers' real income. In this section, we show that "a conflict of interest" may arise under service outsourcing. In skilled-labor abundant Home, skilled workers prefer migration to outsourcing but the opposite is true for unskilled workers. However, *full outsourcing* can eliminate this conflict, because it is equivalent or superior to migration for both types of workers.

Recall that there are two migration equilibria, depending on whether condition (14) holds or not. If the productivity effect outweighs the factor abundance effect, all workers would

migrate to Home. Then, using (11) and (12), we can derive the real skilled and unskilled wages respectively as

$$\frac{w_H}{p_y} = (1 - \beta)\left(\frac{\delta}{c}\right)(n + n^*)^{\frac{(1-\delta)(1-\beta)}{\delta}}\left[\frac{L + L^*}{(n + n^*)z}\right]^{\beta}, \tag{33}$$

$$\frac{w_L}{p_y} = \beta(n + n^*)^{\frac{(1-\delta)(1-\beta)}{\delta}}\left[\frac{(n + n^*)z}{L + L^*}\right]^{1-\beta}. \tag{34}$$

We obtain two interesting findings for skilled workers, by comparing (21) with (33). On the one hand, in terms of the productivity effect, service outsourcing and immigration are equivalent. This is because the same variety of business services is available in either equilibrium. On the other hand, there exists a difference in the factor abundance effect. The numbers of skilled and unskilled workers increase in Home in the migration equilibrium, but remain the same in the outsourcing equilibrium. Specifically, the real skilled wage is higher in the migration equilibrium than in the outsourcing equilibrium iff

$$\frac{n}{L} > \frac{n + n^*}{L + L^*}. \tag{35}$$

This holds since $\frac{n}{L} > \frac{n^*}{L^*}$ by assumption[16]. That is, Home is relatively more skilled-labor abundant, and thus the factor abundance effect is greater in the outsourcing equilibrium than in the migration equilibrium. Consequently, immigration is more desirable than service outsourcing for skilled workers.

A similar argument can be applied to unskilled workers. By comparing (23) with (34), we find that the productivity effect is canceled out, but the factor abundance effect remains. In contrast to the case of skilled workers, the ranking of real income is completely opposite because Home is relatively more unskilled-labor scarce. Thus the real unskilled wage is higher in the service-outsourcing equilibrium than in the migration equilibrium iff (35) holds.

Proposition 1 *Suppose that condition (14) is satisfied. Then, in the migration equilibrium, all skilled and unskilled workers concentrate in Home. For skilled workers, the real income*

is higher in the migration equilibrium than in the service outsourcing equilibrium. However,
the opposite arises for unskilled workers.

What if condition (14) is not satisfied, i.e., when the factor abundance effect overwhelms the productivity effect? Then, the emigration of skilled workers from Home makes the size of skilled workers symmetric between countries and the real wages of skilled and unskilled workers become respectively

$$\frac{w_H}{p_y} = (1-\beta)\left(\frac{\delta}{c}\right)(\frac{n+n^*}{2})^{\frac{(1-\delta)(1-\beta)}{\delta}}\left[\frac{2L}{(n+n^*)z}\right]^{\beta}, \tag{36}$$

$$\frac{w_L}{p_y} = \beta(\frac{n+n^*}{2})^{\frac{(1-\delta)(1-\beta)}{\delta}}\left[\frac{(n+n^*)z}{2L}\right]^{1-\beta}. \tag{37}$$

In Home, as compared to autarky, the emigration of skilled workers hurts unskilled workers. Thus, home unskilled workers prefer service outsourcing to migration. Meanwhile, it is not obvious whether the same result holds or not for skilled workers because they benefit from migration as well as service outsourcing. A direct comparison of (21) with (36) shows that the real skilled wage is higher under emigration than under service outsourcing iff

$$2^{\frac{\delta-(1-\beta)}{\beta\delta}} > \frac{n+n^*}{n}. \tag{38}$$

This condition is more easily satisfied as δ rises. The positive productivity effect is greater under service outsourcing, but the negative factor abundance effect is smaller under emigration of skilled workers. The productivity effect is dominated by the factor abundance effect under a sufficiently large δ. It follows then Home skilled workers prefer migration to service outsourcing.

Applying a similar argument, we can show that, in Foreign, skilled workers prefer service outsourcing to immigration but the opposite arises for unskilled workers. If (14) is not satisfied, skilled workers lose from immigration of skilled workers and thus they prefer service outsourcing to immigration. In contrast, by using (23) and (37), we can show that unskilled

workers gain more from immigration of skilled workers than from service outsourcing iff

$$2^{\frac{1}{\delta}} < \frac{n + n^*}{n^*}. \tag{39}$$

This condition is more easily met as δ rises. That is, in Foreign, unskilled workers prefer migration to service outsourcing if the degree of scale economies is sufficiently small. We can summarize these as follows:

Proposition 2 *Suppose that condition (14) is not satisfied and the degree of scale economies is small enough for (38) and (39) to hold. Then, in the migration equilibrium, countries are symmetric in the sizes of both skilled and unskilled workers. In Home, the real skilled wage is higher under migration than under service outsourcing, but the opposite is true for the real unskilled wage. And exactly the opposite arises in Foreign.*

Propositions 1 and 2 suggest that a conflict of interest among workers with different skills may arise in either country, regardless if condition (14) is satisfied or not.

Finally, we examine how the above result would change if we allow outsourcing in unskilled-labor intensive processing. As is clear from Lemma 4, such outsourcing can benefit skilled workers but harm unskilled workers in Home. The issue is how full outsourcing affects the ranking of the real wages. Again, condition (14) is critical. If the productivity effect overwhelms the factor abundance effect (i.e., condition (14) is satisfied), then the real wage of each type of workers is identical to that under immigration. That is, migration and full outsourcing are equivalent.

On the other hand, if the factor abundance effect outweighs the productivity effect (condition (14) is violated), then the equivalence above does not hold. Since outsourcing makes available a greater variety of services, the productivity effect is higher under outsourcing than under migration. This implies that full outsourcing is superior to migration in terms of the real wages of both skilled and unskilled workers.

Proposition 3 *(i). If condition (14) holds, i.e., the productivity effect outweighs the factor abundance effect, then full outsourcing and immigration are equivalent in terms of the real wages of both skilled and unskilled workers. (ii). If condition (14) is violated, the full outsourcing equilibrium is superior to the migration equilibrium.*

Somewhat surprisingly, equivalence between migration and outsourcing arises again in terms of their effects on the inter-sectoral wage inequality. This is because the productivity effect is cancelled out and full outsourcing is equivalent to migration in terms of the factor abundance effect.

Corollary 2 *The effect of migration on the wage inequality is equivalent to that of full outsourcing, regardless if condition (14) holds or not.*

7 Outsourcing and Migration: Complements or Substitutes?

There is a large literature on whether commodity trade and factor mobility are complements or substitutes.[17] In this section we discuss this issue in the context of the present model. Our analysis suggests that international migration and *outsourcing* of unskilled labor-intensive processing are substitutes, since the former erodes the incentive for the latter. However, *service outsourcing* and migration of *skilled workers* are complements because the latter promotes the former.

Let us first consider the service outsourcing equilibrium. Recall that, in this equilibrium unskilled workers earn higher real wages in Home than in Foreign. This implies that unskilled workers would migrate to Home from Foreign. Meanwhile, the opposite result arises for skilled workers due to their higher real wage in Foreign rather than in Home. In either case, such migration leads to equalization in the skilled-unskilled labor ratios between countries, i.e., the equilibria would lie on the 45 degree ray from the origin in Figure 1.[18] Thus, the real

wages of both types of workers are the same as those in the full outsourcing equilibrium.[19] It follows that international migration of workers is a substitute for outsourcing in unskilled-labor intensive processing. Therefore, there is no incentive for such outsourcing in the migration-cum-service-outsourcing equilibrium.

In addition, migration may promote service outsourcing. Suppose that the migration equilibrium is achieved only through movements of skilled workers from Home to Foreign. This can be caused by government restrictions on unskilled-worker immigration. Then in equilibrium, the sizes of skilled workers are equalized between countries, and the volume of service imports in Home is $(\frac{n+n^*}{2})V' = \frac{(n+n^*)v^*}{4}$, where the import of each foreign service is $V' = \frac{v^*}{2}$. This is greater than the one in the service outsourcing equilibrium, $n^*V = \frac{n^*nv^*}{n+n^*}$, obtained from (22).[20] The emigration of skilled workers expands the foreign production of services, increasing Home imports of them. That is, the emigration of skilled workers is a complement for service outsourcing.

On the other hand, the migration equilibrium can also be achieved only through the movements of unskilled workers from Foreign to Home. Such migration does not have any effect on the volume of service imports since the number of skilled workers does not change. In this case, service outsourcing is independent of unskilled-worker migration. Thus we have:

Proposition 4 *International migration is a substitute for outsourcing in unskilled-labor intensive processing, but skilled-worker emigration is a complement to service outsourcing.*

8   Concluding Remarks

This paper analyzed the effects of outsourcing and migration on the wages of both skilled and unskilled workers. Our main findings are summarized in Table 1, which shows the effects of respectively migration and outsourcing on wages relative to autarky in the case where the productivity effect outweighs the factor abundance effect. Outsourcing raises all wages and reduces the wage gap between countries, but migration widens the international wage gap

and the wage inequality in the country that attracts workers.

We also examined whether offshore outsourcing and international migration are complements or substitutes. International migration is a substitute for outsourcing in unskilled-labor intensive processing. This arises because outsourcing in labor processing is caused by factor endowment differences and migration leads to the equalization of skilled-unskilled labor ratios between countries. Meanwhile, service outsourcing and skilled-labor migration are complements because the increasing similarity in the sizes of skilled workers promotes two-way outsourcing in differentiated business services.

Finally, the present model can probably be extended to a setting of two sectors (business services and final good) and three factors (skilled labor, unskilled labor and capital). Over the past two decades, the importance of FDI inflows increased in developing countries (Goldberg and Pavcnik 2007). Incorporating capital may enable us to examine the relationship between outsourcing and actual capital movement, and the impact of capital movements on the wage inequality. We leave these for future research.

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Notes

[1]Mattoo (2002) states, "while some developing countries are increasingly investing in other countries to export services, most supply services via cross border sales (for example data processing)... Developments in information and communication technology have dramatically increased the scope for cross-border exports of services, ranging from software developments in the Philippines to data processing in Barbados... One of the most striking recent examples of developing-country service export success story is the Indian software industry."

[2] Griswold and Buss (2004, p. 5) report that "In 2002, ... U.S. companies exported $14.8 billion worth of computer, data processing, research, development, construction, architectural, engineering and other IT services. During that same year, Americans imported $3.9 billion of those same kinds of services. So for every dollar Americans sent abroad for IT outsourcing in 2002, the world sent more than three dollars to the United States for 'insourcing'."

Note that in this paper, outsourcing does not mean the relocation of a whole stage of the production process from one country to another. Instead, it means the import of new intermediate services available only from abroad. For instance, *World Investment Report 2004* (2004, p. 171) reports that Nortel (a Canadian company) started outsourcing some parts of software development activities to India not because it could achieve cost savings by the relocation of its R&D activities but because it saw a serious constraint in terms of a shortage of locally available technical skills. Nortel started using Indian programmers not because it substituted them for North American programmers but because it complemented its software development activities.

[3]Jones (2005) reviews the existing literature on the labor market effects of outsourcing and immigration.

[4]Also, Acemoglu (2003) argues that trade liberalization induces skill-biased technological change, which leads to an increase in wage inequality in developing countries. However, the

empirical evidence is mixed (Goldberg and Pavcnik 2007).

[5]Ethier (1982) and Markusen (1989) assume that differentiated producer services are costlessly assembled into a final good. In Helpman and Krugman (1985, Ch. 11), the production of a final good uses capital and labor in addition to a variety of differentiated intermediate inputs. Marrewijk et al. (1997) generalize these models in that both final goods require differentiated producer services and primary factors, and examine the effects of service trade liberalization on the factor price equalization set by the use of the World Integrated Equilibrium a la Helpman and Krugman. All of these models have a Heckscher-Ohlin feature such that production requires two primary factors.

Another branch of the literature has a Ricardian feature in that only labor is used in production. Marrewijk, Stibora, and Vaal (1996) consider technological differences between countries, i.e., differentiated intermediate services can be produced only in one country, and examine the welfare effects of service trade liberalization. In addition, Matusz (1996) merges a model of monopolistic competition in intermediate goods with the Shapiro-Stiglitz model of efficiency wages to show that the introduction of international trade leads to increased employment in both countries.

[6]Recently, Grossman and Helpman (2002) and Antras and Helpman (2004) also examine outsourcing of production, but their interests are different from ours since they analyze the organizational structure of firms. In addition, Grossman and Rossi-Hansberg (2006) develop a model based on the Heckscher-Ohlin framework to study the labor market effect of offshore outsourcing, but they do not make a comparison between outsourcing and international migration. In a most recent paper, Mitra and Ranjan (2007) study offshoring by focusing on unemployment which is caused by search frictions.

[7]Let a superscript * denote variables associated with Foreign.

[8]We only consider manufacturing and services industries, where outsourcing is most active. Goldberg and Pavcnic (2007) state, "when China liberalized its markets, many firms in Hong Kong shifted their relatively less-skilled-labor-intensive activities to Chinese border re-

gions, while specializing in higher-skilled intensive activities, such as headquarter services, at home." Of course, LDCs and DCs can differ in many other aspects, such as land and capital endowments, agricultural technology, labor market institutions, etc., which we abstract from in this paper. In spite of these differences, some developing countries such as Columbia and Mexico recently implemented various policy changes including labor market reform, which substantially increased labor market flexibility (Goldberg and Pavcnic (2007)).

[9]Since the elasticity of substitution between differentiated services is equal to $\frac{1}{1-\delta}$, the parameter δ is also the measure of the degree of substitution. A smaller δ leads to a higher degree of differentiation and a larger productivity effect.

[10]The wage inequality can be written as $\frac{w_H}{w_L} = \left(\frac{1-\beta}{\beta}\right)\left(\frac{L}{H}\right)$, which implies that the skilled wage is higher than the unskilled wage if skilled workers' factor share is greater than their endowment share, relative to those of unskilled workers.

[11]The nature of unskilled-labor outsourcing is the improvement in production efficiency, since it equalizes the marginal products of unskilled labor across countries. This arises because, in the full outsourcing equilibrium, Home exports services and imports the final good, i.e., its balance of trade equation would be $p_y(C_y - y) = p_z n(z - Z) - p_v^* n^* V$. Since $V = Z^*$, we have $p_y(C_y - y) = (p_z n - p_v^* n^*)V$, which implies that the difference in the size of skilled labor results in inter-industry trade. Also note that complete specialization does not arise because labor is sector specific.

[12]In Krugman's setting, both factors are used in the sectors with scale economies, and in this sense, both factors are symmetric. In contrast, skilled and unskilled workers are asymmetric in the present model.

[13]In the full outsourcing equilibrium, (30) can be written as $\frac{1-\beta}{\beta}\left(\frac{2L}{H+H^*}\right)$, which is higher than the Home autarkic wage inequality $\frac{1-\beta}{\beta}\left(\frac{L}{H}\right)$, but lower than the Foreign one, $\frac{1-\beta}{\beta}\left(\frac{L}{H^*}\right)$, because of the factor abundance difference between countries.

[14]Hong Kong experienced a large increase in the relative demand for skilled workers after firms shifted relatively unskilled-labor-intensive production activities to China (Hsieh and

Woo (2005)).

[15]India experienced an increase in wage inequality during recent decades and such an increase is mainly attributed to skill-biased technological changes within industries (Kijima (2006)). Examining the impact of outsourcing on wage inequality in India remains a topical issue (Goldberg and Pavcnik (2007)).

[16]In deriving (35), we use the expression of V in (22) to rewrite (21).

[17]For a description of recent developments on this topic, see Jones (2000, Ch. 1).

[18]See the Appendix for proofs.

[19]This can be easily confirmed because the equalization of skilled-unskilled labor ratios leads to the equality of the factor endowment effect under migration-cum-service outsourcing and under full outsourcing.

[20]$\left(\frac{n+n^*}{2}\right) V' - n^* V = \frac{(n-n^*)^2 v^*}{4(n+n^*)} > 0.$

	Service outsourcing	Full outsourcing	Migration
Home skilled wage	+	+	+
Foreign skilled wage	+	+	-
Home unskilled wage	+	+*	+**
Foreign unskilled wage	+	+	-
Home wage inequality	0	+	+
Foreign wage inequality	0	-	-
Skilled wage gap $\left(\frac{w_H}{p_y} - \frac{w_H^*}{p_y^*}\right)$	-	-	+
Unskilled wage gap $\left(\frac{w_L}{p_y} - \frac{w_L^*}{p_y^*}\right)$	-	-	+**

Table 1: Wage effects relative to autarky when $1 - \beta > \delta$ holds, i.e., all types of workers concentrate in Home in the migration equilibrium. * indicates that the sign holds if δ is sufficiently small and/or skilled-labor endowments are sufficiently similar between countries. ** indicates the sign holds if δ is sufficiently small.

Figure captions: Figure 1: Migration equilibria
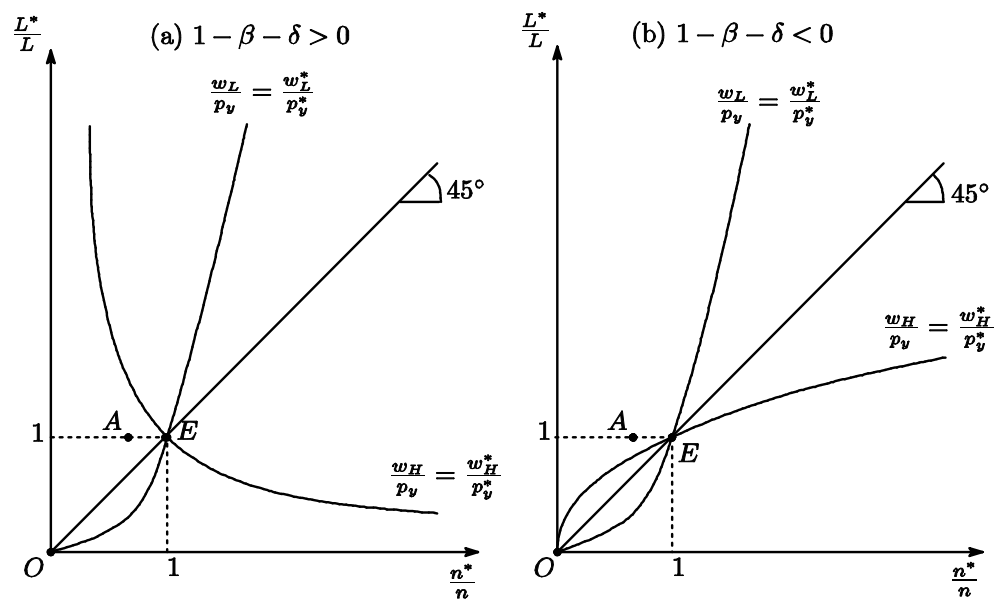

Figure 1

Appendix

Proof: We now derive the condition for the migration-cum-service-outsourcing equilibrium.

From (21) and the foreign counterpart, the real skilled wages are equalized iff

$$\left[\frac{L}{(n+n^*)V}\right]^\beta = \left[\frac{L^*}{(n+n^*)Z^*}\right]^\beta. \tag{A1}$$

Using (22), we can rewrite it as

$$\frac{L}{nv^*} = \frac{L^*}{n^*z}. \tag{A2}$$

Since $z = v^*$, (A2) is equivalent to

$$\frac{L^*}{L} = \frac{n^*}{n}. \tag{A3}$$

For the real unskilled wages to be equalized between countries, condition (A3) must hold.

Q.E.D.