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FREE TRADE AND WAGE INEQUALITY IN THE ADVANCED ECONOMY

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This paper develops a general equilibrium model for examining the impact of free trade on the wage inequality in the Northern economy and synthesizing the sensitivity of wage inequality indices to changes in causal factors. The model has three types of labor: sector-specific high-skilled, mobile unskilled and immobile unskilled labor. Thus, three types of wage inequality indices are derived. The major findings are: first, introducing heterogeneous classes of labor the overall wage inequality of the Northern economy does not necessarily deteriorate with free trade; second, expenditure shifts for the final good that is produced by high-skill content requirements always lead to a rise in overall wage inequality; third, the sensitivity of the wage inequality indices to biased technological changes is greatly affected by factor mobility.

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I. INTRODUCTION

Considering the dominance of wage income, wage inequality takes a primary importance to economic inequality. In recent years there has been a great deal of research done to analyze the widening of wage inequality in developed countries. These studies are divided on the main forces driving wage inequality.

Bhagwati and Kosters(1994), Lawrence and Slaughter(1993), Sachs and Shatz (1994), and Krugman and Lawrence(1994) conclude that globalization has

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played a minor role in lowering the relative wages of unskilled workers. These authors argue that the trend towards wage inequality is mainly the result of technological change rather than pressure on the wages of low-skilled workers from foreign competition. In particular, Krugman and Lawrence(1994) claim that the decline in blue-collar wages must be attributed not to international trade that changes the country's industrial mix, but to other factors that have reduced the relative demand for less skilled workers throughout the economy.

Though Slaughter and Swagel(1997) claim that the majority of research supports this line of view, and Leamer(1966) gives us a modified view concluding that trade did not contribute to rising income inequality in the US during the 1980s, Batra(1993), Wood(1994), Bergstrand et al(1994), and Leamer(1994) state that the trend in wage inequality is mainly due to trade developments. Wood(1995) suggests that trade lowered the economy-wide relative demand for unskilled labor in all developed countries by about 20 percent as of 1990, and further claims that a 20 percent fall in the relative demand for unskilled labor is sufficient to explain the marked widening of skill differentials in wages and unemployment rates, even though the methodology used to calculate the quantity of labor displaced by imports is still debatable.

However, although Borjas and Ramey(1995) develop a partial equilibrium model in which the impact of foreign competition on the relative wages of less skilled workers depends on the market structure of the industry penetrated, there are few formal models synthesizing the determinants of change in wage inequality within a North-South trade framework. Therefore, this paper provides a general equilibrium model examining the impact of free trade on wage inequality in the advanced economy and synthesizing the sensitivity of wage inequality indices to changes in causal factors such as technological changes, relative expenditure shifts, and relative shifts of labor supply. In particular, relative expenditure shares have not been treated in existing literature on wage inequality. The model also incorporates industry specificity that is originated from imperfect competition.

Assuming the advanced economy is the sole supplier of a variety of high technology intermediate goods, and has its own specific high-skilled factors and firm-specific increasing returns to scale, the world is divided into North and South. This classification is non-traditional in the sense that any country that can produce differentiated high technology intermediate goods joins the North. In other words, a trade partner is classified not by per capita income, but by industrial organization which can exercise industrial market power. The indices of wage inequality after trade liberalization are defined as changes in the factoral terms of trade. Sex, education, experience, and job classification can measure factoral terms of trade in practice. For example, Lawrence and Slaughter(1993) have measured factoral terms of trade by the ratio of average annual wages of non-production workers to average annual wages of production workers. Krugman and Lawrence(1994) identify the rise in the ratio of

white-collar to blue-collar wages as the wage divergence between skilled and unskilled workers.

The structure of this paper is as follows. In section II, a formal North-South trade model is presented where there are three factors of production: sector-specific high-skilled labor, immobile unskilled labor, and mobile unskilled labor. The Northern economy is the only region with high-skilled labor that can produce a variety of intermediate goods. The South can adopt high skill-intensive technologies from the North via intermediate goods trade. Thus, the South can export high-skill content final goods by the use of intermediate goods. Increased trade flows would raise relative demand for skill in both South and North. Section III derives three wage inequality indices shaped by four causal factors that are (i) trade, (ii) factor endowments, (iii) consumer expenditure shares, and (iv) biased technological changes, and demonstrates the possibility of a decrease in overall wage inequality due to a subsectoral gain in wage equity. Based on these causes, comparative static results for the wage inequality indices are provided. Section IV concludes by summarizing the findings and by providing some policy implications.

II. A FORMAL MODEL

Suppose the world consists of two economies, North and South. The Northern economy is described, simply noting that the "f" denotes the variable of the Southern economy. Assume that the two economies have identical and homothetic preferences, the same production conditions, free trade in two kinds of final manufactures, such as the low-skill content and the high-skill content, and n variety of intermediate goods(T_i, $i=1, \cdots, n$). Suppose the Northern economy is the only supplier of differentiated intermediate goods(T_i, $i=1, \cdots, n$). Then, the South can produce the high-skill content final manufacture (X_f) only through the import of Northern intermediate goods. In other words, South cannot produce and consume the high-skill content final manufacture in the autarky. Importing Northern intermediate goods is a kind of technology adoption. Further, suppose that no migration of labor is allowed between the two economies.

Consider the Northern economy with two final goods X and Y, and n variety of intermediate goods: T_i, $i=1, \cdots, n$. There are three factors of production: intermediate good sector-specific high-skilled labor($L_{s,T}$), sector Y specific unskilled labor($L_{us,Y}$), and mobile unskilled labor(L_{us}). The labor markets are competitive.

The final good X is produced using not only unskilled labor, L_{us}, but also n variety of intermediate goods: T_i, $i=1, \cdots, n$. Intermediate goods are produced using only sector-specific high-skilled labor, $L_{s,T}$.

Assuming an aggregate two-stage Cobb-Douglas-CES production function

which is similar to Dixit and Stiglitz's(1977) utility function, the production function of good X takes the form,

$$X=L_{us}^{1-\alpha}(\sum_{i=1,\ldots,n} T_i^{\beta})^{\alpha/\beta}. \quad (1)$$

If T_i are the same for all i in the equation (1), $n^{\alpha/\beta}$ represents external economies of scale. It is assumed that

$$0<\beta<1 \text{ and } 0<\alpha<1,$$
$$\beta=[1-(1/\sigma)],$$

where σ=the constant elasticity of substitution among the variety of intermediate goods. The value of β shows the degree of substitutability among intermediate goods. The lower the β is, the more differentiated the intermediate goods are, allowing a higher market power for the high-skill content final goods.

The high-skill sector produces differentiated intermediate goods under Chamberlinean monopolistic competition, so that the number of intermediate goods produced is large enough to make oligopolistic interaction negligible. There are increasing returns at the level of an individual firm. The production of the i^{th} *intermediate good*, T_i, involves some fixed labor input requirements (z_0) and variable labor input requirements(zT_i) where z represents the constant marginal labor input requirements.

It is assumed that all firms in the high-skill sector are symmetric. Thus, in equilibrium, all intermediate goods actually produced will be produced in the same quantity and at the same price.

Sector Y specific unskilled labor($L_{us,Y}$) and mobile unskilled labor(L_{us}) combine to produce low-skill content final good Y by the Cobb-Douglas production function which has a different distributive share $\gamma\in(0, 1)$. A different distributive share implies a different specific factor intensity. Therefore, the production function of low-skill content final good Y can be written as,

$$Y=L_{us}^{1-\gamma}L_{us,Y}^{\gamma}. \quad (2)$$

Suppose both final goods X and Y are produced competitively. Let good Y be the numeraire. Then, under free trade the common competitive profit conditions are

$$p=kn^{-(\alpha/\beta)+\alpha}q^{\alpha}W_{us}^{1-\alpha}, \quad (3)$$

$$1=cW_{us,Y}^{\gamma}W_{us}^{1-\gamma}, \quad (4)$$

where $k=\alpha^{-\alpha}(1-\alpha)^{\alpha-1}$; $c=r^{-\gamma}(1-r)^{\gamma-1}$; p is the price of good X; q is the price of intermediate goods; W_{us} is the wage rate for mobile unskilled labor; and $W_{us,Y}$ is the wage rate for sector Y specific unskilled labor.

The condition for profit maximization in the high-skill sector of the Northern economy is to equate marginal revenue to marginal cost, i.e.

$$q[1-(1-\beta)]=W_{s,T}z, \tag{5}$$

where $W_{s,T}$ is the wage rate for high-skill sector specific skilled labor, and $(1-\beta)$ is in absolute value the elasticity of the inverse demand for intermediate goods.

Since free entry is assumed, any non-zero profit will be eliminated and in equilibrium,

$$qT=(z_0+zT)W_{s,T}, \tag{6}$$

Note that the symmetry assumption of the high-skill sector is used in (6).

The unskilled and skilled labor market clearing conditions for both economies, North and South, are given, respectively, by

$$k(1-\alpha)n^{-(\alpha/\beta)+\alpha}q^{\alpha}W_{us}^{-\alpha}X+c(1-r)W_{us,Y}^{\gamma}W_{us}^{-\gamma}Y=L_{us}^{0} \tag{7}$$

$$n(z_0+zT)=L_{s,T}^{0} \tag{8}$$

$$crW_{us,Y}^{\gamma-1}W_{us}^{1-\gamma}Y=L_{us,Y}^{0} \tag{9}$$

$$k(1-\alpha)n^{-(\alpha/\beta)+\alpha}q^{\alpha}W_{us}^{-\alpha}X_f+c(1-r)W_{us,Y}^{\gamma}W_{us}^{-\gamma}Y_f=L_{f,us}^{0} \tag{10}$$

$$crW_{us,Y}^{\gamma-1}W_{us}^{1-\gamma}Y_f=L_{f,us,Y}^{0} \tag{11}$$

where L_{us}^{0} is the endowment of mobile unskilled labor, $L_{u,T}^{0}$ is the endowment of intermediate good sector-specific skilled labor, and $L_{us,Y}^{0}$ is the endowment of sector Y specific unskilled labor.

The national budget constraints for both economies are, respectively, given by

$$pX+Y+nqT=pD_x+D_y+qnT_d, \tag{12}$$

$$pX_f+Y_f=pD_x^{f}+D_y^{f}+qnT_d^{f}, \tag{13}$$

where D_x = Northern demand for X,
D_y = Northern demand for Y,

$$T_d = k\alpha\, n^{-(\alpha/\beta)+\alpha-1} q^{\alpha-1} W_{us}^{1-\alpha} X, \tag{14}$$

$$T_d^f = k\alpha n^{-(\alpha/\beta)+\alpha-1} q^{\alpha-1} W_{us}^{1-\alpha} X_f. \tag{15}$$

T_d is the Northern usage of each intermediate product and T_d^f is the Southern usage of each intermediate product. This intermediate goods trade can generate the demand shifts toward more skilled labor, which contribute to rising wage inequality. Therefore, the world market clearing condition for intermediate goods is

$$nT_d + nT_d^f = nT. \tag{16}$$

Since individuals have identical and homothetic preferences for X and Y, suppose a fixed share of expenditure, $\lambda_x \in (0,1)$, falls on X, *i.e.*

$$\lambda_x = pD_x/(pD_x + D_y), \tag{17}$$

$$\lambda_x = pD_x^f/(pD_x^f + D_y^f). \tag{18}$$

The model here assumes that the consumers in the advanced economy have the same share of expenditure on high-skill content final good X as in the autarky.

From (17) and (18), we know that an increase in λ_x indicates the rising world demand for product X relative to product Y.

The world market clearing condition for X is

$$\lambda_x = p(X + X_f)/[p(X + X_f) + Y + Y_f]. \tag{19}$$

Therefore, seventeen independent equations (3)-(19) will determine the value of seventeen endogenous variables: p, W_{us}, $W_{s,T}$, $W_{us,Y}$, q, T, T_d, T_d^f, X, X_f, Y, Y_f, D_x, D_y, D_x^f, D_y^f, n.

III. FREE TRADE AND WAGE INEQUALITY

It follows from the solutions of the model that wage inequality is determined according to the combined effects of four causal factors which are (i) trade, (ii) factor endowments, (iii) shares of consumer expenditure, and (iv) shares of wage distribution. This section focuses on assessing the impact a change in each cause has on the three wage inequality indices.

A biased technological change affects wage distribution, as Berman, Bound and Griliches(1994) suggest. Thus, a biased technological change is captured

by a change in magnitude of the share of wage distribution. In this model an increase in α represents a skill-biased technological change that also means an intermediate goods sector biased one, while an increase in r indicates a low skill-biased technological change that favors immobile unskilled labor. A change in magnitude of the share of consumer expenditure induces a change in the relative demand for labor. Thus, this paper shows that an increase in λ_x expands intermediate goods trade and brings out a greater relative demand for skill.

The impact of free trade on wage inequality is measured by the difference between the solution value of relative wages with trade and the solution value without trade in the model of section II. Thus, the index of the wage inequality between sector-specific skilled and mobile unskilled labor is

$$(W_{s,T}/W_{us})-(W_{s,T}/W_{us})_a = [\lambda_x \alpha/\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}](L^0_{f,us}/L^0_{s,T}), \quad (20)$$

where "a" denotes the value of autarky one. For the autarkic equilibrium, see the Appendix A, and the Appendix B provides the solution values of relative wages.

Eq. (20) indicates that trade liberalization always widens the wage inequality between sector-specific skilled and mobile unskilled labor.

To identify the sensitivity of the wage inequality index of (20) to changes in consumer expenditure shares, technological changes, and relative endowment changes after trade liberalization, take the natural log of both sides of (20) and totally differentiate it. Then, (20) is transformed into the type of relative change in variables as follows:

$$\begin{aligned}\hat{I}_{s/us} =& [(1-r)/\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}]\hat{\lambda}_x \\ &+[\{\lambda_x+(1-\lambda_x)(1-r)\}/\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}]\hat{\alpha} \\ &+[\{(1-\alpha)\lambda_x+(1-\lambda_x)\}/\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}]\hat{r} \\ &+\hat{L}^0_{f,us}-\hat{L}^0_{s,T} \end{aligned} \quad (21)$$

A $\wedge$ over variable indicates the relative change in that variable. For example, $\hat{I}_{s/us}$ is $d[(W_{s,T}/W_{us})-(W_{s,T}/W_{us})_a]/[(W_{s,T}/W_{us})-(W_{s,T}/W_{us})_a]$, the relative change in the index of the wage inequality between sector-specific skilled and mobile unskilled labor.

The term $\hat{\lambda}_x$ in (21) is the relative change in the share of expenditure on high-skill content final good X. This kind of preference change has not been part of the inequality debate. According to (21), the relative demand shift for

final good X leads to a rise in the wage inequality between sector-specific high-skilled and mobile unskilled labor. This is because an increase in λ_x has increased derived demand for high-skilled labor and high-skilled labor has an absolute wage premium due to product market imperfection.

The terms $\hat{\alpha}$ $\hat{r}$ and show biased technological changes. An increase in α which favors sector-specific high-skilled labor and an increase in r which favors immobile unskilled labor lead to a more than proportional rise in the wage inequality between sector-specific high-skilled and mobile unskilled labor, respectively, according to (21).

Suppose that α rises and r falls equiproportionally. Then, will the wage inequality between sector-specific high-skilled and mobile unskilled labor be improved? It depends on relative factor shares and relative expenditure shares. If the share of high-technology intermediate goods is sufficiently large relative to the share of immobile unskilled labor and the share of expenditure on high-skill content final good X is sufficiently large relative to the share of ordinary final goods, then the wage inequality between sector-specific high-skilled and mobile unskilled labor will be widened. Specifically, we can conclude that the wage inequality between sector-specific high-skilled and mobile unskilled labor will deteriorate due to the equiproportional increase in the factor share α and decrease in the factor share r if and only if $(\alpha/\mathrm{r})[\lambda_x/(1-\lambda_x)]>1$.

The term $\hat{L}^0_{f,us}$ is a trade-related factor on the Northern wage inequality. Suppose that an increase in supply of Southern-mobile-unskilled labor $L^0_{f,us}$ is relatively larger than that of Northern sector-specific high-skilled labor. According to (21), then, the wage inequality between sector-specific high-skilled and mobile unskilled labor deteriorates.

Then, as (21) indicates, a decrease in λ_x, α and r, and an increase in $L^0_{s,T}$ move the wage inequality in the opposite direction. Therefore, the North had better resort to some policy mix such as an appropriate taxation on expenditures and redistribution of tax revenues in the short-run and expanding the endowments of high-skilled labor through education and training in the long-run in order to cure the worsened wage inequality due to the increased supply of Southern-mobile-unskilled labor,.

The index of the wage inequality between sector-specific high-skilled and immobile unskilled labor is

$$(W_{s,T}/W_{us,Y})-(W_{s,T}/W_{us,Y})_a=[\lambda_x/(1-\lambda_x)](\alpha/\mathrm{r})(L^0_{f,us,Y}/L^0_{s,T}). \qquad (22)$$

Eq.(22) gives us the result that trade liberalization always leads to widen the wage inequality between sector-specific high-skilled and immobile unskilled labor.

To identify the impact a change in each cause has on the wages inequality index of (22), it can be written as:

$$\hat{I}_{s/us,Y}=\{1/(1-\lambda_x)\}\hat{\lambda}_x+\hat{\alpha}-\hat{r}+\hat{L}^0_{f,us,Y}-\hat{L}^0_{s,T} \tag{23}$$

As (23) indicates, an increase in the share of expenditure on high-skill content final good X leads to a rise in the wage inequality between sector-specific high-skilled and immobile unskilled labor more than proportionally. However, the relative factor shares and the relative expenditure shares do not play any role in that result.

Also, the effects of biased technological changes on the wage inequality between specific factors are determined regardless of relative factor shares and relative expenditure shares. Thus, we find that if factors are specific to respective product markets, the sensitivity of the wage inequality between specific factors to biased technological changes solely depends on the absolute size of changes in each parameter. Since the biased technological changes move the wage inequality between specific factors in the opposite direction, the increase in the factor share of sector-specific high-skilled labor relative to immobile unskilled labor will cause the wage inequality to deteriorate.

An increase in the supply of Southern-immobile-unskilled labor relative to Northern sector-specific high-skilled labor also causes the wage inequality between specific factors via trade to deteriorate.

The index of the Northern wage inequality between mobile and immobile unskilled labor can be represented by

$$(W_{us}/W_{us,Y})-(W_{us}/W_{us,Y})_a=[\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-\mathrm{r})\}/(1-\lambda_x)\mathrm{r}]$$
$$[\{(L^0_{us,Y}+L^0_{f,us,Y})/(L^0_{us}+L^0_{f,us})\}-(L^0_{us,Y}+L^0_{us})]. \tag{24}$$

From (24), the Northern wage inequality between mobile and immobile unskilled labor decreases with free trade if and only if the Southern economy is mobile unskilled labor abundant relative to immobile unskilled labor compared to the Northern economy, i.e. $(L^0_{us}/L^0_{us,Y})<(L^0_{f,us}/L^0_{f,us,Y})$. This result demonstrates that the overall wage inequality of the Northern economy does not necessarily deteriorate with free trade, which is not consistent with the prediction of the traditional Heckscher-Ohlin framework. For example, if the advanced economy is immobile unskilled labor abundant relative to mobile unskilled labor by two times or more and it is experiencing the increasing wage inequality between sector-specific skilled and unskilled labor with free trade, then North can further reduce the overall wage inequality by inducing South to be mobile skilled labor abundant relative to immobile unskilled labor. This indicates that the Southern factor endowments, $L^0_{f,us}$ and $L^0_{f,us,Y}$ are playing an important role in determining wage inequality in the advanced economy as trade cause. Combining the results of (20), (22), and (24), we can conclude that in order to lessen the widening of wage inequality with free trade, the

Northern economy should concentrate on local wage inequality, in particular within the less skilled group, rather than on overall wage inequality.

To identify the sensitivity of the index of the wage inequality within the less skilled group, it proves convenient to transform (24) into relative changes as follows:

$$\begin{aligned}\hat{I}_{us/us,Y} = & [(1-\alpha)\lambda_x/\{(1-\lambda_x)((1-\alpha)\lambda_x+(1-\lambda_x))(1-r))\}]\hat{\lambda}_x \\ & -[\alpha\lambda_x/\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}]\hat{\alpha} \\ & -[\{(1-\alpha)\lambda_x+(1-\lambda_x)\}/\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}]\hat{r} \\ & -[\{L^0_{us,Y}L^0_{f,us}/(L^0_{us}L^0_{f,us,Y}-L^0_{us,Y}L^0_{f,us})\}]\hat{L}^0_{us,Y} \\ & +[\{L^0_{us}L^0_{f,us,Y}/(L^0_{us}L^0_{f,us,Y}-L^0_{us,Y}L^0_{f,us})\}]\hat{L}^0_{f,us,Y} \\ & -[\{L^0_{us,Y}L^0_{f,us}/(L^0_{us}L^0_{f,us,Y}-L^0_{us,Y}L^0_{f,us})\}+\{L^0_{f,us}/(L^0_{us}+L^0_{f,us})\}]\hat{} \\ & L^0_{f,us} \\ & +[\{L^0_{us}/(L^0_{us}L^0_{f,us,Y}-L^0_{us,Y}L^0_{f,us})\}-\{L^0_{us}/(L^0_{us}+L^0_{f,us})\}-1]\hat{L}^0_{us} \quad (25)\end{aligned}$$

According to (25), an increase in the share of expenditure on high-skill content final good X causes the wage inequality between mobile and immobile unskilled labor to be widened. This is because the demand shifts for high-skill content final good X increases the intermediate goods usage, and hence raises the derived demand for mobile unskilled labor.

The impacts of changes in expenditure share are consistently positive throughout (21), (23), and (25). This shows that the expenditure shifts for final goods of which the main contents are intermediate goods with market power always lead to a rise in the overall wage inequality.

The biased technological changes, $\hat{\alpha}$ and $\hat{r}$, cause the wage inequality between mobile and immobile unskilled labor to be reduced. This is the opposite result compared to the case of the wage inequality between sector-specific high-skilled and mobile unskilled labor. Because the biased technological changes favor the factor incomes of immobile factors, they move the two wage inequality indices in the opposite direction. Therefore, we find that if there are two symmetric immobile factors and one mobile factor, variations in the two wage inequality indices with respect to sector-specific high-skilled versus mobile unskilled and mobile versus immobile unskilled labor are offset by each other.

Finally, consider comparative statics for relative supply shifts of labor in the integrated trading world. An increase in Southern-mobile-unskilled labor causes the Northern wage inequality between mobile and immobile unskilled labor to

rise via trade if and only if the South is mobile unskilled labor abundant relative to immobile unskilled labor compared to the North, i.e. $(L^0_{us}/L^0_{us,Y}) < (L^0_{f,us}/L^0_{f,us,Y})$. According to (25), a rise in Northern-mobile-unskilled labor moves the wage inequality index in the opposite direction compared to a rise in Southern-mobile-unskilled labor, while a rise in Northern-immobile-unskilled labor moves it in the same direction as a rise in Southern-mobile-unskilled labor.

Also, an increase in Southern-immobile-unskilled labor leads to an improvement in the Northern wage inequality between mobile and immobile unskilled labor if and only if the South is mobile unskilled labor abundant relative to immobile unskilled labor compared to the North, i.e. $(L^0_{us}/L^0_{us,Y}) < (L^0_{f,us}/L^0_{f,us,Y})$. A rise in Northern-immobile-unskilled labor moves the wage inequality index in the opposite direction compared to a rise in Southern-immobile-unskilled labor, while a rise in Northern-mobile-unskilled labor moves it in the same direction as a rise in Southern-immobile-unskilled labor.

Therefore, we can conclude that the effects of the Southern relative endowment changes on the Northern wage inequality via trade could be different depending on the corresponding relative changes in the Northern endowments of labor.

The findings in this section are summarized in the Table 1.

[Table 1] The Sensitivity of the Wage Inequality Indices

Change	Effect on the wage inequality indices		
	$\hat{I}_{s/us}$	$\hat{I}_{s/us,Y}$	$\hat{I}_{us/us,Y}$
$\hat{\lambda}_x$	+	+	+
$\hat{\alpha}$	+	+	−
$\hat{\tau}$	+	−	−
$\hat{L}^0_{s,T}$	−	−	None
$\hat{L}^0_{f,us}$	+	None	+*
$\hat{L}^0_{f,us,Y}$	None	+	−*
$\hat{L}^0_{us,Y}$	None	None	+*
$\hat{L}^0_{us}$	None	None	−*

Notes: +indicates positive association; −indicates negative association;
* holds if and only if $(L^0_{us}/L^0_{us\,Y}) < (L^0_{f,us}/L^0_{f,us,Y})$.

Ⅳ. CONCLUSION

A widening of wage inequality in recent years has been a source of great concern in many advanced economies. Though a lot of literature has addressed this problem, there are few formal models that analyze changes in wage inequality within an integrated general equilibrium framework.

This paper has developed a formal model for examining the impact of free trade on the wage inequality in the Northern economy and synthesizing the sensitivity of wage inequality indices to changes in causal factors within a general equilibrium setting.

The model has three types of labor: sector-specific high-skilled, mobile unskilled and immobile unskilled labor. Thus, three types of wage inequality indices are derived. Selected comparative statics for changes in consumer expenditure shares, biased technological changes, changes in relative endowments have been provided.

This paper has several findings. First, disaggregating labor into three classes, the analysis finds that the overall wage inequality of the Northern economy does not necessarily deteriorate with free trade, which is not consistent with the prediction of the traditional Heckscher-Ohlin framework. This suggests that the North can achieve greater overall wage equality by improving the local wage inequality that could be greatly affected by factor market structures in the globalization process.

Second, expenditure shifts for the final good that is produced by high-skill content requirements always lead to a rise in overall wage inequality. Thus, taxation on expenditure shifts for the final goods that are produced by high-skill content requirements is recommended.

Third, the sensitivity of the wage inequality indices to biased technological changes is greatly affected by factor mobility. The effect of biased technological changes on the wage inequality between mobile and immobile factors depends on relative factor shares and relative expenditure shares, while that on the wage inequality between immobile factors does not. Thus, we know that the greater the factor mobility is, the more the role of relative factor shares and relative expenditure shares are played in the sensitivity of the wage inequality indices. This implies that it would be better for the government to use a policy mix such as redistribution and expenditure switching in order to cure the widening of wage inequality due to biased technological changes.

Fourth, the effects of the Southern endowment changes on the Northern wage inequality via trade could be constrained by the North's ability to change the global structure of factor supply. Thus, it will be helpful to monitor and induce trade partners' factor endowment changes in order to reduce distribution conflicts due to trade.

Appendix

A. The Closed Economy

The closed economy model has the same structure as in the open economy model of the main text except that the Southern economy cannot produce and consume the high-skill content final manufacture(X_f) in the autarky. Therefore, each economy has the following autarkic equilibrium. Note that the subscript "a" denoting the autarkic value is abbreviated in the endogenous variables, such as p, W_{us}, $W_{s,T}$, $W_{us,Y}$, q, T, X, Y, n, Y_f, $W_{f,us}$, and $W_{f,us,Y}$.

North:

$$p=kn^{-(\alpha/\beta)+\alpha}q^{\alpha}W_{us}^{1-\alpha}, \tag{N1}$$

$$1=cW_{us,Y}^{\gamma}W_{us}^{1-\gamma}, \tag{N2}$$

$$q[1-(1-\beta)]=W_{s,T}z, \tag{N3}$$

$$qT=(z_0+zT)W_{s,T}, \tag{N4}$$

$$k(1-\alpha)n^{-(\alpha/\beta)+\alpha}q^{\alpha}W_{us}^{-\alpha}X+c(1-r)W_{us,Y}^{\gamma}W_{us}^{-\gamma}Y=L_{us}^{0}, \tag{N5}$$

$$n(z_0+zT)=L_{s,T}^{0} \tag{N6}$$

$$crW_{us,Y}^{\gamma-1}W_{us}^{1-\gamma}Y=L_{us,Y}^{0}, \tag{N7}$$

$$k\alpha n^{-(\alpha/\beta)+\alpha}q^{\alpha-1}W_{us}^{1-\alpha}X=nT, \tag{N8}$$

$$\lambda_x=pX/(pX+Y). \tag{N9}$$

South:

$$1=cW_{f,us,Y}^{\gamma}W_{f,us}^{1-\gamma}, \tag{S1}$$

$$c(1-r)W_{f,us,Y}^{\gamma}W_{f,us}^{-\gamma}Y_f=L_{f,us}^{0}, \tag{S2}$$

$$crW_{f,us,Y}^{\gamma-1}W_{f,us}^{1-\gamma}Y_f=L_{f,us,Y}^{0}. \tag{S3}$$

B. The Solution Values of Relative Wages

The method of substitution is used to get the solution values of relative

wages.

Using (3), (4), (7), (14), and (15), we get

$$(W_{s,T}/W_{us})=[\lambda_x\alpha/\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}]\{(L^0_{us}+L^0_{f,us})/L^0_{s,T}\}.$$

Combining (7) and (10), (9) and (11), (14) and (15), and using (6) and (8), we can get

$$(W_{us}/W_{us,Y})=[\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}/(1-\lambda_x)r]$$
$$\{(L^0_{us,Y}+L^0_{f,us,Y})/(L^0_{us}+L^0_{f,us})\}.$$

From $(W_{s,T}/W_{us})$ and $(W_{us}/W_{us,Y})$, we get

$$(W_{s,T}/W_{us,Y})=[\lambda_x/(1-\lambda_x)](\alpha/r)\{(L^0_{us,Y}+L^0_{f,us,Y})/L^0_{s,T}\}.$$

Similarly, we can get

$$(W_{s,T}/W_{us})_a=[\lambda_x\alpha/\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}](L^0_{us}/L^0_{s,T}),$$

$$(W_{us}/W_{us,Y})_a=[\{(1-\alpha)\lambda_x+(1-\lambda_x)(1-r)\}/(1-\lambda_x)r](L^0_{us,Y}/L^0_{us}),$$

$$(W_{s,T}/W_{us,Y})_a=[\lambda_x/\{(1-\lambda_x)](\alpha/r)(L^0_{us,Y}/L^0_{s,T}).$$

From these solutions, we can derive (20), (22), and (24).

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