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# Offshoring and Labor Markets in Developing Nations

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*Abstract*

We present a model of task offshoring from a developed nation to a developing nation. We find that an improvement in offshoring technology must benefit the developed nation and the world as a whole. However, the developing nation receiving the offshored jobs may suffer welfare losses. What is intriguing is that this paradoxical result obtains in a perfectly competitive world which is also free of any policy distortions. In the presence of a unilaterally optimal wage tax imposed by the developing nation on its offshoring sector, this paradox can be ruled out. Similarly, a minimum wage regulation can also rule out this paradox. Although the context is different, these results are reminiscent of Bhagwati's findings on immiserizing growth, where optimal trade taxation rules out the paradox.

Keywords: Offshoring, Outsourcing, Developing nation labor markets, Optimal taxation.

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## 1. Introduction

In this paper we analyze the impact of offshoring of production tasks from a developed nation to a developing nation. An improvement in offshoring technology reduces the transportation cost of tasks and should lead to a rise in the level of offshoring. At the same time, each task will require less labor to be used up for the transportation process. The expansionary effect of the technological improvement will tend to raise the demand for labor in the developing nation, while the reduction in transportation cost will reduce labor demand. The net effect of these two factors on the developing nation labor market is ambiguous, in general. We present a model that identifies the qualitative conditions which determine whether technological improvement in offshoring is immiserizing for the developing nation. Furthermore, we analyze the effects of a wage tax policy in the developing nation.

The "Great Recession" starting 2007 has focused policy attention on the effects of offshoring on employment in developed nations. The literature has established that contrary to popular belief laborers in developed nations can benefit from offshoring. Among others, an influential paper by Grossman and Rossi-Hansberg (2008, henceforth referred to as GRH) shows that improved offshoring technology may raise productivity and benefit domestic labor in the offshoring nation. In a similar vein, the empirical literature has established that offshoring and developed nations' employment can be complements rather than substitutes. For example, Desai et al. (2005) show a strong positive correlation between foreign activities and domestic activities of US multinational firms. Mankiw and Swagel (2006) conclude that increased employment in the overseas affiliates of U.S. multinationals is associated with more employment in the U.S. parent. Harrison and McMillan (2011) find that foreign employment and domestic employment

are substitutes for firms undertaking horizontal foreign direct investment and they are complements for firms undertaking vertical foreign direct investment.

Acemoglu and Autor (2010) use a competitive model to analyze how recent changes in earnings and employment distribution in the United States and other advanced economies are shaped by the interactions among worker skills, job tasks, and shifting trading opportunities. Mitra and Ranjan (2010) focus on search frictions and how offshoring may impact unemployment in such an environment. While most of the literature in this area has used competitive and monopolistically competitive models, there are some exceptions. For example, using an oligopolistic framework, Zhao (2001) focuses on a vertically integrated unionized firm which may want to outsource to hedge against disruptions caused by the domestic union. Chen et al. (2004) analyzes strategic incentives to buy intermediate inputs provided by a foreign firm, where the domestic and the foreign firm compete oligopolistically in the final goods market. Bandyopadhyay et al. (2014) also use an oligopolistic framework and identify conditions under which barriers to offshoring may be counterproductive in terms of raising domestic employment.

The focus of the existing literature is predominantly on the developed nations' labor markets, where the developing nations' markets are typically black-boxed by assuming that they supply labor at constant terms-of-trade. It is, however, important to explore how such offshoring may impact the developing nations. While this focus is important by itself, it also informs us about the feedback effects on developed nations. Also, just as the labor market effects of offshoring on the developed nations may not be obvious, our analysis shows that offshoring may pose interesting dilemmas for developing nations as well.

## 2. The Model

Consider a world where there is a developed nation *F* and a developing nation *H*. The developed nation's competitive firms produce a single numeraire good $x^*$ with one factor of production, which is labor. Labor supply of the developed nation is inelastically given at $\bar{L}^*$, and the wage rate in the developed nation is assumed to be fully flexible. Along the lines of GRH, a unit of $x^*$ requires a continuum of labor tasks $i \in [0,1]$ to be performed either in *H* or in *F*. A task *i* from *F* to *H* requires an offshoring cost of $\beta t(i)$ of *H*'s labor [where $\beta t(i) > 1$].[1] If the wage cost of performing a task *T* is lower in *F* compared to *H*, the task is performed in *F*, otherwise it is offshored to *H*.

In addition to performing the offshored tasks from nation *F*, nation *H*'s labor is also used to produce the same good domestically with an alternate constant returns to scale production technique

$$x = F\left(L^a, T\right), \tag{1}$$

where $L^a$ and *T* are labor and land used in this alternate sector and *x* is its output. Given that land is a specific input in this sector, and given that its endowment is $\bar{T}$, we can suppress it from the functional form, and express Eq. (1) as:

$$x = f\left(L^a\right), \; f'(.) > 0, \text{ and } f''(.) < 0, \tag{2}$$

*H*'s labor supply is given inelastically at $\bar{L}$. Let *w* be the wage rate in *H*. Then, profit maximization in the alternate sector requires that

[1] In the rest of the paper we refer to a reduction of $\beta$ as an improvement in offshoring technology, or as a parametric reduction in offshoring cost. It is important to note that offshoring cost also involves endogenous elements like the range of tasks offshored and the wage rates at which such tasks are performed. Hence, when we write "parametric reduction in offshoring cost", we are referring solely to the exogenous element of the cost, captured by $\beta$.

$$w = f'\left(L^a\right) \Rightarrow L^a = L^a\left(w\right),\ L^{a'}\left(.\right) < 0. \tag{3}$$

Trade is assumed to be balanced, where the import of good $x^*$ by *H* is balanced by equivalent export of *H*'s labor services through performance of the offshored tasks.

### 3. Global First Best: No Policy Intervention

Let $w^*$ be the wage rate in *F*. Let any task *i* that has to be performed to produce $x^*$ require $a^*$ units of labor to complete in *F*, and $a$ units of labor to complete in *H*. For simplicity, let $a^* = a = 1$. Recall that $\beta t\left(i\right)$ labor units of *H* are required to offshoring task *i* from *F* to *H*. Therefore, a task *i* is offshored to *H* if and only if:

$$w^* \geq w\beta t\left(i\right). \tag{4}$$

As in GRH we assume that task $i = 0$ is cheaper to conduct in *H* and is offshored from *F*, while task $i = 1$ is cheaper to perform in *F*. Under these assumptions, and given continuity and monotonicity of $t\left(i\right)$, an interior solution obtains where Eq. (4) holds as an equality. Denoting the marginal task as $I$, Eq. (4) yields

$$t\left(I\right) = \frac{w^*}{w\beta} \Rightarrow I = I\left(\frac{w^*}{w\beta}\right),\ \text{where},\ I'\left(\frac{w^*}{w\beta}\right) = \frac{1}{t'\left(I\right)} > 0. \tag{5}$$

Given that $t'\left(i\right) > 0$, it is clear that tasks $i \in \left(I, 1\right]$ cost more to be done in *H* compared to *F*, and hence are conducted in *F*. The remaining tasks $i \in \left[0, I\right]$ are offshored to *H*. Noting that each offshored task *i* uses $\beta t\left(i\right)$ units of *H*'s labor per unit of the final good, labor demand in *H*'s offshoring sector, $L^{dH}$, is

$$L^{dH} = x^*\beta\mu\left(I\right),\ \mu\left(I\right) = \int_{i=0}^{I} t\left(i\right)di, \tag{6}$$

Full employment in *H* requires that:

$$L^{dH} + L^{a}\left(w\right) = \overline{L}\,, \tag{7}$$

Similarly, full employment in *F* requires:

$$L^{dF} = x^{*}\left(1-I\right) = \overline{L}^{*} \Rightarrow x^{*} = x^{*}\left(I;\overline{L}^{*}\right),\ x_{I}^{*} > 0\,, \tag{8}$$

where $L^{dF}$ denotes labor demand in *F*. The firms' unit cost of production $c^{*}$ is the sum of their unit labor costs in *H* and *F* for carrying out all the different stages of production. Thus,

$$c^{*} = w^{*}\left(1-I\right) + w\beta\mu\left(I\right). \tag{9}$$

Let us define a variable $z = w\beta$, to capture the effective wage paid by the firms to developing nation's labor. When $\beta$ is unity, the effective wage equals the developing nation's wage. When $\beta$ falls below unity, the effective wage is smaller reflecting greater efficiency in offshoring.

Using Eq. (5) in Eq. (9), and using the zero-profit condition, which requires $c^{*}$ to equal the price of the numeraire good, we have:

$$w^{*}\left[1-I\left(\frac{w^{*}}{z}\right)\right] + z\mu\left[I\left(\frac{w^{*}}{z}\right)\right] = 1 \Rightarrow w^{*} = w^{*}\left(z\right),\ w^{*\prime}\left(z\right) = -\frac{\mu}{1-I} < 0\,, \tag{10}$$

Using Eq. (10) in Eq. (5):

$$I = I\left(\frac{w^{*}\left(z\right)}{z}\right) = \phi\left(z\right), \text{ where } \phi'\left(z\right) = -\frac{I'\left(.\right)\left(t\left(1-I\right)+\mu\right)}{z\left(1-I\right)} < 0 \tag{11}$$

Using Eq. (11), and substituting $\tilde{w} = z/\beta$ in Eq. (7), we can use Eqs. (6) through (8) to yield:

$$\frac{L^{dH}}{L^{dF}} = \frac{\beta\mu\left(\phi\left(z\right)\right)}{1-\phi\left(z\right)} = \overline{l} - \frac{L^{a}\left(z/\beta\right)}{\overline{L}^{*}} \Rightarrow z = z\left(\beta\right), z'\left(\beta\right) > 0\,, \tag{12}$$

where $\overline{l}$ is the ratio of home and foreign labor endowments.

Using Eq. (12) in Eqs. (10) and (11), we have

$$\frac{dw^*}{d\beta} = w^{*\prime}(z)z'(\beta) < 0, \text{ and } \frac{dI}{d\beta} = \phi'(z)z'(\beta) < 0. \tag{13}$$

GRH had shown that there are different effects on the wage rate of the developed nation of a reduction in the offshoring parameter $\beta$. Among them, the pure technology improvement effect tends to raise the offshoring nation's wage in their model. In this section's model, other confounding aspects of the GRH model for the developed nation are absent, hence a fall in $\beta$ must raise *F*'s wage.

Using Eqs. (8) and (11) in Eq. (6), we get

$$L^{dH}(\beta, z) = \frac{\beta \bar{L}^* \mu\left[\phi(z)\right]}{1-\phi(z)} = \frac{\psi(z)}{w}, \text{ where, } \psi(z) \equiv \frac{z\bar{L}^* \mu\left[\phi(z)\right]}{1-\phi(z)} \tag{14}$$

Let $\tilde{L}^{dH} = L^{dH} / \beta$, denote a measure of effective demand for labor. Then

$$\tilde{L}^{dH} = \frac{\bar{L}^* \mu\left[\phi(z)\right]}{1-\phi(z)} = \tilde{L}^{dH}(z). \tag{15}$$

Using Eqs. (14) and (15):

$$\psi(z) \equiv z\tilde{L}^{dH}(z). \tag{16}$$

Eq. (16) yields:

$$\psi'(z) = \tilde{L}^{dH}(1-\eta) < 0 \text{ iff } \eta > 1, \ \eta = -d\ln\tilde{L}^{dH} / d\ln z = -d\ln L^{dH} / d\ln w > 0, \tag{17}$$

where $\eta$ is labor demand elasticity in the offshoring sector of the developing nation. Using Eqs. (7) and (14),

$$\frac{\psi(z)}{w} + L^a(w) = \bar{L} \Rightarrow w = w(z),$$

$$\text{where } \frac{dw}{dz} = \frac{\psi'(z)}{L^{dH} - wL^{a\prime}(w)} < 0, \text{ if and only if } \psi'(z) < 0. \tag{18}$$

Using Eqs. (12), (17) and (18):

$$\frac{dw}{d\beta} = z'(\beta)\frac{dw}{dz} < 0 \text{ , if and only if } \eta > 1. \tag{19}$$

Now, $\eta$ can be shown to be:

$$\eta = \eta(I) = \frac{\left[t(I)(1-I) + \mu(I)\right]^2}{t'(I)\mu(I)(1-I)^2}. \tag{20}$$

It is clear from the form above, that the form of the transportation cost function $t(i)$ has an important bearing on this elasticity, as does other exogenous factors which determines the level of the equilibrium level of offshoring. If the transportation cost function is relatively flat, offshoring can rise to a greater extent in response to a fall in $\beta$. This is reflected in a lower $t'(I)$, which, *ceteris paribus*, will tend to raise the elasticity of labor demand in *H*'s offshoring sector, as evident from Eq. (20) above. Analogously, if transportation cost rises rapidly [i.e., $t'(I)$ is large], demand $\tilde{L}^{dH}$ is more likely to be inelastic, raising the possibility of a decline in *H*'s wage rate. In this case, the labor saving effect of an improvement in offshoring technology dominates the scale effect, reducing total labor demand in *H*'s offshoring sector. Full employment is restored through a fall in $\tilde{w}$. Now, *H*'s welfare is:

$$W = w\bar{L} + \rho\bar{T}, \tag{21}$$

where $\rho$ is land rental. Differentiating Eq. (21) and using CRS properties described in Eq. (1), we get:

$$\frac{dW}{d\beta} = \left(\bar{L} - L^a\right)\frac{d\tilde{w}}{d\beta} = L^{dH}\frac{dw}{d\beta} < 0 \text{ if and only if } \eta > 1. \tag{22}$$

Foreign welfare $W^*$ is simply the foreign wage bill $w^*\bar{L}^*$. Thus, using Eq. (13),

$$\frac{dW^*}{d\beta} = \overline{L}^* \frac{dw^*}{d\beta} < 0 . \tag{23}$$

Finally, note that global welfare $U$ must equal both the sum of the individual nations' welfare levels and also must equal the global production of the numeraire good. Thus,

$$U = W + W^* = x^* + x . \tag{24}$$

Differentiating Eq. (24), and using Eqs. (22) and (23), it is clear that when $\eta > 1$,

$$\frac{dU}{d\beta} = \frac{dW}{d\beta} + \frac{dW^*}{d\beta} < 0 . \tag{25}$$

Now, Eq. (24) also implies that:

$$\frac{dU}{d\beta} = \frac{dx^*}{d\beta} + \frac{dx}{d\beta} . \tag{26}$$

Using Eqs. (8) and (13) we can infer that $\frac{dx^*}{d\beta} < 0$. Using CRS properties of Eq. (1) and profit maximizing conditions, we can show that:

$$\frac{dx}{d\beta} = wL^{a\prime}(w)\frac{dw}{d\beta} < 0 , \text{ when } \frac{dw}{d\beta} > 0 \Leftrightarrow \eta < 1. \tag{27}$$

Using Eqs. (26) and (27), we can infer that when $\eta < 1$, it must be that $\frac{dU}{d\beta} < 0$. Using this result and also Eq. (25), we can infer that global welfare must always rise in response to an improvement in offshoring technology.

Proposition 1

When both the developed nation and the developing nation are characterized by fully flexible wages, a parametric reduction in the offshoring cost raises wages and welfare in the developed

nation. The developing nation gains if and only if labor demand in the offshoring sector is elastic. Global welfare must rise.

*Comment*

Proposition 1 provides an intriguing twist to the discussion of the effects of offshoring and globalization. Typically policy discussions tend to focus on potential problems for the developed nation labor markets due to improved efficiency in offshoring. At the same time, the developing nation labor markets are typically ignored, perhaps from the assumption that offshoring should raise labor demand in these nations, to their benefit. Proposition 1, derived in the context of a first-best standard offshoring model, turns these presumptions on their head. While the developed nation and the world must gain from such a technology improvement, the developing nation must lose. When demand is inelastic, the labor saving effect of the technological change dominates the expansionary scale effect, and domestic wage can fall. What is also striking that this paradox occurs in a world characterized by competitive markets and absence of any policy distortions.

## 4. Policy Intervention by *H*

Let there be a tax at the ad valorem rate $\tau$ on the wage earned in the offshoring sector of *H*. Denoting the offshoring sector's wage as $w$ and that of the alternate sector as $w^a$, we have that in equilibrium,

$$w(1-\tau) = w^a . \tag{28}$$

Eq. (3) has to be replaced by:

$$w^a = f'(L^a) \Rightarrow L^a = L^a(w^a),\ L^{a\prime}(w^a) < 0 . \tag{29}$$

Noting that $z = w\beta$, using Eqs. (28) and (29), we can replace Eq. (12) by:

$$\frac{L^{dH}}{L^{dF}}=\frac{\beta\mu\left(\phi\left(z\right)\right)}{1-\phi\left(z\right)}=\overline{l}-\frac{L^{a}\left[z\left(1-\tau\right)/\beta\right]}{\overline{L}^{*}}\Rightarrow z=z\left(\beta,\tau\right),\ z_{\beta}>0\text{, and }z_{\tau}>0\text{.} \tag{30}$$

Using Eq. (30) in Eqs. (10) and (11) we can see that a rise in $\tau$ must reduce $w^{*}$. Also, noting that $w=z/\beta$, it is clear that the tax will raise domestic wage in the offshoring sector. Finally, because the tax raises $z$, using Eq. (14) it is easy to see that it reduces $L^{dH}$. To maintain full employment $L^{a}\left(w^{a}\right)$must rise. This means that the tax must reduce $w^{a}$. Assuming that the taxes that are collected are returned to the home residents in a lump sum manner, *H*'s welfare is:

$$W=wL^{dH}+w^{a}L^{a}+\rho\overline{T}\text{.} \tag{31}$$

This reduces to:

$$dW=\left(w-w^{a}\right)dL^{dH}+L^{dH}dw\text{.} \tag{32}$$

The second term in the right-hand-side of the equality is the terms-of-trade effect we saw in Eq. (22), while the first term is due the wedge between the wages in the two sectors caused by the tax. Eq. (32) yields:

$$dW=Ad\beta+Bd\tau\text{ ,where }A=\left(\tau+\frac{L^{dH}}{L^{dH}-w^{a}L^{a'}}\right)\left(1-\eta\right)\tilde{L}^{dH}z_{\beta}\text{, and }B=\left(1-\tau\eta\right)\tilde{L}^{dH}z_{\tau}\text{.} \tag{33}$$

**Case 1:** Tax rate is exogenously given at $\tau=\overline{\tau}$.

$$\frac{dW}{d\beta}=A<0\text{, iff }\eta>1\text{.} \tag{34}$$

Thus, proposition 1 extends to this case for any tax rate $\tau=\overline{\tau}$.

**Case 2:** Tax rate is chosen to maximize domestic welfare.

If an interior optimum exists at $\tau^{o}$, then,

$$\frac{\partial W}{\partial\tau}=0\Rightarrow B=0\Rightarrow\tau^{o}=\frac{1}{\eta}\text{.} \tag{35}$$

Now, given that at an interior optimum $\tau^o < 1$, it must be that $\eta > 1$. Using this fact in Eq. (33), the envelope property of the optimized welfare function yields:

$$\frac{dW}{d\beta}_{|\tau=\tau^o} = A < 0 . \qquad (36)$$

Proposition 2

For any arbitrary wage tax rate on the offshoring sector, welfare must rise in response to an improvement in the offshoring technology if labor demand is elastic. At an optimal wage tax, labor demand must be elastic, and therefore developing nation welfare must rise under optimal wage taxation.

*Comment*

Proposition 2 rules out the possibility of the welfare paradox identified in proposition 1 in the presence of optimal intervention. This is reminiscent of Bhagwati's (1968) result that immiserization can be ruled out under optimal trade taxation.

## 5. Further Work: Minimum Wages/Search Frictions/Multi-country Analysis

*In this ongoing project, we intend exploring some or all of the following questions:*

*(A). How do minimum wages and/or search frictions affect the analysis?*

*(B). When we have several potential destination nations for offshoring, the interdependence of their tax policies call for a strategic analysis. How is the analysis modified in this case?*

## 6. Conclusion

Our analysis shows that while improvements in offshoring technology must benefit the developed nation, its effect on the developing nation is ambiguous. If the labor saving effect of technological improvement dominates, the developing nation may suffer a welfare loss. This outcome arises when the labor demand in the offshoring sector is inelastic. This surprising welfare effect is akin to Bhagwati's (1958) immiserizing growth paradox. We extend the analysis to the case where the developing nation can tax wages in the offshoring sector. If this tax is exogenously given, the welfare paradox cannot be ruled out. However, if the tax is set at an unilaterally optimal level, the equilibrium must occur on the elastic range of the labor demand curve, which, along the lines of Bhagawti (1968), rules out the immiserization paradox.

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