E C O N O M I C S B U L L E T I N

Equilibrium unemployment in a small open economy with a frictionless nontradeables sector

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Abstract

This paper analyzes the impact of international trade on the equilibrium rate of unemployment and economic welfare in a three-sector small open economy. While tradeables sectors have search-theoretic unemployment, the labor market of the nontradeables sector has no matching friction, which leads to Harris-Todaro (1970) type labor movements across the sectors. Under free trade, one of the tradeables sectors shrinks because of import competition, which forces workers in the sector to seek jobs in the other tradeables sector or in the nontradeables sector. If the home country has a comparative advantage in the capital-intensive tradeables, trade liberalization improves national welfare but raises the unemployment rate and ex-post wage inequality.

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1. Introduction

International trade has been blamed as a cause of increasing unemployment in advanced nations, at least in the short run (see Kletzer 2004 for a survey and some evidence for the U.S. economy). Furthermore, recent studies based on the search-theoretic approach to equilibrium unemployment have argued that trade liberalization has a *long-run* effect on national unemployment rate and economic welfare [1]. This paper extends previous studies by adding a frictionless nontradeables sector where full employment is guaranteed, and shows that trade liberalization raises the unemployment rate notwithstanding the presence of such a sector.

Previous studies on search-theoretic unemployment with multiple sectors have rarely paid attention to the determinants of the productivity of a firm-worker pair, or equivalently, to the price of the goods they can produce in the context of the goods market equilibrium. Some of the exceptions are Moore and Ranjan (2005) and Sato (2004). Moore and Ranjan (2005) study a two-sector small open economy model, where each good is produced by sector-specific labor only. As they noticed themselves, however, the assumption of labor immobility between sectors makes it difficult to interpret their result as a long-run analysis of unemployment rate. This is because workers may be able to obtain the sector-specific skill over a sufficiently long period of time or with some training costs. On the other hand, Sato (2004) investigates a two-sector—one with labor market friction and the other without such friction—closed economy model and endogenizes the relative price. Because one of the two sectors is frictionless, an expansion of "the sector with unemployment" immediately raises the unemployment rate; further, the impact of international trade is not examined in his paper. Moreover, none of these studies consider the nontradeables sector as one that generates potential job opportunities as it is a sector that is not affected by trade liberalization directly.

The purpose of this paper, then, is to introduce the frictionless nontradeables sector explicitly, allow workers to move freely across the sectors, and analyze the impact of international trade on the equilibrium rate of unemployment and economic welfare through the change of the industrial structure of the economy [2]. Tradeables sectors are assumed to have different capital intensities. In order to emphasize the role of nontradeables as an indispensable factor of production, we further assume that only nontradeables can be used as capital goods. When the home country has a comparative advantage in capital-intensive goods, trade liberalization causes the shutdown of the import-competing sector. With the structure of labor markets unchanged, it is shown that the nontradeables sector cannot compensate for the job loss in the import-competing sector and the unemployment rate rises in the trade equilibrium. Intuitively, firms in the capital-intensive sector post fewer vacancies than the other tradeables sector, the expansion of which leads to more frictional unemployment as compared with the autarky case. Fewer vacancies imply that the demand for nontradeables as investment goods is limited, and the assumption of constant expenditure share for each sector also hinders the expansion of this sector.

Section 2 describes the model and characterizes the equilibrium of the model in the autarky economy. Section 3 adds international trade to the model and compares the unemployment rate

[1] See, for example, Davidson *et al.* (1999). Helpman *et al.* (2008) also claim that the relationship between the degree of trade liberalization and unemployment rate is nonmonotonic.

[2] To concentrate on this supply-side mechanism, the demand side of this model is simplified by the Cobb-Douglas preference. A consideration of other preference structures is left for future investigation.

and welfare with the case of autarky. Section 4 concludes the paper.

2. The Autarky Economy

Labor Markets We follow the basic setup of Sato (2004). There is a continuum of workers of fixed size L in this static economy, and all the workers are homogeneous. l_i $(i = X, Y)$ workers search for jobs in the tradeables sector i, and l_Z workers are self-employed in the nontradeables sector to produce one unit of nontradeable goods. There is also a continuum of firms of size f_i in each tradeables sector, each of which can employ only one worker. The number of successful matches, M_i, is determined by the matching function $M_i = m(l_i, f_i)$, which is assumed to be strictly increasing in both its arguments and homogeneous of degree one (see Pissarides 2000, chap.1). We define labor market tightness in each tradeables sector as $\theta_i \equiv f_i/l_i$. Then, the probability that each worker finds a job in sector i can be represented as

$$\phi_i \equiv \frac{M_i}{l_i} = m(1, \theta_i) = \phi(\theta_i), \tag{1}$$

which is increasing in θ_i. On the other hand, the probability of a successful match for each firm is a decreasing function of θ_i:

$$\psi_i \equiv \frac{M_i}{f_i} = m\left(\frac{1}{\theta_i}, 1\right) = \psi(\theta_i). \tag{2}$$

In each tradeables sector, therefore, $\phi_i l_i$ of l_i workers are employed and $(1 - \phi_i)l_i$ workers are unemployed; further, $\psi_i f_i$ of f_i firms fill their vacancies and $(1 - \psi_i) f_i$ firms remain with vacancies. One successful match of a worker and a firm produces one unit of tradeable goods.

Workers All workers are assumed to have an identical utility function $U = c_X^{\alpha} c_Y^{\beta} c_Z^{1-\alpha-\beta}$, where c_i is the consumption of good i and $\alpha, \beta \in (0, 1)$, $\alpha + \beta < 1$. Let tradeable good X be the numeraire: $p_X \equiv 1$ and let the relative price of other goods be denoted as p_i $(i = Y, Z)$. Then, we obtain the indirect utility of a worker with income I_j:

$$V_j = a \frac{I_j}{p_Y^{\beta} p_Z^{1-\alpha-\beta}}, \quad a \equiv \alpha^{\alpha}\beta^{\beta}(1 - \alpha - \beta)^{1-\alpha-\beta}. \tag{3}$$

Each worker is endowed with one unit of labor and obtains the wage w_i if employed in sector i; an unemployed worker does not obtain any income. Workers are perfectly mobile across sectors *ex ante*, which leads to the equalization of the expected indirect utility $\phi_X V_X = \phi_Y V_Y = V_Z$. By substituting (3), this condition is reduced to

$$\phi_X w_X = \phi_Y w_Y = w_Z. \tag{4}$$

We refer to this Harris-Todaro (1970) type equation as the *expected wage equalization condition*.

Firms and Wages There are no firms in the frictionless nontradeables sector Z, and under the perfectly competitive goods market, each worker earns $w_Z = p_Z$. In tradeables sectors, firms must bear costs k_i in advance to post vacancies. k_i is the fixed cost of recruitment, interpreted as investment per worker, and only nontradeables can be used for this purpose. We also assume $k_X < k_Y$, that is, tradeables sector Y is more *capital intensive* than sector X. The expected profit of each firm is $\pi_i = \psi_i(p_i - w_i) - p_Z k_i$, and the free entry of firms reduces this profit to zero:

$$\psi_i(p_i - w_i) = p_Z k_i, \tag{5}$$

which we refer to as the *free entry condition*. The wage in tradeables sectors, w_i $(i = X, Y)$, is determined by the symmetric Nash bargain; hence, it splits the worker's surplus and the firm's surplus evenly. For a worker, the matching surplus is the difference between the indirect utility when employed and that when unemployed, $V_i - 0$; for a firm, it is the difference between the profit when it fills the vacancies and that otherwise, $(p_i - w_i - p_Z k_i) - (-p_Z k_i)$. The wage is therefore $w_i = \arg\max V_i^{0.5}(p_i - w_i)^{0.5}$, which results in

$$w_i = \frac{p_i}{2}. \tag{6}$$

Prices and Tightness With the wage-setting rule (6), the expected wage equalization condition (4) can be written as

$$\frac{\phi(\theta_i)}{2}\frac{p_i}{p_Z} = 1, \tag{7}$$

which is a downward-sloping relationship in the $(\theta_i, p_i/p_Z)$ plane: see figure 1. Intuitively, the vertical axis indicates the wage of tradeables sector i relative to the frictionless nontradeables sector Z, and the horizontal axis indicates the degree of ease in finding a job in tradeables sector i. If the probability of a worker's matching with a firm in a tradeables sector is high, then a lower actual wage in the sector may maintain the same level of expected wage as the nontradeables sector. On the other hand, substituting (6) into the free entry condition (5) yields

$$\frac{\psi(\theta_i)}{2}\frac{p_i}{p_Z} = k_i, \tag{8}$$

an upward-sloping curve in the same plane. For firms in tradeables sectors, the vertical axis measures the value of goods they produce relative to nontradeables, while the horizontal axis indicates their degree of difficulty in finding an appropriate worker. If the matching probability for a firm is lower, then the price of tradeables must be higher in order to maintain the same level of expected profit.

The equilibrium relative prices and labor market tightness are determined at the intersections of these loci. Note that the free entry condition of the capital-intensive sector Y lies on the left of that of sector X. Because of the relatively high investment costs in sector Y, the labor market tightness θ_Y must be more in favor of firms in this sector than in sector X [3].

[3] Search models with two sectors that vary in their capital intensities or recruiting costs are investigated by Acemoglu (2001) and Coulson *et al.* (2001).

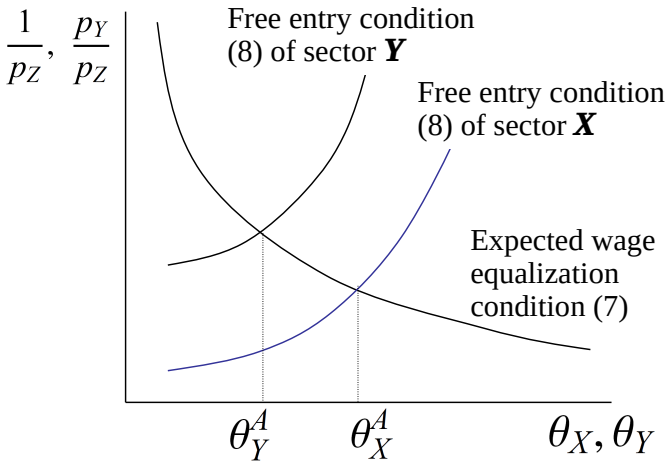

Figure 1: Equilibrium Prices and Labor Market Tightness

Proposition 1. *In the autarky equilibrium, the labor market tightness in capital-intensive sector θ_Y^A is lower than that in the other tradeables sector θ_X^A. This also implies that a worker's probability of finding a job in this sector is lower ($\phi_Y^A < \phi_X^A$) and a firm's probability of matching is higher ($\psi_Y^A > \psi_X^A$). The wage in sector Y is accordingly higher ($w_Y^A = p_Y^A/2 > 1/2 = w_X^A$).*

Labor Allocation and Unemployment To close the model, we impose the following goods markets equilibrium conditions; recall that nontradeables are used as investment goods as well as final consumption goods.

$$l_X \phi_X = \alpha I^A, \tag{9}$$

$$l_Y \phi_Y = \frac{\beta I^A}{p_Y}, \tag{10}$$

$$L - l_X - l_Y = \frac{(1-\alpha-\beta) I^A}{p_Z} + k_X f_X + k_Y f_Y, \tag{11}$$

where $I^A = l_X \phi_X w_X + l_Y \phi_Y w_Y + (L - l_X - l_Y) w_Z$ is the autarky national income [4]. The left-hand sides represent the total supply of each good; the right-hand sides, the total demand. Using the wage-setting rule (6) and worker's expected wage equalization condition (7), this national income can be written as

$$I^A = L p_Z^A. \tag{12}$$

Substituting this and (7) into (9) and (10) respectively, we obtain the equilibrium labor allocation of the autarky economy:

$$l_X^A = \frac{\alpha}{2} L, \quad l_Y^A = \frac{\beta}{2} L. \tag{13}$$

Similarly, the number of firms in each tradeables sector can be derived from the relationship $f_i^A \psi_i = l_i^A \phi_i$ and using (13) as well as (8):

$$f_X^A = \frac{\alpha}{2k_X} L, \quad f_Y^A = \frac{\beta}{2k_Y} L. \tag{14}$$

[4] The firm's profit π_i doesnot show up in I^A because it is 0 in equilibrium: see the free entry condition (5).

The number of unemployed workers is $(1-\phi_X^A)l_X^A + (1-\phi_Y^A)l_Y^A$; hence, the unemployment rate of this autarky economy is the ratio of this to total workers L:

$$u^A = \frac{\alpha}{2}\left(1-\phi_X^A\right) + \frac{\beta}{2}\left(1-\phi_Y^A\right). \tag{15}$$

3. Trade Liberalization

Small Open Economy When this economy begins international trade with the outside world, we assume that the relative price of tradeables Y is given and higher than the autarky equilibrium: $p_Y^* > p_Y^A$ [5]. In other words, the home country is assumed to have a comparative advantage in capital-intensive sector Y. This makes all firms in sector X in the home country unprofitable, and no firm in sector X posts vacancies: $l_X^* = f_X^* = 0$. As far as tradeables sectors are concerned, the home country hence perfectly specializes in sector Y.

Trade Equilibrium The wage setting rule is not altered: $w_Y^* = p_Y^*/2, w_Z^* = p_Z^*$. As a result, the expected wage equalization condition for workers

$$\frac{\phi(\theta_Y^*)}{2}\frac{p_Y^*}{p_Z^*} = 1, \tag{16}$$

as well as the free entry condition for firms

$$\frac{\psi(\theta_Y^*)}{2}\frac{p_Y^*}{p_Z^*} = k_Y, \tag{17}$$

is also the same as the autarky case. Although the world price p_Y^* is given, the relative price p_Y^*/p_Z^* is still an endogenous variable that is determined at the intersection of these equations. Therefore, figure 1 is still valid.

Proposition 2. *In the trade equilibrium under the assumption $p_Y^* > p_Y^A$, the labor market tightness in sector Y is the same as that in the autarky ($\theta_Y^* = \theta_Y^A$), and hence, the matching probabilities are also the same ($\phi_Y^* = \phi_Y^A, \psi_Y^* = \psi_Y^A$). Furthermore, the relative price does not change either: $p_Y^*/p_Z^* = p_Y^A/p_Z^A$, which implies that $p_Z^* > p_Z^A$.*

The goods markets clearing conditions are now

$$C_X = \alpha I^*, \tag{18}$$

$$C_Y = \frac{\beta I^*}{p_Y^*}, \tag{19}$$

$$L - l_Y^* = \frac{(1-\alpha-\beta)I^*}{p_Z^*} + k_Y f_Y^*, \tag{20}$$

[5] We denote variables of the small open economy with asterisks.

where C_i is the home country's total consumption of tradeables i, and I^* is the national income of this small open economy: $I^* = l_Y^* \phi_Y^* w_Y^* + (L - l_Y^*) w_Z^*$. This simplifies to $I^* = L p_Z^*$ with the usage of (16). We also impose the trade balance condition:

$$p_Y^* \left(l_Y^* \phi_Y^* - C_Y \right) = C_X. \tag{21}$$

Solving for l_Y^* and f_Y^* yields (see the Appendix for the derivation)

$$l_Y^* = \frac{\alpha + \beta}{2} L, \quad f_Y^* = \frac{\alpha + \beta}{2 k_Y} L. \tag{22}$$

The total employment and number of firms in tradeables sectors in the trade equilibrium, where only sector Y operates, are the same as those in the autarky case, where both sectors X and Y operate. From the viewpoint of nontradeables, this result can be stated as follows.

Proposition 3. *In the trade equilibrium, the employment in nontradeables sector Z is the same as that in the autarky ($l_Z^* = l_Z^A$). The total investment does not change either: $k_X f_X^A + k_Y f_Y^A = k_Y f_Y^*$.*

Although the labor market of the nontradeables sector is free from frictional unemployment, it fails to increase the employment in that sector. This is due to our assumption about the consumer preference of fixed expenditure share, as well as the rise in p_Z, the investment cost for a firm to post vacancies.

Unemployment Rate The number of unemployed workers in the trade equilibrium is $(1 - \phi_Y^*) l_Y^*$. Thus, the unemployment rate is now

$$u^* = \frac{\alpha + \beta}{2} \left(1 - \phi_Y^* \right). \tag{23}$$

Because proposition 2 shows that $\phi_Y^* = \phi_Y^A < \phi_X^A$, the right-hand side of (23) is larger than that of autarky case (15). The labor market tightness is relatively low in capital-intensive sector Y; hence, the expansion of this sector cannot compensate for the job loss in sector X [6].

Proposition 4. *In the trade equilibrium, the unemployment rate is higher than the autarky equilibrium ($u^* > u^A$).*

Welfare Comparison We compare the national economic welfare measured by the indirect utility (3) evaluated at the autarky income I^A with the counterpart of the trade equilibrium I^*:

$$V^* = aL \left(\frac{p_Z^*}{p_Y^*} \right)^{\beta} (p_Z^*)^{\alpha} > aL \left(\frac{p_Z^A}{p_Y^A} \right)^{\beta} \left(p_Z^A \right)^{\alpha} = V^A. \tag{24}$$

[6] Davidson *et al.* (1999) claim a similar property in a model without the nontradeables sector.

The inequality follows from proposition 2; relative prices are the same and the national income, proportional to the price of nontradeables, is higher in the trade equilibrium. For a worker employed in each sector,

$$V_Y^* = \frac{a}{2}\left(\frac{p_Y^*}{p_Z^*}\right)^{1-\beta}(p_Z^*)^{\alpha} > \frac{a}{2}\left(\frac{p_Y^A}{p_Z^A}\right)^{1-\beta}\left(p_Z^A\right)^{\alpha} = V_Y^A, \tag{25}$$

$$V_Z^* = a\left(\frac{p_Z^*}{p_Y^*}\right)^{\beta}(p_Z^*)^{\alpha} > a\left(\frac{p_Z^A}{p_Y^A}\right)^{\beta}\left(p_Z^A\right)^{\alpha} = V_Z^A. \tag{26}$$

In addition, for the workers who are employed in sector X in the autarky economy but move to sector Y in the trade equilibrium, it is obvious [7] that $V_Y^* > V_Y^A > V_X^A$; hence, all the *employed* workers are better off thanks to trade liberalization. The rise of unemployment, however, implies that there are more workers with income 0 in the trade equilibrium. In this sense, international trade strengthens the ex-post inequality between the employed and the unemployed.

Proposition 5. *In the trade equilibrium, national welfare is higher than that in the autarky case* ($V^* > V^A$). *Moreover, each employed worker is better off* ($V_i^* > V_i^A$), *while there are more unemployed workers with no income.*

4. Concluding Remarks

In this paper, we investigated the impact of international trade on the unemployment rate and welfare in the presence of a frictionless nontradeables sector that generates potential job opportunities. Trade expands the capital-intensive tradeables sector and eliminates the import-competing sector, forcing workers in this sector to seek jobs in other sectors. Because of its high investment costs, the exporting sector posts relatively fewer vacancies, failing to increase the investment demand for the nontradeables. The nontradeables sector therefore cannot create enough jobs, which results in the rise of the unemployment rate and ex-post inequality among the workers.

The next step should involve a more specific explanation of the determinants of capital intensities themselves: why do some industries or some countries use more capital per worker than others? Considering this point may lead to a richer analysis with particular policy implications, such as employment subsidies or capital taxation.

References

[1] Acemoglu, D. (2001) "Good Jobs versus Bad Jobs" *Journal of Labor Economics* **19**, 1-21.

[2] Coulson, E. N., D. Laing, and P. Wang (2001) "Spatial Mismatch in Search Equilibrium" *Journal of Labor Economics* **19**, 949-972.

[7] In the autarky equilibrium, the wage is higher in sector Y than in sector X; recall proposition 1.

[3] Davidson, C., L. Martin, and S. Matusz (1999) "Trade and Search Generated Unemployment" *Journal of International Economics* **48**, 271-299.

[4] Harris, J. R., and M. P. Todaro (1970) "Migration, Unemployment and Development: A Two-Sector Analysis" *American Economic Review* **60**, 126-142.

[5] Helpman, E., O. Itskhoki, and S. Redding (2008) "Inequality and Unemployment in a Global Economy" mimeo.

[6] Kletzer, L. G. (2004) "Trade-related Job Loss and Wage Insurance: a Synthetic Review" *Review of International Economics* **12**, 724-748.

[7] Moore, M. P., and P. Ranjan (2005) "Globalisation vs Skill-Biased Technological Change: Implications for Unemployment and Wage Inequality" *The Economic Journal* **115**, 391-422.

[8] Pissarides, C. A. (2000) *Equilibrium Unemployment Theory* (2nd edition), The MIT Press.

[9] Sato, Y. (2004) "Migration, Frictional Unemployment, and Welfare-Improving Labor Policies" *Journal of Regional Science* **44**, 773-793.

Appendix

Derivation of equation (22)

Substituting the national income $I^* = Lp_Z^*$ into (19), we obtain

$$C_Y = \frac{p_Z^*}{p_Y^*}\beta L, \tag{A.1}$$

while taking the ratio of (18) and (19) yields $C_X = (\alpha/\beta)p_Y^* C_Y$. Substituting these equations in the trade balance (21), we obtain

$$l_Y^*\phi_Y^* - C_Y = \frac{\alpha}{\beta}C_Y. \tag{A.2}$$

Solving this for l_Y^* and using (A.1) yields

$$l_Y^* = \frac{\alpha+\beta}{\beta}\frac{p_Z^*}{\phi_Y^* p_Y^*}\beta L. \tag{A.3}$$

Then, by substituting the expected wage equalization condition (16) into the right-hand side of (A.3), we obtain the l_Y^* of equation (22). For the number of firms, solve $f_Y^*\psi_Y^* = l_Y^*\phi_Y^*$ for f_Y^* and use the free entry condition (17):

$$f_Y^* = \frac{\phi_Y^* p_Y^*}{2k_Y p_Z^*}l_Y^*. \tag{A.4}$$

Using the expected wage equalization condition (16) to eliminate ϕ_Y^* and substituting for l_Y^* into (A.4) yields

$$f_Y^* = \frac{\alpha+\beta}{2k_Y}L, \tag{A.5}$$

which is the f_Y^* of equation (22).