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5 January 2014

Online at https://mpra.ub.uni-muenchen.de/59388/
MPRA Paper No. 59388, posted 21 Oct 2014 07:42 UTC

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Keita Kamei*

Abstract

This paper incorporates the efficiency wage model of Shapiro and Stiglitz (1984) into a general oligopolistic equilibrium model of Neary (2009). We show that the pro-competitive effect stemming from trade liberalization increases the real wage of employees and relaxes the non-shirking condition. Therefore, the unemployment rate improves. Using numerical analysis, we show that, if firm productivity is sufficiently low, trade liberalization improves the utility of firm owners.

Keywords: Efficiency wages; Unemployment; International trade; General equilibrium with oligopoly (GOLE); Cournot competition

JEL Classification: F64, J66

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1 Introduction

Does international trade improve the unemployment rate? With regard to NAFTA participation, there were a lot of statements on this question by the media and government officers in the United States. Some people believed that international trade induces job destruction.[1)] Some advocators of this statement often emphasized the pro-competitive side of trade liberalization. However, most of the literature of international trade ignores the relationship between the unemployment rate and the trade-induced pro-competitive effect, which is one of the important effects of international trade.[2)] If unemployment exists, then how does the pro-competitive effect of international trade affect the unemployment rate and the welfare of firm owners? This paper discusses these points.

In this paper, we incorporate the efficiency wage of Shapiro and Stiglitz (1984) into Neary's (2009) general oligopolistic equilibrium (GOLE) model to investigate the relationship between the unemployment rate and the trade-induced pro-competitive effect, which comes from strategic interaction among oligopolistic firms. We find that trade improves the unemployment rate. In addition, using numerical analysis, we reveal that, if firm productivity is sufficiently low, then international trade improves the utility of firm owners.

Our model shows that international trade promotes a decrease in the market power of oligopolistic firms, and, hence, an increase in the real wage of employees. An increase in the real wage of employees increases the difference between the present-discounted utility values of unemployment and employment: the non-shirking condition (NSC, hereafter) relaxes. Therefore, the unemployment rate improves.

Next, international trade has the following two effects on the utility of firm owners: the pro-competitive effect and the employment effect. The pro-competitive effect implies that international trade decreases the monopoly power of firms and reduces profit, which reduces

1) For example, see Davidson and Matusz (2010).

2) In recent years, some economists have investigated the relationship between international trade and unemployment. For example, Matusz (1996), Hoon (1994), Moore and Ranjan (2005), Egger and Kreickemeier (2009), Davidson and Matusz (2010), Helpman and Itskhoki (2010), and Davis and Harrigan (2011).

the nominal wage of firm owners. On the other hand, the employment effect implies that international trade improves the unemployment rate and promotes an increase in total output and a decrease in price. Hence, if the employment effect is larger than the pro-competitive effect, then international trade improves the utility of firm owners.

To focus on the pro-competitive side of international trade, Neary (2009) constructs a GOLE model with the competitive labor market and shows that the trade-induced pro-competitive effect promotes an increase in both aggregate and workers' welfares and, on the other hand, a decrease in the firm owner's welfare. Hence, we believe that the GOLE model is appropriate for considering the relationship between trade-induced pro-competitive effect and welfare of firm owner who receives firm profit.

To embed unemployment into the GOLE model, we use the efficiency wage model from the seminal paper by Shapiro and Stiglitz (1984). This model explains that unemployment is produced by the efficiency wage, which prevents workers from shirking. Using this model, we show the relationship between the trade-induced pro-competitive effect and unemployment.

Only a few attempts so far have been made at investigating the relationship between efficiency wage and intra-industry trade.[3)] Matusz (1996) combines the monopolistic competition model of Krugman (1980) with the efficiency wage model of Shapiro and Stiglitz (1984). He shows that trade liberalization promotes a deep division of labor, which implies an increase in the varieties of intermediate goods and, hence, reduces the price index. A reduction of the price index promotes an increase in the real wage rate. Hence, NSC relaxes, which improves the unemployment rate. Moreover, Davis and Harrigan (2011) incorporate the efficiency wage of Shapiro and Stiglitz (1984) into the monopolistic competition model with firm heterogeneity of Melitz (2003). Using numerical simulation, they show that the reduction of trade cost promotes an increase in the real wage of workers but has a small in-

3) One of our purposes is to reconsider intra-industry trade with the efficiency wage model. Related papers include Hoon (1994), Matusz (1996, 1998), Altenburg and Brenken (2008), and Davis and Harrigan (2011).

fluence on unemployment. However, these studies do not consider the relationship between the pro-competitive effect and the unemployment rate.

In addition, Egger and Etzel (2012) incorporate the unionized oligopoly model into Neary's GOLE model. They investigate the relationship between the trade-induced pro-competitive effect and the unemployment rate, focusing on how trade liberalization affects the wage differential among workers and firm owners. Unemployment, in their model, is produced by the reservation wage, which trade unions impose on oligopolistic firms.

There are a small number of empirical studies investigating the relationship between trade liberalization and unemployment. Dutt, Mitra, and Ranjan (2009) find that unemployment and trade openness are negatively correlated, which corresponds to our result.

The remainder of this paper is structured as follows. Section 2 constructs a basic model that merges the efficiency wage model of Shapiro and Stiglitz (1984) into the GOLE model of Neary (2009). Section 3 shows that trade liberalization promotes an increase in real wage of employee, and hence it relaxes the NSC constraint generates unemployment. In addition, we investigate the relationship between the trade-induced pro-competitive effect and the utility of firm owners. Section 4 concludes.

2 Model

2.1 Preferences

We consider a representative consumer. In this economy, there is a continuum of sectors $z \in [0, 1]$. In addition, each sector has $n \geq 1$ identical firms producing identical goods, respectively. Total consumption in sector z is defined as $x(z)$ and the price is $p(z)$. The utility

function of the representative consumer is specified in CRRA form as follows[4]:

$$U = \int_0^1 \frac{x(z)^{1-\gamma}}{1-\gamma} dz, \tag{1}$$

where $0 < \gamma < 1$.[5] The aggregate demand in each good is restricted by the following budget constraint:

$$\int_0^1 p(z)x(z)dz = I. \tag{3}$$

The inverse demand of good z in a country, derived from utility maximization, is:

$$p(z) = \frac{1}{\lambda x(z)^{\gamma}}, \tag{4}$$

where the Lagrange multiplier, λ, implies the marginal utility of income.[6] From Equations (3) and (4), λ is derived as follows:

$$\lambda = \left[\frac{\int_0^1 p(z)^{\frac{\gamma-1}{\gamma}} dz}{I} \right]^{\gamma}. \tag{5}$$

In addition, we obtain the indirect utility, $\tilde{U}$, from Equations (1), (4), and (5) as follows:

$$\tilde{U} = \frac{I^{1-\gamma} \cdot \left[\int_0^1 p(z)^{\frac{\gamma-1}{\gamma}} dz \right]^{\gamma}}{1-\gamma}. \tag{6}$$

4) This paper assumes a CRRA utility function, which has the properties of iso-elastic demand. McAfee and Lewis (2009) and Beard (2013) study the properties of iso-elastic demand under oligopolistic competition.

5) All consumers are infinitely lived, risk-neutral, and discount the future at rate ρ. Subject to an intertemporal budget constraint, consumer i maximizes the following expected intertemporal utility function, W_i:

$$W_i = E\left[\int_0^{\infty} U_i \exp(\rho t) dt \right], \tag{2}$$

where we implicitly assume that consumers cannot borrow and lend. This assumption follows Shapiro and Stiglitz (1984).

6) The CRRA specification in Equation (1) is a special case of the Gorman (1961) form. Therefore, it allows for consistent aggregation over agents with different incomes.

2.2 Firm behavior

In this paper, assumptions of firm behavior are based on Neary (2009). We consider the $m \geq 1$ countries trade with each other and assume that each country is completely symmetric in all respects and trade cost is zero. Hence, all variables of each country are also identical. Because of the symmetric assumption, we are able to focus on the home country case.

Each firm in sector z supplies its good $q(z)$ to each country, and, hence, total production of each firm in sector z is $m \cdot q(z)$ and the only production factor is the worker. Firm productivity is defined as $h > 0$, which is identical among sectors. The firm's production function in sector z is defined as $m \cdot q(z) = h \cdot l(z)$, where $l(z)$ represents the firm's factor input in sector z. In each sector, there are $n \geq 1$ identical firms, which are exogenously determined and, hence, total output in sector z is $x(z) = m \cdot n \cdot q(z)$. Each firm competes *à la* Cournot in its respective sector, and it takes the price of the other sectors as given. The workers receives only wage, w.[7] The firm profit in sector z is defined as

$$\pi(z) = m[p(z) - w/h]q(z). \tag{7}$$

From Equation (7), the profit maximization condition is derived as follows:

$$\frac{1}{\lambda(mnq(z))^{\gamma}} \cdot \left[1 - \frac{\gamma}{mn}\right] \cdot h = w. \tag{8}$$

The LHS of Equation (8) represents the marginal profit of each firm, and the RHS represents the marginal cost. From Equations (4) and (8), we obtain

$$\frac{w}{p(z)} = \left[1 - \frac{\gamma}{mn}\right] \cdot h. \tag{9}$$

Moreover, we integrate Equation (9) from sector 0 to 1 and obtain the real wage of the

7) In our paper, we assume that total firm profit is distributed to firm owners. We explain this assumption in Section 3.2 in detail.

worker:

$$w \Big/ \left[\int_0^1 p(z)^{\frac{\gamma-1}{\gamma}} dz \right]^{\frac{\gamma}{\gamma-1}} = h \cdot \left(\frac{mn-\gamma}{mn} \right). \tag{10}$$

Next, we substitute the Equation (10) into (6) and obtain the indirect utility of worker l, $\tilde{U}_l$:

$$\tilde{U}_l = \frac{1}{1-\gamma} \cdot \left[h \cdot \left(\frac{mn-\gamma}{mn} \right) \right]^{1-\gamma}. \tag{11}$$

2.3 Efficiency wage and the labor markets

We consider a labor market based on the efficiency-wage model constructed by Shapiro and Stiglitz (1984). In their model, unemployment exists because firm owner has limited resources to monitor worker's efforts. The work effort of the employee generates disutility, $e > 0$; if the worker is unemployed or shirks, then $e = 0$. The firm owner imperfectly monitors the effort of the worker. Therefore, the employee has incentive to shirk his work. However, if his shirking is discovered, then the worker is fired.[8)]

The probability of detection is defined as $g > 0$. The break-up rate is exogenously determined by $b > 0$, and the accession rate is a, which is endogenously determined. In addition, we define V_s, V_n, and V_u as the present-discounted value of utility for shirking employees, non-shirking employees, and the unemployed, respectively. From Equation (1), (4), and (5), the indirect utility of each worker is derived $\tilde{U}_l - e = \frac{w^{1-\gamma}\left[\int_0^1 p(z)^{\frac{\gamma-1}{\gamma}} dz\right]^{\gamma}}{1-\gamma} - e$.[9)]

By solving the simple dynamic programming problem, in the steady state, we obtain

$$\rho V_u = a(V_n - V_u), \tag{13}$$

8) The utility of agent j is

$$U_j = \int_0^1 \frac{\tilde{x}_j(z)^{1-\gamma}}{1-\gamma} dz - e, \tag{12}$$

where $\tilde{x}_j$ represents agent j's consumption of the good from sector z, and e is work effort of agent j.

9) From Equation (11), we know that the utility of employee, U_l, does not depend on the market size, L.

$$\rho V_n = \tilde{U}_l - e + b(V_u - V_n), \tag{14}$$

$$\rho V_s = \tilde{U}_l + (g + b)(V_u - V_s). \tag{15}$$

where $\rho > 0$ is the constant discount rate.[10] From Equations (14) and (15), if $V_n \geq V_s$, then it is not valuable for the employee to shirk. Hence, the firm imposes the following condition to prevent shirking:

$$V_n = V_s. \tag{16}$$

Using Equations (14), (15), and (16), we derive

$$\rho V_u = \tilde{U}_l - \frac{e(\rho + g + b)}{g} \tag{17}$$

There is a total endowment of L workers. From Equation (17), the flow-out of the number of unemployed getting a job is equal to that of the number of employees becoming unemployed:

$$a\left(L - \int_0^1 nl(z)dz\right) = b\int_0^1 nl(z)dz. \tag{18}$$

From Equations (13), (17), and (18), we obtain the NSC as follows:

$$\frac{w^{1-\gamma}\left[\int_0^1 p(z)^{\frac{\gamma-1}{\gamma}}dz\right]^{\gamma}}{1-\gamma} = e\left[1 + \frac{b+\rho}{g} + \frac{b\int_0^1 nl(z)dz}{g\left(L - \int_0^1 nl(z)dz\right)}\right]. \tag{19}$$

10) In our model, we focus on the case of $0 < \gamma < 1$ because, if $\gamma > 1$, then unemployment does not break out since the utility of unemployment would be $u(0) = -\infty$. However, if $0 < \gamma < 1$, unemployment can break out because the utility of unemployment is $u(0) = 0$.

2.4 Equilibrium

In this section, we derive the unemployment rate in equilibrium. Using Equations (9) and (19), we obtain

$$\frac{1}{1-\gamma}\left[h\cdot\left(1-\frac{\gamma}{mn}\right)\right]^{1-\gamma}=e\left[1+\frac{b+\rho}{g}+\frac{b\int_0^1 nl(z)dz}{g(L-\int_0^1 nl(z)dz)}\right]. \tag{20}$$

From Equation (20), we derive the unemployment rate in equilibrium, $\bar{u}$, as follows:

$$\bar{u}=1-\frac{\int_0^1 nl(z)dz}{L}=1-\frac{\frac{1}{1-\gamma}\left[h\cdot\left(1-\frac{\gamma}{mn}\right)\right]^{1-\gamma}-e\left(1+\frac{b+\rho}{g}\right)}{\frac{be}{g}+\frac{1}{1-\gamma}\left[h\cdot\left(1-\frac{\gamma}{mn}\right)\right]^{1-\gamma}-e\left(1+\frac{b+\rho}{g}\right)}. \tag{21}$$

From Equation (21), we obtain the following proposition:

Proposition 1. *If* $\frac{1}{1-\gamma}\left[h\cdot\left(1-\frac{\gamma}{mn}\right)\right]^{1-\gamma}>e\left(1+\frac{\rho}{g}\right)$, *then* $0<\bar{u}<1$.

Proof. If $0<\bar{u}<1$, then the RHS of Equation (21) is positive:

$$\frac{be}{g}+\frac{1}{1-\gamma}\left[h\cdot\left(1-\frac{\gamma}{mn}\right)\right]^{1-\gamma}-e\left(1+\frac{b+\rho}{g}\right)>0, \tag{22}$$

$$\Leftrightarrow\frac{1}{1-\gamma}\left[h\cdot\left(1-\frac{\gamma}{mn}\right)\right]^{1-\gamma}>e\left(1+\frac{\rho}{g}\right). \tag{23}$$

■

We explain Proposition 12. The LHS of the condition of Proposition 1 represents the utility from work, and the RHS represents the non-shirking worker's disutility from work. Note that Proposition 1 does not depend on the break-up rate, b.

3 Trade-Induced Pro-Competitive Effect

3.1 International trade and unemployment rate

In this section, we consider the effect of trade liberalization. In this paper, we interpret trade liberalization as an increase in the number of countries, m.

From Equation (10), we immediately obtain Proposition 2.

Proposition 2. *Trade liberalization increases the real wage of workers.*

Proof. We define the real wage of the worker as $\bar{w}$. From Equation (10),

$$\bar{w} \equiv w \Big/ \left[\int_0^1 p(z)^{\frac{\gamma-1}{\gamma}} dz \right]^{\frac{\gamma}{\gamma-1}} = h \cdot \left(\frac{mn-\gamma}{mn} \right). \tag{24}$$

Next, if we differentiate Equation (24) with respect to m, then

$$\frac{d\bar{w}}{dm} = \frac{\gamma h}{(mn)^2} > 0. \tag{25}$$

■

In addition, from Equation (21), we obtain the following proposition:

Proposition 3. *Trade liberalization decreases the unemployment rate.*

Proof. Equation (21) shows total employment, $\int_0^1 nl(z)dz$:

$$\frac{d\bar{u}}{dm} = -\frac{h^{1-\gamma}\left(1-\frac{\gamma}{mn}\right)^{-\gamma} \cdot \frac{\gamma}{m^2 n}}{\left(\frac{be}{g}+Q\right)^2} \cdot \frac{be}{g} < 0 \tag{26}$$

where $Q = \frac{1}{1-\gamma}\left[h \cdot \left(1-\frac{\gamma}{mn}\right)\right]^{1-\gamma} - e\left(1+\frac{b+\rho}{g}\right)$. ■

We explain Propositions 13 and 14. Trade liberalization induces further competition among firms, which reduces market power in each firm which implies a decrease in the

price in each sector. Therefore, firm profit declines, and the real wage of workers increases. Because of the increase in their real wage, the difference between the expected utility of employment and that of unemployment expands. That is, workers have a higher utility of employment and a lower utility of unemployment than before: they will want to work, and they will not want to get fired. Hence, the expansion implies that the NSC is relaxed. The relaxation promotes an increase in employment in each sector, and, therefore, an increase in the total output in each sector.

3.2 Firm owners

This section discusses the relationship between the trade-induced pro-competitive effect and the utility of firm owners. Hereafter, the number of firm owners is defined as $H > 0$, and the firm owner's income is represented by w_h. In addition, we assume that all firm profit is absorbed by the firm owner: $\int_0^1 n \cdot \pi(z)dz = w_h \cdot H$. This assumption follows Egger and Etzel (2012), Kreickemeier and Meland (2013), and Kamei (2014).

Using Equations (7), (21), and (24), we obtain the utility of firm owners, $\tilde{U}_h$, as follows:

$$\tilde{U}_h = \frac{1}{1-\gamma} \cdot w_h^{1-\gamma} \left[\int_0^1 p(z)^{\frac{\gamma-1}{\gamma}} \right]^{\gamma} = \frac{1}{1-\gamma} \cdot \left[\frac{\gamma}{mn} \cdot \frac{L \left[\frac{1}{1-\gamma} \left[h \cdot \left(1 - \frac{\gamma}{mn} \right) \right]^{1-\gamma} - e \left(1 + \frac{b+\rho}{g} \right) \right]}{H \left[\frac{be}{g} + \frac{1}{1-\gamma} \left[h \cdot \left(1 - \frac{\gamma}{mn} \right) \right]^{1-\gamma} - e \left(1 + \frac{b+\rho}{g} \right) \right]} \right]^{1-\gamma}. \tag{27}$$

We differentiate Equation (27) with respect to m and obtain the following condition:

$$\frac{d\tilde{U}_h}{dm} \gtreqless 0, \tag{28}$$

$$\Longleftrightarrow \left(\frac{be}{g} + Q \right) \cdot Q - h^{1-\gamma} \frac{\gamma}{mn} \left(1 - \frac{\gamma}{mn} \right)^{-\gamma} \frac{be}{g} \gtreqless 0, \tag{29}$$

where, $Q = \frac{1}{1-\gamma} \left[h \cdot \left(1 - \frac{\gamma}{mn} \right) \right]^{1-\gamma} - e \left(1 + \frac{b+\rho}{g} \right)$.

Next, we use numerical analysis to confirm the above result, (29), and assume that

$\rho = 0.01$, $m = n = 3$, $\gamma = 0.5$, $e = 1$, $b = 0.2$, and $g = 0.3$.[11] Figure 1 shows the results of the calculation. The horizontal axis represents firm productivity, h, and the vertical axis represents the change in the firm owner's utility due to trade liberalization, $d\tilde{U}_h/dm$. In Figure 1, if firm productivity, h, is sufficiently low, then trade liberalization improves the utility of firm owners: $d\tilde{U}_h/dm$ is positive. On the other hand, if firm productivity is sufficiently high, trade liberalization causes the utility of the firm owner to decline: $d\tilde{U}_h/dm$ is negative.

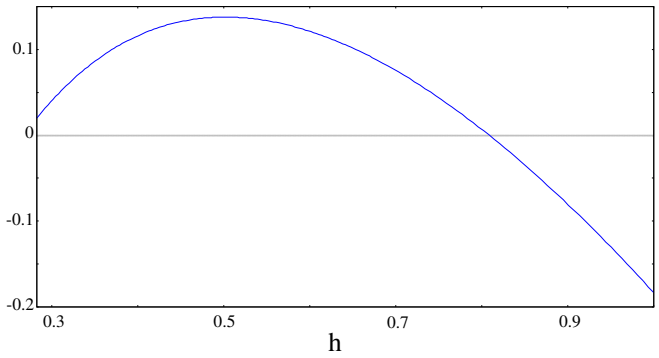

Figure 1: Trade liberalization and firm owner's utility.

We explain the intuition of the above results. From Equation (21), we know that high productivity of a firm implies a low unemployment rate. Hence, if firm productivity is sufficiently high, then trade liberalization reduces the utility of firm owner.[12] In this case, there is low unemployment in the economy. Hence, trade liberalization very few produce additional output due to new employees. Therefore, this effect, which we call the employment effect, is weak. Thereby, the pro-competitive effect from trade liberalization dominates the employment effects.

Next, we investigate the case where firm productivity is sufficiently low. In this sce-

11) In the parameters case, the condition of $0 < \bar{u} < 1$ is $h > 0.282647$.

12) In our model, if the labor market is competitive or firm productivity, h, is very high, $\int_0^1 nl(z)dz = L$, then the results correspond to that of Neary (2009). He considers the case of the perfect labor market of a general equilibrium with oligopoly. In his model, trade liberalization reduces firm profit and there is no unemployment. Hence, trade liberalization does not produce additional output, and, hence, it reduces the utility of firm owners.

nario, trade liberalization improves the welfare of firm owners because there are a lot of unemployment in the economy, which implies that the employment effect is larger than the pro-competitive effect.

4 Conclusion

In this paper, we combine a GOLE model with the efficiency wage model of Shapiro and Stiglitz (1984). We summarize our results as follows. Trade liberalization reduces market power of oligopolistic firms and raises the real wage of workers, which relaxes the NSC. Therefore, trade liberalization improves the unemployment rate. In addition, if firm productivity is sufficiently low, trade liberalization raises the utility of firm owners.

Some extensions are left for future research. To begin with, we can assume asymmetric countries. In our model, all countries are symmetric, which implies North-North trade. However, if we adapt asymmetric assumption to our model, the impact of trade liberalization may have different effects among the countries with regard to unemployment. Next, our model has assumed that the number of firms are exogenous. In addition to this, it is also valuable to consider the case of free entry-exit of firms. Then, trade liberalization reduces the number of firms, which implies monopoly power of surviving firms increases. Therefore, if trade liberalization sufficiently decreases the number of firms, then unemployment rate may increase.

Acknowledgements

We thank Hiroaki Sasaki, Naoto Jinji, Masui Makoto, Taiji Furusawa, Akihiko Yanase, Hiroshi Mukunoki, Koji Shintaku, and seminar participants at Doshisha University and Kyoto University for their useful comments and helpful suggestions on earlier versions of this paper. I am grateful to Grant-in-Aid for JSPS Fellows (13J05882).

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