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Economy-Wide Skill-Biased Technological Change, Demand Shift, Labor Supply Change, and Income Distribution Problem —

Reinterpreting Dornbusch-Fischer-Samuelson Model

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1. Introduction

The trade and wage problem has been one of the key issues in the recent economic policy debate. The focus has been both deindustrialization of the United States on the one hand, and income distribution on the other. The former concerns the idea that import competition reduced high-paying manufacturing jobs from the U.S. and led to the reduction of average wages. The latter addresses the increasing skill premium or the change in relative wages due to an increasing trade with low-skill intensive countries. In both cases, mainstream trade economists refuted the notion that “trade is a culprit.” In particular, data analysis has shown that deindustrialization is not because of something bad, but because of something good, namely, productivity improvement. However, the issue of increasing skill premium has been a more political and controversial one. Many people believe increasing inequality comes from international transaction because some of the concepts in international economics seem to support those arguments. Misused concepts include the Factor Price Equalization Theorem and

Stolper-Samuelson Theorem. See Leamer (1995) and Lawrence and Slaughter (1993) for how those concepts do not fit the reality nor the data. Trade is not likely to explain the wage gap created through 1970s and 1980s. Well, then what is the source of this wage gap between skilled and unskilled workers? In this paper, I will present a conceptual framework to approach this distributional issue.

Most economists attribute the cause of these "trade and wage" issues to technological change. A widely held view is that trade explains only a small fraction of the income inequality. Even though it is impossible to test empirically, I agree with the view that technological change had contributed to an increasing wage gap. But what kind of technological change is relevant? By looking at the conceptual model originally developed by Dornbusch, Fischer and Samuelson in 1977, I found the consistent (with the data) technological change has to be an economy wide skill-biased one. And I will show that this change can happen at the same time with the increase in supply of skilled labor. Also, I will assert that the product demand shift contributed to a large fraction of rise in skill premium which I think is a new approach to the debate of trade and income distribution.

In the next section, I will review the recent literature on trade and wage issues. In the following third section, I will explain the new integrated approach to trade by telling the Samuelson's angel story. In the fourth section, I will present a modified version of the Dornbusch-Fischer-Samuelson (hereafter, D-F-S) model and give a new interpretation. I will modify the model and assess the impact of some comparative static exercises. Concluding remarks and the potential problems will be discussed in the last section.

2. Literature Review

There is a wide variety of literature on the trade and wages issues in academia. While I am reviewing existing literature below, I will

focus on two problems: deindustrialization (decrease in average wage) and increasing premium gap (a change in relative wages). First, let me look at the stagnant average wages issue.

Lawrence and Slaughter (1993) looked at the sluggish growth of average real wages. They found that by adjusting the price deflator the real product compensation increased rather than decreased. They also found that the slow productivity growth in the non-manufacturing sector contributed to an overall productivity slowdown and thus to the sluggish growth of average wages.

Similar points were made by Krugman and Lawrence (1994). They claim that a rapid growth of productivity in the manufacturing sector contributed to a deindustrialization. The manufacturing sales decreased in the United States because of price change. That is, the US residents began to spend a smaller fraction of income on goods because goods have become relatively cheaper (compared to service) even though they were buying the same physical amount as before. The factor that pushed goods prices down (relative to service prices) was high productivity increase in the manufacturing sector. They concluded that shrinkage in the industry sector is largely the result of high productivity growth. They further claimed that the small size of the trade deficit can account for only a small contribution to wage changes.

Krugman (1997) built a model with two sectors: manufacturing (tradable) and service (non-tradable). The model allowed a structure in which trade will worsen the wage of manufacturing employees. But when he conducted a simple CGE (Calibrating General Equilibrium) calculation to check the order of magnitude, he found that “an estimate of the real income loss due to the trade-induced loss of high-wage manufacturing jobs” was trivial.

The issue of deindustrialization is mostly the result of the productivity growth. If trade contributed any to it, the amount of contribution is trivially small.

Next I will look at the implication of increasing income inequality. In sum, many authors attributed it to technological change rather than trade. I will review the literature in detail on what kind of technological change is a likely culprit.

Lawrence and Slaughter (1993) pointed out the possibility of skill-biased technological change. They denied the implication of the Stolper-Samuelson theorem because they did not find any evidence in price behavior.[1] In spite of the high cost of skilled labor, they found the intensive use of skilled labor in almost all sectors, which contradicts the prediction of the theorem. They also found the growth in total factor productivity which implies technological change. But because of a pervasive shift in US manufacturing toward the increased use of skilled labor despite the rise in its relative wage, this technological progress has to be biased toward skilled labor.

Krugman and Lawrence (1994) also found that increased wage inequality is from domestic causes. They excluded the possibility of the Stolper-Samuelson effect because the data lack two empirical implications: if trade is the cause for the increased wage inequality, 1) the ratio of skilled to unskilled employment should decline in most industries; and 2) employment should increase more rapidly in skill-intensive sectors than in those that employ more unskilled labor. But the real data showed that nearly all sectors employed an increasing proportion of white-collar workers. They concluded that "nobody knows why reduced relative demand for less skilled workers and that technological change is a likely candidate." They claimed that the ratio of import from low-wage countries does not change much.

Krugman (1997) used a large open economy trading model which

1 The Stolper-Samuelson theorem asserts that the change in goods prices due to trade intervention will affect factor prices. In particular, protectionism favors the owners of non-abundant factors.

endogenized price. He used a "miniature two-sector CGE model" (Krugman 1995c) (based on a combination of actual data and guesswork) and found that the advanced (skill-intensive) country group's offer curve is quite flat. That is, only a small different price from autarky can elicit a large amount of trade volume. Thus even with the magnification effect of Stolper-Samuelson effect, the impact of relative price change on wage differential is modest; According to Krugman's "back-of-the-envelope" calculation, it is only 3% at most whose figure is far smaller to explain the actual wage premium increase of 15-30%.

The logically consistent[2] explanation of the reason for rising income inequalities is a "pervasive skill-biased technological change" as described in Krugman (1995a) and tested in Berman, Machin and Bound (1996). Krugman explained that factor bias does matter in a large open economy framework which is a closer approximation of the real world than a small open economy model. Large economies like US and Europe can affect relative prices (terms of trade) and are collectively thought of as an almost closed economy. In such a framework, Krugman pointed out the importance of considering a "simultaneous technological change in the world as a whole." Berman, Machin and Bound (1996) supported this point by using the data analysis.

Finally, I introduce several articles which share different point of views. Based on factor content studies, Borjas, Freeman, and Katz (1992) and Sachs and Shatz (1994) found that trade has non-significant but larger than Krugman's (1997) estimate impact on wages. However, Wood (1995) concluded the impact of trade on the wage gap is quite substantial based on the assumption that the normal factor content analysis tends to understate the impact of trade. But I would argue that

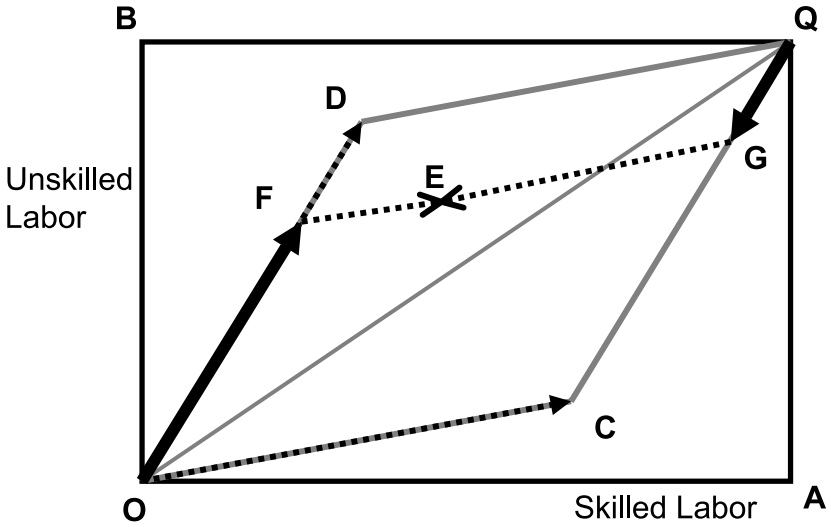
2 "Consistent" with the fact of increasing relative demand for skilled labor within industries.

many of the assumptions by Wood are dubious. As argued by Lawrence (1996), Wood's crucial assumption that NIEs have the same technologies as advanced countries cannot be justified.[3] Thus I will follow the line of arguments by Krugman, Lawrence, Berman, Machin and Bound, and others.

3. Samuelson's Angel Story and Its Implication to Multi-Goods Model

Since I will adopt the integrated-economy approach to international trade and will discuss the multi-goods model with two factors, it will be worthwhile to review Samuelson's Angel story here.[4]

Figure 1: Integrated Edgeworth Box for Inputs



3 This point is also made by Krugman (1995a).

4 This way of looking at international trade was first introduced to me by Professor Elhanan Helpman during his trade policy course at Harvard. Later I found the complete description of the story in Krugman (1995b).

First, think of a single economy with two factors. In this case, as factors of production, we choose high-skill labor and low-skill labor.[5] The combination of factor endowments is expressed as a rectangle whose sides represent each factor amount. (See Figure 1: Integrated Edgeworth Box for Inputs.) Thus, **OA** represents the world endowment of the factor 1 (skilled labor) whereas **OB** represents the endowment of the factor 2 (unskilled labor). We assume Leontief type production technique which has fixed factor intensity coefficients for each good. We now think of two products, one with skilled labor intensive technique (expressed by vector **OC**), and the other unskilled labor intensive (expressed by vector **OD**). (Later, we allow more than two products.) Since we assume full employment, given the endowment of two factors in this single economy, the sum of the production vectors must equal to the endowment vector. (**OC + OD = OQ**) So we can draw a parallelogram (**OCQD**) inside the rectangle (**OAQB**).

Now Samuelson's angel came into the world and split the world into two: the one with high-skill labor abundant (**Q**) and the other low-skill labor abundant (**O**). Now the division of endowment point is expressed as a point **E** in the diagram. To make things easier, we assume the allocation should be within a cone of diversification (within the area of parallelogram). As long as free trade is allowed between these two countries, employment structure will replicate even after the division. The country **O** produces two goods using the production vectors **OF** and **FE**. The other country **Q** produces two goods using the production vectors **QG** and **GE**. The sum of those vectors will become simply **OC** and **OD**. As Professor Helpman put it, "Free trade restored

5 Following Krugman (1995a, 1997), we will focus on two different skill labors rather than on a traditional labor-capital combination. See Krugman's papers for the arguments for this justification. The main reason for leaving capital out is that the distribution of income between capital and labor has been quite stable.

the economic structure which would have existed as a world as a whole."[6] The implication of this story is that trade can allow divided economies to replicate the structure of the global economy as if it is a closed economy. But in this case, we have same number of factors and products, which is not necessary true in reality.

Another implication of this story is that when there are more goods than factors we cannot determine the pattern of trade precisely. (And the assumption I will make in the next section is such a case: a continuum of infinitely many goods with two factors — skilled-labor and unskilled-labor). In a closed (or integrated) economy model like this, we can disregard the demand side, because it is the endowment of factors which limits demand. When we have two factors and more than two goods, we have to allocate our factors so that the sum of the production vectors must equal the endowment vector. But there are many ways.

Mathematical property tells us that there is only one way to come up with a vector by adding up two linearly independent vectors but that there are many ways to make up one vector with more than two vectors.[7] Thus we cannot really specify the pattern of production or trade patterns in a multi goods case. If this is the case, trade patterns will not be determined by factor intensity of the endowment. The usual assumption of advanced countries are trading with low-skill intensive developing countries may not hold.

This multi-goods setting makes the theory consistent with what is actually occurring. In such a setting, terms of trade does not necessary reflect cheap labor intensive goods. Increase in trade may not reflect the terms of trade improvement from buying more cheap (labor in-

6 Elhanan Helpman, Statement in class on February 13, 1997.

7 In a Euclidean space R^2, more than two vectors cannot be linearly independent.

tensive) products from China. Growing trade may come from differentiated products and increasing tastes of the people for such differentiated products.[8] In such a case, the Stolper-Samuelson Theorem is not the right model to predict the outcome in factor rewards of international trade. We need a model which looks at both multi goods settings and the effect of the product demand shift. Thus, in the next section, I will introduce a model with multi goods and with product demand interaction.

4. Reinterpreting D-F-S Model

In this section, I will reinterpret the continuum goods Ricardian model developed by Dornbusch, Fischer and Samuelson (1977) so that I will draw the implication of the skill-biased technological change, labor-supply change and product demand change on the income distribution.

Setting of the model

With minor changes, I will closely follow the D-F-S model. However, there is a strong assumption in this version of the model. In the original model, two economic agents are the domestic and foreign economies. But in this one, I treat the world economy as integrated and two agents are two types of labor.[9] That is, instead of foreign and

8 Krugman (1997) points out the difficulty of finding a true cause of surge in international trade. As he puts it, "It is quite hard to be explicit about the source of this increased trade share [in GDP]." He further claims that both transportation cost and trade restriction has been quite low already and reduction of those could not account for the sharp rise in volume like this.

9 I treat the economy as integrated because of the pervasiveness of technological change described in Berman, Machin and Bound (1996). Since we observe both the increasing wage discrepancy and increase employment of skilled labor all over the world, we can treat the world as a whole rather than separately when we examine the

home labor, I use high-skill and low-skill labor. The strongest assumption here is that to produce one type of goods, firms do not use two types of labor at a time, but use only one type of labor according to its comparative advantage. (So, this model is not a H-O model. It is Ricardian.) This assumption may seem to be too strong, but if you arrange the definition of goods, it is not as strong as you might think. (And the continuity in the assumption of the goods in this model allows us to do so easily.) For example, a toy maker employs two types of labor as an entity. But imagine skilled labor produce management service (we call this service as goods) and unskilled labor produce the manufacturing goods inside one entity according to their comparative advantage. Even a production manager in the manufacturing plant can be regarded as producing management service by himself and sell it to the firm.

This model assumes constant unit labor requirements expressed as (α_s 1, α_s 2, ..., α_s n) for skilled labor, and (α_u 1, α_u 2, ..., α_u n) for unskilled labor where subscript **s** and **u** stand for skill category and numbers 1 … n stand for goods. We can think of a goods category as a continuum rather than discrete in which case, unit labor requirement for good $\mathbf{z} \in [0, 1]$ can be expressed as $\alpha_u(\mathbf{z})$ or $\alpha_s(\mathbf{z})$.

Define $A(\mathbf{z}) = \alpha_u(\mathbf{z}) / \alpha_s(\mathbf{z})$ such that $A(\mathbf{z})$ will be decreasing in **z**. This means that as **z** becomes larger, unskilled labor will have comparative advantage. Therefore, we can conclude that $A'(\mathbf{z}) < 0$. Let w_s be the wage of high skill worker and w_u that of low skill worker. Define skill premium $\mathbf{w} = w_s / w_u$. In a competitive market, price of the good **z** will be $p(\mathbf{z}) = \alpha_u(\mathbf{z}) \cdot w_u$ or $p(\mathbf{z}) = \alpha_s(\mathbf{z}) \cdot w_s$ depending on comparative advantage. It must be true that, at the margin of comparative advantage, $A(\mathbf{z}) = \mathbf{w}$. But how will this margin be determined? In order to answer this question, let us look at demand side.

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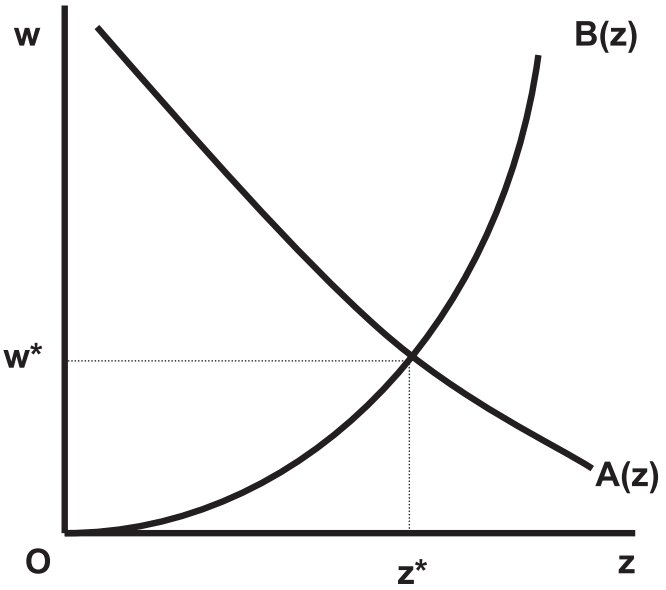
impact of such pervasive changes.

On the demand side, we assume both types of labor share the same demand structure. Define b(**z***) as a fraction of income spent on goods indexed up to **z***. So, by integrating, $b(\mathbf{z}^*) = \int_0^{z^*} \beta(\mathbf{z})\, d\mathbf{z}$ where $\beta(\mathbf{z}^*)$ stands for the fraction of income spent on **z***, and $\int_0^1 \beta(\mathbf{z})\, d\mathbf{z} = 1$. Let the labor endowment be L_s for skilled labor and L_u for unskilled. If **z*** is the marginal good, it must be true that income of total skilled labor equals the total spending of the goods they produced. This is represented as:

$$w_s \cdot L_s = b(\mathbf{z}^*)\,(w_s \cdot L_s + w_u \cdot L_u).$$

Figure 2: Modified D-F-S model



After rewriting this equation, we can get

$$\mathbf{w} = w_s / w_u = \{\, b(\mathbf{z}^*) / (1 - b(\mathbf{z}^*)) \,\} \cdot (L_u / L_s)$$

To which we set

$$B(\mathbf{z};\, L_u / L_s) = w_s / w_u = \{\, b(\mathbf{z}) / (1 - b(\mathbf{z})) \,\} \cdot (L_u / L_s).$$

And we can tell that B(·) is upward sloping in **z**. If we combine this B(**z**; ·) schedule with A(**z**), we will obtain the equilibrium level of **w*** and **z*** which specifies the competitive margin. (See figure 2)

After building the setting of the D-F-S model, the next step is to see how the changes in labor supply, product demand and technology affect the relative wages. I will examine them one by one.

The Impact of Labor Supply Change

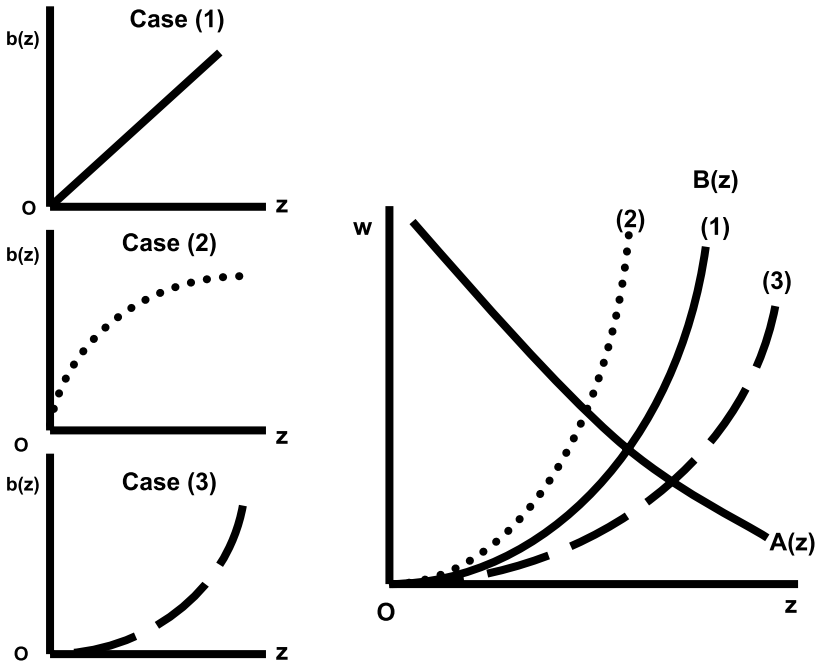
The effect of labor supply change will appear as the shift in B(·) schedule because it is a function of L_u / L_s given a constant level of **z**. The results will intuitively make sense. Given A(**z**) schedule unchanged, the increase of one type of labor will lead to a decrease in their relative wages and the decrease of labor will have the opposite effect. For example, an increase of unskilled labor will cause L_u / L_s to rise, thus will shift B(·) schedule up. Given A(**z**) schedule, this will lead to an increase in $\mathbf{w} = w_s / w_u$. So if we think of labor supply only, the consistent change with the increasing wage premium will be the increase in unskilled labor supply or the decrease in skilled labor supply, both of which are unobserved. Labor supply change alone cannot explain the whole story of the current distributional issue, and we have to consider a different source of change.

The Impact of Demand Change

The change in demand will also enter the B(·) schedule because the

shift in demand will appear as the tilt (locus-change) in b(**z**) schedule. Since b(1) $= \int_0^1 \beta(\mathbf{z})\, d\mathbf{z} = 1$ must hold always, b(**z**) schedule must share the two points in common, which are (**z**, b(**z**)) = (0, 0) and (1, 1). Satisfying these restrictions, three figures in Figure 3 will describe three possibilities of demand change. Figure 3- Case (1) is the standard case where consumption pattern is smooth over different kind of goods. Figure 3- Case (2) is the case where the consumption is skewed toward the goods indexed lower numbers. That is, people spend relatively more money on high skill goods compared with the base case (1). Figure 3- Case (3) is the case where the consumption is skewed toward the goods indexed higher numbers. That is, people spend relatively more money on low skill goods compared with the base case (1).

Figure 3: Consumption Skewness and Demand Schedule



Through the calibrating calculation by assigning specific functional form to b(**z**) in each case, I found that the case (2) will tilt the B(**z**) schedule upward and the case (3) will tilt downward relative to the base case of (1).[10] Therefore, given other things held constant, the increase in demand for high skill goods will shift the B(·) schedule upward and thus raise the skill premium on wages.

The Impact of Sector Biased Technological Change

Next, I will look at technological change effects. I will examine sectoral biased change first. In this D-F-S framework, Hicks-neutral sector biased technological change in one sector can affect nothing. Let λ be a technological change coefficient, and assume that the size of the coefficient is $0 < \lambda < 1$. Technological advance is expressed as a shrinkage of unit labor cost for good $\mathbf{z}^*$ or a change from $\alpha_u(\mathbf{z}^*)$ to $\lambda \cdot \alpha_u(\mathbf{z}^*)$ which is smaller than $\alpha_u(\mathbf{z}^*)$. A pure Hicks-neutral way of change does not affect comparative advantage of good z* because $\{\lambda \cdot \alpha_u(\mathbf{z}^*)\}/\{\lambda \cdot \alpha_s(\mathbf{z}^*)\} = \alpha_u(\mathbf{z}^*)/\alpha_s(\mathbf{z}^*)$.

A combination of sector-biased and skill-biased technological change in one sector may not affect wage change much either. Pick two sectors $\mathbf{z}_1$, $\mathbf{z}_2$ such that $\mathbf{z}_1$ has comparative advantage in skilled workers. That is $0 < \mathbf{z}_1 < \mathbf{z}_2 < 1$ and $A(\mathbf{z}_1) > A(\mathbf{z}_2)$. Imagine skill biased technological change happened only in sector $\mathbf{z}_2$ and the change is described as $A(\mathbf{z}_2) \rightarrow A^*(\mathbf{z}_2)$ where $A^*(\mathbf{z}_2) = \alpha_u(\mathbf{z}_2)/\{\lambda \cdot \alpha_s(\mathbf{z}_2)\}$ which is now larger than $A(\mathbf{z}_2)$. Because the choice of $\mathbf{z}_1$, $\mathbf{z}_2$ is rather arbitrary, suppose we now assume that $A^*(\mathbf{z}_2) > A(\mathbf{z}_1)$ but $A(\mathbf{z}) > A^*(\mathbf{z}_2)$ for any $\mathbf{z}$ such that $A(\mathbf{z}) > A(\mathbf{z}_1)$ before the technological change. The comparative advantage of $\mathbf{z}_2$ in skilled labor rose just enough to surpass $\mathbf{z}_1$ but not enough to allow other sectors between

10 As specific functional forms, I used $b(\mathbf{z}) = \mathbf{z}$ for base case (1), $b(\mathbf{z}) = \log_2(1+\mathbf{z})$ for (2), and $b(\mathbf{z}) = z^2$ for (3).

them. This technology change alters the ordering of the sectors only in between $z_1 \leq z \leq z_2$. This change is described as follows:

(before) $z^{**} < z_1 < z_0 < z_2$ and $A(z^{**}) > A(z_1) > A(z_0) > A(z_2)$
(after) $A(z^{**}) > A^*(z_2) > A(z_1) > A(z_0)$

which will redefine the ordering in the domain as

$z^{**} < z_2^* < z_1 < z_0$ where $z^{**} \in [0, z_1)$, and $z_0 \in (z_1, z_2)$.

Unless z_0 contains the marginal sector, the change will not affect the relative wage at all. Even if it contains the marginal sector such that the sector z_2 switched its comparative advantage because of technological change, it is not likely that such change affects large increases in wage differentials. It will affect a reshuffling of the domain z's and may affect a shape of $A(z)$ as a whole, but should be a little effect since we still reorder z's such that $A(z)$ is decreasing in z.

The Impact of Economy-Wide Skill Biased Technological Change

As long as it is happening in only one sector, it was shown that skill biased technological change cannot explain a large increase of wage differentials which we observe in the US. But if we assume the skill biased change is happening all through the sectors, if the change is economy-wide, we will find the implications for the relative wage change, because economy-wide technology change will appear as the shift in $A(z)$ schedule.

The economy-wide skill biased change will be expressed as

$A^*(z) = (1/\lambda) \cdot A(z) = \alpha_u(z) / \{\lambda \cdot \alpha_s(z)\}$ for all z's.

The condition $0 < \lambda < 1$ implies $(1/\lambda) > 1$. So new $A^*(z)$ curve is an upward shift of $A(z)$. Given $B(z)$ schedule, this shift will lead to a wage premium increase. The point here is that in order to shift the $A(z)$

schedule, technological change must be economy-wide.

The Effect of Combination of Those Changes

Finally, let's examine a combination effect of those changes with respect to what seems to be happening in the real world. Berman, Machin and Bound (1996) found the increase of high-skill labor employed in almost all sectors in the economy. Therefore, we must observe not only labor demand change but also labor supply change such that the total employment of high-skill workers is getting larger. But this increase in skilled labor (relative to unskilled labor) will shift B(·) schedule down, rather than up. Thus, it must be the case that something else is happening at the same time.

Another change which will shift the B(·) schedule is the change in product demand. The demand shift toward high-skill goods will move the B(·) schedule upward such that the movement can mitigate the effect of labor supply change or even can fully counter the effect. If the demand shift fully counters the labor supply, it pushes the schedule upward after combining the labor supply effect. In either case, it is plausible to assume the increase in demand toward high-skill goods by observing the recent increase in demand for computer software, high-skill services, and so on.[11]

Then, if we observe A(·) schedule shift (upward) induced by "economy-wide" skill biased technological change, it is most likely that we will expect the relative change in wage favoring high skill workers.

My guess of what is really happening is the combination of all three effects. Labor supply shift must be occurring and this can be confirmed from the data. Then to observe increasing skill premium, we

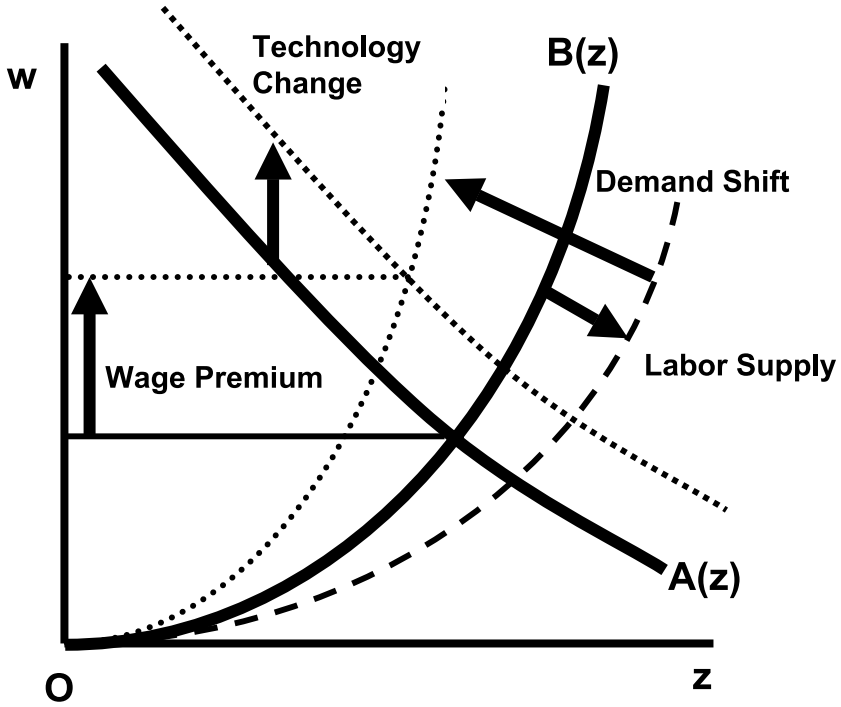
11 Note that, according to the setup of this model, shift in demand toward high-skilled production services inside of the firm (such as administrational staffs using PCs) can be counted as the demand shift toward high-skilled output goods.

must have counter effects through either or both "economy-wide" technology change and demand shift toward high-skill goods. I would say that both effects are happening and especially, the demand change is large enough to offset the labor supply shift. If that is true, we can easily predict a "huge" wage premium increase without changing production pattern of the economy much. (See Figure 4)

5. Concluding Remarks

From the reinterpretation of the old D-F-S model, I found that there is likely to be an economy-wide skill-biased technological change and product demand shift, possibly together with skilled labor supply

Figure 4: Source of Wage Premium



increase in order to explain the recent increase in skill premium of American workers.

The merit of using D-F-S model is that it allows us to analyze the effect of demand side changes together with supply side effect. The current literature on conceptual framework about trade and wage issues tends to focus on product supply side[12] which can be explained by the augmented Heckscher-Ohlin model but has not been discussing product demand aspects of the economy. The contribution of this paper is that it showed that the possible impact of product demand side effect on wage differentials.

If we look at labor supply issue, this model is consistent with data which shows large increase in skilled labor employment all over the world. There are many explanations out there looking at labor demand change, but the explanation of labor supply shift is not enough. In order to explain such a change in the employment structure, we have to have a supply side explanation which is consistent with wage premium increases. The combined explanation given in the last section 4 will do that.

One of the potential problems in using this model is that the model doesn't explain trade patterns at all, even though the original D-F-S model did explain them.[13] This is simply because I wanted to look at the impact of pervasive structural change on the income distribution by assuming that what is happening is because of pervasive changes, not because of trade.

Another potential problem is the assumption of homogeneous two groups of labor. While adopting a continuum of final goods, my assumption on factors is just two types of equally productive workers.

12 The analysis on labor demand is also a product supply side issue.

13 Original DFS model is a trade model whereas this amendment version is about a closed economy.

However, if we extend the model including many factors, it may become closer to the reality, but it may lose simplicity. It may not be beautiful enough to serve as a theory. As Krugman (1993) cited Stephen Weinberg's book, *Dreams of a Final Theory* (1992), and said "theories should be beautiful."[14] I view this two factor assumption as benevolent to keep the model as simple as possible.

Krugman appreciated D-F-S model in his same paper (1993) not because of its beauty per se, but because the D-F-S paper dealt with the connection between real and monetary sides of international economy. I appreciate those three economists for the applicability of their model even twenty five years after it was first written.

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