

Offshoring and Dual 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. The developed nation's labor market is assumed to feature flexible wages and full employment, while the developing nation's labor market is considered in alternate scenarios. First, with complete wage flexibility, an improvement in the offshoring technology raises wages and welfare in both nations. Second, when the developing nation has a rigid minimum wage, its unemployment may rise and its welfare may fall due to improved offshoring technology, while the developed nation must gain. Finally, when the developing nation is characterized by a minimum wage formal sector and a flexible wage informal sector, improved offshoring technology may hurt the developed nation. If the developed nation loses, the developing nation must gain, and the informal sector wage must rise. Among other results, we find the paradoxical possibility that the developing nation's unemployment and welfare can both increase with an increase in the minimum wage.

Keywords: Dual labor markets, Informal sector, Minimum wage, Task Offshoring, Developing nations.

JEL codes: F1; H8

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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. In particular, we focus on the effects of such offshoring on the developing nation's labor market. While the developed nation's labor market is assumed to feature flexible wages and full employment, the developing nation's labor market is considered in three alternate scenarios. In scenario 1, the developing nation features full employment and wage flexibility. In scenario 2, there is a rigid minimum wage and unemployment in the developing nation. In the third and final scenario, we consider a dual labor market structure in the developing nation where a formal and an informal sector coexist. While the formal sector is subject to the minimum wage regulation, the informal sector is assumed to be able to circumvent the law and pay a lower market clearing wage.

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, even for laborers in developed nations such offshoring can be beneficial. While improved offshoring technology may help in substituting away toward cheaper foreign labor, the productivity improvement that is realized can have a scale effect which may benefit domestic labor in the developed nation. Among others, an influential paper by Grossman and Rossi-Hansberg (2008) demonstrates this possibility. In a similar vein, the empirical literature has established that for developed nations, offshoring and 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.

Theoretical developments in the offshoring literature have kept pace with the evolving scenarios in such trade. 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. A Parsimonious Model of Offshoring and Dual labor Markets

Consider a world where there is a developed nation F and a developing nation H . The developed nation's competitive firms produce a single good x^* with one factor of production, which is labor. Labor supply of the developed nation is inelastically given at \bar{L}^* . Along the lines of Grossman and Rossi-Hansberg (2008, henceforth referred to as GRH) a unit of x^* requires a continuum of labor tasks $i \in [0,1]$ to be performed either in H or in F . First, we consider a standard labor market for H , where there is no dual structure. Later, we extend the analysis to consider a dual labor market in H characterized by a formal and an informal sector.

In the standard labor market representation, 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 labor 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 . Nation H has an inelastic labor supply of \bar{L} , the sole use of this labor is in completing tasks offshored by H . If the wage rate is flexible, the labor market clears at a wage that ensures full employment in H . If there is a minimum wage in H , then there may be unemployment in that nation. We assume

¹ In the rest of the paper we refer to a reduction of β 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 β .

throughout that the wage rate in F is flexible, guaranteeing full employment in F . Also, 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. Good x^* serves as the numeraire.

Developing nations are often characterized by a dual labor market environment, where a formal and an informal labor market coexist. Formal labor markets typically feature large and well organized firms bound by laws and regulations that they conform to, pay corporate income taxes, get import licenses, have labor unions etc. The informal sector is usually characterized by smaller firms which may not possess the entire range of capabilities of formal sector firms, but can perform some less demanding tasks, do not face organized labor, and are able to perform their work without being subject to many laws and regulations of the formal sector firms. Our model offers two distinguishing elements of the formal-informal characterization. First, we assume that while the formal sector is subject to a government mandated minimum wage, the informal sector can ignore this regulation. Essentially, the informal structure makes it hard for a developing nation government to monitor minimum wage laws in such establishments. Second, we assume that getting tasks done in an informal sector involves additional costs. This may be due to lack of infrastructure that this sector is endowed with, and consequent difficulty with transporting such tasks to this sector. We discuss this issue in more detail in the next paragraph.

As in GRH, while some tasks may be more easily offshored (compared to other tasks) to nation H from F , some tasks are more easily offshored to the formal compared to the informal sector in H . We assume that three things that guide the choice between performing a task in the informal sector vis-à-vis the formal sector. First, we assume that for any task i an offshoring labor cost $\beta t(i) > 1$ is incurred in units of labor belonging to the sector (formal or informal) to which the task is offshored. Secondly, if the task is offshored to the informal sector there is an

additional labor cost $\tilde{\beta}\tau(i) > 1$ in terms of informal sector labor units.² Finally, tasks differ in terms of their offshorability to the informal sector compared to the formal sector.³ While some tasks are almost equally costly to offshore to the two sectors, some others are much harder to offshore to the informal sector compared to the formal sector. In particular, we assume that tasks that are more difficult to offshore to the formal sector from nation F , are also relatively more difficult to offshore to the informal sector in comparison to the formal sector. We order tasks in increasing degree of difficulty of offshorability to H 's formal sector to get $t'(i) > 0$ for $i \in [0,1]$.

² Thus, the cost of offshoring task i to the formal sector is $\beta t(i)$ in labor units, while this cost is $\beta\tilde{\beta}t(i)\tau(i)$ for the informal sector. The additional cost $\tilde{\beta}\tau(i)$ captures the inconvenience of moving a task to a location that is not as well organized as the formal sector. There may be different ways to think about it. The simplest is that firms need to incur additional transportation cost in getting the task to the informal sector, which may be located in areas which are more difficult to get to from the port of entry into H . Another way to think about it is that the technology in the informal sector mimics the transportation costs that we model, where it is more costly to complete any task in the informal sector compared to the formal sector.

³ Building on the previous footnote, one can imagine that it is harder to move some tasks to the less accessible informal sector locations. An alternate interpretation is that while all tasks in the formal sector may use the same amount of labor, it is possible that technology differences between the sectors make some tasks in the informal sectors use more labor than others. Given the structure of our offshoring costs being measured in units of labor time in the respective sectors, this second interpretation is entirely consistent with our model and analysis.

This same order is maintained in terms of the additional difficulty of offshoring to the informal sector, which requires that $\tau'(i) > 0$ for $i \in [0, 1]$.⁴

Under complete wage flexibility in the formal sector, the informal sector does not exist, and our model reduces to one dealing only with *offshoring* and with no informal labor market. As a *first-best* benchmark that features no wage rigidity, we analyze this model in section 2.1 below. Next, in section 2.2, we turn our attention to the case where there is a binding minimum wage in H , but where no informal labor market exists. In this case, the minimum wage causes some unemployment in H 's labor market, and we can compare how the wage rigidity causes departures from the first-best situation of section 2.1. Finally, in section 2.3, we build a full-fledged model of *offshoring* with dual labor markets along the lines we have discussed above.

2.1 First Best: The Model with Full Employment and Wage Flexibility in Both Nations (with no informal sector)

Let \tilde{w} and w^* be the wage rates in H and F , respectively. Let any task i 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 $\beta t(i)$ 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:

⁴ This assumption is not crucial. If we have a different ordering of $t(i)$ and $\tau(i)$, it is possible that the marginal task to be offshored may not be conducted in the formal sector. This brings in a different set of analytical conditions to play. It is less cumbersome to proceed with our current assumption, where assuming that some offshored tasks are conducted in the formal sector, the marginal offshored task must be conducted in the formal sector.

$$w^* \geq \tilde{w}\beta t(i). \quad (1)$$

Eq. (1) reduces to:

$$t(i) \leq \frac{w^*}{\tilde{w}\beta}. \quad (2)$$

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 , and in both cases Eq. (2) holds as strict inequalities. Under these assumptions, and given continuity and monotonicity of $t(i)$, an interior solution obtains where Eq. (2) holds as an equality. Denoting the marginal task as I , Eq. (2) yields

$$t(I) = \frac{w^*}{\tilde{w}\beta} \Rightarrow I = I\left(\frac{w^*}{\tilde{w}\beta}\right), \text{ where, } I'\left(\frac{w^*}{\tilde{w}\beta}\right) = \frac{1}{t'(I)} > 0. \quad (3)$$

Given Eqs. (1)-(3), and given that $t'(i) > 0$, it is clear that tasks $i \in (I, 1]$ cost more to be done in H compared to F , and hence are conducted in F . The remaining tasks $i \in [0, I]$ are offshored to H .⁵ Denoting the total output produced by F 's firms as x^* , recalling that $a = 1$, and noting that each offshored task i uses $\beta t(i)$ units of H 's labor per unit of the final good, full employment in H requires that:

⁵ See Figure 1. We note that all wages except the minimum wage in nation H (introduced later) used in figures 1 through 4 are endogenous, and treated accordingly throughout our analysis. However, this is a competitive model where firms are identical and atomistic. Therefore, a representative firm ignores the effect of their offshoring decision on the wage rates. Accordingly, these figures which assume given wages, provide a qualitatively accurate description of firm behavior.

$$L^{dH} = x^* \beta \mu(I) = \bar{L}, \quad \mu(I) = \int_{i=0}^I t(i) di, \quad (4)$$

where L^{dH} denotes labor demand in H . Recalling that $a^* = 1$, full employment in F requires:

$$L^{dF} = x^* (1-I) = \bar{L}^* \Rightarrow x^* = x^*(I; \bar{L}^*), \quad x_i^* > 0, \quad (5)$$

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

$$c^* = w^* (1-I) + \tilde{w} \beta \mu(I). \quad (6)$$

Noting that the final good produced by the competitive firms in F is the numeraire good, the zero profit condition requires that:

$$w^* (1-I) + \tilde{w} \beta \mu(I) = 1. \quad (7)$$

Using Eqs. (4) and (5):

$$\frac{\beta \mu(I)}{1-I} = \bar{l} \Rightarrow I = \phi(\beta, \bar{l}), \quad \text{where } \bar{l} = \frac{\bar{L}}{\bar{L}^*}. \quad (8)$$

Using Eqs. (3) and (7):

$$w^* \left[1 - I + \left(\frac{\tilde{w} \beta}{w^*} \right) \mu(I) \right] = 1 \Rightarrow w^* \left[1 - I + \frac{\mu(I)}{t(I)} \right] = 1 \Rightarrow w^* = w^*(I), \quad \text{and,}$$

$$\frac{dw^*}{dI} = \frac{\mu t'}{t^2 \left(1 - I + \frac{\mu}{t} \right)} > 0. \quad (9)$$

Using Eqs. (8) and (9):

$$\frac{\partial I}{\partial \beta} = -\frac{\mu}{\beta t + \bar{l}} < 0, \quad \text{and} \quad \frac{\partial w^*}{\partial \beta} = \left(\frac{dw^*}{dI} \right) \left(\frac{\partial I}{\partial \beta} \right) < 0. \quad (10)$$

GRH had shown that there are different effects on the wage rate of the developed nation of a reduction in the offshoring parameter β . 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 β must raise F 's wage. Now, using Eq. (3), we get

$$\tilde{w} = \frac{w^*(I)}{\beta t(I)}. \quad (11)$$

Using Eqs. (8) through (11), we can show that

$$\frac{\partial \tilde{w}}{\partial \beta} < 0. \quad (12)$$

Thus, in addition to raising the developed nation's wage, a fall in β must also raise the developing nation's wage. The finding is not obvious, because while greater offshoring raises labor demand in the developing nation, improvement in offshoring technology requires less of such labor for every task offshored. However, the foregoing analysis suggests that the expansionary effect of offshoring must dominate.

Finally, note that the welfare in the each nation is its wage bill, and that employment in each nation is given by the full employment condition. It is immediate that a rise in the wage rates in the two nations must also raise both nations' welfare levels. Summarizing the findings thus far, we get proposition 1 below.

Proposition 1

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

2.2 The Model with a Minimum Wage in H but with no Informal Sector

Let \bar{w} be the minimum wage in H . Eqs. (1) through (7) of the previous subsection still hold with the caveat that \tilde{w} is replaced by \bar{w} . Eq. (9) of the previous section is modified to:

$$w^* \left[1 - I \left(\frac{w^*}{\bar{w}\beta} \right) \right] + \bar{w}\beta\mu \left[I \left(\frac{w^*}{\bar{w}\beta} \right) \right] = 1 \Rightarrow w^* = w^*(\bar{w}\beta), \quad w^{*'}(\bar{w}\beta) = -\frac{\mu}{1-I} < 0. \quad (13)$$

From Eq. (13) we immediately get the result that a lowering of offshoring cost through a reduction in β must raise the wage in the developed nation F . Similarly, a fall in the minimum wage in H also must raise F 's wage rate. We now turn to the effect of these parameters on labor demand and hence on unemployment in H . Keeping in mind that the labor market does not clear, we can use Eqs. (3), (4), and (5) of the previous section to get

$$L^{dH} = L^{dH}(\bar{w}, \beta) = \beta x^* \left[I \left(\frac{w^*(\bar{w}\beta)}{\bar{w}\beta} \right) \right] \mu \left[I \left(\frac{w^*(\bar{w}\beta)}{\bar{w}\beta} \right) \right]. \quad (14)$$

It is easy to check using Eq. (14) that $L^{dH}(\bar{w}, \beta)$ is monotonically decreasing in the minimum wage, and hence unemployment

$$U = U(\bar{w}, \beta) = \bar{L} - L^{dH}(\bar{w}, \beta), \quad (15)$$

is monotonically increasing in the minimum wage.⁶ The effects of the offshoring cost parameter β are:

$$\frac{dI}{d\beta} = \frac{I'(\cdot)}{\beta} \left(w^{*'} - \frac{w^*}{\bar{w}\beta} \right) < 0; \quad I' = \frac{1}{t'(I)} > 0 \quad (16)$$

$$\frac{\partial L^{dH}}{\partial \beta} < 0 \text{ iff } \mu < \left(t + \frac{\mu}{1-I} \right)^2 I'. \quad (17)$$

⁶ See Figure 2.

In the light of Eq. (13), Eq. (16) suggests that a fall in β must raise offshoring, because the effective wage of nation F relative to nation H (i.e., $\frac{w^*}{\bar{w}\beta}$) rises. However, Eqs. (15) and (17) suggest that the effect of the offshoring parameter on H 's unemployment is less clear. If $t'(I)$ is small, a shifting of the margin of offshoring does not significantly raise the offshoring cost, allowing for a large expansion of offshoring in response to a fall in β . In this case, it is more likely that labor demand in H will rise (and its unemployment will fall) in response to a fall in β .

Welfare in H is:

$$W = \bar{w}L^{dH}(\bar{w}, \beta). \quad (18)$$

It can be shown that:

$$\frac{\partial W}{\partial \bar{w}} < 0 \text{ iff } \mu < \left(t + \frac{\mu}{1-I}\right)^2 I', \quad (19)$$

which is the same condition as one outlined in Eq. (17) above. The intuition is that when the minimum wage rises, if there is a large cutback in offshoring then the wage bill $\bar{w}L^{dH}(\bar{w}, \beta)$ declines in response to a rise in \bar{w} . Thus, the welfare effect of a minimum wage increase is ambiguous. Notice that:

$$\frac{\partial W}{\partial \beta} = \bar{w} \frac{\partial L^{dH}}{\partial \beta} < 0 \text{ iff } \mu < \left(t + \frac{\mu}{1-I}\right)^2 I'. \quad (20)$$

Thus, if and only if $\mu < \left(t + \frac{\mu}{1-I}\right)^2 I'$, a rise in the minimum wage reduces H 's welfare and a

fall in β raises H 's welfare. Welfare in F is:

$$W^* = w^* \bar{L}^*. \quad (21)$$

Using Eqs. (13) and (21):

$$\frac{\partial W^*}{\partial \bar{w}} = \bar{L}^* \frac{\partial w^*}{\partial \bar{w}} < 0, \text{ and } \frac{\partial W^*}{\partial \beta} = \bar{L}^* \frac{\partial w^*}{\partial \beta} < 0. \quad (22)$$

Thus, a rise in H 's minimum wage unambiguously reduces F 's welfare, while an improvement in offshoring technology unambiguously improves F 's welfare. Taking the welfare levels of the two nations into consideration, we can conclude that a rise in the minimum wage must hurt at least one of the nations, and can hurt both nations. On the other hand, an improvement of offshoring technology must benefit at least one nation, and can benefit both. Also, when both nations are hurt by a rise in the minimum wage, it must be that both nations gain from a parametric reduction in offshoring cost. Proposition 2 below summarizes the findings of this subsection.

Proposition 2

When the developing nation has a minimum wage and unemployment, an improvement in offshoring technology must raise the developed nation's wage and welfare, but unemployment may rise and welfare may fall in the developing nation. A rise in the minimum wage must reduce the developed nation's wage and welfare, and raise the developing nation's unemployment. However, it is possible that the developing nation's welfare rises if offshoring is relatively inelastic with respect to change in the effective relative wage between the nations.

2.3 The Model with a Minimum Wage Formal Sector and a Flexible Wage Informal Sector in H and with Full Employment in both Nations

2.3.1 The Offshoring and Outsourcing Equilibrium

In this subsection we consider the choice of a firm of nation F to conduct a task in one of three locations, (i), in F 's own labor market; or (ii). in the formal sector of H which is characterized by a minimum wage \bar{w} ; or (iii). in the informal sector of H which has a flexible labor market clearing wage w .⁷ For analytical simplicity, consider the choice to be made in two stages.⁸ In stage 1, a firm chooses whether to offshore a task i to nation H . In stage 2, the firm chooses whether to conduct the task in H 's formal sector or in its informal sector. We solve the model by backward induction.

Stage 2:

Let the marginal task offshored in stage 1 be I . Given our ordering which requires that $t(i)$ and $\tau(\cdot)$ are both strictly increasing in i , all tasks $i \in [0, I]$ are also offshored. The cost of conducting a task j in the formal sector is $\bar{w}\beta t(j)$. Cost of doing the same task in the informal sector is $w\beta\tilde{\beta}t(j)\tau(j)$. Now, for $i = 0$, let the wage cost of the task in the informal sector [i.e., $w\beta\tilde{\beta}t(0)\tau(0)$] be lower than doing the task in the formal sector [i.e., $\bar{w}\beta t(0)\tau(0)$]. Also, for

⁷ Unit labor requirement for performing a task is assumed to be unity in all locations including the informal sector.

⁸ The staging assumption is purely for ease of exposition, nothing changes when we consider a simultaneous three-way choice between F 's own labor market and the two sectors in H .

$i = I$, let the corresponding cost be lower in the formal sector. These two conditions require, respectively,

$$\bar{w} > w\tilde{\beta}\tau(0) \Rightarrow \tau(0) < \frac{\bar{w}}{w\tilde{\beta}}; \text{ and, } \bar{w} < w\tilde{\beta}\tau(I) \Rightarrow \tau(I) > \frac{\bar{w}}{w\tilde{\beta}}. \quad (23)$$

If the conditions outlined in Eq. (23) are met, an interior solution for allocation of the tasks between the formal and informal sector obtains as:

$$\tau(J) = \frac{\bar{w}}{w\tilde{\beta}} \Rightarrow J = J\left(\frac{\bar{w}}{w\tilde{\beta}}\right), \quad J'(\cdot) = \frac{1}{\tau'(J)}. \quad (24)$$

Thus, tasks $i \in [0, J(\cdot)]$ are conducted in the informal sector, while the remaining tasks $i \in [J(\cdot), I]$ are conducted in the formal sector.⁹ Noting that x^* units of output are produced by nation F 's firms, labor demand in H 's informal sector is:

$$\tilde{L}^{dH} = x^* \int_{i=0}^J \beta\tilde{\beta}t(i)\tau(i)di = x^* \beta\tilde{\beta}\theta(J), \text{ where } \theta(J) = \int_{i=0}^J t(i)\tau(i)di. \quad (25)$$

Labor demand in H 's formal sector is:

$$\hat{L}^{dH} = x^* \int_{i=J}^I \beta t(i)di = x^* \beta\mu(J, I), \text{ where } \mu(J, I) = \beta \int_{i=J}^I t(i)di. \quad (26)$$

Noting that labor supply of H is given at \bar{L} , full employment in H requires that:

$$\tilde{L}^{dH} + \hat{L}^{dH} = x^* \beta [\tilde{\beta}\theta(J) + \mu(J, I)] = \bar{L}. \quad (27)$$

Using Eq. (24) in (27), we get the informal wage in H as:

$$w = w(I, x^*; \gamma), \quad \gamma = (\beta, \tilde{\beta}, \bar{w}, \bar{L}). \quad (28)$$

⁹ See Figure 3.

Stage 1:

Given $\tau'(i) > 0$, and given Eqs. (23) and (24) above, the marginal offshored task I is more costly to produce in the informal sector compared to the formal sector. Thus, when there is an interior offshoring solution, it must be that the margin in the formal sector of H is equated to the margin in F 's labor market.¹⁰ Thus:

$$w^* = \bar{w}\beta t(I) \Rightarrow I = I\left(\frac{w^*}{\bar{w}\beta}\right), \quad I'(\cdot) = \frac{1}{t'(I)} \quad (29)$$

Because $t'(\cdot) > 0$, all tasks $i \in (I, 1]$ are strictly more expensive to offshore than to be conducted in F . Thus, tasks $i \in [0, I]$ are offshored to H , and the remaining tasks $(1 - I)$ are conducted in F .

Using Eqs. (25), (26) and (29), the cost of conducting all the different stages to produce a unit of output is given by:

$$c^* = w^*(1 - I) + w\beta\tilde{\beta}\theta(J) + \bar{w}\beta\mu(J, I). \quad (30)$$

Using Eqs. (24), (28), and (29), in (30), we get the firms' zero profit condition as:

$$c^*(w^*, x^*; \gamma) = 1, \quad (31)$$

where,

$$c^*(w^*, x^*; \gamma) = w^*[1 - I(\cdot)] + w(I, x^*; \gamma)\beta\tilde{\beta}\theta[J(\cdot)] + \bar{w}\beta\mu[J(\cdot), I(\cdot)].$$

The full employment condition for F is:

$$x^*[1 - I(\cdot)] = \bar{L}^*. \quad (32)$$

Using Eqs. (31) and (32) we get:

¹⁰ See Figure 4. The lower envelope of the curves which is denoted using solid lines is the lowest cost method for the firm to conduct the different offshored tasks.

$$w^* = w^*(\gamma, \bar{L}^*), \text{ and } x^* = x^*(\gamma, \bar{L}^*). \quad (33)$$

Using Eq. (33) we can derive all the variables presented in the preceding equations.

2.3.2 Comparative Statics

For conducting comparative statics, it is convenient to solve the model recursively as follows.

Using Eqs. (27) and (32) we get

$$\beta \left[\tilde{\beta} \theta \left\{ J \left(\frac{\bar{w}}{w \tilde{\beta}} \right) \right\} + \mu \left\{ J \left(\frac{\bar{w}}{w \tilde{\beta}} \right), I \left(\frac{w^*}{\bar{w} \beta} \right) \right\} \right] = [1 - I(\cdot)] \bar{l} \Rightarrow w = \chi(w^*, \bar{l}, \gamma), \quad (34)$$

where, $\frac{\bar{L}}{\bar{L}^*} = \bar{l}$. Using Eq. (34) in Eq. (31), we get

$$\psi(w^*, \gamma, \bar{l}) = 0, \quad (35)$$

where,

$$\psi(w^*, \gamma, \bar{l}) = w^* \left[1 - I \left(\frac{w^*}{\bar{w} \beta} \right) \right] + \chi(w^*, \bar{l}, \gamma) \beta \tilde{\beta} \theta \left[J \left(\frac{\bar{w}}{\chi(\cdot) \tilde{\beta}} \right) \right] + \bar{w} \beta \mu [J(\cdot), I(\cdot)] - 1.$$

Now, we can use Eqs. (34) and (35) to derive comparative static wage changes in the two nations. Then, we can use Eq. (32) to derive the effect on the scale of output x^* . We first explore the effect of a fall in the offshoring cost parameter β . GRH show that a fall in this cost must raise the wage rate in the developed offshoring nation. They do not consider the effect on the developing nation's labor market. In sections 2.1 and 2.2 above we show that their finding extends to models with or without full employment in the developing nation as long as there is no informal sector. We show below that in the presence of an informal sector it is possible that the developed nation's wage (and welfare) may indeed fall in response to an improvement in offshoring technology. Using Eq. (35):

$$\frac{dw^*}{d\beta} = -\frac{\psi_\beta}{\psi_{w^*}}, \text{ where } \frac{\partial\chi}{\partial w^*} > 0 \Rightarrow \psi_{w^*} = 1 - I + \beta\tilde{\beta}\theta \frac{\partial\chi}{\partial w^*} > 0, \text{ and,}$$

$$\psi_\beta = \tilde{\beta}w\theta + \bar{w}\mu + \beta\tilde{\beta}\theta \frac{\partial\chi}{\partial\beta}. \quad (36)$$

Now, $\frac{\partial\chi}{\partial\beta}$ captures changes in the relative excess demand for labor in H (relative to F), for a

given w^* . While a fall in β reduces the labor demand for a given level of I , the rise in

offshoring tends to raise labor demand in H . If the first effect dominates, a fall in β reduces

labor demand in H and reduces w . In this case, $\frac{\partial\chi}{\partial\beta} > 0$, implying that $\psi_\beta > 0$.¹¹ In turn, Eq.

(36) implies that $\frac{dw^*}{d\beta} = -\frac{\psi_\beta}{\psi_{w^*}} < 0$, which means that as in GRH, an improvement in offshoring

technology must raise the developed nation's wage. On the other hand, if the fall in β raises

offshoring by a sufficiently large amount in response to a fall in β , relative demand for labor in

H rises, leading to a rise in the informal wage. In this case, $\frac{\partial\chi}{\partial\beta} < 0$, and it is not possible to rule

out the case where $\psi_\beta < 0$. When $\psi_\beta < 0$, Eq. (36) implies that $\frac{dw^*}{d\beta} > 0$, implying that an

improvement in offshoring technology reduces the offshoring nation's wage. This happens

¹¹ Using Eq. (34), we get that $\frac{\partial\chi}{\partial\beta} > 0$ if and only if $\tilde{\beta}\theta + \mu > I'(\cdot)t(I)\left(t + \frac{\bar{I}}{\beta}\right)$, where

$I'(\cdot) = 1/t'(I)$. The left-hand-side of the inequality is the labor saving due to a fall in the offshoring parameter β at a given offshoring level I , while the right-hand-side reflects the rise in labor demand in H due to an increase in the offshoring level (engendered by a fall in β).

because there are essentially two factors with flexible factor prices that get rewarded from the production of a unit of output. One of these factors is labor in F , the other is the labor of H 's informal sector. If the reward of the latter rises, then in a constant sum game (where there are no efficiency gains) the reward of the other factor must fall. However, because β falls, there are efficiency gains, and hence it is possible that both factors gain, which will be the case if $\frac{\partial \chi}{\partial \beta} < 0$,

and $\psi_\beta > 0$. Now, we turn to the effect of β on the informal sector wage. Using Eq. (34):

$$\frac{dw}{d\beta} = \chi_{w^*} \frac{dw^*}{d\beta} + \chi_\beta. \quad (37)$$

Substituting for $\frac{dw^*}{d\beta}$ by using Eq. (36), Eq. (37) reduces to:

$$\frac{dw}{d\beta} = -\frac{\chi_{w^*} (\tilde{\beta} w \theta + \bar{w} \mu)}{\psi_{w^*}} + \frac{\chi_\beta (1-I)}{\psi_{w^*}}. \quad (38)$$

Noting that $\chi_{w^*} > 0$, and $\psi_{w^*} > 0$, we have the following possibilities:

Case 1: ($\chi_\beta \geq 0$)

In this case, Eq. (36) implies that $\frac{dw^*}{d\beta} < 0$. On the other hand, Eqs. (37) and (38) imply that $\frac{dw}{d\beta}$

can be either negative or positive. From Eq. (38) we can conclude that if $\chi_\beta = 0$, then $\frac{dw}{d\beta} < 0$.

Case 2: ($\chi_\beta < 0$)

When $\chi_\beta < 0$, Eq. (36) implies that $\frac{dw^*}{d\beta}$ may be positive or negative. However, Eq. (38)

implies that when $\chi_\beta < 0$, $\frac{dw}{d\beta} < 0$. Welfare in F is:

$$W^* = w^* \bar{L}^*. \quad (39)$$

Thus, F 's welfare rises with a fall in β if and only if $\frac{dw^*}{d\beta} < 0$. Now x^* is the only consumption good in this model. Thus, global welfare is simply the level of x^* . Thus, H 's welfare (which is the sum of the wage earnings in the formal and the informal sectors) must be:

$$W = x^* - W^*. \quad (40)$$

Using (32) and (39) in (40), we get:

$$W = \bar{L}^* \left(\frac{1}{1-I} - w^* \right). \quad (41)$$

Thus, if a fall in β raises w^* , that tends to reduce W . On the other hand, I must rise (because $\frac{w^*}{\bar{w}\beta}$ rises). The latter effect tends to raise W . The developing nation's welfare rises if and only if the second effect dominates.¹² If a fall in β reduces w^* , we can show that offshoring must

¹² The technical condition for this to happen is the following. We can show that when $\frac{dw^*}{d\beta} < 0$,

$$\frac{dW}{d\beta} < 0 \text{ if and only if } \varepsilon_{\beta}^{w^*} < \frac{I'}{\bar{w}\beta(1-I)^2 - I'}, \text{ where } \varepsilon_{\beta}^{w^*} \equiv -\frac{d \ln w^*}{d \ln \beta} > 0. \text{ Clearly, when } I' \text{ is}$$

large, the right-hand-side of the inequality is large. The elasticity on the left-hand-side is endogenous, but from Eq. (36) and its discussion we may conclude that when positive, this elasticity is more likely to be small for large values of I' , which can potentially raise the informal wage, dampening the upward movement of w^* . Thus, H 's welfare is more likely to rise with a fall in β if offshoring is very elastic with respect to changes in β .

still rise, implying that both effects (changes in I and w^*) tend to raise H 's welfare.¹³

Proposition 3 below summarizes the important findings of this subsection.

Proposition 3

When the developing nation has a minimum wage formal sector and a flexible wage informal sector, an improvement in the offshoring technology may or may not raise the developed nation's wage (and welfare). If the developed nation's wage falls, the developing nation's aggregate welfare and the wage in its informal sector must rise.

The welfare of the formal sector workers is:

$$W^\phi = \bar{w}\beta\mu x^* . \tag{42}$$

Welfare of informal sector workers is:

$$W^\eta = w\beta\tilde{\beta}\theta x^* . \tag{43}$$

Welfare of H (i.e., W) is the sum of W^ϕ and W^η . Although Eq. (41) informs us about this sum, we do not yet know how its individual components change (i.e., how the distribution between the formal and informal sector changes). Next we turn to this analysis.

¹³ It is clear from Eq. (36) and the discussion following it that w^* can fall only if w rises in response to a fall in β . In turn, this is only possible if offshoring rises sufficiently to increase labor demand in H . Thus, in both cases, where w^* may rise or fall, offshoring must rise.

3. Conclusion

The analysis features full wage flexibility for the developed nation, but different labor market scenarios for the developing nation. Wages and welfare levels in both nations rise in response to an improvement in offshoring technology under full wage flexibility in both nations. When there is a minimum wage in the developing nation, its unemployment may rise and its welfare may fall in response to an improvement in offshoring technology. However, the developed nation must gain. Finally, when a minimum wage formal sector and a flexible wage informal sector coexist in the developing nation, cost reduction in offshoring may hurt the developed nation. If the developed nation's wage and welfare decline, the developing nation must benefit, and the informal wage in the developing nation must rise. Results pertaining to changes in the minimum wage have also been derived. For example, in the model that features a minimum wage and unemployment in the developing nation, a rise in the minimum wage must raise its unemployment, yet its welfare may rise.

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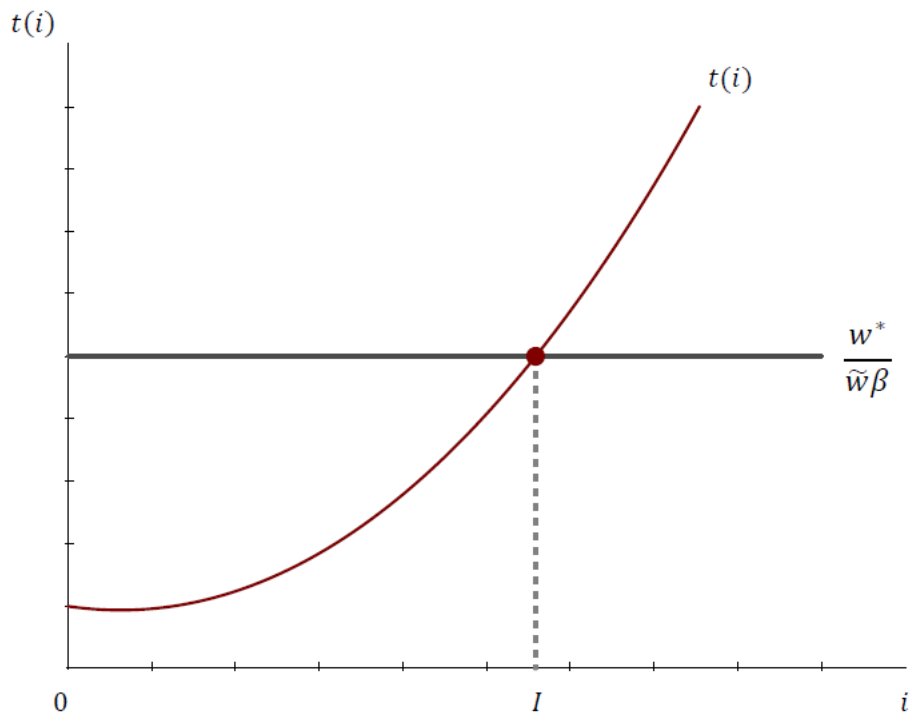


Figure 1

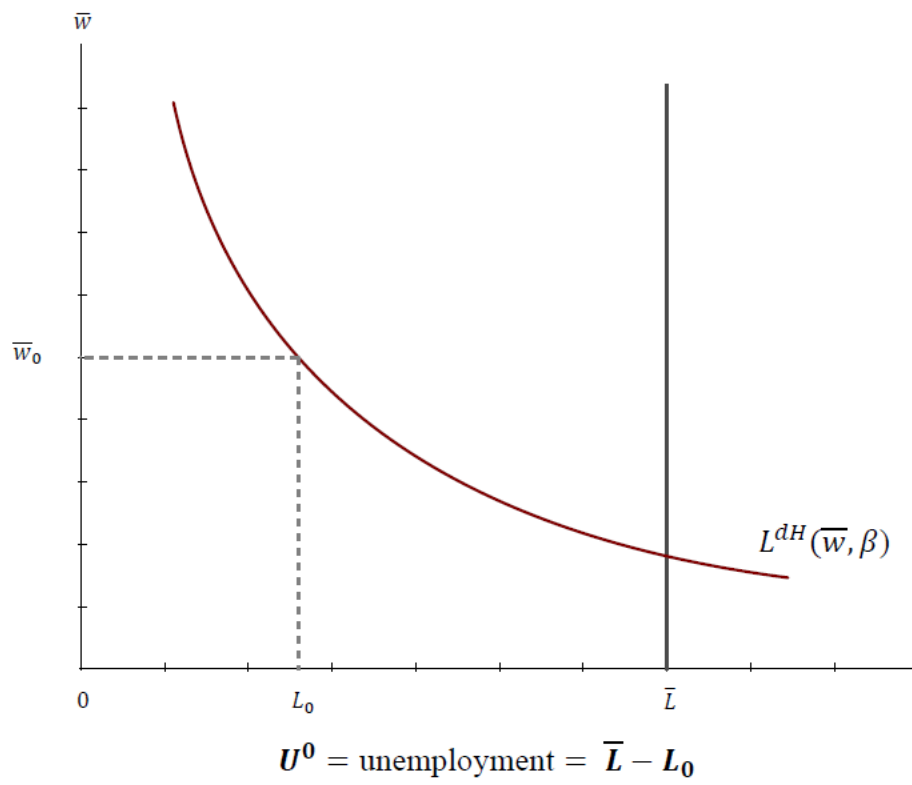


Figure 2

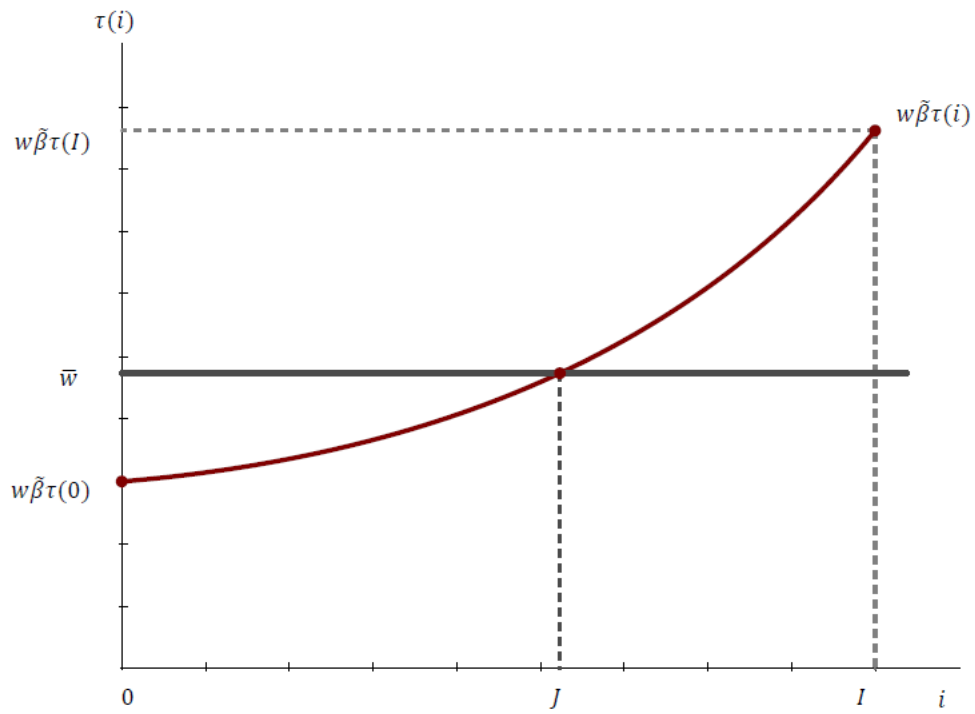


Figure 3 (For a given w)

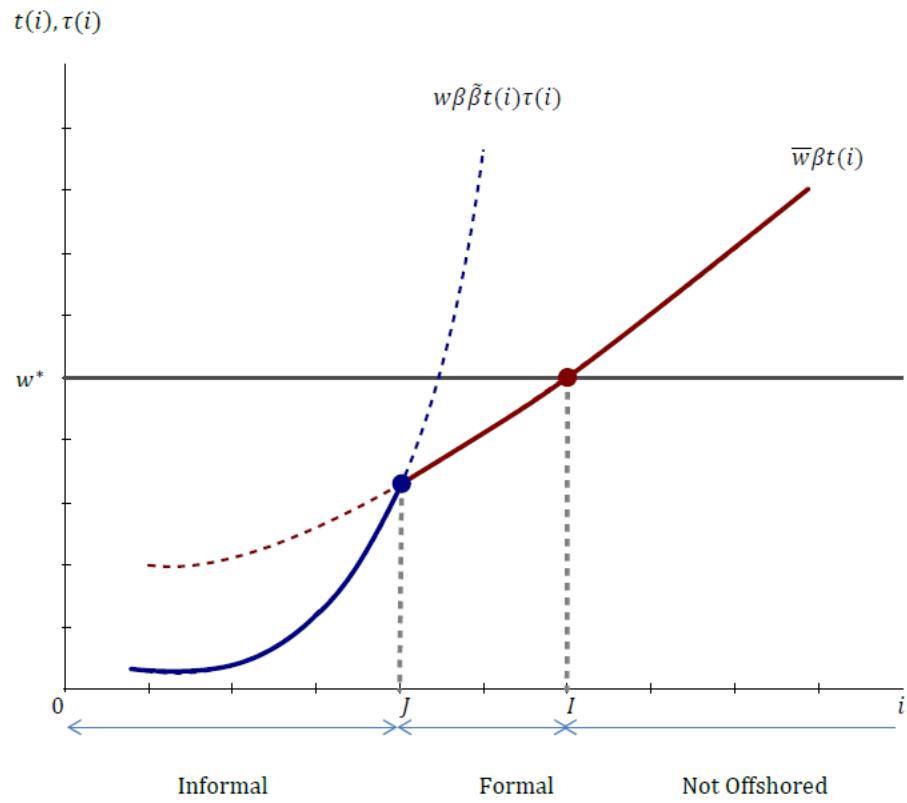


Figure 4 (For given w)