# Discussion Papers In Economics And Business

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**Abstract**

This paper presents a multi-sector general oligopolistic equilibrium trade model. We investigate how a country's labor union structure affects a mobile firm's location decision. We propose a model in which there is international trade and firm mobility between a partial unionized country and a non-unionized country. When the proportion of unionized sectors is low, the welfares of the two countries are equal; otherwise, the unionized country's welfare is lower. Compared to the case with no firm mobility, the difference in welfare is larger when the proportion of the unionized sectors is sufficiently large.

Keywords: labor union, international trade, general oligopolistic equilibrium
JEL classification F15, F16, L13

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## 1. Introduction

In general, a high relative wage drives a firm to move to a foreign country. For example, Nokia closed its production facilities in Bochum, German and established a new plant in Jucu, Romania in 2008 in order to avoid high wages. On the one hand, labor unions are relatively strong in Western European countries like Germany, which raises wages. On the other hand, in Eastern European countries like Romania, the influence of labor unions is relatively weak. Therefore, firms have an incentive to move for a cheaper wage.

However, an agglomeration of manufacturing firms can be seen in many countries where the influence of labor unions is strong. The participation rate in labor unions is high in Nordic countries such as Finland, Sweden, and Denmark. Some areas, including the city of Oulu in Finland, can be seen agglomeration of manufacturing.

Accordingly, in this paper, we highlight how the presence of labor unions affects the movement of firms between countries. Specifically, we study the welfare consequences in a model with labor unions and internationally mobile firms.

Lommerud, Meland, and Sørgard (2003) showed that the presence of a labor union promotes FDI. In a study of labor union and firm location, Egger and Etzel (2014) analyzed the effect of differences in the forms of labor unions between two countries. Munch (2003) analyzed a model with two-country model where the bargaining power of labor unions in each country differed. Persyn (2013) analyzed a model of two countries with different productivity levels and market sizes. For a study of labor unions and firms' locations between two symmetric countries, Picard and Toulemonde (2006) carried out an analysis with a model of two symmetric countries where there are labor unions.

In the general oligopolistic equilibrium model (Neary 2016) literature, Bastos and Kreickemeier (2009) analyzed the international trade between symmetric, unionized countries. Kreickemeier and Meland (2013) analyzed unionized countries with trade and non-trade sectors. Egger and Koch (2012) analyzed multi-product firms in unionized countries.

In this paper, we develop the paper by Egger, Meland, and Schmerer (2015). Their paper analyzed international trade between unionized and non-unionized countries using a general oligopolistic model. They showed that the unionized country's welfare is lower than the non-unionized country's. In contrast to Egger, Meland, and Schmerer (2015), this paper's model includes firms that are mobile between countries. We show that, compared to that paper, firm mobility widens the welfare difference between the two countries when the proportion of the unionized sector is sufficiently high.

## 2. The model

In this paper, we adopt the general oligopolistic model (Neary 2016). This model makes it tractable to analyze the interaction between unionized and non-unionized sectors. We expand on the paper by Egger, Meland, and Schmerer (2015) about firm's mobility. We also analyze a two-country model($i \in \{A, B\}$).

2.1 Preference and consumer demand

We assume that the representative utility function is additively separable over a continuum of different goods, with each sub-utility function quadratic:

$$U_i[\{x(z)\}] = \int_0^1 \left[ax_i(z) - \frac{1}{2}bx_i^2(z)\right]dz. \tag{1}$$

where $x_i(z)$ denotes the consumption of good $z$. The budget constraint of the representative consumer is given by

$$\int_0^1 p_i(z)x_i(z)dz \leq I_i. \tag{2}$$

where $p_i(z)$ denotes the price of good $z$, and $I_i$ is aggregate income.

Maximizing Eq. (1) subject to the budget constraint for each good provides the inverse demand function for good $z$:

$$p_i(z) = \frac{1}{\lambda_i}\left(a - bx_i(z)\right), x_i(z) = \frac{a - \lambda_i p_i(z)}{b}, \tag{3}$$

$$\lambda_i[\{p_i(z)\}, I_i] = \frac{a\mu_{pi} - bI_i}{\sigma_{pi}^2}.$$

where $\lambda$ is the marginal utility of income and $\mu_{pi}$ and $\sigma_{pi}^2$ are the first and second moments of prices, respectively. $\mu_{pi}$ and $\sigma_{pi}^2$ are given by

$$\mu_{pi} \equiv \int_0^1 p_i(z)dz, \sigma_{pi}^2 \equiv \int_0^1 p_i^2(z)dz.$$

Furthermore, by substituting $x(z)$ into Eq. (1), we can derive the indirect utility function as follows:

$$\widetilde{U}_i = \frac{a^2 - \lambda_i^2\sigma_{p_i}^2}{2b}. \tag{4}$$

Hence, consumer welfare is decreasing in the second moment of prices.

2.2 Technology and production

We chose the consumer's marginal utility of income as the numéraire and set $\lambda \equiv \lambda_A + \lambda_B$ equal to one, as is standard in the GOLE literature (Neary 2016; Bastos and Kreickemeier 2009; Egger and Koch 2012; Egger and Etzel 2014). Hereafter, we weighted wages, prices, union utility, and profits by the marginal utility of income.

We assumed that each industry produces a differentiated good, that there is a total of $n$ symmetric firms in the two countries, and that $n_i(z)$ is the number of firms located in country $i$. We assumed that $n_A(z) + n_B(z) = n$ always holds in all sectors. Namely, each firm can move between the two countries, but cannot move across sectors. In each sector, firms compete in Cournot competition across the world. Therefore, firms are relatively large in their industry but are infinitesimal in the economy as a whole. For simplicity, there is no trade cost.

Firms use labor to produce outputs and compete in quantity in their industry. We assumed that the labor input coefficient equals one. Thus, the profit function of firm $j$ located in country A is given by

$$\pi_{Aj}(z) = \left[p_A(z) - c_{Aj}(z)\right]y_{AAj}(z) + \left[p_B(z) - c_{Aj}(z)\right]y_{ABj}(z). \tag{5}$$

where $c_{Aj}(z)$ is the marginal cost of labor and $y_{ABj}$ is firm $j$'s production level from country A to B.

The production level follows:

$$y_{AA}(z) = \frac{a + n_B(z)c_B(z) - c_A(z) - n_B(z)c_A(z)}{b\left(1 + n_A(z) + n_B(z)\right)} = y_{AB}(z).$$

Hence, a firm's total production level follows:

$$y_A(z) = y_{AA}(z) + y_{AB}(z) = \frac{2\left(a + n_B(z)c_B(z) - c_A(z) - n_B(z)c_A(z)\right)}{b\left(1 + n_A(z) + n_B(z)\right)}. \tag{6}$$

A firm's labor demand equals production:

$$l_A(z) = y_A(z) = \frac{2\left(a + n_B(z)c_B(z) - c_A(z) - n_B(z)c_A(z)\right)}{b\left(1 + n_A(z) + n_B(z)\right)}.$$

We also similarly computed the production level in country B.

## 2.3 Labor union

We assumed that there are industry-level labor unions which operate at the some industries only in country A. Sectors in $[0, \tilde{z}]$ are unionized, otherwise they are non-unionized. There are no labor unions in country B. Therefore, firms in sectors $[0, \tilde{z}]$ face wage claims from labor unions if located in country A.

We introduced a Stone-Geary function to represent the union's utility. Each labor union unilaterally sets a union wage that maximizes the union's utility for the firm. Workers receive the union wage in unionized sectors, whereas workers receive the competitive wage in non-unionized sectors. Hence, union utility is given by:

$$V_A(z) = (w_A(z) - w_A^c)n_A(z)l_A(z). \tag{7}$$

where $w_A$ is the union wage and $w_A^c$ is the competitive wage in country A. Workers receive the union wage in sectors $[0, \tilde{z}]$, whereas workers in sectors $[\tilde{z}, 1]$ receive the competitive wage $w_A^c$, and workers in country B receive the competitive wage $w_B^c$. Maximizing Eq. (7), we get the union wage:

$$w_A(z) = \frac{a + w_A^c + n_B w_A^c + n_B w_B^c}{2(n_B + 1)}. \tag{8}$$

Hereafter, superscript *u* and *c* express variables in sectors $[0, \tilde{z}]$ and $[\tilde{z}, 1]$ respectively. Substituting Eq. (8) into Eq. (6), we get the production level:

$$y_A^u = \frac{a + n_B^u w_B^c - w_A^c - n_B^u w_A^c}{b(1 + n_A^u + n_B^u)}, \tag{9}$$

$$y_A^c = \frac{2(a + n_B^c w_B^c - w_A^c - n_B^c w_A^c)}{b(1 + n_A^c + n_B^c)}, \tag{10}$$

$$y_B^u = \frac{a(2 + n_A^u + 2n_B^u) - 2(1 + n_B^u)w_B^c + n_A^u\{(1 + n_B^u)w_A^c - (2 + n_B^u)w_B^c\}}{b(1 + n_B^u)(1 + n_A^u + n_B^u)}, \tag{11}$$

$$y_B^c = \frac{2(a + n_A^c w_A^c - w_B^c - n_A^c w_B^c)}{b(1 + n_A^c + n_B^c)}. \tag{12}$$

2.4 Labor market

We assumed that there are L workers in each country, workers supply one inelastic unit of labor, and that there is no unemployment. Therefore, the labor market clearing conditions follow:

$$L \equiv \int_0^1 nl(z)dz = \int_0^{\tilde{z}} n_i^u y_i^u dz + \int_{\tilde{z}}^1 n_i^c y_i^c \, dz. \tag{13}$$

## 3. Solving the equilibrium

3.1 Game structure

The game structure was as follows. In the first stage, firms choose a location. At that time, a firm in sectors $[0, \tilde{z}]$ faces wage claims from labor unions when the firm chooses to locate in country A. On the other hand, a firm in sectors $[\tilde{z}, 1]$ pays the competitive wage of the country to workers. In the second stage, labor unions set the union wage in country A. In the third stage, firms determine the production level. We backwards solve the three-stage game and derive the sub-game perfect Nash equilibrium.

3.2 Equilibrium

In the first stage, firms determine their location by comparing profit. Firms' profits are only decided by marginal costs, namely wages, because there are no trade costs. Hence, the number of firms $n_i(z)$ is determined by the comparison of wages. We derive the equilibrium values from production levels Eqs. (9) ~ (12), and labor market clearing conditions Eq. (13) and $n_A(z) + n_B(z) = n$.

The condition that $n_A^1$ is an interior solution is given by:

$$w_A = w_B^c \quad and \quad d(w_A - w_B^c)/dn_A^u < 0$$

The condition that $n_A^1$ is a corner solution is given by:

$$w_A > w_B^c \; and \; n_A^u = n, \text{ or } \; w_A < w_B^c \; and \; n_A^u = 0$$

The condition that $n_A^2$ is an interior solution is given by:

$$w_A^c = w_B^c \quad and \quad d(w_A - w_B^c)/dn_A^c < 0$$

The condition that $n_A^2$ is a corner solution is given by:

$$w_A^c > w_B^c \ and \ n_A^c = n, \text{ or } \ w_A^c < w_B^c \ and \ n_A^c = 0$$

**Proposition 1**

*The result of the equilibrium value is as follows:*

$$n_A^{u*} = 0, \quad n_A^{c*} = \frac{n}{2(1-\tilde{z})} \quad if \ \tilde{z} \in \left[0, \frac{1}{2}\right],$$

$$n_A^{u*} = 0, \quad n_A^{c*} = n \quad if \ \tilde{z} \in \left[\frac{1}{2}, \frac{2+n}{2n+3}\right],$$

$$n_A^{u*} = \frac{1}{4\tilde{z}}\left(-n + 2\tilde{z} + 4n\tilde{z} - \sqrt{n^2 + 12n\tilde{z} + 4\tilde{z}^2 - 8n\tilde{z}}\right), \quad n_A^{c*} = n \quad if \ \tilde{z} \in \left[\frac{2+n}{2n+3}, 1\right].$$

This result is illustrated in Figure 1. If the proportion of unionized sectors is $\tilde{z} < 1/2$, firms are not influenced by labor unions, because firms can relocate and completely avoid labor unions. Therefore, the competitive wages are equal, the total number of firms in each country is also equal to $\sum n_A(z) = \sum n_B(z) = n/2$, and there are no unionized firms in equilibrium. If $1/2 < \tilde{z}$, the total number of firms is different between countries; the total number of firms in country B is larger than in country A $\sum n_A(z) < \sum n_B(z)$, because more than $n/2$ firms move to country B to avoid labor unions. At that time, the competitive wage in country B is larger than in country A. Especially if $\frac{1}{2} < \tilde{z} < \frac{2+n}{2n+3}$, all firms in sectors $[0, \tilde{z}]$ move to country B; thus, there are no unionized firms in equilibrium. When the proportion of unionized sectors $\tilde{z}$ is greater than $\frac{2+n}{2n+3}$, firms in sectors $[0, \tilde{z}]$ disperse in both countries because of the high competitive wage in country B. At that time, the union wage equals the competitive wage in country B: $w_A = w_B^c$.

3.3 Welfare

We analyze welfare from Eq. (4). First, we compute the marginal utility of income in each country from Eq. (3). We assume that a firm's profits are shared by workers in the country the firm is located. Hence, the aggregate income corresponds to GDP, namely $I_i = \tilde{z}p^u q_i^u + (1-\tilde{z})p^c q_i^c$.

When $1/2 < \tilde{z}$, the total number of firms in country B is higher than in country A, due to labor union avoidance. For that reason, the aggregate income in country B is higher than in country A, thus the welfare of country B is also larger. We depict their welfares in Figure 2 and compare them to Egger, Meland, and Schmerer (2015). In Figure 2, $V_{Am}$, $V_{Bm}$, and $\bar{V}_m$ represent the welfare in country A, country B, and the average of the two countries, respectively, from our model. In contrast, $V_A$ and $V_B$ are the welfare in country A and B, and $\bar{V}$ is average of the two countries, in the case of no firm mobility from Egger, Meland, and Schmerer (2015). Comparing the welfares, we show the following.

**Proposition 2**

*Firm mobility widens the welfare difference between two countries and lowers the average welfare, compared to the case of immobile firms, if (2+n)/(2n+3)< $\tilde{z}$.*

We show that, if $\frac{2+n}{2n+3} < \tilde{z}$, the non-unionized county's welfare in the case of mobile firms is larger, the unionized country's welfare is lower, and the average of the two countries' welfares is lower, than in the case of no mobility from Egger, Meland, and Schmerer (2015). However, the relationship to welfare is ambiguous if $\frac{1}{2} < \tilde{z} < \frac{2+n}{2n+3}$.

## 4. Conclusion

The form of international trade agreements between unionized and non-unionized countries changes their welfare. The outflow of firms heavily damages welfare in the country where the influence of labor unions is strong.

## References


Bastos, P., and Kreickemeier, U. (2009). Unions, competition and international trade in general equilibrium. Journal of International Economics Volume 79, Issue 2, November, 238–247.

Egger, H., and Etzel, D. (2014). Union wage-setting and international trade with footloose capital. Regional Science and Urban Economics Volume 48, Issue 2, September, 56–67.

Egger, H., and Koch, M. (2012). Labour unions and multi‐product firms in closed and open economies. Canadian Journal of Economics/Revue canadienne d'économique, 45(4), 1456-1479.

Egger, H., Meland, F., and Schmerer, H. J. (2015). Differences in the degree of unionization as a source of comparative advantage in open economies. Canadian Journal of Economics/Revue canadienne d'économique, 48(1), 245-272.

Kreickemeier, U., and Meland, F. (2013). Non‐traded Goods, Globalization and Union Influence. Economica, 80(320), 774-792.

Lommerud, K.E., Meland, F., and Sørgard, L. (2003). Unionised Oligopoly, Trade Liberalisation and Location Choice. The Economic Journal Volume 113, Issue 490, October, 782–800.

Munch, J. R. (2003). The Location of Firms in Unionized Countries*. The Scandinavian Journal of Economics, 105(1), 49-72.

Neary, J. P. (2016). International Trade in General Oligopolistic Equilibrium. Review of International Economics, 24: 669–698.

Persyn, D. (2013). Union wage demands with footloose firms and agglomeration forces. Regional Science and Urban Economics Volume 43, Issue 1, January, 142–150.

Picard, P.M., and Toulemonde, E. (2006). Firms agglomeration and unions. European Economic Review Volume 50, Issue 3, April, 669–694.

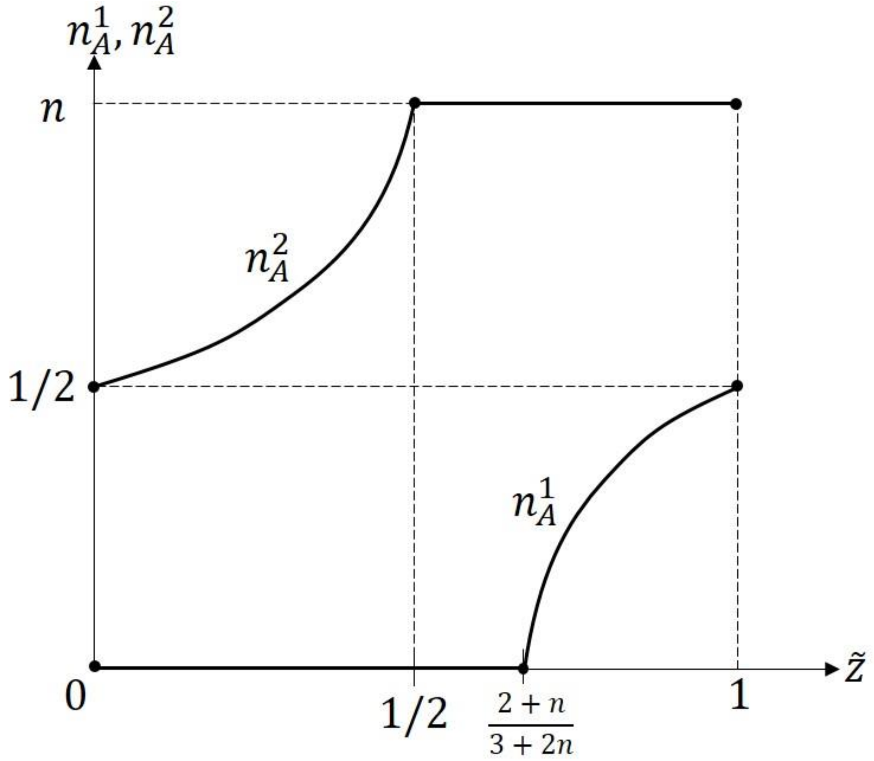


**Figure 1. The number of firms located in country A**

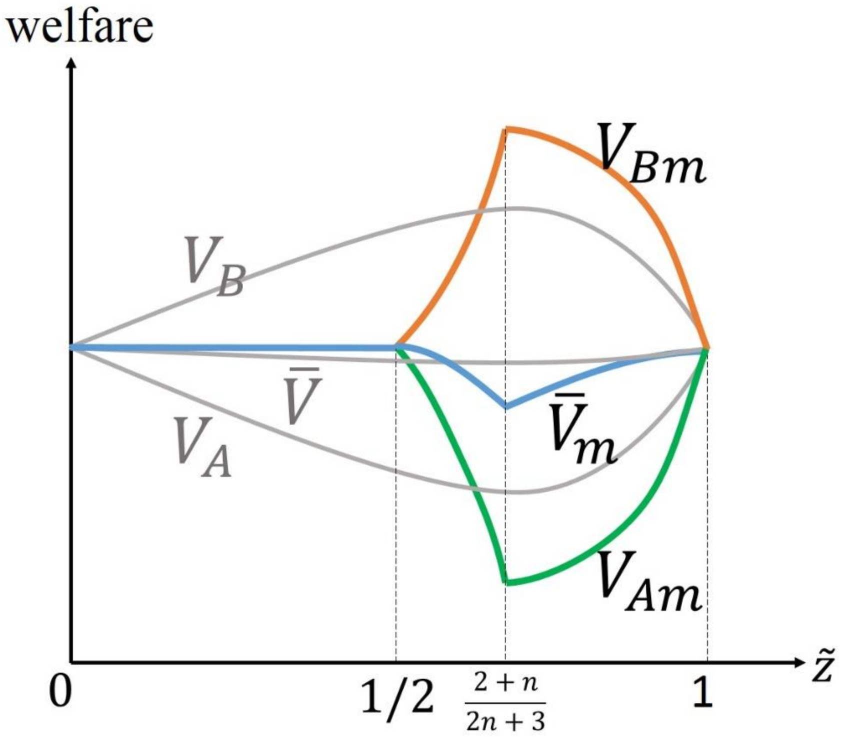


**Figure 2. Comparison of welfares**