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FDI and the relative wage in a North South Global Economy

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Abstract

This paper examines the effect on relative wages when FDI occurs from the North to the South. The Northern firms undertake FDI to take advantage of the lower wage of unskilled labor in the South. The key assumption is that FDI from North to South occurs in an unskilled labor intensive production activity, but that activity is located in a sector that is relatively skill-intensive. It is shown that FDI leads to an increase in the relative wage of skilled labor in both North and South. It is also found that FDI may increase unemployment of unskilled labor in the South.

KEYWORDS: FDI, Relative wage, North-South trade, Vertical integration, Arms-length trading.
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1 Introduction

Many developed countries like the USA, UK, Canada and Japan have experienced a significant increase in the wages of skilled workers relative to those of unskilled workers in the last two decades. This has been discussed in many recent works, for example in Feenstra and Hansen (1996, 1997), and Katz and Autor (1999), to name only a few. In the US, for example, the wages of college graduates relative to the wages of high school graduates increased by over 25% between 1979 and 1995 (Acemoglu (2002)).

One explanation behind this rise in wage inequality is based on FDI activity. There has been substantial reduction of FDI restrictions in many developing countries from 1980 onwards. Since then many Northern multinationals have been shifting parts of their production process in the developing countries. Typically, those parts of the production activity are shifted that require high amounts of unskilled labor, which is abundant and cheap in the South. Indeed, as noted in Ray (1998, pp 730-735), many U.S. based automobile and electronics manufacturers, for example, have set up large offshore units in Mexico. It is argued that this shifting of unskilled labor-intensive production processes to the South has reduced the demand for unskilled labor in the North, and raised the relative wage inequality.[1]

This theory however leads to an unavoidable implication – that is, since demand for unskilled labor increases in the South, the relative wage should decrease there.[2] Indeed, in some developing countries like Malaysia and Philippines the relative wage has fallen (Das (2002), Marjit and Acharyya (2003)). However, in many other developing countries especially in Latin America like Mexico, Costa Rica, Columbia and Chile, the relative wage has increased following FDI inflows from the North (Feenstra and Hansen (1996, 1997), Cragg and Epelbaum (1996)), Marjit and Acharyya (2003). Robbins (1994), for example, noted that in Chile the wages of college graduates relative to the wages of high school graduates increased by over 56% between 1980 and 1990.

Most of the recent literature regarding the effect of FDI on relative wages confines itself to either the relative wage change in the North (e.g. Katz and Murphy (1992)), or only in the South (e.g. Das (2002)). A notable exception is Feenstra and Hansen (F-H) (1996, 1997), who explained the simultaneous rise in the relative wage both in the North (USA) and in the South (Mexico) following FDI by Northern multinationals. They assume a production technology with a continuum of production stages, differing in their skilled-unskilled labor intensities. Initially, with free trade but no FDI, North (South) specializes in the more skilled (unskilled) labor-intensive stages. After FDI, North firms shift

[1] There are other well-known explanations as well like unskilled labor saving technological progress.

[2] Throughout the paper, by relative wage we will mean the wage of skilled labor relative to unskilled labor.

those production stages to the South that is unskilled labor intensive among those that they already specialize. However, while these production activities are low skilled ones from North's perspective, they are high-skilled ones for the South. Thus the average skilled labor intensity in production rises in both the North and the South. So the demand for skilled labor increases both in North and in South, thereby raising the relative wage inequality in both countries.

This ingenious argument however depends crucially on the assumption that FDI takes place on those production activities which, though relatively low skilled in the North, are high skilled in the South. If, as often the case, this activity is less skilled in the South also (take, for example, the shifting of call-centers) then the relative wage falls in the South. In contrast, this paper demonstrates that even if the production activities that are shifted from the North to the South are low-skilled *in the South*, the relative wage can increase in *both* North and South. That the relative wage rises in the South is the 'surprising' part of course, and, it constitutes the main result of this paper.

How can this happen? Similar to F-H, think of the world economy having two countries, North and South, between which there is free international trade in goods. However, in contrast to the F-H model which has one traded good with multiple stages of production that vary in skill intensity, suppose – more conventionally – that there are two goods – a numeraire food (F), and manufactures (M). Good F is the unskilled-labor intensive sector, compared to good M. While good F is produced by a single stage technology, the production of good M has two stages: upstream and downstream. In the upstream (first) stage, an intermediate input is produced with the help of unskilled labor only. In the downstream (second) stage, skilled labor is combined with the intermediates to produce the final good.

Both upstream and downstream activities may be undertaken by a single firm, i.e. firms in sector M are vertically integrated. Or final-good producers in sector M (who engage only in the downstream activity) may be buying the intermediates at arms length. Assume that in either case the Northern producers of the intermediates are technologically more efficient than their Southern counterparts. Also assume that the Northern firms are more efficient in the downstream activity.

Suppose that FDI takes place in the manufacturing sector in the upstream stage, i.e. the Northern firms produce the intermediates in the South – using unskilled labor only, which is cheaper than in the North. In this framework there are two ways in which FDI would affect relative wages in the two countries.

1. In the case of vertical integration, the North firms, by engaging in FDI in the South, are able to lower their unit cost. Free entry and exit in sector M imply price equals unit cost.

Thus, at given relative price of good M, the lowering of cost via FDI is analogous to a sector-

specific technological progress occurring only in the North – although as such, there is no technological progress either in the North or South. FDI would thus exert a Findlay-Grubert effect: the manufacturing sector being relatively skilled-labor intensive, the relative wage tends to increase in the North. Since the South firms continue to produce the intermediate input themselves, there is no such effect on them and hence no change in the relative wage occurs in the South through this effect. We can call this a *localized cost-saving effect*.

In the case where the intermediate good is produced by other firms competitively at arms length, after FDI the Southern final good manufacturers buy the intermediate input from the Northern producers at a lower cost. Hence they also benefit from the cost reduction because of FDI. Hence, the cost saving effect is *global*, and the relative wage at a *given price of good M* tends to rise in the South as well as the North.

2. The global economy is obviously closed. The relative price changes as a result of the sectoral output change due to FDI. This exerts a *Stolper-Samuelson effect.* If FDI increases (decreases) the relative price of manufactures in the global economy, it will increase (decrease) the relative wage of skilled labor in both North and South. As will be outlined in a moment, there are two scenarios analyzed in the paper in which the relative price of the manufactures does *increase* as a result of FDI.

Therefore, the combined influence of the two effects is that the relative wage increases in both North and South. In summary, two features deliver the result: (a) although FDI occurs in an unskilled labor intensive activity (possibly using unskilled labor only), this activity is located in a sector, which, compared to the other sector in the economy, is relatively skilled labor intensive; (b) FDI raises the relative price of good *M* in the global economy.

Insofar as Northern firms undertake FDI to exploit lower unskilled labor wages in the South, our model is similar to Glass and Saggi (1999). But they show that FDI, by shifting labor demand across countries, raises (lowers) the wages in the host (source) country. This benefits the workers of the host country, but their firms earn lower profits. However, Glass and Saggi (1999) makes no differentiation between skilled and unskilled labor. Further, while their main objective is to analyze the welfare effects of FDI on the host country, ours is to examine the effect of FDI on the relative wage in the host as well as the source country.

The result that FDI increases the relative wage globally is established through a sequence of related but different models. Section 2 develops a fixed unskilled-wage model. It postulates that the numeraire good F is competitively produced by unskilled labor only (thus the skilled labor is specific to sector M). This "fixes" the unskilled wage (in both North and South). A movement in the skilled wage reflects the movement in the relative wage. Within this framework, first, a model

with zero income effect in the manufacturing sector in formulated. In such a model, the Stolper-Samuelson effect is absent – FDI affects relative wage only through the cost-saving effect. Therefore, under vertical-integration mode of production, though the relative wage rises in the North, it remains unchanged in the South. Under arms-length trading, however, since the cost saving effect is global in the sense that it lowers the costs of both the Northern and the Southern firms, the relative wage rises in each country. Later it is shown that with positive income effect, FDI causes the price of good *M* to rise. Thus there is a Stolper-Samuelson effect via which the relative wage increases in both countries. The overall effect of FDI on relative wages is positive in both countries.

In Section 3 it is assumed that food is produced by both unskilled and skilled labor. Hence unskilled wage can change. In this two good-two factor scenario, FDI affects the relative price change through supply-side changes. As it occurs, the intermediate good production moves entirely to the South. To the extent that it releases unskilled labor in the North, it raises the output of good F, the unskilled labor intensive good and lowers that of the good M, the skilled labor intensive good. This is a Rybczinski effect. The opposite happens in the South. As North firms demand unskilled labor in the South in producing the intermediates, there is effectively a reduction of the supply of unskilled labor for the production of good M and good F. By the Rybczinski effect, the output of good M rises and that of good F falls. However, given that South is technologically inferior in producing good M, the ratio global output of the good M to global output of good F *falls* with FDI.[3] This raises the relative price of good M and leads to a positive Stolper-Samuelson effect on relative wages globally.

Section 4 extends the model in two ways. First, it considers unemployment of unskilled labor in the South. It is shown that FDI may exacerbate the unemployment problem in the South. Up to this point, this paper assumed a fixed coefficient technology in the global economy. The second extension in section 4 is to allow for positive substitutability in production. It is found that in the presence of positive substitutability the results are somewhat weakened.

2 A Model of Fixed 'Unskilled' Wage

There are two countries – a developed country (the North) and a developing country (the South)– which are differentiated both in terms of endowment as well as technology (to be specified later). These countries are denoted by the subscripts *N* and *S* respectively. Each country produces and

[3] As we shall see, this model also assumes a North-South technological difference in producing food also – South, again, being less efficient than the North. However, the technological superiority of the North is more in producing M than in the producing F.

consumes two final goods – food F, and manufactures M.

In the supply side, there are two factors of production – skilled labor (H) and unskilled labor (L). The North is assumed to have a higher endowment of skilled labor than the South, i.e. $H_N > H_S$.[4]

Good F is produced by only unskilled labor. This sector is characterized by a constant-returns technology and perfect competition with free entry and exit. Hence the unskilled wage in terms of good F, the numeraire good, is fixed by technology. This is why it is a model of fixed unskilled wage. Let r_N and r_S denote the unskilled wage in the North and South respectively. It is assumed that the labor coefficient in producing F is lower in the North than in the South. This implies $r_S < r_N$: North is the 'high-unskilled-wage' and South is the 'low-unskilled-wage' country. It forms the basis of FDI from North to South.

The production for good M consists of two stages. In the first, or upstream stage, unskilled labor is used to produce an intermediate input I. In the second or downstream stage, the intermediate input and skilled labor are used in fixed proportions to produce the final good. The final good (good M) is assumed to be sold in an oligopoly market. Oligopoly is assumed in view of the fact that FDI is more common in industries dominated by firms who have market power. Firms are assumed to compete in the Cournot-Nash fashion.

2.1 Vertical Integration

Assume that firms in sector M are vertically integrated, i.e., the upstream and the downstream activities are undertaken by a single firm (arms-length trading in the intermediates is examined later). There are increasing returns in producing good M from skilled labor and the intermediates, via a fixed cost parameter (to be denoted by γ).

In the North, in the upstream stage one unit of unskilled labor is assumed to produce one unit of the intermediate good. The downstream production technology facing firm j is given by

$$q_N^j = \min\left(H_N^j,\, L_{NM}^j\right) - \gamma, \quad \gamma > 0, \tag{1}$$

where H_N^j and L_{NM}^j denote respectively the amount of skilled and unskilled labor used.

The Southern firms have technological disadvantages in producing the intermediate good as well as the final manufacturing good: b (> 1) units of unskilled labor are required to produce one unit of the intermediate good and the parameter b is also present in the downstream technology relating

[4] For now, we do not need to assume which country has a larger endowment of unskilled labor.

output to skilled labor. Accordingly, the downstream production function facing firm k is:

$$q_S^k = \min\left(\frac{H_S^k}{b}, \frac{L_{SM}^k}{b}\right) - \gamma, \tag{2}$$

where H_S^k and L_{SM}^k represent the respective amounts of skilled and unskilled labor used in the South.

Let w_N and w_S be the respective skilled wage rate. Since the unskilled wages are fixed in each country, any movement in a country's skilled wage mirrors the movement of relative wage as well.

The above production functions imply the following cost functions:

$$c_N(q_N^j) = (q_N^j + \gamma)(w_N + r_N), \quad c_S(q_S^k) = b(q_S^k + \gamma)(w_S + r_S). \tag{3}$$

For a North firm the function $c_N(\cdot)$ is the cost function in the regime of no FDI. If free FDI is allowed, the North firms will produce the intermediate in the South, pay r_S to unskilled labor and their cost function becomes $c_N(q_N^j) = (q_N^j + \gamma)(w_N + r_S)$. In general then we can write a North firm's cost function as

$$c_N(q_N^j) = (q_N^j + \gamma)(w_N + r_N - \delta), \tag{4}$$

where $\delta = 0$ or $r_N - r_S > 0$ as there is no FDI or there is FDI.

On the demand side, assume that each country has the following quasi-linear utility function:

$$U = \ln(C_M) + C_F, \tag{5}$$

where C_M (C_F) is the amount of manufactures (food) consumed. Quasi-linearity implies zero income effect on the demand for good M. This assumption will be relaxed later.

Whether there is FDI or not, there is free trade in goods between countries and firms compete in the integrated world market. Also, there is free entry, and hence the number of operational firms in a country in endogenous, determined by the zero-profit condition. Let n_N (n_S) be the number of manufacturing firms in the North (South).

The utility function (5) leads to the following inverse demand function for good M in the world market:

$$P = \frac{1}{\sum^{n_N} q_N^j + \sum^{n_S} q_S^k}. \tag{6}$$

Given symmetry across firms within a country, in equilibrium

$$P = \frac{1}{n_N q_N + n_S q_S}, \tag{7}$$

where q_N and q_S denote the uniform firm-level output in the North and South respectively.

Using the cost function in (4), and the inverse demand function in (6), the objective of a manufacturing firm in the North is as follows:

$$\max_{q_N^j} \left[\frac{1}{\sum^{n_N} q_N^j + \sum^{n_S} m_S^k} - (w_N + r_N - \delta) \right] q_N^j.$$

At the Cournot-Nash equilibrium, the first-order condition is given by

$$\frac{(Q_M - q_N^j)}{Q_M^2} = w_N + r_N - \delta$$

where Q_M is the total or global manufacturing output. In symmetric equilibrium, $Q_M = n_N q_N + n_S q_S$. Thus the first-order condition reduces to

$$\frac{(n_N - 1)q_N + n_S q_S}{(n_N q_N + n_S q_S)^2} = w_N + r_N - \delta.$$

Using equation (7), this can be simplified and written as

$$P\frac{(n_N - 1)q_N + n_S q_S}{n_N q_N + n_S q_S} = w_N + r_N - \delta. \tag{8}$$

Similarly, the profit maximization condition for any South firm at the symmetric equilibrium can be stated as

$$P\frac{n_N q_N + (n_S - 1)q_S}{n_N q_N + n_S q_S} = b(w_S + r_S). \tag{9}$$

The zero profit condition states that price is equal to the average cost. For North and South firms respectively, these are:

$$P = (1 + \frac{\gamma}{q_N})(w_N + r_N - \delta), \quad P = (1 + \frac{\gamma}{q_S})b(w_S + r_S). \tag{10}$$

The next two equations spell the full employment of skilled workers in North and South respectively:

$$H_N = (q_N + \gamma)n_N, \quad H_S = b(q_S + \gamma)n_S. \tag{11}$$

Equations in (7)-(11) are altogether seven containing seven unknowns: $q_N, q_S, P, n_N, n_S, w_N$ and w_S. Note that these equations represent *both* the no FDI regime and the FDI regime, with the provision that, under no FDI, $\delta = 0$ and with FDI, δ is positive, and equal to $r_N - r_S$.

Impacts of FDI

The effect of FDI is the comparative statics of this system with respect to δ. This parameter appears in (8) and the first equation in (10) only. From inspection, it is evident from these two equations that a change in δ leads to a proportional effect in w_N, and, *no* impact on the other variables. Therefore

Proposition 1 *In the absence of income effect, a change in regime from no FDI to FDI increases the relative wage in the North, but leaves it unchanged in the South. Other variables, namely the long run output produced by each firm, number of firms in each country and the relative price of manufactures remain unchanged also.*

As explained in the Introduction, in general, two effects, namely a localized cost-saving effect and a Stolper-Samuelson effect, govern how FDI affects the relative wage in the world economy. The first effect is through a fall in the marginal cost induced by FDI, which is experienced only by the North firms. This creates a Findlay-Grubert effect: since the manufacturing sector is relatively skilled-labor intensive, the relative wage increases and it happens in the North only. The other is through the change in P. If FDI affects the world relative price of the manufactures, then the relative wage will change in *both* North and South *a la* the Stolper-Samuelson theorem.

However, in the current model economy, only the first effect is present. The long run output produced by each firm (q_N and q_S) is given by technology, and the number of firms (n_N and n_S) are determined by full employment of skilled labor. Thus industry output in each country is unchanged when FDI occurs. From equation (6) this implies that the price of the manufactures in the global economy is unchanged following FDI. Hence there is no Stolper-Samuelson effect.

The net result, therefore, is that the relative wage increases in the North, but remains unchanged in the South.

Income Effect

It is now shown that, with a positive income effect, there are Stolper-Samuelson impacts on relative wages too and, together with the localized cost-saving effect, they imply that relative wage increases in *both* countries.

To capture this, assume now that the utility function is Cobb-Douglas, with μ being the share of expenditure in manufactures (M). The inverse demand function facing the M industry is

$$P = \frac{\mu Y_R}{Q_M} = \frac{\mu Y_R}{\sum_{j=1}^{n_N} q_N^j + \sum_{k=1}^{n_S} q_S^k}, \tag{12}$$

where Y_R is the world income level. Accordingly, at the Cournot-Nash equilibrium, the first-order condition of profit maximization by a North firm is given by

$$\frac{\mu Y_R(Q_M - q_N^j)}{{Q_M}^2} = w_N + r_N - \delta,$$

where recall that Q_M is the global manufacturing output. In symmetric equilibrium, the above equation reduces to

$$\frac{\mu Y_R[(n_N - 1)q_N + n_S q_S]}{(n_N q_N + n_S q_S)^2} = w_N + r_N - \delta.$$

Also, equation (12) reduces to $P = \mu Y_R/(n_N q_N + n_S q_S)$. Using this, the first order condition is further simplified as

$$P\frac{(n_N - 1)q_N + n_S q_S}{n_N q_N + n_S q_S} = w_N + r_N - \delta. \tag{8'}$$

Similarly, the profit maximization condition for any South firm at the symmetric equilibrium can be stated as

$$P\frac{n_N q_N + (n_S - 1)q_S}{n_N q_N + n_S q_S} = b(w_S + r_S). \tag{9'}$$

Note interestingly that these are exactly the same profit-maximizing conditions are as in the no income effect case.

The zero profit conditions and the full employment of skilled labor conditions are also the same as in the no income effect case as well. The only difference lies in the world market clearing condition for good M, which is now

$$\mu(w_N H_N + r_N L_N + w_S H_S + r_S L_S) = P(n_N q_N + n_S q_S), \tag{13}$$

where $w_N H_N + r_N L_N + w_S H_S + r_S L_S = Y_R$. Therefore, equations (8)-(11) and (13) will now constitute the system of seven equations that determine the seven unknowns in this model – q_N, q_S, P, n_N, n_S, w_N and w_S.[5]

First, we show that, q_N, q_S, n_N and n_S remains unchanged (as in the zero income effect case). From equations (8') and (10), and from equations (9') and (10), we respectively obtain

$$(1 + \frac{\gamma}{q_N})(1 - \frac{q_N}{n_N q_N + n_S q_S}) = 1. \quad (1 + \frac{\gamma}{q_S})(1 - \frac{q_S}{n_N q_N + n_S q_S}) = 1.$$

These two equations, along with the two full employment conditions for skilled labor given in

[5]The zero-income effect case is where the expenditure on good M is not dependent on income. In this case, the left-hand side of (13) is substituted by a constant.

(11) are four equations that determine the equilibrium values of the four variables $q_N, q_S,\ n_N$ and n_S. Since none of the four equations contain δ, it follows that the above four variables do not change with FDI. This implies that the global output $\bar{Q_R} = \bar{n_N}\bar{q_N} + \bar{n_S}\bar{q_S}$ remains unchanged too.

We can now respecify equations (8') and (9') as

$$w_N = P(1 - \frac{\bar{q_N}}{Q_R}) - r_N + \delta = w_N(\underset{+}{\delta}, \underset{+}{P}); \quad w_S = P(1 - \frac{\bar{q_S}}{Q_R}) - r_S = w_S(\underset{+}{P}), \tag{14}$$

where the bar at the top signifies that the variable remains unchanged. Note that as δ increases, w_N increases while w_S remains unchanged. This is the 'localized' technological progress effect '*at given P*' as in the earlier zero-income effect case.

With a positive income effect however, P changes and hence there is an additional effect. Note from equations (14) that an increase in P increases both w_N and w_S, which is essentially a Stolper-Samuelson effect. Therefore, it suffices to show that as δ increases, that is, as FDI flows in from the North to the South, P rises. To do that, combine equations (14) with the market clearing equation (13). It gives

$$\mu(H_N w_N(P, \delta) + r_N L_N + H_S w_S(P) + r_S L_S) = P\bar{Q_R}. \tag{15}$$

Totally differentiating (15) with respect to δ, and using equation (14)

$$\frac{dP}{d\delta} = \frac{\mu(H_N \frac{\partial w_N}{\partial \delta} + H_S \frac{\partial w_S}{\partial \delta})}{\bar{Q_R} - \mu(\frac{\partial w_N}{\partial P} H_N + \frac{\partial w_S}{\partial P} H_S)} = \frac{\mu H_N}{(1-\mu)\bar{Q_R}}\ . \tag{16}$$

In deriving the last expression we have used

(a) $\frac{\partial w_N}{\partial \delta} = 1$ and $\frac{\partial w_S}{\partial \delta} = 0$, from equation (14),

(b) $\frac{\partial w_N}{\partial P} = 1 - \frac{q_N}{Q_R} = \frac{w_N + r_N - \delta}{P} = \frac{q_N}{q_N + \gamma} = \frac{n_N q_N}{H_N}$, by using equations (14), (10) and (11),

(c) $\frac{\partial w_S}{\partial P} = \frac{n_S q_S}{H_S}$ by using equations (14), (10) and (11).

Intuitively, the localized cost saving effect induced rise in the skilled wage in the North raises the world income level, which increases the demand for manufactures. However, the total manufacturing output is given by the technology and full employment of skilled labor as in the earlier model – it does not change following FDI. Therefore the higher demand translates into an increased price of good M. This exerts a Stolper-Samuelson effect in both countries. The manufacturing sector being relatively more skilled-labor intensive than food, the relative wage-rate of skilled labor increases in both countries. We can call this is a *demand-pulled Stolper-Samuelson effect*.

Proposition 2 *Present income effect on the manufacturing sector, FDI leads to an increase in the relative price of manufactures P, no change in the firm level outputs or number of firms in either*

country and an increase in relative wages in both countries.

2.2 Arms-Length trading of Intermediate goods

Our results do not however depend on the assumption that firms in the manufacturing sector are vertically integrated. Suppose, instead, that the intermediate input is produced by a perfectly competitive sector.

Whether the firms choose to be vertically integrated, or buy the intermediate good from independent producers depend on the costs associated with these modes of organization, as in Grossman and Helpman (2002).[6] They noted that, for a vertically integrated firm, there are higher corporate governance costs of running a larger, less specialized organization than a firm that buys the intermediate input from independent suppliers and concentrates solely on the production of the final manufacturing good. On the other hand, the non-integrated firms have extra costs (that the vertically integrated ones do not have) of entering the arms-length market, e.g., costs from search frictions and those needed to insure against potential hold up problems like uncertainty in quality or time of delivery. For simplicity, we can think of differences in cost structures of integrated and non-integrated firms in terms of fixed costs of organization. Therefore, let the choice between the two modes of organization be governed by a difference in fixed costs.

We can now interpret the parameter γ in the previous model as the fixed costs associated with the 'vertical-integration' mode of organization. Let η be the fixed cost associated with arms-length trading. If $\eta < \gamma$, the firms prefer arms-length trading in the intermediates to vertical integration.

Consider what happens if $\eta > \gamma$. While this is a necessary condition for vertical integration, it is not sufficient. To elucidate, suppose $br_S < r_N$. Note that perfect competition in the intermediate good sector implies marginal cost pricing. Now under our assumption that one unit of the I good is produced by one (b) units of unskilled labor in the North (South), the marginal cost of producing the I good for a North (South) firm is r_N (br_S). Therefore $br_S(r_N)$ is the supply-price of the intermediate input by the Southern (Northern) firms.

Then, given $br_S < r_N$, a North M-good firm by buying at arms length from a Southern I-good producer gets the intermediate good at a lower marginal cost, and hence its variable costs are lower, although it incurs a higher fixed cost. Hence the North firm will choose to buy at arms length from Southern I-good producers even if $\eta > \gamma$, as long as the fixed costs occupy a sufficiently small

[6]Our framework is different from theirs in that in their model when a firm is not vertically integrated, it subcontracts its input requirements to specialized companies, whereas in ours the firm buys the input from a perfectly competitive intermediate good industry. Further, their main objective was to examine when a firm chooses to vertically integrate and when to subcontract its intermediate good requirements to independent producers.

proportion of total costs. Thus, our earlier analysis with vertically integrated firms is founded on the assumption that $\eta > \gamma$ and $|\eta - \gamma|$ sufficiently high.

We now assume that $\eta < \gamma$, such that firms in sector M choose arms-length trading in the intermediates. In this case sector M firms have the option to buy the intermediates from Northern or Southern vendors. There are two sub cases to be considered, (a) $r_N > br_S$, and (b) $r_N < br_S$. In case (a) the entire I-good market is served by the Southern sellers before FDI, while in case (b) it is the Northern sellers who serve the entire market. However, after FDI it is always the Northern I-good sellers who will serve the entire market because of their technological advantage. In what follows, the sub cases (a) and (b) are examined in turns.[7]

2.2.1 Southern Sellers produce the Intermediate Good at a lower cost ($br_S < r_N$)

The Southern I-good sellers serve the entire global market before FDI. After FDI, however, the unit cost of production for a North I-sector firm drops down to r_S which is lower than br_S – the lowest price that the Southern sellers can offer.[8] Therefore the Northern I-sector firms capture the entire I-good market.

The cost function of a Northern and Southern M-good producers, both before and after FDI, can now be represented as:

$$c_N(q_N) = (q_N + \eta)(w_N + br_S - \delta), \quad c_S(q_S) = (q_S + \eta)(bw_S + br_S - \delta), \tag{17}$$

where $\delta = 0$ or $(b-1)r_S$ as there is no FDI or there is FDI. The profit maximization condition of a North M-good firm and its Southern counterpart are respectively

$$P\frac{(n_N - 1)q_N + n_S q_S}{n_N q_N + n_S q_S} = w_N + br_S - \delta, \quad P\frac{n_N q_N + (n_S - 1)q_S}{n_N q_N + n_S q_S} = bw_S + br_S - \delta. \tag{18}$$

Likewise, the respective the zero profit and skilled-labor full employment conditions are

$$P = (1 + \frac{\eta}{q_N})(w_N + br_S - \delta), \quad P = (1 + \frac{\eta}{q_S})(bw_S + br_S - \delta); \tag{19}$$

$$H_N = (q_N + \eta)n_N, \quad H_S = b(q_S + \eta)n_S. \tag{20}$$

The equations (18)-(20), and equation (13) from the previous section, characterize the model. These

[7] In the knife-edge case where $br_S = r_N$, both North and South firms are competitive before FDI, but after FDI here also the North firms will serve the entire market – no qualitative change in the conclusions occur.

[8] Here FDI occurs because of the technological superiority of the Northern firms, captured by $b > 1$.

seven equations determine the same seven endogenous variables as in the earlier model.

Proceeding as in our earlier analysis on vertical integration (V-I in brief), we can show that the equilibrium values of $n_N,\ n_S,\ q_N$ and q_S remain unaffected by FDI here also. Further, equations (18) can be expressed as

$$w_N = P(1-\frac{\bar{q_N}}{Q}) - br_S + \delta = w_N((\underset{+}{\delta},\underset{+}{P})); \quad w_S = \frac{P}{b}(1-\frac{\bar{q_S}}{Q}) - r_S + \frac{\delta}{b} = w_S((\underset{+}{\delta},\underset{+}{P})) \tag{21}$$

These equations in comparison with (14) illustrate an important qualitative difference between the V-I model and arms length trading. That is, at given P, FDI (an increase in δ) not only increases w_N but also raises w_S. In other words, FDI exerts a global cost-saving effect. Therefore, in this case, even if we consider a model with zero income effect, both w_N and w_S will increase here following FDI.

The reason is that after FDI – which decreases the unit cost of production for the Northern sub-sector-I firms – both the Northern and the Southern good M sellers now buy input I from these Northern firms. Therefore, the cost of procuring the intermediate input goes down for *both* the Northern and the Southern manufacturers.[9]

Using equations (21) along with the market clearing condition (13), it can be easily seen that as δ increases, P increases as well. This is because increases in both w_N and w_S raise the world income and hence the demand of good M, which creates a Stolper-Samuelson effect – consequently, a secondary increase in both w_N and w_S.

Thus the combined impact of these two effects is to raise w_N and w_S.

2.2.2 Northern sellers produce the intermediate good at a lower cost before FDI ($br_S > r_N$)

In this case, when FDI is not permitted, both the Northern and Southern manufacturing firms buy from the Northern I good producers at price r_N. Once FDI is allowed, the Northern I-good sellers move to the South to take advantage of the cheaper unskilled labor there. Thus the final good manufacturers are able to obtain the intermediate good at the price r_S instead of r_N.

Accordingly, the cost functions of the final good manufacturers in the North and the South are respectively of the form

$$c_N(q_N) = (q_N + \eta)(w_N + r_N - \delta), \quad c_S(q_S) = (q_S + \eta)(bw_S + \delta), \tag{22}$$

[9] In contrast, in the V-I case, the cost of obtaining the input I fall *only* for the North firms, while that of the South firms is unaffected.

The parameter δ is 0 when there is no FDI, and $r_N - r_S$ when there is FDI. This contrasts with (17). The profit maximizing and zero profit conditions for the North and South firms are different accordingly, compared to the earlier case. But, solving as before, one finds that FDI raises the relative wage in both the North and the South.

The intuition is similar to the earlier case. After FDI – which decreases the unit cost of production for the Northern sector-I firms – both the Northern and the Southern good M sellers obtain the input I at a lower price r_S. This produces a global cost-saving effect. Both w_N and w_S increase, at given P. In turn, this raises incomes in both North and South, exerting a upward pressure on P. As a result, w_N and w_S increase further by an income-induced Stolper-Samuelson effect.

Proposition 3 *With arms-length trading of intermediate inputs, the skilled-unskilled wage differential increases both in the North and the South after FDI, irrespective of whether income effect on manufacturing is zero or positive.*

Thus the positive global effect of FDI on relative wages holds even more strongly in this case compared to the earlier cases.

3 Variable Unskilled Wage

Our result that FDI from North to South concentrated in an unskilled labor intensive activity *raises* the skilled-unskilled wage ratio in the South might be thought to be dependent on the assumption that the unskilled wage is fixed by technology. The purpose of this section is to demonstrate that this is not so. Assume that skilled labor is used in the food sector also, such that unskilled wage can vary. For tractability however, assume perfect competition in sector M. Similar to the fixed unskilled-wage case, let the unskilled-wage differential between North and South be a result of technology difference in the food sector (to be denoted by β).

The production functions in sector M are:

$$Q_N = \min\left(H_{NM}, L_{NM}\right), \quad Q_S = \min\left(\frac{H_{SM}}{b}, \frac{L_{SM}}{b}\right), \quad b \geq 1. \tag{23}$$

Those in the food sector are:

$$X_N = \min\left(\frac{H_{NF}}{a_H}, \frac{L_{NF}}{a_L}\right) \quad X_S = \min\left(\frac{H_{SF}}{\beta a_H}, \frac{L_{SF}}{\beta a_L}\right) \quad \beta > b \geq 1,\ a_L > a_H. \tag{24}$$

The inequality $a_L > a_H$ ensures that the food sector is relatively unskilled labor intensive. The

assumption $\beta > b$ would imply that $r_N > r_S$.[10]

We also need the following regularity conditions to ensure that equilibrium outputs are positive:

$$L_N > H_N, \quad L_S > H_S, \quad a_L H_N > a_H L_N, \quad a_L H_S > a_H L_S. \tag{R1}$$

As before, we consider the cases of vertical integration and arms length trading. In both cases however, the results are qualitatively the same. In what follows, the case of vertical integration is laid out fully, whereas Appendix 1 outlines the arms-length trading case.

Suppose that there is zero fixed cost associated with vertical integration and a positive fixed cost involved in arms-length trading, such that the former is the preferred choice.

No FDI

First, without FDI, the world economy is described by the following equations,

$$P = w_N + r_N; \quad 1 = a_H w_N + a_L r_N \tag{25}$$

$$P = b(w_S + r_S); \quad 1 = \beta(a_H w_S + a_L r_S) \tag{26}$$

$$H_N = Q_N + a_H X_N; \quad L_N = Q_N + a_L X_N \tag{27}$$

$$H_S = bQ_S + \beta a_H X_S; \quad L_S = bQ_S + \beta a_L X_S. \tag{28}$$

$$\frac{X_N + X_S}{Q_N + Q_S} = \frac{1-\mu}{\mu} P. \tag{29}$$

These are 9 equations, having 9 endogenous variables, Q_N, Q_S, X_N, X_S, P, r_N, r_S, w_N and w_S. Equations (25) and (26) are the respective zero profit conditions. The following equations except the last are the full employment conditions. The last equation states the market clearing condition; in equilibrium, the ratio of world outputs is equal to the ratio of world demands for goods F and M; the latter depends on relative price only.[11]

In principle, the model is solved as follows. The four full employment equations, (27)-(28), determine the outputs. Given the outputs, the market clearing equation solves P, and given P, the

[10] For the South to have comparative advantage in food (which is empirically plausible), we thus need to assume that L_S is sufficiently greater than L_N. In that case, even though North is relatively more efficient in food sector ($\beta > b$), it will tend to import food and export manufactures.

[11] From the zero-profit conditions, we can verify that for any given P, $r_S < r_N$ as long as $\beta > b > 1$.

factor rewards are solved from the zero-profit conditions The output solutions are the following:

$$\begin{aligned} Q_N^v &= \frac{a_L H_N - a_H L_N}{a_L - a_H}, \quad X_N^v = \frac{L_N - H_N}{a_L - a_H} \\ Q_S^v &= \frac{a_L H_S - a_H L_S}{b(a_L - a_H)}, \quad X_S^v = \frac{L_S - H_S}{\beta(a_L - a_H)}, \end{aligned} \tag{30}$$

where the superscript v marks vertical integration. Note that, the regularity conditions (R1) ensure that the equilibrium output levels are all positive.

FDI

Now suppose FDI is allowed. Since the Northern manufacturing firms produce the intermediate good in the South, the unskilled wage they face is r_S, not r_N. Hence, the zero-profit condition in the manufacturing sector in the North changes to

$$P = w_N + r_S. \tag{25'}$$

Further, the production of the intermediates moves to the South completely. Hence unskilled labor in the North is used in the food sector only. Thus, in place of the first equation in (27), we have

$$L_N = a_L X_N, \tag{27'}$$

Also, in the market for the services of unskilled labor in the South, there is an additional source of demand, namely, the Northern firms producing intermediates. Accordingly, instead of the second equation in (28),

$$L_S = bQ_S + Q_N + \beta a_L X_S. \tag{28'}$$

Other equations remain the same.[12]

Once again, we can understand the impact of FDI on relative wages in two steps: first, a 'direct' impact at the original P and an indirect impact through the change in P. Since among the zero-profit conditions, only that relating to the manufacturing sector in the North changes, as long as P remains unchanged, there is no change in the relative wage in the South. In the North, comparing (25) with (25'), we see that the relative wage in the North increases. This is again a localized cost-saving effect.

Next, in view of the market-clearing condition (29), how P changes with FDI depends on how

[12] The zero profit equations imply that $r_S < r_N$ holds in the FDI regime also.

the global output ratio changes. We now discuss how FDI affects outputs. From (27), (28) (27') and (28'), we obtain the following solution values for outputs under FDI:

$$\begin{aligned} Q_N^{vf} &= \frac{a_L H_N - a_H L_N}{a_L} < Q_N^v; \qquad & X_N^{vf} &= \tfrac{L_N}{a_L} > X_N^v. \\ Q_S^{vf} &= \frac{a_L(a_L H_S - a_H L_S) + a_H(a_L H_N - a_H L_N)}{b a_L (a_L - a_H)} > Q_S^v; \qquad & & \\ X_S^{vf} &= \frac{a_L L_S - a_L H_N + a_H L_N - a_L H_S}{\beta a_L (a_L - a_H)} < X_S^v. \qquad & & \end{aligned} \tag{31}$$

Now consider global outputs. It is easy to verify that $Q_N^{vf} + Q_S^{vf} > Q_N^v + Q_S^v$ and $X_N^{vf} + X_S^{vf} > X_N^v + X_S^v$, i.e. compared to the no-FDI regime, the global output of the manufacturing is lower, while that of food is greater. This is because North, the country that is more efficient in the production of both food and manufactures, is engaging more resources in food and less in manufactures following FDI, and South the less efficient country in the production of each good is doing the opposite.

The comparison of global outputs between no FDI and FDI implies that the relative price of good M is greater in the FDI regime (from equation. (29)). Via the Stolper-Samuelson theorem, it implies, in turn, that relative wage increases in both countries. This can be interpreted as a *supply-pushed* Stolper-Samuelson effect, as opposed to the demand-pull Stolper-Samuelson effects on relative wages in the fixed unskilled wage case.

The overall impact – the sum of localized cost-saving and Stolper-Samuelson effects – of FDI on the relative wage is positive in both North and South – as in the fixed unskilled wage case. Hence

Proposition 4 *Even when the food sector requires skilled labor, and thus the unskilled wage is variable, FDI raises the relative wage in both North and South.*

4 Extensions

In this section, we consider two extensions. Needless to say, unemployment is a major problem in many developed and developing countries. However, it is considered to be more severe in the latter than in the former. Further, between unemployment in the two categories of workers in developing countries, it is the unemployment among unskilled workers, which is more prevalent. Analyzing this issue is our first extension. Second, we relax the assumption of fixed coefficient technology, i.e. zero factor substitutability, and discuss how our results may change when there is positive substitution among the inputs.

4.1 Unskilled Labor Unemployment in the South

Assume that skilled labor is fully employed in both North and South, whereas unskilled labor is fully employed only in the North, but partly unemployed in the South.

There are many micro models of wage rigidity and concomitant unemployment in the context of a developing economy e.g. efficiency wage models (see Basu (1997)). However, from the viewpoint of tractability of our global-economy model, we simply allude to the notion of surplus unskilled labor and assume that the unskilled wage ($\bar{r_S}$) is given institutionally.[13] The model is thus similar to the "America-Europe" model of Davis (1998).

Insofar as the effect of FDI on relative wage is concerned, the consideration of the zero-profit conditions is sufficient for us to determine how FDI affects relative wages. Assuming vertical integration, these conditions before FDI are as follows:

$$P = w_N + r_N, \quad 1 = a_H w_N + a_L r_N; \tag{32}$$

$$P = b(w_S + \bar{r_S}), \quad 1 = \beta(w_S + \bar{r_S}). \tag{33}$$

These four equations determine the values of four variables: P, w_N, w_S and r_N. After FDI, as Northern manufacturing firms face Southern unskilled wage, the zero-profit conditions in sector-M in the North is:

$$P = w_N + \bar{r_S} \tag{32'}$$

The other three equations are unchanged.

We can now compare FDI to no FDI. Since the Southern zero-profit conditions do not change, P and w_S are unchanged. Comparing equations (32) with (32'), it is clear that w_N increases and r_N falls. In summary then, after FDI, factor rewards remains unchanged in the South, whereas in the North the relative wage increases.

Our main interest here is in unskilled labor unemployment in the South, which we now examine. In general, there are two effects of FDI on unskilled labor employment in the South. First, there is a 'direct effect' of FDI, which is the following. As FDI occurs in an unskilled labor intensive activity, compared to no FDI there is an additional source of demand for unskilled labor in the South, which tends to increase employment.

Second, there is an effect due to change in the output mix in the South. The output of the manufactures in that country increases and that of food decreases. This change has a Rybczinski

[13] This is obviously different in nature from the technologically fixed unskilled-wage considered earlier in section 2.

effect, which is *negative* on the total employment of unskilled labor, because the manufacturing activity is more skilled-labor intensive relative to the production of food.

Interestingly, it is found – proven formally in Appendix 2 – that the overall effect of FDI on unemployment of unskilled labor is *unambiguously* negative, i.e. the second effect dominates. This is because, in FDI equilibrium, the manufacturing output in the North is small, as all its unskilled labor moves to the unskilled-labor-intensive food sector. The technology coefficients being constant, this means a relatively small level of production of the intermediate by the North in the South (through FDI), i.e., a small direct effect relative to the Rybczinski effect.

In summary, whereas FDI occurs in an unskilled labor intensive task, the economy-wide employment of unskilled labor in the South falls. This is the analog of FDI-led increase in the relative wage in the South in the full-employment model.

Consider now arms-length trading. Turning first to the case where the Southern intermediate good producers supply the entire world demand for the intermediate good before FDI (which occurs when $b\bar{r_S} < r_N$), the zero profit equations are

$$P = w_N + b\bar{r_S}, \quad 1 = a_H w_N + a_L r_N; \tag{34}$$

$$P = b(w_S + \bar{r_S}), \quad 1 = \beta(w_S + \bar{r_S}), \tag{35}$$

in the absence of FDI. After FDI, the zero-profit conditions in the food sector in each country remains unchanged, while those in the manufacturing sector change, which are now:

$$P = w_N + \bar{r_S}, \quad P = bw_S + \bar{r_S}. \tag{36}$$

It is easy to deduce from these equations that relative wages in both countries remain unchanged and P falls or remains same according as $b > 1$ or $b = 1$.[14] Intuitively, when $b = 1$, the price of the I-good does not fall following FDI. Hence there is no cost-saving effect enjoyed by the M-good producers so that P remains unchanged.

In this case also, as shown in Appendix 2, the effect on employment of unskilled labor in the South is unambiguously negative. Intuitively, unlike the V-I case, there is no positive 'direct effect' of FDI on employment of unskilled labor in the South, because even before FDI the entire good-I that was used by the Northern sector-M firms were being produced in the South. The only effect

[14]The sector-F zero profit condition in the South implies w_S remains unchanged after FDI. Further, the sector-M conditions imply that $w_N = bw_S$, both before and after FDI, which implies w_N remains unchanged after FDI. Now from the sector-F equation in the North in (34), this implies r_N also remains unchanged.

on unemployment is through a change in output mix in the South – the manufacturing output increases while that of food decreases. This (Rybczinsky-type) effect is negative, and tends to reduce employment.

Finally suppose that the Northern intermediate good producers cater to its entire world demand before FDI ($b\bar{r_S} > r_N$). The zero-profit equations before FDI are

$$P = w_N + r_N, \quad P = bw_S + r_N, \tag{37}$$

$$1 = a_H w_N + a_L r_N, \quad 1 = \beta a_H w_S + \beta a_L \bar{r_S} \tag{38}$$

After FDI, while the zero profit conditions in the food sector remains unchanged, those in the manufacturing sector become

$$P = w_N + \bar{r_S}, \quad P = bw_S + \bar{r_S}. \tag{37'}$$

Note again that relative wages are unchanged, and P falls as long as $b \geq 1$. In this case, the more efficient Northern I-good sellers were supplying to the entire global market even before FDI. Hence the fall in P does not occur because production shifts to the technologically more efficient Northern producers. Rather, it occurs solely because of lower unskilled wage in the South. Hence FDI will occur, and the results will go through even if $b = 1$. This is unlike the previous case when South exported the input I before FDI, where the relative wages remained unchanged when $b = 1$.

However, in this case, the effect of employment of unskilled labor in the South is ambiguous. It is because, along with the negative 'output-mix' effect as before, there is a positive direct effect of FDI on employment of unskilled labor (as in the V-I case). Moreover, this effect is stronger than the V-I case, since while after FDI the entire world supply of good-I is shifted from the North to the South. In contrast, in the V-I case, only those demanded by the Northern firms were shifted, causing a weaker positive effect on employment.

Therefore, this strong positive effect may or may not outweigh the negative output mix effect.

Proposition 5 *As a result of FDI, unskilled labor employed in the South falls unambiguously when the firms are vertically integrated. In the case of arms-length trading, the same result occurs if the South country was exporting the intermediate good before FDI. However, if the North was exporter of the intermediate good before FDI, the unskilled labor employment in the South may increase or decrease .*

4.2 Positive Factor Substitution

Recall the two effects, namely, the cost-saving effect and the price effect, of FDI on the relative wage. When factor substitution is positive, the former effect remains unchanged qualitatively. To see this, let $c_M(w_N, r_N)$ denote the general unit (and marginal) cost function facing a Northern firm before FDI. Let it satisfy all the properties of a standard neo-classical cost function. Similarly let $bc_M(w_N, r_N)$ is the corresponding cost function facing the South firm before FDI. Consider the case of vertical integration, where the price equations are described by the following equations.

$$p = c_M(w_N, r_N - \delta), \quad 1 = c_F(w_N, r_N) \tag{39}$$

$$p = bc_M(w_S, r_S), \quad 1 = \beta c_F(w_S, r_S), \tag{40}$$

where, as before, $\delta = 0,$ or $r_N - r_S > 0$, according as there is no FDI or there is FDI. Thus FDI can be interpreted as an increase in δ, which, from equation (39), will tend to increase w_N *at given P*. Thus the relative wage in the North, at given *P*, rises, and that in the South remains unchanged.

Consider now the price effect. It depends on how FDI affects the ratio of manufacturing good output to food output in the global economy *at given p*. Compared to the fixed coefficient case, there is an additional impact through changes in the input coefficients stemming from a change in the relative wage (due to the cost-saving effect).

In case of vertical integration, in the North, as the skilled-unskilled wage ratio increases, firms in both sectors will use higher unskilled-labor coefficient and lower skilled-labor coefficient in their production. This is equivalent to an increase in the skilled-labor endowment and a decrease in the unskilled-labor endowment at given factor coefficients. Via the Rybczinksi effect, the output of the manufactures tends to increase and that of food tends to decrease.

In the South, there is no cost-saving effect and hence for the Southern firms the input coefficients are unchanged. However, with FDI, the Northern manufacturers demand Southern unskilled labor, based on the relative wage that these firms face. It is equal to w_N/r_S (in the FDI regime) which is less than w_N/r_N (in the absence of FDI). This tends to increase the unskilled labor coefficient for the Northern manufacturing firms, which tends to reduce the total availability of unskilled labor for Southern firms. In view of the Rybczinksi theorem, the output of manufactures tends to increase in the South and food output tends to decrease. This effect is qualitatively same as what happens in the North.

Overall then, the effect due to change in input coefficients on the ratio of global manufacturing to food output is positive, which exerts a negative effect on the relative price of manufactures in the

world economy. The magnitude of this effect is positively related to the elasticity of substitution. When these elasticities are sufficiently high in both sectors, the ratio of global manufacturing to food output rises after FDI occurs, which tends to lower the relative wage. The price effect and the cost-saving effect will thus tend to act in opposite directions. It is possible that the relative wage falls in one country or both countries.[15]

In summary then, positive factor substitutability tends to somewhat weaken the positive effect of FDI on relative wage in both countries. However, as long as the elasticity of factor substitution is not sufficiently high, by virtue of continuity, our earlier results continue to hold.

5 Concluding Remarks

When the firms from developed countries shift their unskilled labor intensive production activities to the developing countries, where unskilled labor is cheaper, it is normally anticipated that the relative wage increases in the former and decreases in the latter. However, empirical evidence suggests FDI from developed to developing countries has increased the relative wage not only in the former but also in many of the developing countries.

Feenstra and Hansen (1996, 1997) explains this phenomenon by assuming that FDI takes place in production activities, which are unskilled labor intensive for the North, but skilled labor intensive for the South. This paper, however assumes that the North firms undertake FDI in production activities that are unskilled labor intensive also in the South, yet such activity is shown to increase the relative wage in the South as well. The key assumption in the model is that FDI takes place in an unskilled labor intensive activity but in the manufacturing sector, which, in the global economy is relatively skilled-labor intensive compared to other sectors.

The production of the manufacturing good is assumed to involve two stages, upstream and downstream. In the upstream stage an intermediate input is produced with only unskilled labor, while in the downstream stage, this input and skilled labor are combined to produce the final good. The firms can be either vertically integrated, or they may buy the intermediate input at arms length, depending on the respective cost structures of the two modes of organization. FDI occurs in the upstream stage of the manufacturing sector. The paper initially considers a model where the unskilled wage is fixed, and the manufacturing sector is assumed to be oligopolistic in nature. Later, the assumption of fixed unskilled wage is relaxed.

[15] In the case of arms-length trading, as before, the cost-saving effect is global and hence it raises the relative wage in each country. This is the only difference. The price effects are analogous to the V-I case.

In both cases of vertical integration and arms length trading, the paper highlights two effects through which FDI affects the relative wage in the global economy – a cost-saving effect, and a Stolper-Samuelson (S-S) effect. The first effect is as follows. Since FDI reduces the cost of obtaining the intermediate good for the final good sellers, it is like a cost-saving technological progress in the manufacturing sector, which raises the relative wage. The S-S effect is that, as FDI occurs, the relative price of manufactures in the world economy changes, and this price change affects the relative wage. More specifically it is shown that FDI may lead to changes in the world income or the world relative output of the manufactures such that the relative price of the manufactures increases. This tends to raise the relative wage, since the manufacturing sector is relatively more skilled-labor intensive.

The paper also considers the effect of FDI on the unskilled labor unemployment in the South, and demonstrates that even though FDI occurs in an unskilled labor intensive activity, the employment of unskilled labor generally tend to fall in the South. This can be viewed as the counterpart of the increase in relative wage in the model with full employment. Since FDI occurs in an unskilled labor intensive task, it has a positive 'direct' effect on employment. However, FDI is shown to decrease (increase) the output of food (manufactures) in the South. Food being the unskilled labor intensive sector, this change in output-mix reduces its employment, and is shown to outweigh the first effect.

At a very general level, in the existing literature, the effect of FDI on the income distribution is much less addressed than the issue of effect of trade on income distribution. There are many avenues for further research in this important area. In what follows, we briefly discuss two such avenues, where the focus is mostly on the effects of FDI on the recipient developing country.

Technology transfer is a very important aspect of FDI in the developing economies. One obvious extension is to investigate the effect of technology transfer on relative wages. Glass and Saggi (2002) have analyzed the effect of FDI on wages while considering technology transfer from the MNC to the local firms. This occurs as workers move from the MNC to the local firms. To prevent such 'leakage' the MNC offers a wage premium to its workers. However, in their model there is no differentiation between workers with respect to skill. Since such technology transfer is typically associated with the movement of skilled workers such as engineers and managers (Bloom (1992)), such wage premium will tend to raise the relative wage. However, if FDI occurs in an unskilled labor intensive sector, this will also increase the demand for unskilled labor, which will tend to lower the relative wage. It will be interesting, then, to analyze formally the net effect of FDI on the relative wage in such a situation.

Also, if skill-acquisition is endogenous, as in Das (2003), it would be interesting to see if FDI has a favorable or perverse effect on the 'incentives' toward skill acquisition, and how this in turn

affects the relative wage. Flow of capital from North to South via FDI will tend to reduce the return to physical capital, reducing the incentive to accumulate physical capital. This will increase the incentives to acquire human capital. If further FDI occurs in a skilled intensive sector, this will further raise the return to human capital, and consequently the incentive to acquire it. On the other hand, if FDI occurs in an unskilled labor intensive sector, this may reduce the return on human capital and hence lower incentives for formation of human capital as well. Thus, it would be interesting to see whether such FDI raises or lowers the formation of human capital in a developing economy. Further, if FDI does lower the formation of human capital along with lowering the return on physical capital, it may have a negative impact on the long-term growth of a developing country.

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Appendix

Appendix 1: Variable-unskilled Wage with Arms-Length Trading

It is assumed here that there is zero fixed cost associated with arms-length trading and a positive fixed cost involved in vertical integration, such that the former is the preferred mode of organization.

Southern Sellers produce the Intermediate Good at a lower cost

First we examine the model before FDI. Since the Southern firms cater to the entire good I demand, the following set of equations describe the model before FDI:

$$P = w_N + br_S, \quad P = bw_S + br_S, \tag{A 1}$$

$$1 = a_H w_N + a_L r_N, \quad 1 = \beta a_H w_S + \beta a_L r_S, \tag{A 2}$$

$$H_N = Q_N + a_H X_N, \quad L_N = a_L X_N, \tag{A 3}$$

$$H^S = bQ_S + \beta a_H X_S, \quad L^S = bQ_S + bQ_N + \beta a_L X_S, \tag{A 4}$$

$$\frac{1-\mu}{\mu} P = \frac{X_N + X_S}{Q_N + Q_S}. \tag{A 5}$$

These 9 equations solve for the same 9 variables as mentioned in the V-I model. The equations denote the same conditions as in the V-I model, and in the same order. The model is solved in a similar manner as well. From the full employment conditions, we obtain the solution values of the output in each sector of both North and South. They are

$$\begin{array}{cc} Q_N^a = \frac{a_L H_N - a_H L_N}{a_L}, & X_N^a = \frac{L_N}{a_L}, \\ Q_S^a = \frac{a_L(a_L H_S - a_H L_S) + b a_H (a_L H_N - a_H L_N)}{b a_L (a_L - a_H)}, & X_S^a = \frac{a_L (L_S - H_S) - b(a_L H_N - a_H L_N)}{\beta a_L (a_L - a_H)}, \end{array} \tag{A 6}$$

where the superscript a implies arms-length trading.

FDI

We now allow for FDI from North to South in the model. Formally, the following changes take place. Since the Northern good-I producers now produce the input in south and supply it at price r_S, the zero profit condition in manufacturing for both North and South is now

$$P = w_N + r_S, \quad P = b(w_S + r_S) \tag{A 7}$$

Next, since the North firms require 1 unit – while the South firms need b unit – of unskilled labor to produce one unit of good I, in place of equation (A 4) we now have

$$L_S = Q_S + Q_N + \beta a_L X_S. \tag{A 8}$$

As in the V-I model, the impact of FDI on real wage can be broken down into two steps: first the effect at 'unchanged P', and second the effect due to a consequent change in P. Note that at unchanged P, comparing (A1) with (A 7), we obtain that both the relative wages in the North and the South increase after FDI. This contrasts with the V-I analysis, where only the relative wage in the North increase, but that of the South remain unchanged. The reason is, with arms-length trading, after FDI, both the Northern and the Southern M-good firms obtain the input I at a lower cost r_S rather than $br_S (> r_S)$ as before FDI. Hence the cost saving effect is global.

Next we consider how P changes after FDI. This depends on how $\frac{X_N+X_S}{Q_N+Q_S}$ changes, as indicated by the market clearing equation (A 5). Using the full employment equations, we obtain that

$$\begin{aligned} Q_N^{af} = \tfrac{a_L H_N - a_H L_N}{a_L} = Q_N^a; \quad X_N^{af} = \tfrac{L_N}{a_L} = X_N^a. \\ Q_S^{af} = \tfrac{a_L(a_L H_S - a_H L_S) + a_H(a_L H_N - a_H L_N)}{a_L(ba_L - a_H)} < Q_S a; \quad X_S^{af} = \tfrac{a_L(bL_S - H_S) - b(a_L H_N - a_H L_N)}{\gamma a_L(ba_L - a_H)} > X_S^a. \end{aligned} \tag{A 9}$$

These inequalities imply that when FDI is allowed the global output of manufactures fall and that of food rises, which indicate that P increases. This in turn causes a Stolper Samuelson effect of raising the relative wages in both North and South, thus reinforcing the cost saving effect. The sum of the two effects is thus to raise the relative wages in both countries.

Northern Sellers produce the Intermediate Good at a lower cost

In this case, the Northern firms cater to the entire good I demand before FDI. Therefore the following set of equations describe the model before FDI:

$$P = w_N + r_N, \quad P = bw_S + r_N, \tag{A 10}$$

$$1 = a_H w_N + a_L r_N, \quad 1 = \beta a_H w_S + \beta a_L r_S, \tag{A 11}$$

$$H_N = Q_N + a_H X_N, \quad L_N = a_L X_N + Q_N + Q_S, \tag{A 12}$$

$$H^S = bQ_S + \beta a_H X_S, \quad L^S = \beta a_L X_S, \tag{A 13}$$

$$\frac{1-\mu}{\mu} P = \frac{X_N + X_S}{Q_N + Q_S}. \tag{A 14}$$

The model is solved in a similar manner as before. From the full employment conditions, we obtain the solution values of the output in each sector of both North and South. They are

$$\begin{aligned} Q_N^{a2} = \tfrac{ba_L(a_L H_N - a_H L_N) + a_H(a_L H_S - a_H L_S)}{ba_L(a_L - a_H)}, \quad X_N^{a2} = \tfrac{ba_L(L_N - H_N) - (a_L H_S - a_H L_S)}{ba_L(a_L - a_H)}, \\ Q_S^{a2} = \tfrac{(a_L H_S - a_H L_S)}{ba_L}, \quad X_S^{a2} = \tfrac{L_S}{\beta a_L}, \end{aligned} \tag{A 15}$$

where the superscript 'a2' implies the second case of arms-length trading, where before FDI North was the exporter of the intermediate good.

FDI

We now allow for FDI from North to South in the model. Formally, the following change take place. Since the Northern good-I producers now produce the input in south and supply it at price r_S, the zero profit condition in manufacturing for both North and South is now

$$P = w_N + r_S, \quad P = b(w_S + r_S) \tag{A 16}$$

Next, since the North I-subsector firms now undertake FDI and shift their entire operations in the South, the entire unskilled labor will be employed in the food sector in the North. Hence, equation (**??**) changes and becomes

$$L_N = a_L Q_F^N \tag{A 17}$$

Since the entire intermediate good production shifts to the South, the equation (A 4) changes as well to the following:

$$L_S = Q_S + Q_N + \beta a_L X_S. \tag{A 18}$$

As earlier, the impact of FDI on real wage can be broken down into two steps: first the effect at unchanged P, and second the effect due to a consequent change in P. Note that at unchanged P,

comparing (A 10) with (A 16), we obtain that both the relative wages in the North and the south increase after FDI. This contrasts with the V-I analysis, where only the relative wage in the North increase, but that of the South remain unchanged. The reason is, since the Northern good-*I* sellers have had a cost-saving, and they cater to the entire world market before and after FDI, the cost saving effect is global.

Next we consider how P changes after FDI. This depends on how $\frac{X_N+X_S}{Q_N+Q_S}$ changes, as indicated by the market clearing equation (A 14). Using the full employment equations, we obtain that

$$\begin{array}{c} Q_N^{af2} = \frac{a_L H_N - a_H L_N}{a_L}, \quad X_N^{af2} = \frac{L_N}{a_L}. \\ Q_S^{af2} = \frac{a_L(a_L H_S - a_H L_S) + a_H(a_L H_N - a_H L_N)}{a_L(ba_L - a_H)}; \quad X_S^{af} = \frac{a_L(bL_S - H_S) - b(a_L H_N - a_H L_N)}{\beta a_L(ba_L - a_H)}. \end{array} \tag{A 19}$$

Comparing these outputs with those indicated in the no-FDI case, we find that when FDI is allowed the ratio of global output of manufactures to that of food fall with FDI, which indicate that P increases. This in turn causes a Stolper Samuelson effect of raising the relative wages in both North and South, thus reinforcing the cost saving effect. The sum of the two effects is thus to raise the relative wages in both countries.

Appendix 2: Unskilled Labor Unemployment in the South

Vertical Integration

$$H_N = Q_N + a_H X_N, \quad L_N = Q_N + a_L X_N. \tag{A 20}$$

$$H_S = bQ_S + \beta a_H X_S. \tag{A 21}$$

$$\frac{(1-\mu)P}{\mu} = \frac{X_N + X_S}{Q_N + Q_S}. \tag{A 22}$$

Let us define $k = \frac{(1-\mu)P}{\mu}$. In that case the last equation can be written as $k = \frac{X_N+X_S}{Q_N+Q_S}$, which can be simplified as

$$kQ_S - X_S = X_N - kQ_N. \tag{A 23}$$

Solving these equations, the output levels are the following:

$$\begin{array}{c} Q_N^U = \frac{a_L H_N - a_H L_N}{a_L - a_H}, \quad X_N^U = \frac{L_N - H_N}{a_L - a_H} \\ Q_S^U = \frac{\beta a_H(X_N - kQ_N) + H_S}{b + \beta k a_H} \quad X_S^U = \frac{kH_S - b(X_N - kQ_N)}{b + \beta k a_H} \end{array} \tag{A 24}$$

The unskilled labor employment in the South, using the above solution values, is

$$L_S^U = bQ_S + \beta a_L X_S = \frac{H_S(b + \beta k a_L) + b\beta k(a_L H_N - a_H L_N) - b\beta(L_N - H_N)}{b + \beta k a_H}. \tag{A 25}$$

When there is FDI, the only change in the set of equations above that described the no-FDI case is that the full employment of unskilled labor equation the North is now

$$L_N = a_L X_N. \tag{A 26}$$

While the solution values of Q_S and X_S remains the same as in the no-FDI case, those of Q_N and X_N are as follows:

$$Q_N^{UF} = \frac{a_L H_N - a_H L_N}{a_L}, \quad X_N^{UF} = \frac{L_N}{a_L}. \tag{A 27}$$

Using these values, the total employment of unskilled labor in the South is the following:

$$L_S^{UF} = \frac{a_L(b+\beta k a_L)H_S - b\beta(a_L-a_H)L_N + (a_L H_N - a_H L_N)(b\beta k(a_L-a_H)+b+\beta k a_H)}{a_L(b+\beta k a_H)} \quad \text{(A 28)}$$

Comparing (A 25) with (A 28), we obtain that $L_S^U > L_S^{UF}$, that is, employment of unskilled labor falls in the South following FDI.

5.0.1 Arms Length Trading

First consider the case when South exports the intermediate good before FDI, i.e. $b\bar{r_S} < r_N$. The output levels of food and manufacture in each country before FDI is depicted by the following equations:

$$\begin{aligned} H_N = Q_N^n + a_H X_N^n, \quad L_N^n = a_L X_N^n; \\ H_S = bQ_S^n + \beta a_H X_S^n, \quad \tfrac{1-\mu}{\mu} P^n = \tfrac{X_N^n + X_S^n}{Q_N^n + Q_S^n}, \end{aligned} \quad \text{(A 29)}$$

where P is determined from the zero profit conditions. The set of equations that describe the model after FDI are:

$$\begin{aligned} H_N = Q_N^f + a_H X_N^f, \quad L_N^f = a_L X_N^f; \\ H_S = bQ_S^f + \beta a_H X_S^f, \quad \tfrac{1-\mu}{\mu} P^f = \tfrac{X_N^f + X_S^f}{Q_N^f + Q_S^f}, \end{aligned} \quad \text{(A 30)}$$

where the superscripts n and f stand for the situation before and after FDI. Note that the first two equations determine Q_N and X_N uniquely, hence they remain unchanged after FDI. However, as shown in the main text, P falls after FDI, and hence the values of Q_S and X_S will change. The last equation implies that if P falls after FDI, so will $\frac{X_N+X_S}{Q_N+Q_S}$. Since Q_N and X_N remain unchanged after FDI, this implies $X_S \uparrow$ and $Q_S \downarrow$ after FDI(the Southern skilled labor full employment condition ensures if one rises the other must fall).

Comparing the full employment condition of skilled labor in the South before and after FDI, we obtain that

$$bQ_S^n + \beta a_H X_S^n = H_S = bQ_S^f + \beta a_H X_S^f, \text{ or} \beta a_H (X_S^n - X_S^f) = b(Q_S^f - Q_S^n) \quad \text{(A 31)}$$

To show that unskilled labor unemployment increases after FDI, we need to show that

$$L_S^n = bQ_S^n + \beta a_L X_S^n + bQ_N > Q_S^f + \beta a_L X_S^f + Q_N = L_S^f,$$

where the superscript is removed from Q_N since it has been shown that it remains unchanged after FDI. This can be simplified and written as

$$(b-1)Q_N + \beta a_L (X_S^n - X_S^f) > b(Q_S^f - Q_S^n) - (b-1)Q_S^f.$$

Using (A 31), this can be further simplified into

$$((b-1)(Q_N + Q_S^f) + \beta(X_S^n - X_S^f)(a_L - a_H) > 0, \text{ which always holds.}$$

Hence the proof is complete.