RESEARCH SEMINAR IN INTERNATIONAL ECONOMICS

School of Public Policy
The University of Michigan
Ann Arbor, Michigan 48109-1220

Discussion Paper No. 519

A Trade Theorist's Take on Skilled-Labor Outsourcing

Alan V. Deardorff

University of Michigan

September 13, 2004

A Trade Theorist's Take on Skilled-Labor Outsourcing

Alan V. Deardorff

The University of Michigan

Paper prepared for a Special Issue of the
International Review of Economics and Finance
"Outsourcing and Fragmentation: Blessing or Threat?"
Edited by Henryk Kierzkowski

September 13, 2004

ABSTRACT

A Trade Theorist's Take on Skilled-Labor Outsourcing

Alan V. Deardorff

The University of Michigan

Recent concern has attended the phenomenon of skilled-labor outsourcing, in which firms in the U.S. and other advanced countries have drawn upon the services of skilled workers in developing countries for activities that they used to do at home. Motivated by this and the fact that such outsourcing would be hard to explain without technological differences, this paper explores theoretically a simple story of outsourcing in which factor proportions and technology interact across activities performed within industries or firms. The model has a single sector in which a final output is produced from two activities that differ in their intensity of use of skilled and unskilled labor. In one activity, the developed world (North) has a technical advantage. In the other it does not, but a new regime makes it possible to outsource it to the developing world (South). The paper shows that this outsourcing, if the countries continue to diversify, causes the wage of unskilled labor in North to fall below that in South. However, if factor endowments differ enough to lead to specialization, then it becomes possible for both factors in North to gain.

Keywords: Fragmentation
Outsourcing

JEL Subject Code:
F11 Neoclassical Trade Models

Correspondence:

Alan V. Deardorff
Department of Economics
University of Michigan
Ann Arbor, MI 48109-1220

Tel. 734-764-6817
Fax. 734-763-9181
E-mail: alandear@umich.edu
http://www-personal.umich.edu/~alandear/

September 13, 2004

A Trade Theorist's Take on Skilled-Labor Outsourcing*

Alan V. Deardorff
The University of Michigan

I. Introduction

What is a trade theorist to make of the outsourcing of skilled labor services by a presumably skill-abundant country like the United States? Outsourcing makes perfect sense in any economic model when it takes advantage of international wage differentials. Within the context of the Heckscher-Ohlin (HO) model, however, as I and others have discussed at some length under the heading of fragmentation, we therefore expect outsourcing of activities that use intensively unskilled labor, not skilled.[1] The reason is that, in the absence of factor price equalization, we expect scarce unskilled labor to have a higher wage in the U.S. than in developing countries, but skilled labor to have a lower wage. Of course, this flies in the face of the obvious fact that skilled workers in developing countries in fact earn less than those in the U.S. It therefore requires that we depart somehow from the confines of the simplest HO model.

One such departure would be to allow another factor of production, in addition to skilled and unskilled labor. An even greater abundance of capital, for example, could perhaps raise wages of both skilled and unskilled labor above those abroad. But this is an

*I have benefited conversations with Juan Carlos Hallak and Bob Stern on the topic of this paper.
[1] See Deardorff (2001), Jones and Kierzkowski (2001).

uncomfortable explanation for reality in view of the apparent high international mobility of capital.

An alternative explanation that I will pursue here is differences in technology. That is, suppose that the U.S., along with other developed countries which together I will from here on call the North, possesses superior technology of some sort as compared to the developing world, or South. This, depending on the nature of the technological advantage and also of the sectors in which it exists, could easily account for both skilled and unskilled labor earning more here than abroad. As a simple example, if all sectors in the North have a 100% Hicks-neutral technical advantage over all sectors in the South, then even in a diversified equilibrium both kinds of labor in North will earn twice the wages of their counterparts in South. That would certainly seem to provide the incentive for outsourcing of both unskilled-labor-intensive and skilled-labor-intensive activities to take advantage of the cheap labor in South.

But that presumes that outsourcing can somehow combine the low-wage labor of South with the high technology of North. If that were possible, then why was technology in South so deficient in the first place? Or alternatively, why did not outsourcing take place long ago and erase the technology and wage differential? A simple answer is that it only recently became possible for the owners of North's technology to apply it in South, perhaps because of innovations in information technology. If so, then we might then expect the gradual spread of North's technology to more and more industry in South, perhaps owned and controlled by technology owners in North. The effect, as this process completes itself, would be for North-South wage differentials to be removed as the productivity of labor in South rises, and ultimately the only effect might be a catching up

of South to North. Of course, this story, if it is right, has little to do with outsourcing per se or even trade, except perhaps as the conveyer of technology.

There are many variations on this theme that might be explored, such as different kinds of technological advantage or advantages of different sizes in different sectors. And outsourcing might be possible in only some sectors but not all, thus equalizing technology asymmetrically depending on, for example, the factor intensities of those sectors where it occurs. All of this could be studied, but I fear that it would lead primarily to an exercise in taxonomy, and I will forego that, at least for now.

Instead I want to suggest a very slight variation on this theme that I find intriguing, one that does not involve any flow of technology internationally at all. Suppose that sectors, perhaps all of them, consist of multiple activities that combine to produce an output, and that some of these activities differ in technology between North and South, just as above, while others do not. Initially, the activities within a sector must be performed together, in the same location. Then, as discussed in the fragmentation literature, it becomes possible to separate these activities, performing one in North and the other in South. This new feasibility perhaps arises due to improvements in technologies of transportation and communication that make it newly possible to coordinate these activities in different locations, but I will not try to model that aspect of the problem. Rather, I want to focus on what happens if these activities, when some of them are moved abroad, must adopt the technology of their host countries.

The immediate effect of this, as I will try to demonstrate more formally, will be that prior to the advent of outsourcing (as I will refer to this new technology of fragmentation), wages of both kinds of labor may be higher in North than in South, not

because all technologies in North are superior but because enough different sectors have such superiority in a portion of the activities that they encompass. When outsourcing becomes possible, those activities that are more productive in North than South will not move, or will move only if the savings in wages is larger than their lost productivity from moving to South. But the other activities – the ones which had no superior technology but were performed in North only because previously they had to be bundled within firms – these will move to South as long as wages there are lower.

The question, then, is what effect this will all have on the equilibrium that will be reached. Do wages in South rise? Do wages in North fall? And to what extent are skilled and unskilled workers affected differently in both places?

Before writing this, I anticipated the following result: that both kinds of labor in North might gain from outsourcing. The reason is that, prior to this possibility of outsourcing, every industry in North was forced to perform a variety of relatively unproductive activities in-house. With outsourcing, however, they can slough off these activities to be done in South, concentrating all of their workers in the activities for which they have superior technologies. Thus all industries might become more productive. This, it seemed to me, might easily make all workers in North better off. On the other hand, South's workers are specializing in what might be called the "low-tech" activities, and I worried that perhaps they would lose as a result. I would not be allowing them, after all, to acquire the superior technologies at all. There would be gains from trade, of course; but in the manner of the Stolper-Samuelson Theorem these gains might not be large enough to overcome this asymmetry.

As will become clear, my intuition was wrong, up to a point.

II. The Model

It goes against my trade-theorist's grain to do so, but I will work with a one-sector model. That is, suppose that North and South both produce a single good, in perfectly competitive industries with constant-returns-to-scale (neoclassical) production functions employing skilled labor (S) and unskilled labor (U). There is free trade, but that means nothing at the start since there is only a single good. North has a superior production function, in a sense I that will specify in a moment, and therefore it pays a higher wage to at least one factor and maybe both. North also may have a relative abundance of skilled labor, which also helps to determine the initial factor prices.

In each country, the output of the single sector is produced from two activities, X and Y, that initially must be performed in the same location. I will refer to these activities as services, although they could just as well be production of physical inputs. Together these activities combine to produce an output of the final good Z, according to a neoclassical production function that is the same in both North and South:

$$Z = H(X, Y) \tag{1}$$

X and Y in turn are performed using skilled and unskilled labor according to their own neoclassical production functions

$$X^i = \lambda^i F(S_X^i, U_X^i), \quad i = s, n \tag{2}$$

$$Y^i = G(S_Y^i, U_Y^i), \quad i = s, n \tag{3}$$

where *s* and *n* represent South and North respectively. Notice that while production functions for X in the two countries differ by the Hicks-neutral parameter λ^i, those for Y

do not. X is the activity in which North has a technological advantage that cannot be transmitted to South, so from here on I set $\lambda^s = 1$ and $\lambda^n = \lambda > 1$.

Since there is only one good, I set utility *U* equal to *Z*. Combining (2) and (3) with (1), we can then define utility in the absence of outsourcing in terms of the indirect inputs of skilled and unskilled labor:

$$\begin{aligned} U^i &= U^i(S^i, U^i), \quad i = s, n \\ &= \max_{S_X, U_X} H\left(\lambda^i F(S_X, U_X), G(S^i - S_X, U^i - U_X)\right) \end{aligned} \tag{4}$$

where S^i, U^i, $i = s, n$, are the two countries' endowments of skilled and unskilled labor respectively. Note that (4) also has the properties of a neoclassical production function. And indeed the model is completely equivalent to the standard two-sector HO model, where I have simply relabeled the two industries of the HO model as activities that are inputs to a single industry. Of course, I have not yet specified which of these things may be traded.

Outsourcing now arises from the new possibility of separating the activities X and Y and of doing them in different locations, even different countries. In principle, producers of Z might be able to draw upon the services of either X or Y (or, I suppose, both) from the other country, but if all three of X, Y, and Z were tradable, with only two factors of production and unequal technologies, there would be a strong tendency for specialization. So I will avoid that by keeping X non-tradable and allowing trade in only Y and Z. That is, with free and frictionless trade (the only trading equilibrium I will consider), a single price of Y, p_Y, and a single price of Z, p_Z, prevails in both countries. There may now be both producers of Y and producers of Z in both countries, sharing the

same technologies (1) and (3). But the producers of Z in North are able to produce their needed inputs of X with the superior technology (2) with $\lambda^n = \lambda > 1$.

The question is: how will the factor prices of the two kinds of labor compare prior to outsourcing, and how will they change as a result of outsourcing? One would expect that the technological advantage in North would permit one or both factors to earn higher real wages there than in South, with the relative abundances of the factors also playing a role. And because the technology for Y is the same in South as in North, while factor prices are lower, one would expect producers of Z in North to outsource this activity to South. These expectations do not appear to depend on the relative factor intensities of X and Y, suggesting the possibility that North may outsource a skill-intensive activity to South, although that is not the main case that I will consider. Whichever may be the relative factor intensity of the outsourced activity, it in turn suggests effects of outsourcing on the wage of its intensive factor, falling in North and rising in South. These are the effects that I seek to determine. As may already be clear, the model is so similar to the standard two-sector HO model that finding these effects is little more than an exercise in using that model.

To do it manageably, however, I will now narrow my focus even further to consider only the case of Cobb-Douglas production functions. That is, from here on I assume

$$Z^i = {X^i}^{\alpha} {Y^i}^{1-\alpha} \tag{1'}$$

$$X^i = \lambda^i {S_X^i}^{\beta} {Y_X^i}^{1-\beta} \tag{2'}$$

$$Y^i = {S_Y^i}^{\gamma} {Y_Y^i}^{1-\gamma} \tag{3'}$$

where α is the share of X in producing Z, β and γ are the shares of skilled labor in producing X and Y respectively, and all of these parameters are common to both North and South. The remaining parameters, $\lambda^n = \lambda > 1 = \lambda^s$, continue to measure the Hicks-neutral advantage that North enjoys relative to South in activity X.

Autarky equilibrium [2] (which I will denote by "~") is now easily determined, since these functions collapse into the following single Cobb-Douglas function for producing Z,[3]

$$\tilde{Z}^i = \lambda^{i\alpha} A S^{i\theta} U^{i1-\theta} \tag{5}$$

with a skilled-labor share of

$$\theta = \alpha\beta + (1-\alpha)\gamma < 1 \tag{6}$$

and the parameter *A*, common to both countries,

$$A = \frac{\alpha^\alpha (1-\alpha)^{1-\alpha} \left(\beta^\beta (1-\beta)^{1-\beta}\right)^\alpha \left(\gamma^\gamma (1-\gamma)^{1-\gamma}\right)^{1-\alpha}}{\theta^\theta (1-\theta)^{1-\theta}} > 0 \tag{7}$$

From this it is easy to determine that the autarky wages of skilled labor, $\tilde{r}$,[4] and of unskilled labor, $\tilde{w}$, both in units of good Z, are the following:[5]

$$\tilde{r}^i = \theta \lambda^{i\alpha} A \left(U^i / S^i\right)^{1-\theta} \tag{8}$$

$$\tilde{w}^i = (1-\theta) \lambda^{i\alpha} A \left(S^i / U^i\right)^{\theta} \tag{9}$$

[2] More accurately I should call this "pre-outsourcing equilibrium," since I have assumed that Z was always tradable, even though no trade took place when there was nothing to trade it for.
[3] To get this you need to set the allocation of factors to X and Y so as to maximize Z.
[4] I'd have called this a salary, *s*, if I hadn't already used the letter S excessively.
[5] These follow directly from the factor shares, $r^i S^i = \theta Z^i$ and $w^i U^i = (1-\theta) Z^i$ after substituting for *Z* from (5).

Comparing wages in North, *n*, and South, *s*, these depend both on North's technical advantage in producing X, $\lambda^n = \lambda > 1$, and on North's relative abundance of skilled labor compared to South: $R = (S^n / U^n)/(S^s / U^s)$. That is,

$$\tilde{r}^n = \lambda^\alpha R^{\theta-1} \tilde{r}^s \tag{10}$$

$$\tilde{w}^n = \lambda^\alpha R^\theta \tilde{w}^s \tag{11}$$

from which,

$$\tilde{r}^n / \tilde{w}^n = R^{-1}(\tilde{r}^s / \tilde{w}^s) \tag{10}$$

Thus, North's technical advantage in activity X tends, other things equal ($R = 1$), to increase autarky wages of both factors by the same percentage above those in South, thus leaving their ratio, $\tilde{r} / \tilde{w}$ the same. The size of this effect depends on the importance of X in production of Z, as measured by its share, α. However, relative factor endowments also matter. If North has more skilled labor relative to unskilled labor than South ($R > 1$), then this reduces the wage of the skilled labor and raises the wage of the unskilled labor in North compared to South. If this difference in relative endowments is large enough ($R > \lambda^{\alpha/(1-\theta)}$), then skilled labor will be paid less in autarky in North than in South in spite of North's technical advantage. It is perhaps interesting to note that, in this particular model in autarky, the effect of the technical advantage on relative factor prices does not depend on the relative factor intensity of the activity in which it occurs, in contrast to the much-explored effects of sectoral technical progress in the "trade and wages" literature.[6] The reason is that, in this fully Cobb-Douglas model, the difference in technologies causes a difference in autarky prices that exactly offsets it.

[6] See Xu (2001).

In order to examine equilibrium with free trade in Y and Z, I will now shift from algebra to geometry. That is, I will use a variation of the familiar Lerner Diagram. As normally used, this diagram uses unit-value isoquants to represent the combinations of two factors that yield a unit of value in production of each of two or more goods, given the prices of those two goods. The prices may, with free trade, be the same in two countries making it possible to compare them. For the model here, goods Y and Z, but not X, are tradable, so it is their prices upon which the Lerner diagram needs to be based. Since good Z is produced only indirectly from factors, and also uses a tradable intermediate input Y, the appropriate isoquant for this purpose is its unit-value-added isoquant based on internalizing the production of non-traded X but purchasing traded Y on the market. That is, define value-added in Z as

$$\begin{aligned} \ddot{V}^Z &= p_Z Z - p_Y Y_Z \\ &= p_Z X^{\alpha} Y_Z^{1-\alpha} - p_Y Y_Z \\ &= p_Z \lambda S_X^{\alpha\beta} U_X^{\alpha(1-\beta)} Y_Z^{1-\alpha} - p_Y Y_Z \end{aligned} \tag{12}$$

Choosing Y_Z to maximize this for given prices, one finds

$$V = \max_{Y_Z} \ddot{V}^Z = \tilde{\alpha} \left(\frac{p_Z^{\frac{1}{\alpha}} \lambda^{\frac{1}{\alpha}}}{p_Y^{\frac{1-\alpha}{\alpha}}} \right) S_X^{\beta} U_X^{1-\beta} \tag{13}$$

where

$$\tilde{\alpha} = \left(\alpha^{\alpha} (1-\alpha)^{1-\alpha} \right)^{1/\alpha} \tag{14}$$

and I omit the superscript Z since that is the only thing for which I will be considering value added. That is, the unit-value-added isoquant for Z is also a production isoquant for the X production function, but with the scaling depending on prices of both Z (positively) and Y (negatively), as well as the technology parameter λ for producing X.

Thus a unit-value-added isoquant for Z will be, say, shifted proportionally inward toward the origin in factor space by an increase in p_Z or λ and by a decrease in p_Y. Under free trade, with countries North and South sharing the same prices but North having a higher λ, North's value added, V^n, will be larger than South's, V^s, and therefore its unit-value-added isoquant will be closer to the origin.

Figure 1 shows this, in the standard Lerner-diagram, determining factor prices from goods prices. I now assume, for now, that activity X is skill-intensive compared to activity Y. The axes measure quantities of the two factors, U and S. A solid curve, labeled $Y = 1/p_Y$, is the unit-value isoquant for activity Y, the price of which I will take as numeraire and common to both countries. Another solid curve, labeled $V^s = 1$, is the unit-value-added curve for South, where $\lambda^s = 1$. As usual in a Lerner diagram, the straight line tangent to both of these curves gives the combinations of S and U that must also be worth one unit of value, and therefore the intercepts of this common tangent measure one over the price of each factor. That is, the intercept with the horizontal U axis is $1/w^s$ and the intercept with the vertical S axis is $1/r^s$, where w^s and r^s are the wages of unskilled and skilled labor in South, respectively.

From (13), since the countries share the same prices of Y and Z under free trade and outsourcing, North's technology factor $\lambda > 1$ gives it value added larger than South's at any point in the figure. Therefore its unit-value-added isoquant, $V^n = 1$, is shifted radially inward from $V^s = 1$, to the dashed curve shown. As a result, the common tangent to $V^n = 1$ and $Y = 1/p_Y$ is the flatter dashed line shown, intercepting the axes at $1/w^n$ and $1/r^n$. The implication, as can be seen in the figure, is that equilibrium with outsourcing under the circumstances here causes the wage of skilled labor to be higher in

North than in South, while the wage of unskilled labor is lower. This is due to the particular assumption made in Figure 1 that the technological advantage exists in only one activity, and that this activity is skilled-labor-intensive compared to the other.

Note that the price of the final good Z, as well as the price of the traded (outsourced) activity Y, is the same in North and South, so these wage differences are real. The price of the non-traded activity X is actually not the same in both countries, since if it were, together with the common price of Y and North's technical advantage, North's price of Z would have to be lower. Instead, the price of X must be higher in North than in South, reflecting its intensive use of North's more expensive factor. However, this price difference is irrelevant to the real wage, since it is only the final good Z that is consumed.

We have now seen the autarky wages in the algebra and the wages with trade in the figure. To relate the two, add factor endowments to the Lerner Diagram to see the pattern of trade and thus excess supplies in the trading equilibrium. This will tell us how prices must change if we imagine moving from free trade to autarky.

This is done in Figure 2, where I initially assume that the two countries' factor endowments are the same, at point E^0. From the usual construction, the allocations of factors to activity X (and thus Z) are at points X^s and X^n while allocations to activity Y are at Y^s and Y^n. Clearly, since South allocates more of both factors to Y, it produces more Y than North. At the same time, North not only allocates more of both factors to X, but it also has a technical advantage in X, so for both reasons North produces more X. Since the countries share the same technology for converting X and Y to Z, and they face the same prices, they will demand X and Y in the same proportions. It follows that North

has an excess demand for Y and must import it from (i.e., outsource it from) South. North also produces more X than it needs for the Z that it consumes, but since X is not tradable, it produces extra Z and exports it to South to pay for the outsourced Y.

If we now imagine cutting off all of this trade, then North would have an excess supply of Z, whose price there would therefore fall. Similarly, South would have an excess demand for Z, whose price there would rise. These price changes allow one to relate the free-trade equilibrium to autarky. From (13), a fall in p_Z in North causes its unit-value-added isoquant to shift outward, while an opposite change in South causes its unit-value-added isoquant to shift inward. I do not show these changes, but a construction similar to Figure 1 implies that these price changes lower the skilled wage and raise the unskilled wage in North, with opposite changes occurring in South.

From all of this we can conclude the following, for the case of identical factor endowments: In autarky, relative factor prices (w/r) are the same in North and South, but both absolute factor prices in North are $(\lambda - 1)$ above those in South. When the countries open to free trade in final good Z and unskilled-labor-intensive service Y, North begins to outsource that service from South in exchange for the final good. As factors in both countries adjust to this new situation, the skilled wage in North rises while the unskilled wage there falls, and opposite changes occur in South. When a new equilibrium is reached the skilled wage in North is even higher relative to South than it was in autarky, but the unskilled wage in North is actually lower than that in South.

Suppose now that factor endowments are not equal, but that North has relatively more skilled labor than South: $S^n/U^n > S^s/U^s$. This can be envisioned in Figure 2 by moving North's endowment up and to the left and South's endowment down and to the

right, as shown by the arrows labeled E^n and E^s. This causes the allocations to X and Y in the two countries also to move, as shown by the arrows adjacent to X^n, etc. Thus having relatively more skilled labor causes North to engage in even more of activity X and produce even more Z that was the case before, while South does more of activity Y.[7] This simply increases the amount of trade and therefore the sizes of the excess supplies that would have to be undone by price changes in a move to autarky. However, that is to be expected, since we already knew from (10) and (11) that a relative abundance of skilled labor would reduce its wage in autarky, for example.

There are, of course, many other cases that could be considered. If South instead of North were abundant in skilled labor, this would obviously reverse some of what we have found, but this does not seem to be an empirically interesting case. We could also vary the relative sizes of the two countries, expanding both factor endowments in one and contracting them in the other. This, in contrast, is not theoretically interesting, since the homogeneity of the model will prevent anything interesting from happening if these changes are proportional.

More interesting would be the possibility that activity X, the non-traded activity in which North has a technical advantage, might be intensive in unskilled labor rather than skilled labor. That would, in effect, simply reverse the labels on the axes in both figures. It would then be a skill-intensive service that we would see outsourced to South, corresponding exactly to the "skilled-labor outsourcing" mentioned in the title of this

[7] In order to continue using the curves in Figure 2, prices must remain fixed during this process. That means that the two endowment changes cannot be arbitrary. Rather, as the two countries shift their production in opposite directions, they must do so by amounts such that the ratio of X to Y produced in the two together remains fixed. For any given change in the endowment of North, this requires a particular change in the opposite direction in the endowment of South. In Figure 2 I draw the arrows from point E^0 as co-linear, but I doubt that is the case.

paper. And the effects of this on wages would be reversed as well, with unskilled labor gaining and skilled labor losing from the outsourcing.

However, although I have no particular basis for assuming which activities are skill- and unskill- intensive, my perception of outsourcing in the world is that, while it certainly includes some skilled labor, it includes even more unskilled labor. So I tend to favor the case that I have shown in the figures, since here the outsourcing uses both factors but with a preponderance of unskilled labor.

III. Stepping Outside the Cone

So far, you will note, I have definitely not found what I mentioned at the start that I expected: a gain for both factors in North as it exploits its technological advantage to raise wages for both skilled and unskilled labor. Instead I have found not only a fall in the wage of unskilled labor (or perhaps of skilled labor in the case just mentioned of reversed factor intensities) compared to autarky, but a fall in that wage below what it is in South. The reason is that, as long as North continues to engage in both of activities X and Y, paying one factor more than in South due to the technical advantage in X, it must compensate for that by paying the other factor less so as to remain competitive in the other activity, Y, where it has no technical advantage. As we saw, in autarky a high productivity in one sector can raise wages of all factors in all sectors. But with trade, that no longer works.

This is true, however, only so long as the non-advantaged activity continues to occur in the country at all. Suppose now that the changes in factor endowments that were begun along the arrows in Figure 2 are made more extreme. At some point one, and then

both, countries' endowment points will pass outside of their respective cones of diversification.[8] That is, when point E^n crosses above the ray labeled σ_X^n in Figure 2, North will cease to produce Y at all. Likewise, when South's endowment E^s crosses below ray σ_Y^s, it will cease to produce X. For both, when that happens, the common tangents used to determine factor prices in Figure 1 (and reproduced without labels in Figure 2) no longer serve that purpose. Instead, each country's factor prices will be determined by the slopes of the respective single isoquants – for X in North and for Y in South – on which they will employ their entire factor endowments.

This is shown in Figure 3. The two endowment points are now outside of their respective cones (only one side of which is shown for each) and North produces X^n while South produces (only) Y^s. Since X is not traded, North also combines its X^n with outsourcing of all of South's Y^s to produce Z.

Factor prices in North are now given by the slope of the X^n isoquant at North's endowment point. This is found in the figure by constructing a ray from the origin to point X^n, then drawing the tangent to the unit-value-added isoquant where it crosses this ray. A similar construction identifies the factor prices in South. As drawn, the wage of unskilled labor is now higher in North than in South, and the wage of skilled labor is lower. The latter is perhaps surprising, but it is the natural result of my having substantially increased the relative abundance of skilled labor in North. A smaller change in endowments, taking us just slightly outside the cones of diversification, could

[8] I define a diversification cone here as the set of factor endowments consistent with incomplete specialization for a given technology and set of prices. Thus different prices would yield a different cone. This is a somewhat broader interpretation of the cone than is met in the usual discussion of a HO world economy, where the cone corresponds only to the prices that obtain in an integrated world economy. In

have achieved prices of both factors higher in North than in South, although the picture would have been too cluttered to be comprehensible.

The lesson is, then, that the combination of an activity-specific technical advantage with outsourcing of another activity can indeed leave both factor prices higher in North than in South. But this is only possible (in this particular model) if the outsourced activity ceases completely in North.

As drawn in Figure 3, the skilled wage is lower in North than in South, but as I have said this need not be the case. Furthermore, it is worth pointing out that outsourcing in this example raises the wage of skilled labor *relative* to unskilled labor, compared to autarky. The reason is that, in autarky with the need to produce both X and Y, the economy's overall technology is more unskilled labor-intensive than it becomes when it is able to specialize completely in skill-intensive X. That is, by raising the demand for skilled labor in North, outsourcing raises that factor's relative wage. To see this, note that the move from autarky to specialized trade causes North to move from the Cobb-Douglas technology in (5), with skilled-labor share θ, to the Cobb-Douglas technology in (2') with skilled-labor share β. If X is skill intensive compared to Y ($\beta > \gamma$), as assumed here, then from (6) $\theta < \beta$. It follows that the relative wage of skilled labor in North, r^n / w^n, rises from $(\theta/(1-\theta))(U^n / S^n)$ in autarky to $(\beta/(1-\beta))(U^n / S^n)$ with free trade if it is able to specialize in X.

---

this model an integrated world economy would presumably have all factors move to North to benefits from the superior technology, an outcome that is irrelevant to the equilibrium I am looking at here.

IV. Discussion

Like any model, this one simplifies reality, perhaps to an absurd extent. So the question is, what if anything do we learn from it that we are to believe may possibly be valid about the real world?

I rather like the idea that, within the firms and industries of the developed world, there are some activities that are done distinctly more efficiently than in developing countries, while there are others that we do no better than they. We have, after all, a well developed infrastructure and knowledge base that may actually be good for something. But these are not good for everything. There remain a great many things that we do that we are no better at doing than anyone else in the world. To the extent that the former activities make it possible for us to pay all of our workers more than comparable workers in developing countries, these latter activities are bound to have high costs. And if technologies of transport and communication make it possible to outsource these activities to lower-wage workers of all sorts abroad, then the world must gain from letting this happen, for reasons that are no more than the conventional gains from trade.

But what effects will this have on individual workers? We are accustomed in Heckscher-Ohlin trade theory for trade to alter real and relative factor prices, moving them toward factor price equalization. Here, however, the effect goes further than this. The scarce factor in the initially high-wage country actually falls below its counterpart in the low-wage country. This may be an artifact of the model's having only one sector and two activities within it, but I suspect not.

A more general model, beyond what I can attempt here, would include multiple sectors in which each incorporates multiple activities. Some of these activities would

benefit from a technological advantage in developed countries, while others would not. Some of the activities of both kinds would be capable to being outsourced, while others would not. Without outsourcing, there would then be trade, unlike the model here, with comparative advantage depending both on factor intensities/abundance and on the extent of technological advantage within sectors. The possibility of outsourcing would then allow the activities within industries also to become rationalized. Those that have benefited from Northern technology would stay there, while those that do not would go abroad, or at least this would happen subject to any limits imposed by the costs (here assumed to be zero) of coordinating the activities in different locations.

It is easy to see the gains from trade in such a world, since this model includes more scope than usual for exploiting comparative advantage. In effect, it combines Ricardian differences in technology within industries and firms with the factor-proportions-based comparative advantage of the Heckscher-Ohlin model.[9] And like other reasons for and mechanisms of trade, this one need not cause those gains to be shared equally, or even at all, across the population. In the model here, if free trade leads to only a small amount of trade and outsourcing, due to factor endowments differing across countries by less than factor intensities differ across activities, owners of one factor actually fall below their counterparts abroad as a result of this trade. Only if larger differences in factor endowments generate substantially more trade do we find the possibility of all factors gaining from outsourcing.

[9] Stated this way, it sounds very like the model of Davis (1995), though it is not. In Davis's model, a single industry has multiple goods, each using the same factor proportions, but with Ricardian differences favoring different countries in different ones of these goods.

References

Davis, Donald R. 1995 "Intra-Industry Trade: A Heckscher-Ohlin-Ricardo Approach," *Journal of International Economics* 39(3-4), (November), pp. 201-226.

Deardorff, Alan V. 2001 "Fragmentation across Cones," in Sven W. Arndt and Henryk Kierzkowski, eds., *Fragmentation: New Production Patterns in the World Economy*, Oxford: Oxford University Press, pp. 35-51.

Jones, Ronald W. and Henryk Kierzkowski 2001 "Globalization and the Consequences of International Fragmentation," in Rudi Dornbusch and Maurice Obstfeld, eds., *Money, Capital Mobility and Trade: Essays in Honor of Robert A. Mundell*, Cambridge, MA: MIT Press, pp. 365-383.

Xu, Bin 2001 "Factor Bias, Sector Bias, and the Effects of Technical Progress on Relative Wages," *Journal of International Economics* 54(1), (June), pp. 5-25.

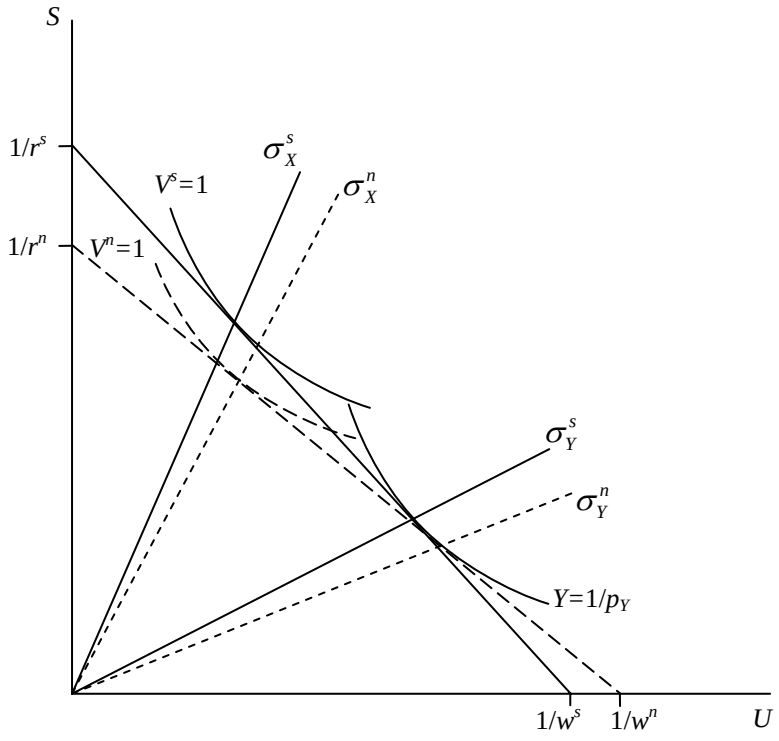

Figure 1

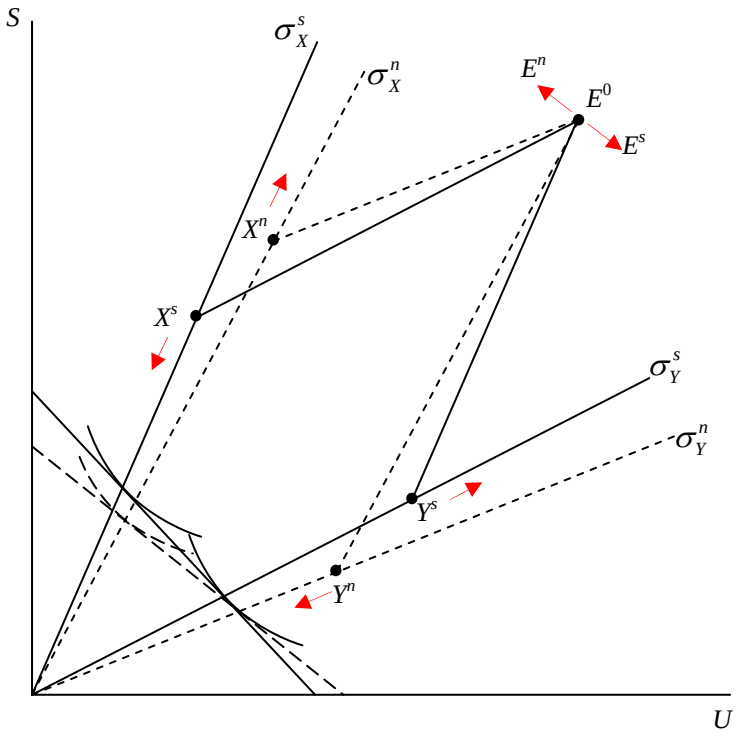

Figure 2

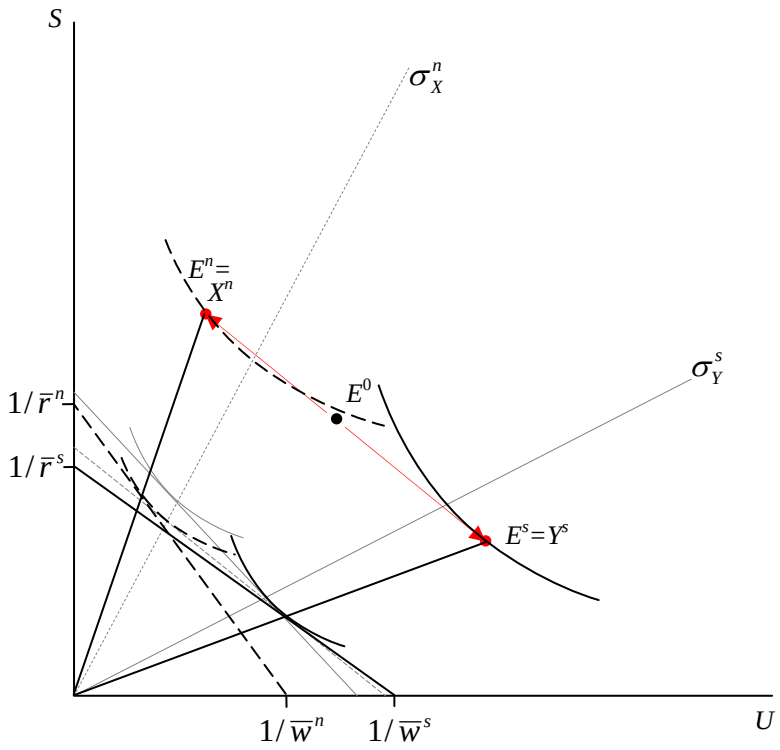
S
σ_X^n
$E^n=$
X^n
E^0
σ_Y^s
$1/\bar{r}^n$
$1/\bar{r}^s$
$E^s=Y^s$
$1/\bar{w}^n$
$1/\bar{w}^s$
U

Figure 3