Law and Borders

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Abstract

What is the effect of falling trade costs and increased openness on predation activities such as crime, corruption, servitude and human trafficking? To help think about this type of issue we consider a small open developing economy in which agents' incomes are subject to misappropriation by other agents - endogenous predation. We find that if predation is relatively intensive in unskilled labour, then falling trade costs will reduce the level of misappropriation. We also use a calibrated version of the model to consider the effects when the provision of legal services is endogenous. The results show that if legal services are relatively skilled labour intensive a fall in trade costs increases the supply of legal services and further amplifies the reduction in expropriation. The model is discussed with reference to the trade and labor standards debate.

Keywords: Trade, Labor Standards, Development, Predation, Enforcement.

JEL: F1, K42

1 Introduction

Increasing openness in developing economies and falling trade costs have led to concerns in developed countries, on the impact of these changes on trade, labour standards and human rights. Examples of this literature include Fields (1995), Kruger (1996), Brown (2000), Brown, Deardorf and Stern (2002), OECD (2000) Maskus (1997), Basu and Van (1998), Basu and Tzannatos (2003) and Brown, Deardorf and Stern (2003). As argued by Deardorf (2002) these types of concerns only make sense in models that feature externalities or other sources of market failure. Thus Deardorf (2002) considers the effects of reductions in trade costs when the labour market is a monopsony. Srinivasan (1995, 1997) and Freeman (1994) consider models where differences in labour standards effect differences in workers preferences.[1]

The aim of this paper is to consider the effect of increased openness in a developing economy where there are significant failures in the delivery of legal and security services. We start from the basis that the provision of police and legal services to provide basic rights is costly. Because of this agents can always expropriate another agents earnings with some positive probability. Thus, in our model, involuntary exchange may occur in equilibrium.

Involuntary exchange is what distinguishes our model from the preceding literature. In particular, we interpret these exchanges as a form of endogenous predation as in Anderson and Marcouiller (2005). Specifically we interpret the involuntary exchanges as an indicator of the most severe, types of labour market failure that exist within the domestic production sectors of developing economies. Thus whereas Anderson and Marcouiller (2005) considered the effect of endogenous predation, which they interpret as piracy, on trade volumes, we consider the effects of trade costs and external prices on the levels of

[1]Other studies have focused on how the existence of labour standards affects international trade and the case for and against harmonization of labour standards.

endogenous predation. Examples of predation or misappropriation within labour markets include forms of theft, corruption servitude and human trafficking.[2] For example Batra, Kaufmann and Stone (2003) report that firms in developing East Asia view street crime and corruption as the two leading constraints on business. A second important example of involuntary exchange is the inability to secure fundamental human rights such as the rights to freedom from servitude and coercion, Fields (1995). For example the ILO (2005) estimates that there are approximately 12.3m people who are victims of forced labour. Much of this is debt bonding and approximately 20 percent of the total is related to human trafficking.[3]

To consider the effects of increasing openness on this type of involuntary exchange we consider a standard small open economy model with two factors - skilled and unskilled labour - and two traded goods. Involuntary exchange arises since, because legal and police services are costly, agents may choose to direct their labour services appropriation of other agent's labour efforts.

We then consider the general equilibrium effects of a reduction in trade costs on the level of involuntary exchange. The model highlights two channels by which trade affects the level of misappropriation. First there is the effect of commodity prices on factor returns and hence the incentives to engage in misappropriation as opposed to production. Second there is the effect of commodity prices on real incomes and the real cost of legal services.

We first consider the model were the supply of legal services is fixed. For the case of a developing economy with a relative abundance of unskilled labour, we show that falling import prices or rising export prices will reduce the level of misappropriation. This occurs due to familiar Stolper-Samuelson effects of the commodity prices on the opportunity cost

[2]Our model is less applicable to situations where agents voluntarily enter into contracts that doe not meet official labour standards criteria, such as various forms of child labour and hazardous occupations.

[3]Despite the prevalence of bonded labour India has prohibited it since 1976, under the passed the Bonded Labor System Abolition Ordinance. Likewise and in Pakistan legislated the Bonded Labour System Abolition Act in 1992-95, Busse and Braun (2003), OECD (2000).

of misappropriation. After allowing for a supply response for legal services in response to changes in input costs, however, the results become ambiguous. We therefore turn to a calibrated version of the model and show that, for reasonable parameter values, reductions in trade costs can generate significant reductions in misappropriation levels and amplify the gains from trade. We interpret the results as suggesting that increasing openness can be beneficial to the the world's poorest economies even when institutions to protect properly rights are absent. The model also suggests some caveats to this that may apply to contrives with high levels of corruption or military rule.

2 The Model

Consider a small open economy comprising of a unit measure of identical individuals. The representative individual is endowed with $\bar{L}_u$ units of unskilled labor and $\bar{L}_s$ units of skilled labor, the returns (per unit) to which are denoted by w_u and w_s respectively. There are two tradable goods, an exportable and an importable denoted x and m respectively. Both goods are produced under constant returns to scale and perfect competition using skilled and unskilled labor. There is also a non-traded public good, z, produced under constant returns to scale and financed by per head lumpsum tax T.

Let p_x and p_m respectively denote the world price of the exportable and importable. Treating exportable good x as the *numeráire* we normalize $p_x = 1$. Choosing units appropriately for the importable good m we also set $p_m = 1$. We assume that the import-competing sector is tariff protected and let p (> 1) denote the tariff-inclusive price of the importable good faced by the domestic consumers. Trade liberalization or any other reduction in trade costs corresponds to lower p.

If both goods are produced perfect competition implies that unit cost equals price in each

of these sectors (x and m).

$$c_x(w_u, w_s) = 1, \tag{1}$$

$$c_m(w_u, w_s) = p, \tag{2}$$

$$c_z(w_s, w_u) = p_z \tag{3}$$

where $c_i(w_u, w_s)$ denote the unit cost function for good i ($i \in x,\ m,\ z$). Though applicable in general, our analysis primarily focuses on developing countries and accordingly for the remainder of the paper we assume that the exportable good x is labor intensive while the importable good m is capital intensive. More formally, for any (w, r) the following holds:

$$\frac{a_{ux}}{a_{sx}} > \frac{a_{um}}{a_{sm}} \tag{4}$$

where $a_{ui} \equiv \frac{\partial c_i}{\partial w_u}$ and $a_{si} \equiv \frac{\partial c_i}{\partial w_s}$ respectively denote the unskilled and skilled labor requirements to produce one unit of good i.

Our departure from the standard trade models in general and Hecksher-Ohlin framework in particular lies in labor usage. Not all labor units are engaged in productive activities. With imperfect law enforcement in place, individuals face an effective choice between employing labor in producing goods or services and expropriating income from other agents. Suppose individual i uses N_u^i units of unskilled labor and N_s^i units of skilled labor in unproductive activities. Accordingly, $L_u^i \equiv \bar{L}_u^i - N_u^i$ units of unskilled labor and $L_s^i \equiv \bar{L}_s^i - N_s^i$ units of skilled are employed in productive activities. Then, absent misappropriation, income from productive activities for i is

$$\omega_i \ \equiv \ w_u L_u^i + w_s \ L_s^i.$$

This income is subject to potential misappropriation and hence the actual income from

productive activities may be less than ω_i. Nevertheless ω_i may also be realized if the act of misappropriation is verified by a court. In this case the expropriated amount is returned back to the owner. Though such rights (i.e. rights to consumption of one's own income in this case) are provided by law, detection and verification are imperfect and costly.

To capture these uncertain outcomes let α denote the probability that a claim of misappropriation is verified in a court. We assume the value of α depends on the supply of legal services z_i, where $\alpha(z_i)$, satisfies the following:

Assumption 1: For all $z \in [0, \infty]$, $\lim_{z_i \to \infty} \alpha(z_i) < 1$.

For the moment, however, we take the supply of z_i as exogenous so that the probability of success in court $\alpha(z_i)$ is fixed $\forall\ i$.

2.1 Technology for Misappropriation

We assume that, in their attempt to appropriate another agents income, each individual can target only one individual and similarly she can be targeted only by one individual.[4] Without loss of generality, assume that individual i attempts to extract income from k and individual j attempts to do the same from individual i.

The probability of successfully misappropriating another agents' market income depends on the resources committed to misappropriation. We assume that misappropriation activities are performed within households and require inputs of skilled and unskilled labour. The household production function for misappropriation is assumed to be given by $g(N_u^i, N_s^i)$ where g is homogeneous of degree one and exhibits dimerising returns to

[4]The overlaps - that the same person is are targeted by the same individual - are ruled out by assumption. Allowing for overlaps simply reduce the effectiveness of misappropriation which has no important consequence in our model.

each argument. It will also be useful to consider the minimum cost function associated with this production technology. Given that g is homogenous of degree one, the unit cost function is:

$$c_g^i(w_u, w_s) = \min\left\{w_u N_u^i + w_s N_s^i \mid g^i = 1\right\} \tag{5}$$

Let $a_{Nu}^* \equiv \partial c_g^i(w_u, w_s)/\partial w_u$ and $a_{Nu}^* \equiv \partial c_g^i(w_u, w_s)/\partial w_u$ denote the optimal labour requirements that satisfy (5). [5] The probability that income is successfully expropriated then depends on the aggregate level of activity g^i. Specifically i succeeds in misappropriation with probability $\phi(g^i)$).

Assumption 2: (i) $\phi(g_i) < 1$ for all finite g_i, (ii) $\lim_{g_i \to 0} \phi(g_i) = 0$, $\phi'(0) = \infty$; (iii) $\phi' > 0, \phi'' < 0$.

Assumption 2(i) says that misappropriation involves uncertainty and yield a positive return to agent i only with probability $\phi(g_i) < 1$ while the latter assumptions ensure that ϕ satisfies the Inada conditions.

2.2 Expected Income from Misappropriation

The returns to i from misappropriation are realized if and only if i succeeds in expropriating income from k and is not detected/convicted by legal authorities. The probabilities of (a) success in misappropriation and (b) failure of detection/verification by courts are given by $\phi(g^i))$ and $(1 - \alpha(z^k))$ respectively. Since these two events (a) and (b) are independent the returns from unproductive activities are realized with probability $\phi(g^i)(1-\alpha(z^k))$. In all other cases we assume $i's$ income from coercion is zero. Thus the possible outcomes are:

[5] In what follows we focus only on diversified equilibria so that these optimal unit labour requirements are fixed for fixed commodity prices by the standard Stolper-Samuelson mechanism.

(i) i is successful in targeting k, k goes to court and looses. In this case i receives ω_k and k receives 0. This occurs with probability $\phi(g^i)\ (1-\alpha(z^k))$;

(ii) i is successful in targeting k, k goes to court and wins. This occurs with probability $\phi(g^i)\ \alpha(z)$. In this case i receives 0 and k receives ω_k, and;

(iii) i is unsuccessful in targeting k. This occurs with probability $1-\phi(g^i)$. In this case i receives 0 and k receives ω_k.

Given these probabilities i's expected income from unproductive activities is $\omega_k\ \phi(g^i)(1-\alpha(z_i))$. Given that i's labor income is subject to misappropriation from j, $i's$ income from productive activities, is $\omega_i\ (1-\phi(g^i))(1-\alpha(z))$. Expected income for i is then;

$$y_i\ =\ \omega_i\ (1-\phi(g^j))(1-\alpha(z))+\omega_k\ \phi(g^i)(1-\alpha(z)),\ i\ \neq\ j\neq\ k. \tag{6}$$

2.3 Utility Maximization

The individuals share a common homothetic utility function in tradeables, x and m. Let $U(c_x, c_m)$ denote such a utility function, where c_x and c_m are the consumption of x and m respectively. In addition to consumption spending individuals also spend on private legal an protection services. Expected income available for consumption on x and m is thus

$$\tilde{y}^i = y_i - T \tag{7}$$

where T is a lump sum tax used to finance legal services. Given price p, an expected income of $\tilde{y}^i$, a representative consumer i maximizes

$$U(c_x, c_m) \tag{8}$$

subject to

$$p\, c_m + c_x = \tilde{y}^i$$

Let $c_x^* \equiv c_x^*(\tilde{y}^i, p)$ and $c_m^* \equiv c_m^*(\tilde{y}^i, p)$ denote the solution to the optimization problem. Substituting these solutions in (8), and subsequently exploiting homotheticity, yields the indirect utility function which is separable in income and prices:

$$V^i = v(p)\ \tilde{y}^i, \tag{9}$$

where $v(p)$ is decreasing in p. Individuals then maximize utility by choosing g^i conditional on $a_{N_u}^*$ and $a_{N_s}^*$. Noting that $\omega^i = w_u\bar{L_u^i} + w_u\bar{L_u^i} - (w_u a_{N_u} + w_s a_{N_s})g^i$, the first order condition with respect to g^i is

$$(w_u a_{N_u} + w_s a_{N_s})\ [1 - \phi(g^i)\ (1 - \alpha(z^i))]\ = \phi'(g^i)\ g^i\ (1 - \alpha(z))\ \omega^k \tag{10}$$

Given identical agents we have $i = j = k$ and (10) simplifies to,

$$1 = (1 - \alpha(z))\ (\phi(g) + \phi'(g))\ (\tilde{w} - g)) \tag{11}$$

where

$$\tilde{w} \equiv \frac{w_u\bar{L_u} + w_u\bar{L_u}}{w_s a_{N_s} + w_u a_{N_u}} \tag{12}$$

is the ratio of GDP to unit costs of misappropriation activities.

Equation (11) shows that, for a given level of z, any change in $\tilde{w}$ will require a changes in g^i for equilibrium to be restored. Furthermore it is clear that changes in $\tilde{w}$ will depend on any changes in relative factor returns and the relative endowment and intensity shares of each factor.

2.4 Equilibrium

An equilibrium in this economy is: a pair of factor prices $\{w_u, w_s\}$; a vector of unit labour allocations $\{a_{u_x},\ a_{u_m},\ a_{s_x},\ a_{s_x},\ a_{N_u}, a_{N_s}\}$; a pair of output levels $\{x,\ m,\ z\}$ and consumption values $\{x_c,\ m_c\}$, and; a scaler g; that satisfy: (i) zero profits (1); (ii) an optimal allocation level of misappropriation (11), and;

(i) factor market clearing

$$a_{u_m}\ m + a_{u_x}\ x + a_{u_z}\phi(g)\ z + a_{N_u}\ g - \bar{L}_u = 0 \tag{13}$$

$$a_{s_m}\ m + a_{s_x}\ x + a_{s_z}\phi(g)\ z + a_{N_s}\ g - \bar{L}_s = 0 \tag{14}$$

(ii) balanced trade

$$p\ (m - c_m) + x - c_x = 0 \tag{15}$$

and; government budget balance

$$T - p_z\phi(g)z = 0 \tag{16}$$

3 Trade Liberalization and Misappropriation

We now consider the effects of trade policy on this economy. Specifically we consider the effects of reducing trade barriers Likewise we consider increasing these barriers as might occur if sanctions were placed on this economy. In either case we expect trade policy to change the relative price ratio p.

We proceed in two steps. First note that the only exogenous variables determining the level of g and the ratio $\tilde{w}$ are factor prices, p and the exogenous supply of legal and

security services z. For given z any international effects on this economy - through falling trade costs or trade reforms - are through changes in relative factor price p. However the standard relationships between commodity prices and factor prices apply in this model. Hence

Lemma 1: Stolper-Samuelson Theorem. Under Assumption 1, that the economy has a relative abundance of unskilled labour, a reduction in trade barriers will reduce p, reduce w_s/p and increase w_u and w_u/w_s.

Second consider the effects of changes in factor prices on the level of misappropriation g. Let $\lambda_u \equiv \frac{w_u \bar{L}_u}{w_u \bar{L}_u + w_s \bar{L}_s}$ be the economy-wide unskilled labour income share and let $\gamma_u \equiv \frac{w_u a_{N_u}}{w_u a_{N_u} + w_s a_{N_s}}$ be the fraction of income earned by unskilled labour in terms of all misappropriation activities.

Lemma 2: If misappropriation is relatively intensive in unskilled labour such that $\lambda_u < \gamma_u$, then an increase in w_u/w_s will result in a decline in $\tilde{w}$.

Proof: See Appendix.

We may now evaluate the relationship between commodity prices and the volume of misappropriation, g, for a given level of legal services, z.

Proposition 1: Consider a small open economy with an imperfect legal system and that has an abundance of unskilled labour (Assumption 1) and a technology for misappropriation which is relatively intensive in unskilled labour, $\lambda_u < \gamma_u$. Then a reduction in trade costs will reduce the level of misappropriation activities, g for a given level of legal/protective services z

Proof: Differentiating (11) with respect to $\tilde{w}$ and applying the implicit function theorem gives gives

$$\frac{\partial g}{\partial \tilde{w}} = \frac{-\phi'(g)}{\phi''(g)\,(\tilde{w} - g)} > 0 \tag{17}$$

where the sign follows from the concavity of $\phi(g)$, and the fact that $\tilde{w} - g > 0$.[6]

3.1 Discussion

Proposition 1 describes the substitution effect between misappropriation and productive activities. Under our assumption that misappropriation activities are relatively intensive in unskilled labour ($\lambda_s - \gamma_u < 0$) then a rise in unskilled wages increases the opportunity cost of illegal activities.

This suggests that the model provides two additional sources of gains from trade over a standard H-O model. First a reduction in g released additional resources to the economy for productive activities. In this sense the model is similar to rent seeking models where rent seeking activities use real resources. Second, however, the decline in g is itself a gain from trade.[7]

The reduction in g however depends crucially on the factor intensity in misappropriation. This is important in the context of the debate over the effects of trade liberalization, and globalization more generally on human rights. Human rights groups often express concerns that trade with developing countries, where human rights are not well protected by legal systems, may encourage a higher degree of human rights abuses. The results here suggest that in principle, trade liberalization can have the opposite effect. For example operating militia groups essentially involves employing private soldiers. The model suggests that the ability to employ these soldiers depends on the relative unskilled wage rate that the employees could earn in productive activities. In a country where milia

[6]Note that $\tilde{w} - g > 0$ as long as not all labour is employed in misappropriation, or equivalently, as long as there is some production since

$$\tilde{w} - g = \frac{w_s \bar{L}_s + w_u \bar{L}_u - (w_s L_s + w_u L_u)}{w_s L_s + w_u L_u} > 0$$

[7]Though, for reasons of transparency, we have not included g as an argument in the utility function, it is clear that misappropriation is undesirable.

groups misappropriate a significant fraction of market incomes, or where the government itself is involved in activities such as child conscription into the military, the results suggest that rising export prices can raise the opportunity costs of these activities.

On the other hand the World Bank has recently emphasized the extent of corruption in developing economies. One view of this is that a large fraction of the government burberry is involved in a form of misappropriation. The model indicates that trade liberalization for a unskilled labour abundant country would tend to increase the level of misappropriation if these activities are relatively skill intensive. Intuitively, falling relative price of skill intensive import goods will reduce the raise the opportunity cost of productive employment for skilled workers.

4 Endogenous Legal Services

The preceding model is essentially a short run model where the supply of z is fixed. A alternative is to assume that in the long run the supply is endogenous. This is important because first, increasing real incomes may allow agents to purchase more security services and second changing prices may alter the cost of providing these services. We therefore now consider a model where each agent purchases their own security services at a competitive price p_z.

To consider the consequences of allowing an elastic supply response for legal services we first note the following result.

Lemma 3: For a given level of factor returns an exogenous increase in z will reduce the level of illegal misappropriation activities.

Proof See Appendix.

We know show, however, that the general equilibrium effects of a change in commodity

prices, which requires simultaneous adjustment of g and z, are ambiguous. First the demand for z comes from maximizing (8) subject to

$$\tilde{y}^i = y_i - p_z \, \phi(g^i) \, z_i \tag{18}$$

This yields the following additional first order condition for choice of z_i

$$\phi(g^j) \, \omega_i \, \alpha'(z^i) \; - p_z \, \phi(g^i) = 0 \tag{19}$$

which, in a symmetric equilibrium with $z_i = z$ gives the following equilibrium condition z.

$$\omega / p_z = 1/\alpha'(z) \tag{20}$$

Since, on the supply side, $c_z(w_s, w_u) = p_z$, (20) is also the market clearing condition for z. It shows that the effects of falling trade costs will depend upon the ratio ω/p_z. Differentiating the left hand side of this expression gives,

$$(\hat{w}_u - \hat{w}_s) \left((\gamma_u - \theta_{uz}) + \Delta(\lambda_u - \gamma_u) \right) \tag{21}$$

where $\theta_u \equiv \frac{w_u a_{uz}}{w_u a_{uz} + w_s a_{sz}}$ and $\Delta \equiv \frac{w_s \bar{L}_s + w_u \bar{L}_u}{w_s \bar{L}_s + w_u \bar{L}_u - (w_s N_s + w_u N_u)}$.

This expression shows the impact of changes in w_u/w_s on the ration ω/p_z in (20). From Lemma 1 we know that falling trade costs imply $\hat{w}_u - \hat{w}_s > 0$. In general however the sign of (21) is ambiguous. Hence, with an endogenous supply of z there are no unambiguous comparative static results. In view this and also the fact that both the factor intensities of legal sector and the size of expropriate activities appear to play an important role, we proceed with a calibrated version of the model.

Nevertheless, before turning a calibrated model, it is useful to consider some of the likely magnitudes of variables in (21) Specifically note that if $\Delta \to 1$ (20) reduces to

$(\hat{w}_u - \hat{w}_s)(\lambda_u - \theta_{uz})$. Thus we have the following informal proposition

Proposition 2 For a sufficiently small values of misappropriation activities g, falling trade costs such that $\hat{w}_u - \hat{w}_s > 0$ will imply $\hat{z} > 0$ if the legal services sector is skill intensive relative in the sense that $\lambda_u > \theta_{uz}$.

This shows that in developing any numerical results the skill intensity of the legal/security sector will play an important role. In particular if the legal/security sector is intensive in skilled labour, then the Stolper-Samuelson effects serve to reduce $p_z = c_z(w_s, w_u)$.[8]

5 Calibration: Incomplete

To evaluate the model we turn to a calibrated version. We assume that the costs function are iso-elastic. Thus for each productive sector we have $c_k(w_u, w_s) = b_k \; a_{u_k}^{\beta_k} \; a_{s_k}^{1-\beta_k}, \; k \in \{m, \; x, \; z\}$. Likewise, as in (5) we assume that dual to the production function for misappropriation $g(N_u, N_s)$ is the unit cost function $c_g(w_u, w_s) = b_g \; a_{N_u}^{\beta_g} a_{N_s}^{1-\beta_g}$. Further homothetic utility implies constant expenditure shares $\beta_{c_x} = c_x/\tilde{y}$ and $1 - \beta_{c_x} = p \; c_m/\tilde{y}$.

For the functional forms for the success rate in court $\phi(g)$and the success rate of misappropriation $\alpha(z)$ we also use iso-elastic functional forms. hence we assume $\theta(z) = \bar{\theta} z^{\sigma}$ and $\phi(g) = \bar{\phi} g^{\kappa}$. We restrict these functions so that the probabilities cannot exceed unity. Specifically Given a maximum feasible values of $z = \bar{z}$ and $g = \bar{g}$ we then choose the constants $\bar{\theta}$ and $\bar{\phi}$ so that $\theta \leq 1, \; \forall z < \bar{z}$ and $\phi \leq 1 \; \forall g < \bar{g}$.

[8]Proposition 2 also serves to offer a long run interpretation of the assumption, made in the previous section, that z is fixed. For a sufficiently small level of g, z will be invariant to changes in factor prices if $\lambda_u = \theta_{uz}$.

Table 1: Parameters Based on data

Parameter	value	Description	Notes
y	1.0	GDP per capita	choice of units
p_x	1.0	price of exportable	numeraire
p_m	1.0	price of importable	choice of units for m
p_z	1.0	price of non traded legal services	choice of units for z
x	0.60	value share of exportable sector	
m	0.35	value share of importable sector	
z	0.05	value share of legal sector	
$c_g\ g$	0.20	value of resources in misappropriation	
β_x	0.66	unskilled income share in export sector	
β_m	0.33	unskilled income share in export sector	
β_z	0.10	unskilled income share in legal sector	
β_g	0.90	unskilled income share misappropriation	
$\bar{L}_u$	1.0	endowment of unskilled labour	
$\bar{L}_s$	0.445	endowment of skilled labour	w_s/w_u=2.0
α	0.350	expenditure share on	
$\phi(g)$	0.10	probability of crime	choice of units for m
σ		growth of aggregate productivity of 1.02	
κ		growth rate of labor of 1.019	

6 Appendix: Incomplete

Proof Lemma 2: Implicit differentiation of (11) with respect to g and $\tilde{w}$ gives

$$(\hat{w}_u - \hat{w}_s)(\lambda_u - \gamma_u) \tag{22}$$

where $\hat{w}_u \equiv d\ln w_u$, $\hat{w}_s \equiv d\ln w_s$ denote proportional changes and

$$\lambda_u \equiv \frac{w_u \bar{L}_u}{w_u \bar{L}_u + w_s \bar{L}_s}$$

$$\gamma_u \equiv \frac{w_u a_{Lu}}{w_u a_{Lu} + w_s a_{Ls}}$$

Lemma 2 thus summarizes the relationship between changes in factor rentals that occur through standard Stolper-Samuelson effects and the ratio $\tilde{w}$. If $\hat{w}_u - \hat{w}_s > 0$ then $\hat{\tilde{w}} > 0$ if $\lambda_s - \gamma_u > 0$ and $\hat{\tilde{w}} < 0$ if $\lambda_s - \gamma_u < 0$.

Lemma 3: For a given level of factor returns w_s, w_u, so that $\tilde{w}$ is also constant, an increase in z will reduce the level of illegal misappropriation activities.

Proof: Differentiating (11) and applying the implicit function theorem we have

$$\frac{\partial g}{\partial z} = -\frac{\alpha'(z)}{(1-\alpha(z))^2} \; \frac{1}{\phi''(g(L_u, L_s)) \; (\tilde{w} - g(L_u, L_s))} \; < \; 0 \tag{23}$$

where the sign follows from the concavity of $\phi(g(L_u, L_s))$, $\alpha(z)$ and the fact that $\tilde{w} - g(L_u, L_s)) > 0$.

Stolper-Samuelson. From the cost function we have

$$\begin{aligned} a_{ux}w_u + a_{sx}w_s &= 1 \\ a_{um}w_u + a_{sm}w_s &= p \\ a_{uz}w_u + a_{sz}w_s &= p_z \end{aligned} \tag{24}$$

Differentiating these gives,

$$\begin{aligned} \theta_{ux}\hat{w}_u + \theta_{sx}\hat{w}_s &= 0 \\ \theta_{um}\hat{w}_u + \theta_{sm}\hat{w}_s &= \hat{p} \\ \theta_{uz}\hat{w}_u + \theta_{sz}\hat{w}_s &= \hat{p}_z \end{aligned}$$

The first two equations are the standard "Jones" H-O cost zero profit conditions can be solved to get

$$\hat{w}_u = \frac{\theta_{sx}}{\theta_{sx} - \theta_{sm}}\,\hat{p} \tag{25}$$

$$\hat{w}_s = \frac{-\theta_{ux}}{\theta_{sx} - \theta_{sm}}\,\hat{p} \tag{26}$$

We then have

$$\frac{\hat{w}_u - \hat{w}_s}{\hat{p}} = \frac{1}{\theta_{sx} - \theta_{sm}} < 0 \tag{27}$$

if $\theta_{sx} < \theta_{sm}0$.

This implies that

$$1/\theta_{sx} > 1/\theta_{sm}$$

$$1 + \frac{a_{ux}}{a_{sx}} \frac{w_u}{w_s} > 1 + \frac{a_{um}}{a_{sm}} \frac{w_u}{w_s}$$

and hence

$$\frac{a_{ux}}{a_{sx}} > \frac{a_{um}}{a_{sm}}$$

Further for the non-traded sector we have an expression that determines $\hat{p_z}$ as a function of factor prices.

$$\hat{p_z} = (1 - \theta_{sx})\hat{w_u} + \theta_{sx}\hat{w_s} \tag{28}$$

Next we note that average wage income is $w = L_u w_u + Ł_s w_s$. Differentiating gives

$$\hat{w} = (1 - \lambda)\hat{w_u} + \lambda\hat{w_s} \tag{29}$$

where $\lambda \equiv (L_s\ w_s)/w$ is the income share of skilled labour. Using (29) and (28) gives

$$\hat{p_z} - \hat{w} = \frac{\theta_{sz} - \lambda_s}{|\theta|}\ \hat{p} \tag{30}$$

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