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## To integrate with a high- or low-wage country: That is the question

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## ABSTRACT

This paper considers the question of whether a country with the intermediate capital–labor ratio is better off forming a free trade area with the higher or lower wage country. Typical analyses of gains from trade ignore the effects of free trade on factor prices. When Europe forms a free trade area with a high-wage economy, the equalized wage rises and rent declines, while the price of the importable declines. Workers unambiguously benefit, but integration has an ambiguous effect on capitalists. However, consumers as a whole benefit from the integration and workers can more than offset the losses of the capitalists. On the other hand, Europe's integration with a low-wage economy raises rent but lowers the wage and the price of the labor-intensive good. Accordingly, capitalists unambiguously benefit, but integration has an ambiguous effect on workers. Again, welfare of all consumers rises and the capitalists can more than offset the losses of workers.

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## 1. Introduction

The factor price equalization theorem is one of the four cornerstones of the celebrated Heckscher–Ohlin model. Some attempts have been made to extend the model to a more realistic world with many industries and factors.<sup>1</sup> However, not much attention has been paid to the equalized factor prices. Samuelson (1948, 1949) showed that under certain conditions free trade equalizes factor prices between countries, but the factor price equalization theorem does not predict at what levels the factor prices are equalized.

The effects of trade on international income inequality have received much attention in recent years. If trading countries have similar resource endowments, factor price equalization also causes income convergence among trading countries.<sup>2</sup> However, the literature shows conflicting empirical evidence. For example, Murphy and Welch (1991), Katz and Murphy (1992), Wood (1995), Leamer (1996), and Borjas and Ramey (1994) claimed that trade has a negative effect on income distribution. They argued that trade has increased the income gap between the United States and developing countries. These empirical studies are relevant, but factor price equalization does not guarantee convergence of per capita income levels between trading countries. Using the data on 11 developing countries, Abdi (2007, p. 2459) did not find any significant role for trade liberalization on the relative wage.<sup>3</sup>

When a country forms a free trade area with another, the integrated region has more resources and will experience a change in factor prices. The effect of free trade on factor prices cannot be analyzed by the Rybczynski Theorem (1955), because it assumes

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<sup>1</sup> For extensions to higher dimensions, see for instance, Ethier (1984), Neary (1985), and Choi (2003). Due to inability to predict the commodity trade pattern in a world with more than two goods, some developed a fifth proposition: the Heckscher–Ohlin–Vanek theorem, which predicts that a country exports the services of its abundant factor through trade.

<sup>2</sup> For income convergence, see Rassek and Thompson (1998) and Slaughter (1997).

<sup>3</sup> Other economists investigated the impact of trade on domestic income inequality. For instance, Kumar and Mishra (2008) found that tariff reductions increased the wage in Indian industries. Verhoogen (2008) noted that trade liberalization increased wage premium for skilled workers in Mexico. Acosta and Gasparini (2007) showed that capital accumulation increased the wage gap between skilled and unskilled wages.

commodity prices are fixed. Recently, [Levy \(1997\)](#) showed that welfare of an agent is minimized when its capital–labor ratio is equal to that of the economy, and evaluated the free trade agreement for a fixed representative voter.

This paper utilizes Levy's indirect utility approach, but is different from his approach in one respect.<sup>4</sup> This paper considers a country with the intermediate capital–labor ratio and investigates whether capitalists and laborers benefit and whether the whole country benefits from a free trade agreement with a high-wage economy. The gains from trade literature usually ignore the effects on income distribution. This paper examines the effects of integration on capitalists, laborers and consumers in general by incorporating the changes in factor prices.

## 2. A three-country model

Assume that there are three countries: America (A), Europe (E) and Asia (C). We consider the question of whether Europe with the intermediate capital–labor ratio is better off forming a free trade area with the high-wage or low-wage country. To investigate the impacts of free trade on factor prices and welfare, we construct a three-country model, employing the following assumptions:

- (1) Consumers in the three countries have identical and homothetic preferences.
- (2) Two factors, capital and labor, are used to produce two goods, 1 and 2.
- (3) All countries have identical production functions with constant returns to scale.
- (4) America is more capital-abundant than Europe, which is more capital-abundant than Asia.
- (5) Factors are fully employed and mobile between sectors.
- (6) Perfect competition prevails in product and factor markets.
- (7) There are no transportation costs or trade barriers.

### 2.1. The supply side

We first consider the effect of Europe's integration with America. Let  $Y_1$  and  $Y_2$  denote the domestic outputs of goods 1 and 2 in Europe, respectively. An asterisk (\*) denotes the variables for America. Industry 2 is assumed to be capital intensive,  $k_2 = K_2/L_2 > K_1/L_1 = k_1$ , where  $K_i$  and  $L_i$  are capital and labor inputs used in the industry  $i$ . Let  $p_1$  and  $p_2$  denote the prices of goods 1 and 2 in Europe. In the absence of transport costs and trade barriers, free trade equalizes output prices, i.e.,  $p_i = p_i^*$ . Since factors are fully employed, input and output relations of the integrated region may be written as

$$\begin{aligned} Y_1 + Y_1^* &= \frac{a_{K2}(L + L^*) - a_{L2}(K + K^*)}{\Delta}, \\ Y_2 + Y_2^* &= \frac{a_{L1}(K + K^*) - a_{K1}(L + L^*)}{\Delta}, \end{aligned} \quad (1)$$

where  $a_{ij}$  is the amount of input  $i$  to produce one unit of output in industry  $j$ ,  $\Delta = a_{L1}a_{K2} - a_{K1}a_{L2} = a_{L1}a_{L2}(k_2 - k_1) > 0$ . As noted in [Samuelson \(1949\)](#), once factor prices are equalized, even though factors are not mobile between countries, the outputs of the integrated region are exactly equal to those when the integrated region is a single country with aggregate resource endowments  $(L + L^*, K + K^*)$  and factors are mobile throughout the integrated region.

The Rybczynski Theorem deals with the impact of factor growth on the outputs of a single country facing constant prices. Each input–output coefficient  $a_{ij}(w, r)$  depends on factor prices, which in turn depend on output prices. When prices are held constant,  $a_{ij}(w, r)$  is fixed. Let  $Y_{iL} \equiv \partial Y_i / \partial L$  and  $Y_{iK} \equiv \partial Y_i / \partial K$ . Supply response to changes in factor endowments is given by the Rybczynski Theorem,

$$Y_{1L} = \frac{a_{K2}}{\Delta} > 0, \quad Y_{2L} = -\frac{a_{K1}}{\Delta}, \quad Y_{1K} = -\frac{a_{L2}}{\Delta} > 0, \quad Y_{2K} = \frac{a_{L1}}{\Delta}. \quad (2)$$

The reciprocity relation implies the [Stolper–Samuelson](#) Theorem:

$$\frac{\partial w}{\partial p_1} = \frac{a_{K2}}{\Delta} > 0, \quad \frac{\partial w}{\partial p_2} = -\frac{a_{K1}}{\Delta} < 0, \quad \frac{\partial r}{\partial p_1} = -\frac{a_{L2}}{\Delta} > 0, \quad \frac{\partial r}{\partial p_2} = \frac{a_{L1}}{\Delta} > 0. \quad (3)$$

### 2.2. Demand side

Consider the integrated region's demand for two goods. Recall that consumers in Europe and America have identical and homothetic preferences. Their preferences are represented by monotone increasing and quasiconcave utility functions

$$U = U(X_1, X_2), \text{ and } U^* = U(X_1^*, X_2^*),$$

<sup>4</sup> Overall gains from formation of trade blocs have been discussed by [Krugman \(1991\)](#), [Bagwell and Staiger \(1999\)](#), [Bond et al. \(2004\)](#), and more recently by [Oladi and Beladi \(2008\)](#).

where  $X_1$  and  $X_2$  denote Europe's consumption of goods 1 and 2, and  $X_1^*$  and  $X_2^*$  are similarly defined for America. Let good 1 be the numéraire so that  $p_1 = 1$  and let  $p = p_2/p_1$  be the relative price of good 2 which Europe imports. The budget constraints of consumers are

$$X_1 + pX_2 = I, \text{ and } X_1^* + pX_2^* = I^*,$$

where  $I$  and  $I^*$  are European and American incomes, respectively.

Let  $X_1 = X_1(p, I)$  and  $X_2 = X_2(p, I)$  denote the demand functions for goods 1 and 2 in Europe, and  $X_1^* = X_1^*(p, I^*)$  and  $X_2^* = X_2^*(p, I^*)$  be their equivalents in America. Indirect utility functions are written as

$$V(p, I) \equiv U[X_1(p, I), X_2(p, I)], \text{ and } V^*(p, I^*) \equiv U^*[X_1^*(p, I^*), X_2^*(p, I^*)],$$

where national incomes are given by

$$I = Y_1 + pY_2, \text{ and } I^* = Y_1^* + pY_2^*.$$

The market clearing price of good 2 for the region is implicitly defined by

$$Y_2 + Y_2^* = X_2(p, I) + X_2^*(p, I^*). \quad (4)$$

Summing the budget constraints of the two countries yields

$$p_1(X_1 + X_1^*) + p_2(X_2 + X_2^*) = p_1(Y_1 + Y_1^*) + p_2(Y_2 + Y_2^*).$$

By Walras Law, if market 2 clears for a given  $p$ , market 1 does as well.

### 3. Factor growth, price and income

Let  $Q = X_2 - Y_2$  denote excess demand for good 2 in Europe, and let  $Q^* = X_2^* - Y_2^*$  be America's excess demand for the same good. Let  $X_{2p}^U = X_{2p} + X_{2L}$  denote the slope of Europe's compensated demand curve, and let  $X_{2p}^{U*}$  be similarly defined for America. [Choi \(2008\)](#) shows that factor growth within the region has the same effect on the terms of trade, regardless of whether growth occurs in one country or the other. Specifically,

$$\frac{\partial p}{\partial L} = \frac{Y_{2L} - wX_{2L}}{D_{2p}^U + D_{2p}^{U*}} = \frac{\partial p}{\partial L^*} > 0, \quad (5)$$

$$\frac{\partial p}{\partial K} = \frac{Y_{2K} - rX_{2K}}{D_{2p}^U + D_{2p}^{U*}} = \frac{\partial p}{\partial K^*} < 0, \quad (6)$$

where  $D_{2p}^U = X_{2p}^U - Y_{2p}$  and  $D_{2p}^{U*} = X_{2p}^{U*} - Y_{2p}^*$  are the slopes of compensated excess demand for good 2 in Europe and America, respectively. Thus, *regardless of where growth occurs, labor growth raises the price of the capital intensive good, while capital growth lowers it.*

Europe's import demand for good 2 is

$$Q(p, I) = X_2(p, I) - Y_2(p), \quad (7)$$

which implies  $Q_L = X_{2L}$ , where subscripts denote partial derivatives. Europe's consumers generate income from labor and capital endowments,  $wL + rK$ . Since markets are competitive, it also is equal to the total revenue  $Y_1 + pY_2$ , which is distributed to factor owners:

$$I = wL + rK = Y_1 + pY_2. \quad (8)$$

Factor growth can affect income both directly and indirectly through a change in the price of the capital-intensive good. If  $p$  were held constant, factor prices also would be constant. Partially differentiating Eq. (8) with respect to  $L$  and  $K$  gives  $\frac{\partial I}{\partial L} = r = Y_{1K} + pY_{2K} > 0$ , and  $\frac{\partial I}{\partial K} = w = Y_{1L} + pY_{2L} > 0$ . Incorporating the terms of trade effect,  $dp/dL$  and  $dp/dK$ , we get

$$\frac{dI}{dL} = w + Y_2 \frac{dp}{dL}. \quad (9)$$

$$\frac{dI}{dK} = r + Y_2 \frac{dp}{dK}. \quad (10)$$

### 3.1. Properties of regional equilibrium price

Tadeus Rybczynski (1955, p. 340) was aware that factor growth lowers the autarky relative price of the good which intensively uses the growing factor. Choi (2008) showed that the terms of trade or the relative price of the capital-intensive good in the integrated region depends only on the region's capital–labor ratio,

$$p(k^o) = h((K + K^*) / (L + L^*)) = h(K^o / L^o), \quad (11)$$

where  $K^o = K + K^*$  and  $L^o = L + L^*$ . Eqs. (5) and (6) suggest that  $\frac{\partial p}{\partial L} = -h' / (L^o)^2 > 0$  and  $\frac{\partial p}{\partial K} = h' / L^o < 0$ , which imply  $h' < 0$ . That is, an increase in the regional capital–labor ratio lowers the price of the capital-intensive good.

Equilibrium price depends on the capital–labor ratio of each region. The autarky price of the capital-intensive good in each country can be obtained from Eq. (11) by assuming zero endowments for the other country:

$$p^E = h(K / L), h' < 0 \quad (12)$$

$$p^A = h(K^* / L^*). \quad (13)$$

As in the integrated region, an increase in a country's capital–labor ratio lowers its autarky price of the capital-intensive good.

Fig. 1 displays two functions: indirect utility of the representative worker  $v(k)$ , and the price of the capital intensive good  $p(k)$ . Since  $h' < 0$  in Eq. (11),  $p(k)$  is negatively sloped. However, a proportionate increase in the region's capital and labor inputs has no effect on the terms of trade. Let the superscript indicate the region index. Since America is more capital abundant than Europe,  $k^A \equiv K^A / L^A > K^E / L^E \equiv k^E$ . The capital–labor ratio of the combined Europe–America regional free trade agreement,  $k^o$ , lies somewhere between  $k^A$  and  $k^E$ . Likewise, a Europe–Asia free trade agreement will lower the capital labor ratio below  $k^E$ .

### 3.2. Factor prices and capital–labor ratio

The Stolper–Samuelson Theorem shows the relationship between the output price and factor prices. The equalized factor prices may be written as functions of  $p$ , which in turn depends on the integrated region's capital–labor ratio:

$$w_o = w(p) = f\left(\frac{K + K^*}{L + L^*}\right), r_o = r(p) = g\left(\frac{K + K^*}{L + L^*}\right). \quad (14)$$

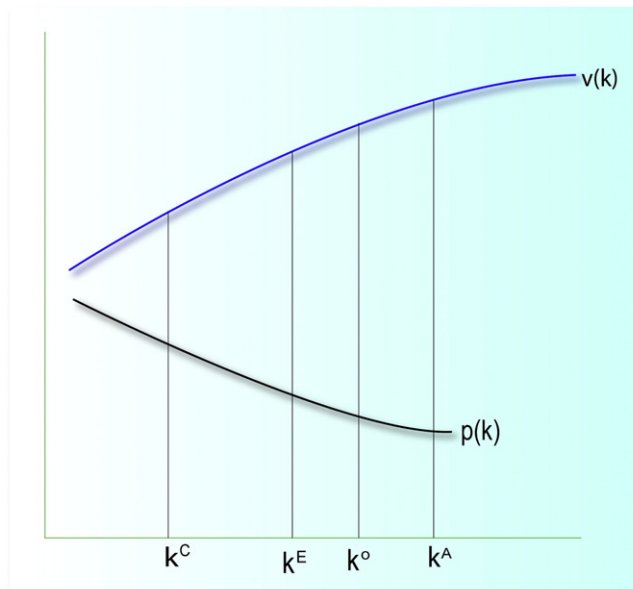


Fig. 1. Price, utility and capital–labor ratios.

An increase in capital stock lowers the price of the capital-intensive good while an increase in labor raises it. A proportionate increase in the region's capital and labor inputs has no effect on  $p$  or on factor prices. The effects of factor growth on the equalized factor prices are given by <sup>5</sup>

$$\frac{\partial w_o}{\partial L} = \frac{\partial w}{\partial p_2} p_L < 0, \quad \frac{\partial r_o}{\partial L} = \frac{\partial r}{\partial p_2} p_L > 0, \quad \frac{\partial w_o}{\partial K} = \frac{\partial w}{\partial p_2} p_K > 0, \quad \frac{\partial r_o}{\partial L} = \frac{\partial r}{\partial p_2} p_K < 0. \quad (15)$$

The following proposition summarizes the effect of factor growth that is not captured by the standard Rybczynski Theorem:

**Proposition 1.** If assumptions (1)–(7) are satisfied, then regardless of where growth occurs in the integrated region, *labor growth necessarily raises the price of the capital-intensive good and lowers the equalized wage rate. On the other hand, capital growth lowers the price of the capital-intensive good and the equalized rental rate.*

Since  $K^* = k^* L^*$ , it can be written:

$$w_o = w(p) = w\left(h\left(\frac{K + k^* L^*}{L + L^*}\right)\right), \quad (16)$$

$$r_o = r(p) = r\left(h\left(\frac{K + k^* L^*}{L + L^*}\right)\right).$$

Differentiating Eq. (16) with respect to  $L^*$  gives

$$\frac{dw_o}{dL^*} = \frac{\partial w}{\partial p} h' L \frac{(k^* - k)}{(K + k^* L^*)^2}. \quad (17)$$

Recall that Europe is abundant in labor, relative to America ( $k^A > k^E$ ). Note that  $h' < 0$  and  $\partial w / \partial p < 0$  implies  $dw_o / dL^* > 0$ . Thus, a Europe–America free trade agreement raises wage and lowers rent in the integrated region. On the other hand, Europe is abundant in capital, relative to Asia ( $k^E > k^A$ ). Thus, a Eurasian free trade area lowers the wage and raises rent in the integrated region.

#### 4. Integrating with a high-wage economy

In the demand theory, consumer welfare decreases with the price of each good. In an open economy, income is not fixed but depends on the prices; hence utility does not always decline as price increases. In this model, there are two types of consumers: capitalists and laborers. They both have identical preferences, but they earn income either from labor or capital. There are  $L$  workers, each worker earns his wage,  $w$ , and hence workers together earn  $wL$ , and indirect utility of workers is  $V(p, wL)$ . Likewise, there are  $M$  capitalists, and they collectively own  $K$  units of capital. Their capital income is  $rK$  and indirect utility is  $V(p, rK)$ . Since all consumers have homothetic and identical preferences, aggregate demand for goods is independent of how national income is split between capitalists and laborers. Thus, indirect utility of all consumers can be written as  $V(p, wL + rK)$ . When it comes to voting on trade policies, each person, whether he is a capitalist or a laborer, has one vote.

When two countries form a free trade area, gains from trade often are measured in terms of consumer welfare or surplus. Free trade not only affects the prices of traded goods, but also the factor prices. Typical studies on gains from trade ignore the effects on factor prices. When Europe integrates with either America or Asia, there will be gains from trade, but their effects on factor prices will be incorporated in the analyses.

Now consider the welfare effects on laborers and capitalists of integrating with a high-wage economy. In this case the country imports good 2, which is the capital-intensive good, and integration lowers its price  $p$ . Differentiating indirect utilities of workers and capitalists with respect to  $p$  gives,

$$\frac{dV(p, wL)}{dp} = V_I(-\alpha X_2 + Lw_p) < 0, \quad (18)$$

$$\frac{dV(p, rK)}{dp} = V_I(-\beta X_2 + Kr_p),$$

where  $\alpha \equiv wL / (wL + rK)$  and  $\beta \equiv rK / (wL + rK)$  are labor and capital shares of income, respectively. Note that by the Stolper–Samuelson Theorem,  $w_p \equiv \partial w / \partial p < 0$ , and  $r_p \equiv \partial r / \partial p > 0$ . Integration with the high-wage economy lowers the price of the importable, which is capital intensive, lowers rent, and raises wage. Thus, Europe's integration with a high-wage economy definitely benefits workers ( $dV(p, wL) / dp < 0$ ). On the other hand, the integration appears to have an ambiguous effect on capitalists because capitalists benefit from the decreased price of the importable, but this effect may be partly or more than fully offset by a decline in rent. When the negative wage effect dominates the price effect on welfare, capitalists would oppose a free

<sup>5</sup> The effects of factor growth on autarky prices can also be obtained by removing the foreign factor endowments. The Rybczynski Theorem conventionally assumes prices are held constant.

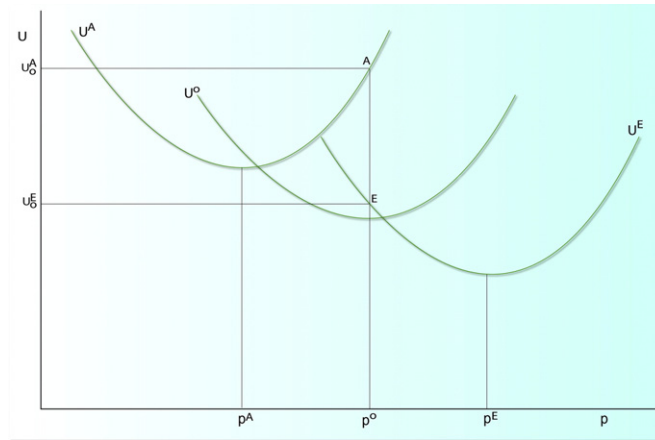


Fig. 2. Europe's integration with America.

trade agreement with a high-wage economy. If they are outnumbered ( $L < M$ ), laborers may have to bribe the capitalists to form a free trade agreement with a high-wage economy.

We now consider whether laborers will gain enough to make a transfer to the capitalists. Indirect utility of all consumers can be written as

$$V(p, I) = V(p, wL + rK) = V(p, Y_1 + pY_2). \quad (19)$$

Roy's Identity states that when consumer income is fixed, indirect utility is negatively related to price,

$$V_p = -V_I X_2. \quad (20)$$

Differentiating aggregate income in Eq. (8) with respect to  $p$  gives

$$dI / dp = Y_2 = w_p L + r_p K. \quad (21)$$

Differentiating with respect to  $p$  and utilizing Roy's Identity yields

$$V'(p) = \frac{dV(p, Y_1 + pY_2)}{dp} = V_p + V_I Y_2 = -V_I(p, Y_1 + pY_2)Q. \quad (22)$$

That is, in an open economy, the effect of price on indirect utility depends on the import level. Specifically, at the autarky price,  $Q = 0$ , and indirect utility reaches its minimum. If price falls below the autarky level,  $Q > 0$ , and indirect utility of all consumers rises as price decreases. Also, if price rises from the autarky level,  $Q < 0$  and  $V'(p) > 0$ . Thus, workers' gains can more than offset the losses of the capitalists.

We now consider whether capitalists gain enough to effect a transfer. The effect of integration on all consumers is given by Eq. (22), which indicates that as the price of the labor-intensive good rises from the autarky situation, the country exports it ( $Q < 0$ ), and  $dV(p, wL + rK)/dp = V'(p) > 0$ , which indicates that  $V(p)$  is U-shaped, reaching a minimum at autarky. Thus, integration with a low-wage economy benefits all consumers, and the capitalists can more than offset the loss of workers.

In Fig. 2, indirect utility of all consumers in each country is U-shaped, and reaches a minimum at its autarky price.<sup>6</sup> Although consumers in the two countries have identical preferences, the autarky prices differ between countries due to differences in

<sup>6</sup> Philip Levy (1997) showed that utility is minimized at autarky using the property of the indirect utility in Woodland (1980). Let  $X_{2p}$  denote the slope of the Marshallian demand curve, and  $X_{2p}^U$  be that of the compensated demand curve. Use of the Slutsky Equation,  $X_{2p} = X_{2p}^U - X_2 X_{2I}$ , yields

$$\begin{aligned} V''(p) &= -V_{Ip}Q - V_I Q' = (V_{II}X_2 + V_{Ip}X_{2I})Q - V_I Q' \\ &= V_{II}X_2Q + V_I(X_{2I}Q - X_{2p}^U + X_2X_{2I} + Y_2') \\ &= V_{II}X_2Q + V_I(X_{2I}(X_2 - Y_2) - X_{2p}^U + X_2X_{2I} + Y_2') \\ &= V_{II}X_2Q + V_I(X_{2I}Q - X_{2p}^U + X_2X_{2I} + Y_2'). \end{aligned}$$

If the endogenous import demand function  $Q(p, Y_1 + pY_2) = X(p, Y_1 + pY_2) - Y_2(p)$  is negatively sloped ( $dQ/dp < 0$ ), then the indirect utility is convex in the neighborhood of autarky ( $Q = 0$ ), but it may not be globally convex.



income. Europe's integration with America, a high-wage economy with a lower autarky price,  $p^A$ , raises wage and lowers rent, but lowers the price of the importable,  $p^O$ , which partly offsets the negative welfare effect of falling rent on the capitalists.

Next, consider the case where Europe integrates with a low-wage economy. Then the country imports good 2, which is now labor-intensive, and integration lowers its price  $p$ . In this case, the Stolper–Samuelson result suggests that  $w_p > 0$  and  $r_p < 0$ . Differentiating the indirect utilities of workers and capitalists, we obtain:

$$\begin{aligned}\frac{dV(p, wL)}{dp} &= V_I(-\alpha X_2 + Lw_p), \\ \frac{dV(p, rK)}{dp} &= V_I(-\beta X_2 + Kr_p) < 0.\end{aligned}\quad (23)$$

As the price of the labor-intensive good declines, rent rises and capitalists definitely benefit ( $dV(p, rK)/dp < 0$ ). However, the effect of integration on workers is ambiguous. Workers benefit from the drop in the price of the labor-intensive imports, but it is partly or more than offset by the fall in wage. Thus, in the absence of transfers from the capitalists, workers may oppose the free trade agreement.

### Proposition 2.

- (i) Europe's integration with a high-wage economy lowers the price of the importable which is capital intensive. The laborers definitely benefit ( $dV(p, wL)/dp < 0$ ), but the welfare effect on capitalists is ambiguous, i.e., the sign of  $dV(p, rK)/dp$  is ambiguous. However, consumers as a whole benefit,  $dV(p, wL + rK)/dp < 0$ .
- (ii) Europe's integration with a low-wage economy lowers the price of its importable which is labor intensive. The capitalists definitely benefit from integration,  $dV(p, rK)/dp < 0$ , but the welfare effect on the laborers is ambiguous. However, consumers as a whole benefit,  $dV(p, wL + rK)/dp < 0$ .

### 5. Concluding remarks

When Europe forms a free trade area with a lower-wage region such as Asia, both regions will benefit from trade, but the equalized wage declines and rent rises. Thus, workers may oppose a free trade agreement with a low-wage region, and may even succeed in thwarting the effort to integrate with low-wage countries.

Europe's free trade agreement with a higher wage economy such as the United States will raise wage and lower rents. Workers definitely benefit but capitalists may lose, while European consumers would benefit from the integration. If workers are dominant ( $L > M$ ), Europe is more likely to form a free trade agreement with the United States than with Asia, although we have yet to see how trade liberalization among the three regions will evolve. The recent trends in Europe seem to indicate that large blocs choose to integrate with low-wage economies. In 2005, the European Union accepted 10 new members of Eastern and Central European countries, Romania and Bulgaria joined in 2007, and all of these are low-wage economies. Likewise, the United States formed the North American Free Trade Agreement in 1995 with Canada and Mexico, both of which are lower-wage economies than the United States.

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