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Offshoring Barriers, Regulatory Burden and National Welfare

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Abstract

We present a model which considers both regulatory burden of offshoring barriers and possible terms of trade gains from such barriers. Non-tariff barriers are shown to be unambiguously welfare-reducing, and tariff barriers raise welfare only when associated terms-of-trade gains exceed resulting regulatory burdens, in which case there is a positive optimal offshoring tax. Otherwise, free trade is optimal. Welfare reductions from an offshoring tax are more likely with several developed nations engaging in offshoring. We derive and characterize the Nash equilibrium in such a case.

Keywords: Offshoring tax, labor market, terms of trade

JEL codes: F1; H8

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1. Introduction

In recent years there has been a rise in protectionist sentiment in the US fueled in part by worries about job losses stemming from cheaper imports from China. The debate on this is far from settled. More importantly, there is the worry that improvements in offshoring technology will lead to shifting jobs abroad, in turn leading to higher unemployment and lower wages in the US.[1] These concerns have led to policy discussions regarding the use of offshoring regulations. A largely ignored issue here is the burden that US firms will face from such regulations, and how that may affect national welfare. In this context, we present a model which considers offshoring barriers, whose welfare effects and optimum levels we derive.[2] The basic two-country analysis is extended to the case of several developed nations.

2. A Two-country Model with Full Employment and Wage Flexibility in Both Nations

Let there be two nations, a developed home nation (*H*) and a developing foreign nation (*F*). All foreign variables are denoted by *. The developed nation offshores some tasks to the developing nation to produce a numeraire good *X*, whose production requires completion of a range of tasks $i \in [0,1]$. One unit of labor is required in each task performed in *H* per unit of the good produced (we call this one unit of a task). Following Grossman and Rossi-Hansberg (2008), offshoring costs take an iceberg form, such that $\beta t(i) > 1$ units of *F*'s labor are required to produce each unit of an offshored task, where β reflects the offshoring environment that applies to all tasks exported. Indexing tasks more costly to offshore with higher values of *i*, we

[1] The current low unemployment rate makes it meaningful to use a full-employment model to focus more on wage effects.

[2] Bandyopadhyay et al. (2014) uses an international oligopoly model to show that market-share considerations can render offshoring barriers ineffective in raising domestic employment. This is an additional channel outside our paper that will also reduce the possibility of domestic welfare gain from offshoring barriers.

have $t'(i) > 0$. β reflects both the general offshoring technology as well as regulatory burdens (or compliance costs) related to offshoring barriers. In particular, let *R* reflect the regulatory burden on a firm arising out of an *ad valorem* offshoring tax τ and non-tariff barrier ρ. While the tax generates revenue, it also increases paperwork for the firm and imposes regulatory burden. Non-tariff barriers involve stricter border inspections among other factors. The following formulation captures this environment:

$$\beta = \beta(R), \beta'(R) > 0; \; R = R(\tau, \rho), R_\tau > 0; R_\rho > 0,$$

$$\Rightarrow \beta = \beta(\tau, \rho), \beta_\tau > 0, \beta_\rho > 0, \;\; \beta(\tau = 0, \rho = 0) = \bar{\beta} > 0, \;\; \tau \geq 0; \rho \geq 0, \quad (1)$$[3]

where $\bar{\beta}$ is a parameter reflecting offshoring technology at free trade.

Marginal Task Offshored

A task *i* is offshored to *F* if and only if:

$$w \geq (1+\tau) w^* \beta(\tau, \rho) t(i). \quad (2)$$

As in GRH, we assume that task $i = 0$ is cheaper to perform in *F* and task $i = 1$ in *H*. Under these assumptions, and given continuity and monotonicity of $t(i)$, an interior solution obtains where (2) holds as an equality. Denoting the marginal task as I, we then have

$$t(I) = \frac{w}{(1+\tau) w^* \beta(\tau, \rho)}. \quad (3)$$

Tasks $i \in (I, 1]$ are conducted in *H*, while the remaining tasks $i \in [0, I]$ are offshored to *F*.

[3] We rule out negative values of the policy variables since offshoring subsidies, by involving administrative costs, cannot benefit the developed nation starting from free trade. In addition, offshoring subsidies can only be financed through taxation, and, therefore, not a realistic policy option in an anti-offshoring environment.

Labor Supply

Let *W*, the utility of a representative consumer in the home nation take the following quasi-linear form:

$$W = u\left(L_e\right) + c_x,\; u'\left(L_e\right) > 0, u''\left(L_e\right) < 0, \tag{4}$$

where L_e is leisure and c_x is consumption of *X*. The concavity of *u*(.) reflects diminishing marginal utility of leisure (increasing marginal disutility of labor). Let this consumer's endowment, $\bar{L}$ of labor time be allocated between labor and leisure. Also, let $T \geq 0$ be a lump-sum transfer from the government to the consumer. Denoting the worker's labor supply by L, the consumer's budget constraint is:

$$c_x = wL + T = w\left(\bar{L} - L_e\right) + T\,. \tag{5}$$

Subject to this budget constraint, utility maximization yields the labor supply function as:

$$u'\left(L_e\right) = w \Rightarrow L = L\left(w\right), L'\left(w\right) = -\frac{1}{u''\left(\bar{L} - L\right)} > 0, L < \bar{L}.^{4} \tag{6}$$

Similarly, labor supply in the foreign nation is:

$$L^* = L^*\left(w^*\right), L^{*\prime}\left(w^*\right) = -\frac{1}{u^{*\prime\prime}\left(\bar{L}^* - L^*\right)} > 0, L^* < \bar{L}^*. \tag{7}$$

Labor Demand and Full Employment Conditions

Full employment in *H* requires that:

$$L^d = x\left(1 - I\right) = L\left(w\right) \Rightarrow x = \frac{L\left(w\right)}{1 - I}, \tag{8}$$

[4] A similarly upward sloping labor supply function faced by the *X* sector can also be derived assuming the presence of another sector, say food, that needs labor and a specific factor, say land, for production under constant returns to scale. The labor supply to *X* in that case will be the economy's labor endowment minus the labor demand in the food sector.

where L^d is labor demand in nation *H*. Let L^{d*} be the offshoring labor demand in nation *F*. Noting that each offshored task requires $\beta t(i)$ units of *F*'s labor per unit of the final good, full employment in *F* requires that:

$$L^{d*} = x\beta\mu(I) = L^*(w^*),\ \mu(I) = \int_{i=0}^{I} t(i)\,di\,, \tag{9}$$

Zero-Profit Condition

The firms' unit cost of production c is the sum of their tax and transportation cost inclusive labor costs in *H* and *F* to complete all necessary tasks. Thus, using (3), we can express unit production cost as:

$$c = w(1-I) + (1+\tau)w^*\beta\mu(I) = w\left[1 - I + \frac{\mu(I)}{t(I)}\right] = c(w,I)\,. \tag{10}$$

Noting that the price of good *X* is unity, we use (10) to get the zero-profit condition as:

$$c(w,I) = 1 \Rightarrow w = w(I),\ w'(I) => \frac{w\mu t'(I)}{t^2\left(1 - I + \frac{\mu}{t}\right)} \quad 0\,. \tag{11}$$

Equilibrium

Using (8) and (11) to substitute for *x* and *w*, respectively, we can use (9) to obtain the market clearing wage in *F* as:

$$L(w(I))\beta\mu(I) - L^*(w^*)(1-I) = 0 \Rightarrow w^* = w^*(I,\beta),$$

$$w_I^* => \frac{\left[Lt + \mu L'(w)w'(I)\right]\beta + L^*(w^*)}{(1-I)L^{*\prime}(w^*)} \quad 0, \text{and},\ w_\beta^* => \frac{\mu L(w)}{(1-I)L^{*\prime}(w^*)} \quad 0. \tag{12}$$

Substituting (12) in (3), and using (1) and (11) we get:

$$(1+\tau)w^*\left[I,\beta(\tau,\rho)\right]\beta(\tau,\rho)t(I) - w(I) = 0 \Rightarrow I = I(\tau,\rho), I_\tau < 0, I_\rho < 0. \tag{13}$$

(13) establishes that the level of offshoring must fall with either an increase in τ or ρ.

Welfare Effect of Offshoring Restrictions

Let the tax revenue $\tau w^* L^{d*}$ be returned in a lump-sum manner by the government to the representative consumer. Using (4) and (5), and noting that $T = \tau w^* L^{d*} = \frac{\tau w^* \beta \mu L}{1-I}$, welfare of the home nation's representative agent is:

$$W = u\left(\bar{L} - L\right) + wL + \frac{\tau w^* \beta \mu L}{1-I}. \tag{14}$$

Using some substitutions (14) reduces to:

$$W = u\left(\bar{L} - L\left(w(I)\right)\right) + w(I) L\left(w(I)\right)\left[1 + \frac{\tau \mu(I)}{(1+\tau) t(I)(1-I)}\right] \equiv W(I,\tau). \tag{15}$$

Using (13) in (15) we get:

$$dW = \left(W_I I_\tau + W_\tau\right) d\tau + W_I I_\rho d\rho. \tag{16}$$

Evaluated at free trade,

$$dW_{|\tau=0,\rho=0} = \left(W_I I_\tau + W_\tau\right)_{|\tau=0,\rho=0} d\tau + \left(W_I I_\rho\right)_{|\tau=0,\rho=0} d\rho. \tag{17}$$

Using (15), we find that $\left(W_I\right)_{|\tau=0,\rho=0} = L(w) w'(I) > 0$. Therefore, using (13), we have $\left(W_I I_\rho\right)_{|\tau=0,\rho=0} < 0$, which means that for a given offshoring tax, any non-tariff barrier $\rho > 0$ has to be welfare-reducing. Let us now consider a change in the offshoring tax. We can show that:

$$\left(W_I I_\tau + W_\tau\right)_{|\tau=0,\rho=0} > 0 \text{ if and only if } \varepsilon^{\beta}_{\tau\,|\tau=0,\rho=0} < \varepsilon^{w^*}_{\tau\,|\tau=0,\rho=0}, \tag{18}$$

where $\varepsilon_\tau^{\beta} = \dfrac{d\ln\beta}{d\ln\left(1+\tau\right)} > 0$ is the elasticity of β with respect to the tax rate, and

$\varepsilon_\tau^{w^*} = -\dfrac{d\ln w^*}{d\ln\left(1+\tau\right)}$ is the elasticity of w^* with respect to the tax rate. Thus, there will be a welfare gain from the offshoring tax if and only if the terms of trade benefit more than offsets the regulatory burden. The necessary condition, of course, is that there is a terms-of-trade benefit, i.e., $\varepsilon_\tau^{w^*} > 0$.

Optimal Offshoring Barriers

It is clear from the discussion above that the optimal level of the non-tariff barrier is always zero. However, if $\varepsilon_\tau^{\beta}\big|_{\tau=0,\rho=0} < \varepsilon_\tau^{w^*}\big|_{\tau=0,\rho=0}$, then a positive offshoring tax is justified, while otherwise no offshoring policy barriers are justified. Consistent with this, the optimal offshoring tax is[5]

$$\tau^{opt} = \begin{cases} \dfrac{\varepsilon_\tau^{w^*} - \varepsilon_\tau^{\beta}}{\varepsilon_\tau^{w^*}\left(1+\eta^*\right)} if\, \varepsilon_\tau^{w^*} > \varepsilon_\tau^{\beta}, \\ 0, otherwise, \end{cases} \tag{19}$$

where $\eta^* = d\ln L^* / d\ln w^*$ is the developing nation's labor-supply elasticity. The second-order condition ensures a positive denominator in the top panel of the RHS of (19). Therefore, *ceteris paribus*, the larger the terms-of-trade gain $\varepsilon_\tau^{w^*}$ relative to the compliance burden ε_τ^{β}, the greater the optimal tax when $\varepsilon_\tau^{w^*} > \varepsilon_\tau^{\beta}$. If β rises rapidly with a positive tax, or if the developed nation's labor-supply function is very elastic (η^* is high and therefore $\varepsilon_\tau^{w^*}$ small), the optimal tax

[5] The second-order condition requires that $\varepsilon_\tau^{w^*}\big|_{\tau=\tau^{opt},\rho=0} > 0$.

is likely to be small, hitting zero at $\varepsilon_\tau^{w^*} = \varepsilon_\tau^\beta$ and remaining there for $\varepsilon_\tau^{w^*} < \varepsilon_\tau^\beta$ [6] Thus a political-economy tax, that overshoots the optimal tax, can well be welfare-reducing relative to free trade.

3. Model with Several Developed Nations

Let there be several developed nations, *j=1,2,…n.* Equation (1) is replaced by:

$$\beta^j = \beta^j\left(R^j\right), \beta^{j\prime}\left(R^j\right) \quad 0;\ R^j = R^j\left(\tau^j, \rho^j\right), R^j_{\tau^j} > 0; R^j_{\rho^j} > 0,$$

$$\Rightarrow \beta^j = \beta^j\left(\tau^j, \rho^j\right), \beta^j_{\tau^j} \quad 0, \beta^j_{\rho^j} \quad 0. \tag{20}$$

The marginal-task condition now is

$$t^j\left(I^j\right) = \frac{w^j\left(I^j\right)}{\left(1+\tau^j\right) w^* \beta^j\left(\tau^j, \rho^j\right)} \quad I^j \quad f^j\left(w^*, \tau^j, \rho^j\right). \tag{21}$$

Similarly, replacing all the relevant equations by their multi-country counterparts, we obtain the market clearing wage in *F* as:

$$\sum_{j=1}^{n} \frac{\beta^j \mu^j\left(I^j\right) L^j\left(w^j\right)}{1 - f^j\left(w^*, \tau^j, \rho^j\right)} - L^*\left(w^*\right) = 0 \Rightarrow w^* = w^*\left(\tilde{\tau}, \tilde{\rho}\right);\ \text{where,}$$

$$\tilde{\tau} = \left(\tau^1, .. \tau^n\right); \tilde{\rho} = \left(\rho^1, .. \rho^n\right). \tag{22}$$

Using (21) and (22), nation *j*'s equilibrium offshoring level is:

$$I^j = I^j\left(\tilde{\tau}; \tilde{\rho}\right). \tag{23}$$

Nash Policy Equilibrium:

Similar to (15) above, nation *j*'s welfare is:

[6] We can show that $\frac{dw^*}{d\tau}$ is inversely related to $L^{*\prime}\left(w^*\right)$.

$$W^j = u^j\left(\bar{L}^j \quad L^j\left(w^j\left(I^j\right)\right)\right) \quad w^j\left(I^j\right)L^j\left(w^j\left(I^j\right)\right)\left[1 \quad \frac{\tau^j \mu^j\left(I^j\right)}{\left(1+\tau^j\right)t^j\left(I^j\right)\left(1-I^j\right)}\right]$$

$$\equiv \phi^j\left(I^j, \tau^j\right). \tag{24}$$

Using (23) in (24),

$$W^j = \phi^j\left(I^j\left(\tilde{\tau};\tilde{\rho}\right), \tau^j\right) \quad W^j\left(\tilde{\tau};\tilde{\rho}\right). \tag{25}$$

The first-order conditions of Nash welfare maximization for nation *j* are:

$$W^j_{\tau^j} = 0, \text{ and } W^j_{\rho^j} = 0, \; j = 1, 2, \ldots n. \tag{26}$$

which implicitly define policy reaction functions of developed nations.

A symmetric developed nation Nash equilibrium

The solution to the system of equations (26) defines the Nash equilibrium

$\left(\tilde{\tau}^{Nash} = \left(\tilde{\tau}^1, ..\tilde{\tau}^n\right); \tilde{\rho}^{Nash} \quad \left(\tilde{\rho}^1, ..\tilde{\rho}^n\right)\right)$. Using (24) and (25) we get:

$$W^j_{\rho^j|\tilde{\tau}=\tilde{\rho}=0} = \phi^j_{I^j|\tilde{\tau}=\tilde{\rho}=0}\left(\frac{dI^j}{d\rho^j}\right)_{|\tilde{\tau}=\tilde{\rho}=0} \quad L^j w^{j\prime}\left(\frac{dI^j}{d\rho^j}\right)_{|\tilde{\tau}=\tilde{\rho}=0}. \tag{27}$$

Evaluated at symmetry of developed nations, we can show that $\left(\frac{dI^j}{d\rho^j}\right)_{|\tilde{\tau}=\tilde{\rho}=0}$ is negative. This implies that nation *j*'s optimal response is to choose $\rho^j = 0$ given that all other nations are pursuing free trade. Turning to the tax, we can show that:

$$W^j_{\tau^j|\tilde{\tau}=\tilde{\rho}=0} > 0 \text{ if and only if } \varepsilon^{\beta^j}_{\tau^j_{|\tilde{\tau}=\tilde{\rho}=0}} < \varepsilon^{w^*}_{\tau^j_{||\tilde{\tau}=\tilde{\rho}=0}}, \tag{28}$$

where $\varepsilon_{\tau^j}^{\beta^j} = \frac{d\ln\beta^j}{d\ln\left(1+\tau^j\right)} > 0$ and $\varepsilon_{\tau^j}^{w^*} = -\frac{d\ln w^*}{d\ln\left(1+\tau^j\right)}$ are the elasticities of β^j and w^* respectively with respect to the tax rate. In other words, if $\varepsilon_{\tau^j|_{\tilde{\tau}=\tilde{\rho}=0}}^{\beta^j} \geq \varepsilon_{\tau^j\|_{\tilde{\tau}=\tilde{\rho}=0}}^{w^*}$, we have $W_{\tau^j|\tilde{\tau}=\tilde{\rho}=0}^{j} \leq 0$. In this case, nation *j*'s optimal response at free trade by other nations is $\tau^j = 0$, and free trade is a Nash equilibrium. On the other hand, if $\varepsilon_{\tau^j}^{w^*} > \varepsilon_{\tau^j}^{\beta^j}$ we will get a Nash equilibrium with positive offshoring taxes. Imposing symmetry and suppressing subscript *j, w*e summarize this insight in the following formula for each developed country's Nash-equilibrium offshoring tariff,

$$\tau^{Nash} = \begin{cases} \dfrac{\varepsilon_\tau^{w^*} - \varepsilon_\tau^{\beta}}{\varepsilon_\tau^{w^*}\left[1+\eta^* + \left(1-1/n\right)\sigma\right]} \, if \, \varepsilon_\tau^{w^*} > \varepsilon_\tau^{\beta}, \\ 0, otherwise, \end{cases} \tag{29}$$

where $\sigma = \frac{1}{\theta}\left[\eta\left(1-\theta\right) + \frac{\varepsilon_I^{\phi}}{\varepsilon_I^{t}}\right]$, $\phi = \beta\mu\left(I\right)/\left(1-I\right)$, $\varepsilon_I^{\phi} = \frac{d\ln\phi}{d\ln I}$, $\varepsilon_I^{t} = \frac{d\ln t}{d\ln I}$, and $\theta = w\left(1-I\right)$, which is the developed-country wage share in costs. It follows that if $\varepsilon_\tau^{w^*} > \varepsilon_\tau^{\beta}$ at a given *n*, the Nash-equilibrium offshoring tax is positive and decreases with *n*, since $\varepsilon_\tau^{w^*}$ falls and $\left(1-1/n\right)$ rises with *n*. For *n* large enough, we can get a reversal in our key inequality to $\varepsilon_\tau^{w^*} \leq \varepsilon_\tau^{\beta}$ leading to free trade ($\tau = 0$) from then on.

If all developed countries could cooperatively set their offshoring tax, its value would be given by (19), optimally set by the union of these countries as a single unit. The union's $\varepsilon_\tau^{w^*}$ is much larger than for individual countries. Clearly then the cooperative tax is larger, unless for both the union and each country independently $\varepsilon_\tau^{w^*} \leq \varepsilon_\tau^{\beta}$. A decline in w^* caused by an increase in nation *j*'s offshoring tax has a public-good effect in the form of a terms-of trade benefit to all other developed nations, with the regulatory burden effect, $\varepsilon_{\tau}^{\beta}$ private to each country. Accordingly, nation *j* has less incentive to tax because it cannot internalize its positive externality. Thus, for the collection of developed nations, the symmetric tax is underprovided in the Nash equilibrium.

4. Conclusion

Offshoring barriers imposed by developed nations are welfare-reducing unless there are strong terms-of-trade benefits that overwhelm the regulatory burden. In a multi-developed nation context, terms-of-trade gains from offshoring taxes are muted, often making unilateral departures from free trade less attractive.

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