

Factor Mobility, Trade, and Wage Inequality

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Abstract

In order to consider the effects of factor mobility on wage inequality between skilled and unskilled labor in developed countries, we provide a simple specific factor model with international factor mobility. This paper shows that factor movement and trade produce wage inequality endogenously and that in the case of factor mobility the difference in factor intensity plays a key role in producing the wage inequality. We show also that a conventional wisdom on wage gap no longer holds under capital mobility

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1. Introduction

Recently the wage differential between highly educated (skilled) and less educated (unskilled) labor in developed countries of Europe and North America has become more pronounced. The drastic increase in wage inequality in the US since 1980s has become a subject of controversy among labor and trade theorists, and theoretical and empirical papers, such as Autor, Katz, and Krueger (1998), Bhagwati and Ksters (1994), Bound and Johnson(1992), Davis(1998), Deardorff (2000), and Krugman(2000) have speculated on the causes and their effects. The empirical studies point out that the most significant development in the US labor market during the past decade has been a decline in the wages of less educated workers vis-à-vis more educated labor. Recent collections of seminal papers such as Choi and Greenaway(2001) and Feenstra(2000) focus on the effects of growing integration of the world economy on wage inequality. ¹ These studies identify two suspects as determinants of wage inequality: trade expansion and technical progress.

The most important features in the world economy in the past two decades are the integration of markets and the fragmentation of production processes, and both of these are realized by the tremendous increase in international factor movements. In spite of this fact, with the exception of Feenstra and Hanson(1996) and Markusen and Venables(1997), the previous literature on wage inequality leaves the implications of international factor mobility an overlooked black box. The purpose of this paper is to fill this gap and consider how factor trade and commodity trade produce wage inequality endogenously. We show that international factor movements can produce the observed

wage inequality endogenously and that the difference in factor intensity plays a key role in producing wage inequality. As an analytical framework, specific factor model is desirable because in this model any changes in factor supply and commodity price can change the factor rewards endogenously even under imperfect specialization.

The rest of this paper is organized as follows. In section 2, we set up a simple specific factor model with international factor mobility. In section 3, we analyze how wage inequality is related with international factor movements at given commodity prices. We show that the factor intensity in the value sense plays a key role in explaining wage inequality between skilled and unskilled labor. In section 4, we analyze how wage inequality is related with trade at given factor supply and consider the differences between the case of factor trade and commodity trade in affecting wage inequality. Section 5 demonstrates that a conventional wisdom on labor movement no longer holds under capital mobility. Section 6 concludes the paper.

2. A Specific Factor Model with Factor Mobility

In this section, we set up a simple specific factors model with international factor mobility in order to find out the effects of factor mobility and trade on wage inequality. Consider an open developed economy that produces two commodities with three input factors under the usual neo-classical production functions. Perfect competition, full employment, decreasing marginal productivity, and constant returns to scale are assumed. The model of this economy is

$$c_j(w_j, r) = a_{Lj}(w_j, r)w_j + a_{Kj}(w_j, r)r = p_j, \quad (j = 1, 2) \quad (1)$$

$$\frac{\partial c_j(w_j, r)}{\partial w_j} X_j = \bar{L}_j + L_j, \quad (j=1,2) \quad (2)$$

$$\frac{\partial c_1(w_1, r)}{\partial r} X_1 + \frac{\partial c_2(w_2, r)}{\partial r} X_2 = \bar{K} + K \quad (3)$$

$$\dot{L}_j = f_j(w_j - w_j^*), \quad f_j(0) = 0, \quad f_j'(\bullet) > 0 \quad (4)$$

$$\dot{K} = g(r - r^*), \quad g(0) = 0, \quad g'(\bullet) > 0 \quad (5)$$

$$w_j = w_j^*, \quad r = r^*, \quad (6)$$

where, $c_j(\bullet)$ is the unit cost function and w_1 and w_2 are the wage rate of unskilled and skilled labor respectively and r is the rental cost of capital. $w_2 - w_1$ is the wage inequality. X_j and p_j are the output and price of j th commodity. The minimum quantity of the i th ($i = K, L$) factor per unit output in the j th good is a_{ij} . The domestic endowments of unskilled and skilled labor are \bar{L}_1 and \bar{L}_2 , while L_1 and L_2 are the quantity of imports of two types of labor. Domestic endowment of capital is \bar{K} , while K is the quantity of imports of capital.

Equation (1) is the zero profit condition, and (2) and (3) are the full employment conditions. Equations (4) and (5) show that any changes in domestic factor supply are realized through international factor movements that depend on the gaps between the returns in two countries.² The dot denotes the time derivative. Equation (6) gives equilibrium conditions for factor market, where w_j^* and r^* are the factor rewards in the foreign country. In equations (1) - (3), we have five equations with the same numbers of variables: w_1, w_2, r, X_1, X_2 with the parameters: $p_1, p_2, L_1, L_2, K, \bar{L}_1, \bar{L}_2, \bar{K}$.

This model has two salient features. First, it is a specific factor model. Second, any changes in domestic factor supply are realized through international factor movements.

These features are based on the following facts. First, skilled labor and unskilled labor are different factors and they are specific to each sector. Second, as the result of the globalization of economies, the acquisition of factors of production from foreign countries has become very easy. Thus, we use a specific factor model with international factor movements.

It is well known that in the absence of international factor mobility comparative advantage determines the pattern of trade and subsequent factor rewards. However in the presence of factor mobility comparative advantage cannot determine the pattern of trade. In reality both factor trade and commodity trade coexist and they are affecting each other. However, in order to determine the trade pattern and to simplify the analysis, the analysis is made under some restrictive assumptions. First, we analyze the effects of factor mobility on wage inequality under no trade. Secondly, we analyze the effects of trade on wage inequality under no factor mobility. Then the differences between them are compared. As an application of this model, we demonstrate that a conventional wisdom in wage gap no longer holds under capital mobility.

3. Effects of Factor Mobility

This section considers the effects of factor mobility on wage rates and wage inequality under given commodity prices.³ It is shown that the factor intensity between the two sectors plays a key role in producing wage inequality.

To determine the direction of factor movements, it is necessary to specify the initial

differences in factor rewards between the two countries. For simplicity, we assume that the initial difference in factor rewards depends on the production side of the model: technology difference and factor endowment differences. From sections 3 - 1 to 3 - 3, we assume that the level of technology is the same between the two countries, while in section 3 - 4, we assume that the factor endowments are the same between them. Since there are three factors, we have at least three types of international factor mobility. For the analytical simplicity, we assume a situation where a factor moves other factors do not move. If $\hat{w}_2 > \hat{w}_1$ ($\hat{w}_2 < \hat{w}_1$), we define that wage inequality changes in favor of the skilled (unskilled) labor, where the hat denotes the relative change of the variables. Further, we assume that this home country is a developed country and foreign country is a developing country, so that home country is abundant in capital and skilled labor while it is scarce in unskilled labor. Furthermore, throughout the paper the second sector is assumed to be capital intensive relative to the first sector.

3 - 1. Inflow of Unskilled labor

Assume initially $w_1 > w_1^*$, $w_2 = w_2^*$, $r = r^*$. Then we have $\hat{L}_1 > 0$. Assuming p_j , L_2 , and K to be fixed, from equations (1) - (3) we have

$$\hat{w}_1 = - \left(\frac{\theta_{K1}}{\theta_{L1}} \right) \frac{\lambda_{K1}}{\Phi} \hat{L}_1 < 0 \quad (7)$$

$$\hat{w}_2 = - \left(\frac{\theta_{K2}}{\theta_{L2}} \right) \frac{\lambda_{K1}}{\Phi} \hat{L}_1 < 0 \quad (8)$$

$$\hat{w}_2 - \hat{w}_1 = \left(\frac{\theta_{K1}}{\theta_{L1}} - \frac{\theta_{K2}}{\theta_{L2}} \right) \frac{\lambda_{K1}}{\Phi} \hat{L}_1 < 0, \quad (9)$$

where, $\theta_{ij} > 0$ is the distributive share of the i ($i = K, L$) th factor in the j ($j = 1, 2$) th sector ($\theta_{Kj} + \theta_{Lj} = 1$), $\lambda_{Kj} > 0$ is the fraction of capital used in the j th sector ($\lambda_{K1} + \lambda_{K2} = 1$), $\Phi = \left(\frac{\lambda_{K1}\sigma_1}{\theta_{L1}} + \frac{\lambda_{K2}\sigma_2}{\theta_{L2}} \right) > 0$, $\sigma_j = (\hat{a}_{Kj} - \hat{a}_{Lj}) / (\hat{w}_j - \hat{r}) > 0$ is the elasticity of factor substitution in the j th sector, and $(\theta_{Kj} / \theta_{Lj})$ is the factor intensity in the value sense in the j th sector.

Several interesting results follow from equations (7) - (9). First, an inflow of unskilled labor reduces the wage rate of both types of labor. In the Heckscher-Ohlin model under imperfect specialization, any changes in factor endowments do not affect factor prices. However, this is not the case in the model of this paper. Second, we see that the direction of wage inequality depends on the difference in factor intensity. By the assumption of factor intensity, an importation of unskilled labor changes the wage inequality in favor of unskilled labor.⁴

The implications of these results could be explained as follows. An inflow of unskilled labor reduces the wage rate of unskilled labor and is given by equation (7). This is the direct effect on unskilled labor and its magnitude depends on the factor intensity in the first sector. However, it also produces a negative indirect effect on skilled labor which is witnessed in equation (8). A rise in the productivity of capital in the first sector initiated by an increase in the supply of unskilled labor induces capital to move from the second sector to the first. This reduces labor productivity in the second sector and produces a negative effect on skilled labor. Its magnitude depends on the factor intensity in the second sector. As the factor intensity in the second sector is greater than that of the first sector, the wage rate of skilled labor declines more than that of unskilled labor, producing a wage differential in favor of unskilled labor. Thus we have

Proposition 1. Both types of labor suffer with the importation of unskilled labor. If the second sector is capital intensive, an importation of unskilled labor changes the wage rate in favor of unskilled labor.

3 - 2. Outflow of Skilled Labor

Assume initially $w_2 < w_2^*$, $w_1 = w_1^*$, $r = r^*$. Then we have $\hat{L}_2 < 0$. Assuming p_j , L_1 , and K to be fixed, from equations (1) - (3), we have

$$\hat{w}_1 = -\left(\frac{\theta_{K1}}{\theta_{L1}}\right) \frac{\lambda_{K2}}{\Phi} \hat{L}_2 > 0 \quad (10)$$

$$\hat{w}_2 = -\left(\frac{\theta_{K2}}{\theta_{L2}}\right) \frac{\lambda_{K2}}{\Phi} \hat{L}_2 > 0 \quad (11)$$

$$\hat{w}_2 - \hat{w}_1 = \left(\frac{\theta_{K1}}{\theta_{L1}} - \frac{\theta_{K2}}{\theta_{L2}}\right) \frac{\lambda_{K2}}{\Phi} \hat{L}_2 > 0. \quad (12)$$

Thus we obtain

Proposition 2. Both types of labor gain by an outflow of skilled labor. If the second sector is capital intensive, the move out of skilled labor changes wage inequality in favor of skilled labor.

This proposition provides important implications to the wage inequality in the US because it produces a situation where both types of labor gain and we have a change in wage inequality in favor of skilled labor. This is explained as follows. The move out of

skilled labor produces a situation where an additional supply of capital has occurred in the economy. Since the second sector is capital intensive, the productivity and wage rate of skilled labor must increase. This is the direct effect on skilled labor. However, it produces a positive indirect effect on unskilled labor, because the additional capital is also used in the first sector. As the second sector is capital intensive, the direct effect dominates the indirect effect, producing the wage inequality in favor of skilled labor.

A technology transfer to developing countries is usually accompanied by the move out of skilled labor from developed countries. If the technology transfer is defined as the move out of skilled labor, it will produce wage inequality in favor of skilled labor in the developed country. It is interesting to see that the technology transfer is beneficial to the skilled labor in developed countries.

3 - 3. Outflow of Capital

Assume initially $r < r^*$, $w_1 = w_1^*$, $w_2 = w_2^*$. Then we have $\hat{K} < 0$. Assuming p_j , L_1 , and L_2 to be fixed, from equations (1) - (3), we have

$$\hat{w}_1 = \left(\frac{\theta_{K1}}{\theta_{L1}} \right) \frac{1}{\Phi} \hat{K} < 0 \quad (13)$$

$$\hat{w}_2 = \left(\frac{\theta_{K2}}{\theta_{L2}} \right) \frac{1}{\Phi} \hat{K} < 0 \quad (14)$$

$$\hat{w}_2 - \hat{w}_1 = \left(\frac{\theta_{K2}}{\theta_{L2}} - \frac{\theta_{K1}}{\theta_{L1}} \right) \frac{1}{\Phi} \hat{K} < 0. \quad (15)$$

Thus we obtain

Proposition 3. The outflow of capital reduces the wage rate for both types of labor. If the second sector is capital intensive, the outflow of capital changes wage inequality in favor of unskilled labor.

Since capital is mobile between the two sectors, the outflow of capital reduces the marginal product of both types of labor, so that both types of labor suffer. This would explain why labor unions in the US opposed the outflow of capital in 1980s. Equation (15) will be explained as follows. If capital moves out when the second sector is capital intensive, the marginal product of labor in the second sector declines more than that of the first sector, so that the wage gap in favor of unskilled labor occurs. In contrast, if developed country accepts capital inflow, the skilled labor will gain.

The above three propositions on wage inequality seem at first to be paradoxical. However, these results have economic reasoning and are derived under the plausible factor intensity ranking.

From equations (9),(12), and (15), we obtain following proposition

Proposition 4. If the factor intensity is the same between the two sectors, international factor mobility does not affect wage inequality. Thus, the difference in factor intensity is a necessary condition for producing wage inequality under factor mobility.

From (12) and (15), it is easy to see the effects of simultaneous outflow of capital and

skilled labor. Usually direct investment is defined as the simultaneous international movements of capital and skilled labor. In such a case, we can demonstrate the effects of direct investment on wage inequality in developed country.

3 - 4. Simultaneous Inflow of All Three Factors

There exists another interesting case where while factor endowments are the same between the two countries the level of technology in the home country is high enough to make the rewards of all three factors in home country higher than those in the foreign country. In such a case, we have $w_1 > w_1^*$, $w_2 > w_2^*$, $r > r^*$, so that all three factors move into home country.⁵ We will derive a condition under which an inflow of all three factors produces wage inequality in favor of skilled labor. From equations (9), (12), and (15), we obtain

$$(\hat{w}_2 - \hat{w}_1) = \frac{1}{\Phi} \left(\frac{\theta_{K2}}{\theta_{L2}} - \frac{\theta_{K1}}{\theta_{L1}} \right) (\hat{K} - \lambda_{K1} \hat{L}_1 - \lambda_{K2} \hat{L}_2). \quad (16)$$

This leads us to

Proposition 5. Suppose that all three factors move into the home country under the assumption that the second sector is capital intensive. Then the necessary and sufficient condition for an inflow of three factors to make wage inequality in favor of skilled labor is $\hat{K} > (\lambda_{K1} \hat{L}_1 + \lambda_{K2} \hat{L}_2)$.

This proposition suggests that in order to change wage inequality in favor of skilled

labor when second sector is capital intensive, the rate of increase in capital inflow should be greater than that of the weighted sum of the labor inflows. As the mobility of capital is higher than that of labors and it is reasonable to assume that the second sector is capital intensive, the possibility of wage inequality in favor of skilled labor is high. Our analysis provides a complement to Davis and Weinstein(2002) with the additional results on wage inequality in favor of skilled labor. It is interesting to see that the skilled labor in the US can gain by this simultaneous inflow of all three factors.

4. Effects of Trade

The previous section analyzed the effects of factor movements on wage inequality under no trade. In contrast, this section considers the effects of trade on wage inequality under no factor mobility. International trade changes the commodity prices which in turn change factor prices and any changes in factor prices will produce an incentive to change factor supply and commodity prices. In this section, we consider trade affects wage inequality under given factor supplies and show that the wage inequality depends on the differences in price changes between the two sectors rather than the differences in factor intensity.

Assume that the country has a comparative advantage in the second good and exports that good and imports the first good. Assuming cost minimization and given factor supply, from (1) - (3), we obtain

$$\hat{w}_1 = \frac{[(\lambda_{K2}\sigma_2 + \lambda_{K1}\theta_{L2}\sigma_1)\hat{p}_1 - (\lambda_{K2}\theta_{K1}\sigma_2)\hat{p}_2]\Gamma}{\Delta} \quad (17)$$

$$\hat{w}_2 = \frac{[(\lambda_{K1}\sigma_1 + \lambda_{K2}\theta_{L1}\sigma_2)\hat{p}_2 - (\lambda_{K1}\theta_{K2}\sigma_1)\hat{p}_1]\Gamma}{\Delta} \quad (18)$$

$$\hat{w}_2 - \hat{w}_1 = \frac{\Gamma^2}{\Delta}(\hat{p}_2 - \hat{p}_1), \quad (19)$$

where, $\Delta = [\lambda_{K1}^2\theta_{L2}\sigma_1^2 + \lambda_{K2}^2\theta_{L1}\sigma_2^2 + \lambda_{K1}\lambda_{K2}\sigma_1\sigma_2(\theta_{L1} + \theta_{L2})] > 0$, $\Gamma = (\lambda_{K1}\sigma_1 + \lambda_{K2}\sigma_2) > 0$, and $\Gamma^2 - \Delta = \lambda_{K1}^2\theta_{K2}\sigma_1^2 + \lambda_{K2}^2\theta_{K1}\sigma_2^2 + \lambda_{K1}\lambda_{K2}\sigma_1\sigma_2(\theta_{K1} + \theta_{K2}) > 0$. As the trade expansion implies $(\hat{p}_2 - \hat{p}_1) \geq 0$, from (19), we obtain

Proposition 6. Expansion of trade can produce wage inequality in favor of skilled labor.

Furthermore, since $\Gamma^2 > \Delta > 0$, any trade expansion produces a magnified effect on wage inequality.

Now compare the above two cases: factor mobility under no trade and commodity trade under no factor mobility. In the former, the difference in the factor intensity determines the wage inequality. In the latter, the difference in the price change of two commodities matter.

5. The Wage Gaps under Capital Mobility

In the analyses of international labor mobility, we have a conventional wisdom: labor movement between the two countries narrow the initial wage gap and reduce the incentives for further labor migration.⁶ However this conventional wisdom is derived

under no capital mobility. As an application of this model, this section considers the wage gaps of two types of labor between the two countries under capital mobility. We show that this wisdom is justified under no capital mobility and it does not hold under capital mobility.

Consider the case of unskilled labor movement under capital mobility. Take up the case of 3 - 1 and suppose that this country accepts unskilled labor from a developing country due to $w_1 > w_1^*$ with $w_2 = w_2^*$ and $r = r^*$. This unskilled labor movement will decrease w_1 and increase w_1^* , making the initial wage gap narrow. However the move out of unskilled labor from developing country reduces r^* and increases r , which induces capital to move from developing country to developed country. The movement of capital will increase w_1 and reduce w_1^* . This capital movement will continue until $r = r^*$ is attained. At this final situation, we are not sure whether the initial gap $w_1 > w_1^*$ has declined or not. The gap may increase and the results depend on the values of elasticities relating capital mobility. The conventional wisdom may no longer hold under capital mobility.

Next consider the case of skilled labor movement under capital mobility. Take up the case of 3 - 2 and suppose that skilled labor moves out from a developed country to a developing country due to $w_2 < w_2^*$ with $w_1 = w_1^*$ and $r = r^*$. The move out of skilled labor will increase w_2 and reduce w_2^* , making the initial wage gap narrow. However move out of skilled labor reduces r and increases r^* , making capital to move out from developed country. This capital movement will reduce w_2 and increase w_2^* and continue until $r = r^*$ is attained. We are not sure whether the initial wage gap in skilled

labor between the two countries has narrowed or not. The gap may increase and the conventional wisdom no longer holds under capital mobility.

The above analyses show that under capital mobility we can not determine the direction of changes in wage gaps and it is possible that the initial wage gaps between the two countries may increase. This result suggests that there exists a case where a skilled labor abundant country becomes more skilled labor abundant country than before under capital mobility. Our analyses will provide another support to the analysis of Davis and Weinstein(2002).

6. Conclusions

This paper was motivated by the significance of factor mobility in the analysis of wage inequality. By the use of a specific factor model with factor mobility, this paper provides the following novel implications to the wage inequality and wage gap for a developed economy.

First, international factor mobility can produce wage inequality endogenously. Second, factor intensity in the value sense plays a key role in explaining wage inequality in the sense that if the factor intensity is the same between the two sectors, international factor mobility does not affect wage inequality. Third, the effects of trade on wage inequality depend on the differences between the commodity price changes and any change in commodity price produces a magnified effect on wage inequality. Fourth, a conventional wisdom on wage gap does not hold under factor mobility.

Different approaches and hypotheses have already been provided to explain the causes and effects of wage inequality. By the use of a specific factor model with factor mobility, this paper added some new results to the previous literature by focusing on the effects of factor mobility on wage inequality.

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Footnotes

1. Two journals in international economics have published a special issue on wage inequality: *Journal of International Economics* 54 (June) 2001 and *Review of International Economics* 8 (August) 2000.
2. The domestic supply of factors of production can change through birth, education, and capital accumulation within a country. However as the result of globalization,

- the international factor movement is now easy and significant. Thus we assume that the domestic supply of factors change through the international factor movements.
3. The assumption of fixed commodity prices has following merits. First, the effects of international factor movements on factor prices become clear and strong. Second, the changes in nominal wages imply that of real wages.
 4. Davis (1998) divided the effects of unskilled labor importation on labor market into two types: flexible-wage US type and rigid-wage Europe type. He insisted that in the former type the wage inequality increases while in the latter the unemployment rate increases.
 5. Davis and Weinstein (2002) noted an interesting fact that all factors of production in the world are moving into the US because the level of technology in the US is higher than that of the rest of the world. We understand that capital, skilled labor, as well as unskilled labor are moving to the US.
 6. We define the wage inequality as the wage differential between skilled and unskilled labor within a country while wage gap as the wage differential of same labor between the two countries.

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