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Middlemen Margins and Globalization[†]

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We study a competitive theory of middlemen with brand-name reputations necessary to overcome product quality moral hazard problems. Agents with heterogeneous abilities sort into different sectors and occupations. Middleman margins do not equalize across sectors if production of different goods are differentially prone to moral hazard, generating endogenous mobility barriers. We embed the model in a setting of North-South trade, and explore the distributive implications of trade liberalization. With large intersectoral moral hazard differences, results similar to those of Ricardo-Viner specific-factor models obtain, whereby southern inequality increases. Otherwise, opposite (i.e., Stolper-Samuelson) results obtain. (*JEL* D82, D63, F12, F13, L15)

Conventional trade theory focuses mainly on sources of production costs, ignoring the role of endogenous marketing costs and margins that accrue to trade intermediaries. Yet there is considerable evidence of the importance of intermediaries and associated markups that drive large wedges between consumer and producer prices. For instance, Feenstra (1998) provides the following breakdown of the \$10 retail price of a Barbie doll sold to US customers: \$0.35 in wages paid to Chinese labor; material costs of \$0.65; \$1 incurred for transportation, profits, and overhead by Hong Kong intermediaries; and at least \$1 return net of transport and distribution costs to Mattel, the US retailer. Arndt et al. (2000) estimate middleman markups of 111 percent in food crops, 52 percent in export crops, 59 percent in food processing, and 36 percent in textile and leather in Mozambique. Fafchamps and Hill (2008); McMillan, Welch, and Rodrik (2003); and Nicita (2004) estimate rates of pass-through less than 50 percent from border prices to producer prices in the case of Ugandan coffee, Mozambique cashews, and a range of Mexican agricultural goods respectively. These facts suggest that only a small fraction of the benefits of export growth in developing countries following trade liberalization trickle down to farmers and workers. Consequently globalization may achieve limited impacts on poverty reduction and increase inequality in developing countries (Hertel and

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Winters 2005; Winters, McCulloch, and McKay 2004), contrary to the predictions of classic trade theory.

These observations motivate our interest in a theory which explains the role of middlemen in trade, which can be used to examine determinants of middleman margins, and subsequently predict distributive impacts of trade liberalization or offshoring. In this paper we explore a competitive equilibrium model in which brand-name reputations of middlemen are needed to overcome product quality moral hazard problems. Middleman margins represent reputational rents, rather than returns to market power resulting from technological increasing returns (in transport, storage or distribution). There is considerable evidence of the role of brand names and reputation in the context of trade (elaborated further in Section IVA), ranging from consumer studies (Berges and Casellas 2006, Roth and Romeo 1992); accounts of the role of trust and long-term relational contracting in international trade (Rauch 2001), and econometric analyses of specific traded goods (Banerjee and Duflo 2000; Dalton and Goksel 2011; Macchiavello 2010).

Our model of middlemen builds on the theory of Biglaiser and Friedman (1994), and extends it to a general equilibrium theory of occupational choice. Middlemen carry out a range of functions, including procurement of goods produced by suppliers, financing their working capital requirements, and marketing the product. Our model is consistent with any one of these functions, as well as any combination of them. Hence middlemen could be involved solely in marketing a good produced entirely by the producers they contract with, or additionally with the financing, and management of production.[1]

Reputational markups form part of returns accruing to middlemen. These rents generate requisite incentives to maintain quality, since they would be sacrificed by middlemen in the event of losing their reputation. The size of these rents are proportional to the size of their business, which in turn is correlated with their underlying ability to manage. Agents in the economy differ in their management ability; we take the distribution of ability as a parameter of the model. As in Lucas (1978), "ability" can be viewed as reflecting innate capacities to supervise workers. Alternatively they may reflect technical knowhow, financing or marketing skills.

Agents with heterogeneous ability sort themselves into different occupations and sectors. Only those with ability above some (endogenous) threshold satisfy the incentive compatibility conditions for credible quality assurance in any given sector. Low ability agents have no choice but to produce goods and supply them to middlemen, as they lack the reputation necessary to sell directly to final consumers. High-ability agents become middlemen in sectors where they meet required ability (i.e., size) thresholds. In order to focus exclusively on the nonconvexities arising due to reputations, we assume that the underlying production technology satisfies constant returns to scale. Moreover, all agents are price takers. Hence middleman margins represent competitively determined incentive rents, rather than market power.

We embed this model in an otherwise standard model of North-South trade, in which countries differ only with respect to relative factor endowments. In this

[1] See Rauch (2001, Section 6, esp. p. 1195) for specific examples of roles played by intermediaries which often include coordination and allocation across different suppliers and transfer of technology.

setting we explore the resulting implications for patterns of comparative advantage, North-South factor price differences, and effects of trade liberalization. Our model allows distributional effects within any given sector to be summarized by a single measure of inequality: the ratio of returns earned by middlemen (of a given ability) to those earned by producers.[2]

Our main finding is that the nature of equilibria and their comparative static properties depend on how moral hazard differs across sectors. With large differences, entry thresholds restrict the movement of entrepreneurs across sectors, allowing intersectoral differences in middlemen rents to persist in equilibrium. For certain configurations of moral hazard, technology and endowments, these mobility restrictions cause equilibrium comparative static effects to resemble the predictions of specific factors (SF) models of the Ricardo-Viner variety. For other configurations, mobility restrictions do not arise, wherein classical results of Heckscher-Ohlin (HO) theory emerge.

Specifically, one set of conditions under which SF results obtain is the following: the proneness to moral hazard differs markedly across goods, and the South has a comparative advantage in the good more prone to moral hazard. This would arise for instance, if the South has a comparative advantage in farm goods, which are more prone to quality adulteration than high-tech goods in which the North has a comparative advantage. Middleman margins are then higher in the farm-goods sector owing to the greater severity of the moral hazard problem. Trade liberalization would increase export demand for farm goods in the South. To satisfy this demand, entrepreneurs less able than existing incumbents must enter the farm-goods sector. For this to happen, middleman rents must increase by more than producer earnings in order to enable the new entrants to be credible suppliers of high quality farm goods. Hence intrasectoral inequality between the earnings of middlemen and producers in the southern farm-goods sector rises. Conversely, the southern high-tech sector contracts in the face of rising import competition, and middleman margins in that sector fall relative to producer earnings. If the export sector is large enough, therefore, average inequality of returns to middlemen and producers in the southern economy as a whole rises, opposite to the predictions of the Stolper-Samuelson Theorem.

Nor will factor returns be equalized across countries under the conditions described above: a higher aggregate endowment of entrepreneurial ability in northern countries results in lower inequality in the North in autarky. Trade liberalization accentuates these differences, since (as explained above) inequality rises in the South and falls in the North.[3]

In this setting, trade liberalization increases incentives for northern middlemen to offshore production to southern countries. However, the distributive effects of offshoring are qualitatively different from trade liberalization. Offshoring allows high-ability middlemen from the North to compete with southern middlemen for southern producers, lowering intrasectoral inequality in the South.

[2] This also equals the ratio of ability gradient of middleman rents to producer earnings. Specifically, if producers earn w then a middleman of ability a in sector i earns $\gamma_i wa$, where γ_i is the measure of inequality of earnings within sector i.

[3] Aggregate welfare effects of trade liberalization turn out to be ambiguous, owing to the pecuniary externalities associated with movement of entrepreneurs across sectors. This is shown in the working paper version of this paper Bardhan, Mookherjee, and Tsumagari (2012).

The preceding results obtain when the farm-goods sector (in which the South has a comparative advantage) is more prone to moral hazard. In the opposite case where the high-tech good is more prone to moral hazard, similar anti-Stolper-Samuelson results can be shown to hold provided the elasticity of substitution between inputs supplied by producers and the services supplied by middlemen is large enough.[4]

On the other hand, equilibria turn out to resemble HO predictions in the case where both sectors are equally prone to moral hazard. Relative factor returns are then equalized across sectors. Entrepreneurs are indifferent between which sector to operate in, so they can switch into the export sector following trade liberalization. An increase in inequality of factor returns in the export sector is no longer necessary to induce entry of more middlemen, and does not happen in equilibrium for exactly the same reason as in the standard HO theory.

It is hard to judge whether proneness to moral hazard differs substantially across export and import competing sectors, as there is relatively little direct evidence concerning the extent of moral hazard in any given sector. Section IVA reviews the fragmentary evidence available concerning this. It is easier instead to check evidence concerning the division of product revenues between middlemen and producers. Our theory indicates that SF results apply in cases where moral hazard differs substantially across sectors. Available evidence from a number of developing countries (reviewed in Section IVA) indicates that relative returns to middlemen are substantially higher in less skill-intensive goods exported from the South.

Moreover, there is some empirical evidence consistent with the key mechanism underlying the anti-Stolper-Samuelson result in our theory. Fafchamps and Hill (2008); McMillan, Rodrik, and Welch (2003) show in the case of Ugandan coffee and Mozambique cashew exports respectively that increases in border prices were accompanied by widening inequality between middleman margins and farmgate prices, and entry of less efficient groups of middlemen into these sectors.

Our theory, therefore, has the potential to explain hitherto puzzling evidence concerning the distributive impact of trade integration on developing countries, wherein Stolper-Samuelson predictions have generally not been borne out. This literature (surveyed by Goldberg and Pavcnik 2007; Harrison, McLaren, and McMillan 2011; Winters, McCulloch, and McKay 2004; or Wood 1997) shows increases in inequality in relative earnings of nonproduction and production workers resulting from trade liberalization in many southern countries. Our theory provides detailed predictions concerning conflicting effects of trade liberalization on inequality within export and import-competing sectors, and the role of differences in factor returns across sectors, which could be tested in future research.

The paper is organized as follows. Section I introduces the model. Section II starts by describing the equilibrium of the supply side of the economy, with given product prices, and its comparative static properties. This is followed by Section III which studies the economy-wide equilibrium, starting with the context of an autarkic economy. We then extend it to a two country context and study effects of trade liberalization and offshoring. Section IV describes relation to existing literature, both

[4] These results are not provided here but are available in Bardhan, Mookherjee, and Tsumagari (2012).

theoretical models as well as empirical evidence in more detail. Finally, Section V concludes, while proofs are collected in the Appendix.

I. Model

A. *Endowment and Technology*

There are two goods L and H. Within each sector the production work is carried out by one set of agents called producers or suppliers, and procured by another set of agents called middlemen. Each middleman operates an independent business specializing in selling a specific good. Middlemen provide raw material needs of each supplier they contract with, following which the supplier produces and delivers one unit of intermediate good to the middleman. The total quantity of intermediate goods procured by each middleman is then packaged, branded and sold to final consumers. We can therefore represent the production process as combining two factors: production services provided by suppliers, and management services provided by the middleman who sells the product.

As in Lucas (1978), every agent is endowed with an amount of entrepreneurial ability, which determines the quantum of management services they can provide, which ultimately affects the size of the business they can manage. Managerial ability reflects limits on how many suppliers the middleman can supervise or finance, or how many consumers he can market the product to.

We normalize the size of the population to unity. Each agent is characterized by a level of entrepreneurial ability a, a nonnegative real variable. A fraction $1 - \mu$ of agents have no ability at all: $a = 0$: we refer to them as *unskilled*. The remaining fraction μ are skilled; the distribution of ability is given by a distribution function $G(a)$ on $(0, \infty)$. We shall frequently use the notation $d(a) \equiv \int_a^\infty \tilde{a}\, dG(\tilde{a})$. G will be assumed to have a density g which is positive-valued. Then d is a strictly decreasing and differentiable function.

Any given agent decides whether to become a middleman or producer. If she decides to become a middleman, she selects which good to specialize in, the scale of the business (equivalently, the number of suppliers contracted with), and the quality of the final good to be sold.

The quality of each good can either be high or low. The number of units of good $i \in \{L, H\}$ that can be delivered by the middleman to consumers is defined by a production function $X_i = F_i(n_i, a)$ for the high quality version, and $F_i(n_i, z_i a)$ for the low quality version. Here $z_i > 1$ is a technology parameter representing the severity of the quality moral hazard problem, a denotes the ability of the entrepreneur, and n_i the number of suppliers she contracts with. F_i is a smooth and strictly concave production function with constant returns to scale, satisfying the Inada condition that the marginal product of each factor grows without bound as its use shrinks to zero. Producing lower quality enables a middleman to deliver a larger quantity of the good with the same number of suppliers. For instance, the ability parameter could represent the maximum amount of raw material that the middleman has the capacity to supply to her suppliers, and the low quality version of the good uses less raw material per unit of intermediate good. Alternatively, if ability refers to inspection capacity, producing a lower quality version requires less intensive inspection of the intermediate good supplied by each supplier.[5]

B. *Middleman's Profit Maximization and Equilibrium Price-Cost Relations*

All agents in our model take prices as given. Consider the problem faced by a middleman of ability a operating in sector $i \in \{L, H\}$ who has decided to supply the high quality version of the good to consumers. A similar analysis applies if the middleman decides to supply the low quality version of the good, where the ability of the middleman a is replaced by az_i.

Each supplier must be paid w, and the product price is p_i (with the H good acting as numeraire, so $p_H = 1$). The middleman would have to decide how many suppliers to contract with, i.e., solve the following problem:

$$\max_{n_i} p_i F_i(n_i, a) - wn_i. \tag{1}$$

The solution n_i^* is a function of p_i/w, besides a, characterized by the first-order condition

$$(p_i/w)\partial F_i(n_i^*, a)/\partial n_i = 1. \tag{2}$$

It is easy to check that n_i^* is linear in a. In the Cobb-Douglas case where the production function is $n_i^{\alpha_i} a^{1-\alpha_i}$ with $\alpha_i \in (0, 1)$, we have

$$n_i^* = a\left[\frac{p_i}{w}\alpha_i\right]^{\frac{1}{1-\alpha_i}}.$$

Let $\Pi_i^*(p_i, w; a)$ denote the resulting level of profit earned by the middleman. This is also linear in a. In the Cobb-Douglas case, we have

$$\Pi_i^* = a(1 - \alpha_i) p_i^{\frac{1}{1-\alpha_i}} \left\{\frac{\alpha_i}{w}\right\}^{\frac{\alpha_i}{1-\alpha_i}}.$$

In other words, the profit is constant per unit of ability of the middleman. This gives rise to a scalar measure of inequality of returns to middlemen and suppliers within sector i : the ratio of middleman profit per unit of ability, to earnings of suppliers:

$$\gamma_i \equiv \frac{\Pi_i^*}{wa}. \tag{3}$$

By definition, $\Pi_i^* - aw\gamma_i = 0$, i.e., the middleman earns zero profit in the hypothetical scenario where she purchases her own ability on a competitive market at a fixed price of $w\gamma_i$. Moreover, it is easy to check that (n_i^*, a) maximizes $p_i F_i(n_i, \tilde{a}) - wn_i - w\gamma_i \tilde{a}$ with respect to choice of $(n_i, \tilde{a})$.[6] In other words, optimal employment

[5] An alternative formulation of the moral hazard problem would be one where the production function for the low quality version is $z_i F_i(n_i, a)$. This is closely related to our formulation, and the two versions coincide in the case of a Leontief technology.

[6] In particular, profits in this hypothetical scenario are zero, and thus invariant with respect to variations in a, a measure of the scale of the business.

of suppliers and the middleman's own ability will be the profit-maximizing factor combinations that would have been chosen by an "as if" firm owner who pays for both inputs at the (imputed) factor prices $(w, w\gamma_i)$, and ends up with zero profit. Hence, γ_i can also be interpreted as the relative return to the two factors: middleman ability and suppliers respectively in sector i.

We now introduce a key assumption on the technology ruling out factor-intensity reversals between the two sectors producing H and L respectively. Consider the cost-minimizing factor combinations in each sector for a hypothetical "as if" firm owner procuring the two factors of production at a fixed relative price γ: $(\theta_n^H(\gamma), \theta_a^H(\gamma))$ and $(\theta_n^L(\gamma), \theta_a^L(\gamma))$ are defined as

$$\left(\theta_n^H(\gamma), \theta_a^H(\gamma)\right) \equiv \arg\min\left\{\theta_n^H + \gamma\theta_a^H \,|\, F_H\left(\theta_n^H, \theta_a^H\right) = 1\right\}$$

and

$$\left(\theta_n^L(\gamma), \theta_a^L(\gamma)\right) \equiv \arg\min\left\{\theta_n^L + \gamma\theta_a^L \,|\, F_L\left(\theta_n^L, \theta_a^L\right) = 1\right\}.$$

The following assumption states that good L is uniformly less "skill-intensive" than good H, where we identify managerial services provided by the entrepreneur as the skilled input and production services provided by suppliers as the unskilled input. Specifically, cost-minimizing factor choices in product L at common factor prices involve a greater input of production services relative to managerial services.

ASSUMPTION 1: *For any* $\gamma > 0$,

$$\frac{\theta_n^L(\gamma)}{\theta_a^L(\gamma)} > \frac{\theta_n^H(\gamma)}{\theta_a^H(\gamma)}.$$

In the case of a Cobb-Douglas technology introduced earlier, this reduces simply to $\alpha_L > \alpha_H$.

The Inada condition for the production function implies that maximized profit Π_i^* of an entrepreneur with positive ability is strictly positive, provided the product price is positive. Moreover, defining $\Pi_i^*(p_i, w, a)/(wa) \equiv \phi_i(p_i/w; a)$, the function $\phi_i(.; a)$ is strictly increasing and differentiable. Hence $\phi_i(.; a)$ is invertible, and it is easy to check that the inverse function equals the minimized unit cost of production (where the price of suppliers is set equal to one, and for ability is set equal to its implicit unit cost relative to n_i). Hence, condition (3) can be inverted to yield the following price-cost relations within each sector:

$$\frac{p_L}{w} = \theta_n^L(\gamma_L) + \gamma_L\theta_a^L(\gamma_L) \tag{4}$$

$$\frac{1}{w} = \theta_n^H(\gamma_H) + \gamma_H\theta_a^H(\gamma_H). \tag{5}$$

The left-hand side of the preceding conditions are the reciprocals of the product wage earned by suppliers in the two sectors respectively. The product wage in each sector is a decreasing function of the corresponding measure of inequality.

Equation (4, 5) yields the following equation for ratio of prices of the two goods to their respective unit costs:

$$p_L = \frac{\theta_n^L(\gamma_L) + \gamma_L \theta_a^L(\gamma_L)}{\theta_n^H(\gamma_H) + \gamma_H \theta_a^H(\gamma_H)}. \tag{6}$$

Note that the right-hand side is increasing γ_L and decreasing in γ_H. Hence, (6) expresses a relation between relative factor returns within the two sectors, and the price p_L of product L relative to H. This can be expressed as follows:

$$\gamma_L = \lambda(\gamma_H; p_L). \tag{7}$$

For any given product price p_L, it expresses a monotone increasing relation between relative factor returns within the two sectors. And for any given γ_H, it expresses a monotone increasing relation between p_L and γ_L.

Various properties of this relationship will prove useful later. For now we note one property in particular.

LEMMA 1: $\frac{d\gamma_L}{d\gamma_H} \equiv \lambda_1(\gamma_H; p_L) > 1$ *whenever* $\gamma_L \geq \gamma_H$.

Assumption 1 plays an important role here. Since sector L is less intensive in its use of middleman ability relative to suppliers, an equal increase in cost of ability relative to suppliers in the two sectors will cause unit cost in the L-sector to increase by less than in the H-sector, if the two sectors face the same relative factor costs to start with. Hence, the relative cost of ability must rise by more in the L-sector if the ratio of unit costs is to remain unchanged. *A fortiori* the same will be true if the relative cost of ability is higher in sector L to start with.

C. *Quality Moral Hazard Problem*

Customers do not observe the quality of the product at the point of sale. We assume they value only the high quality version of the product, and obtain no utility from the low quality version. Middlemen will be tempted to produce the low quality version which enables them to produce and sell more to unsuspecting customers. The short-run benefits of such opportunism can be held in check by possible loss of the seller's reputation. With probability η_i, a middleman selling a low-quality item in sector i will be publicly exposed (say by a product inspection agency or by investigating journalists).[7] In this event the middleman's brand-name reputation is destroyed, and the agent in question is forever barred from entrepreneurship in either sector.

In equilibrium, customers will purchase only from middlemen for whom the threatened loss of reputation is sufficient to deter short-term opportunism. Hence,

[7] This applies independently at each date that the low-quality item is sold.

in order for a middleman with skill a to be able to operate in sector i, the following incentive constraint must be satisfied:

$$\frac{\gamma_i w a}{1 - \delta} \geq \gamma_i w z_i a + \delta \left[\eta_i \frac{w}{1 - \delta} + (1 - \eta_i) \frac{\gamma_i w a}{1 - \delta} \right], \tag{8}$$

where $\delta \in (0, 1)$ denotes a common discount factor for all agents. The left-hand side of (8) is the present value of producing and selling the high quality version of good i forever. The first term on the right-hand side, $\gamma_i w z_i a$ represents the short-term profit that can be attained by the middleman upon deviating to low quality. With probability η_i, this deviation results in the middleman losing her reputation, in which case the agent is forced to work as a supplier thereafter. With the remaining probability, the middleman's reputation remains intact.

The incentive constraint can be equivalently expressed as

$$a \geq m_i / \gamma_i, \tag{9}$$

where

$$m_i \equiv \frac{\delta \eta_i}{\delta \eta_i + (1 - \delta)(1 - z_i)} > 1$$

is a parameter representing the severity of the moral hazard problem in sector i.

Equation (9) represents a *reputational economy of scale*, which also translates into a sector-specific entry barrier in terms of entrepreneurial ability. Intuitively, more able middlemen produce and earn profits at a higher scale, while the consequences of losing one's reputation are independent of ability. The stake involved in losing reputation is thus proportional to the entrepreneur's ability, which has to be large enough for the agent to be a credible seller of a high-quality good. The implicit assumption here is that customers can infer quality from observing the size of the corresponding firm and existing prices, by checking whether the incentive constraint is satisfied.[8] Alternatively, similar outcomes will be realized in the long run through an evolutionary process, even if customers are not so well informed. Middlemen not meeting the incentive constraint will provide shoddy goods and will eventually get weeded out, while those meeting the incentive constraint stand no risk of losing their reputation.

The sector-specific entry barriers represent elements of a specific factor model. However, unlike most specific-factor models, these barriers are endogenously determined. For instance, the ability threshold for entry into a particular sector is decreasing in γ_i, the relative earnings of middlemen within that sector. The reason is simple: a higher γ_i means the middleman margin is higher relative to earnings of suppliers in sector i, so middlemen have more to lose if their reputations are destroyed.

[8] Most descriptions of brand-name reputations by marketing specialists (see e.g., Aaker 1991) include the following attribute: awareness in the consumer's mind that the product in question has achieved widespread recognition, as manifested by a wide consumer base.

Note also that $m_i > 1$ implies that entrepreneurs with ability above the required threshold for sector i will strictly prefer to be middlemen in sector i rather than work as a supplier. The per period profit from the former option is $\gamma_i wa \geq wm_i > w$ if (9) is satisfied.

The seriousness of the moral hazard problem in good i is represented by m_i, which is a function of exogenous parameters. One can contrast three cases:

Case A: $m_L > m_H$: the L-good is more prone to moral hazard.

Case B: $m_L < m_H$: the H-good is more subject to moral hazard.

Case C: $m_L = m_H$: both goods are equally prone.

Consider the context where L and H correspond to a farm good and high-tech good respectively. Case A pertains to the situation where quality moral hazard problems are larger in the farm good, owing to problems in quality control or regulation of these goods, and relative lack of product warranties for farm goods compared with high-tech durable goods. The H-good is more durable; it is produced in a more automated and regulated production process which is easier to inspect. It thus allows less scope for skimping on labor or other essential raw material requirements. An offsetting factor would be the greater technological complexity of these goods, combining a larger number of components in the production process. This may lead to high costs of ensuring high quality, as emphasized in the O-ring theory of Kremer (1993). Hence, it is not clear on a priori grounds which of the three cases is the most plausible.

While there is some evidence (reviewed in Section IV) suggesting Case A is plausible, it is fragmentary and far from conclusive. The analysis turns out to be simpler in Cases A and C where $m_L \geq m_H$, so the rest of the analysis below focuses on these two cases. It turns out that results similar to Case A also obtain in Case B provided some additional conditions on the technology are satisfied. For the sake of brevity we therefore do not include analysis of Case B, and refer the interested reader for a detailed treatment in the previous version of this paper (Bardhan, Mookherjee, and Tsumagari 2012, section 4).

II. Occupational Choices and Factor Market Equilibrium

We break up the analysis of competitive equilibrium into two steps. First we take product prices as given, and derive the resulting equilibrium of factor markets: occupational choices and the market for production workers, which comprise the supply side of the economy. This forms the topic of this section. In the next section we shall close the model by bringing in consumer demands and analyzing the determination of product prices.

Definition.—Given p_L the price of good L relative to H, a *factor market equilibrium* of the economy is a level of producer earnings w and relative factor returns within the two sectors γ_L, γ_H such that: (i) every agent (taking these returns as given) selects between different occupations (i.e., supplier in either sector, L-sector middleman, *H*-sector middleman) to maximize earnings subject to incentive constraints represented by (9); (ii) middlemen within each sector decide on how many suppliers to contract with; and (iii) the market for suppliers clears.

The analysis of factor market equilibria proceeds as follows. Relative factor returns in the two sectors define the entry thresholds into each sector, which determine the occupations that any given agent can feasibly choose from while respecting incentive constraints. Agents select between occupational options to maximize their earnings. The allocation of agents across occupations combined with output prices and the earnings of suppliers determines demand for suppliers from middlemen in each sector. The aggregate demand must equal the mass of agents that do not meet the entry thresholds for entrepreneurship in either sector.

We shall represent the factor market equilibrium by the intersection of two conditions involving the relative factor returns in the two sectors: one which corresponds to clearing of the factor markets, the other to the profit maximization condition (6). We start with the former.

A. *Relationship between* γ_L *and* γ_H

Start by condering Case A where the *L* good is subject to more moral hazard ($m_L > m_H$). We shall later describe what happens in Case C, which is obtained upon considering the limiting case where m_L converges to m_H from above.

First we take the relative factor returns in different sectors as given, and derive occupational choices of agents in the economy. The equilibrium of the factor market is illustrated graphically in Figure 1, in terms of the relationship between relative factor returns in the two sectors. There are four different situations to consider.

Region A1: $\gamma_L \geq \gamma_H \frac{m_L}{m_H}$.

Since we are in Case A where $m_L/m_H > 1$, it follows that in this situation $\gamma_L > \gamma_H$ also holds. This implies that entrepreneurship in sector *L* is more profitable than in sector *H*. The entry threshold for this sector is also lower, as $m_L/\gamma_L < m_H/\gamma_H$. Hence all those with ability above m_L/γ_L will enter the *L*-sector, and those below will become production workers. The economy specializes in production of good *L*. In Figure 1, this region corresponds to the range where $\gamma_H < \gamma_H^1$.

Region A2: $\gamma_H < \gamma_L < \gamma_H \frac{m_L}{m_H}$.

Here $\gamma_L > \gamma_H$ implies that the *L*-sector is more profitable. On the other hand, the entry threshold is higher in the *L*-sector: $a_L = m_L/\gamma_L > m_H/\gamma_H = a_H$. So agents with $a \geq a_L$ will choose to become *L*-sector middlemen, while agents with $a \in [a_H, a_L)$ are unable to enter the *L*-sector and so have to be content with becoming *H*-sector middlemen. And agents with $a < a_H$ become suppliers.

Consider the relation between relative factor returns in the two sectors that must hold for the market for suppliers to clear. *This relationship is downward-sloping, because an increase in the relative factor return in either sector increases excess demand for suppliers.* To see this, note that a rise in γ_H has two effects: (i) it lowers

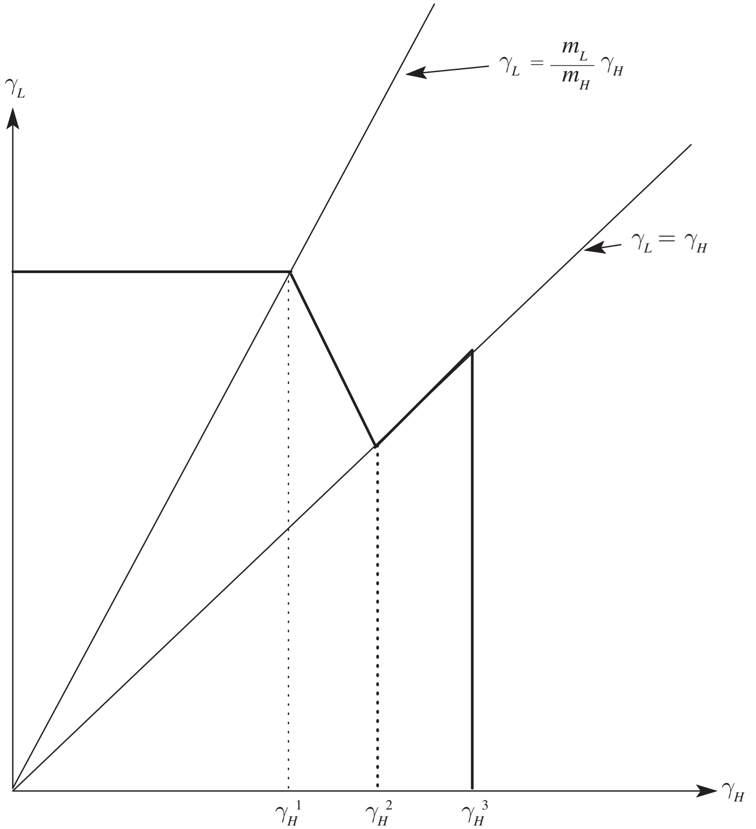

Figure 1. Relation between γ_L and γ_H for Factor Market Clearing

the entry threshold into the H-sector, inducing some suppliers to enter the H-sector as a middleman, and (ii) each incumbent H-middleman wants to contract with more suppliers. A rise in the L-sector relative factor returns also has two effects: (i) it causes the ability entry threshold for the L-sector to fall, motivating some middlemen to switch from the H to the L-sector. Owing to Assumption 1 and the hypothesis that $\gamma_L > \gamma_H$, L-sector middlemen demand more suppliers than the H-sector middlemen. So the switch of entrepreneurs between the two sectors increases excess demand for suppliers. (ii) This is accentuated by the rise in demand for suppliers by incumbent L-sector middlemen.

This region will be of particular interest in the subsequent analysis since relative factor returns are not equalized across the two sectors. Middlemen in the H-sector would prefer to locate in the L-sector but cannot because they cannot offer credible quality assurance if they were to produce the L-good. If this situation happens to prevail, the model ends up exhibiting features of a specific factor model, owing to the restrictions on the freedom of some entrepreneurs of intermediate ability to cross sectors. These restrictions arise endogenously in the model: changes in relative factor returns will cause entry thresholds to change, allowing some (but not all) entrepreneurs to move across sectors.

Region A3: $\gamma_H = \gamma_L$

$\gamma_L = \gamma_H = \gamma$, say, implies that entrepreneurs are indifferent between the two sectors. The L-sector involves a higher entry requirement, as $a_L = m_L/\gamma > m_H/\gamma = a_H$. Hence agents with $a \in [a_H, a_L)$ have no option but to enter sector H as a middleman, while those with $a \geq a_L$ can enter either of the two sectors. The equilibrium in this case will involve a fraction of those with $a \geq a_L$ choosing to become middlemen in sector L, the remaining going to sector H. This fraction must be such as to permit the supplier market to clear. This in turn translates into an upper and lower bound for the common relative factor return γ, as shown in the proof of Lemma 2 of the Appendix.

This region involves equal relative factor returns across the two sectors, thus corresponding to a nonspecific factor setting. *The relationship between the relative factor returns is upward-sloping* (*in contrast to Region* A2)*: it coincides with part of the* 45 *degree line of equality in Figure* 1.

Region A4: $\gamma_H > \gamma_L$

$\gamma_H > \gamma_L$ implies that sector H is more profitable for middlemen. Also the entry threshold in sector H is lower. In this case nobody wants to be a middleman in sector L. Those with ability $a \geq a_H$ enter sector H, the rest become suppliers. Here the economy specializes in production of the H-good.

These four regions exhaust the different possibilities under Case A. Figure 1 shows the relationship between relative factor returns in the two sectors consistent with clearing of the factor market in Case A. For future reference, we shall denote this relationship by the equation

$$\gamma_L = \psi(\gamma_H). \tag{10}$$

It can be checked (see the detailed proof of Lemma 2 presented in the Appendix) that this function depends on parameters μ, m_L, m_H but is independent of p_L. This function is well defined for $\gamma_H < \gamma_H^3$, and is not a monotone relationship: it is decreasing below γ_H^2 but increasing thereafter. The downward-sloping part corresponding to Region A2 is the "nonclassical" region where relative factor returns are not equalized across sectors. The upward-sloping part corresponding to Region A3 coincides with the line of equality, so this is the "classical" region where relative factor returns are equalized. The greater the relative severity m_L/m_H of the moral hazard problem in the L-sector, the greater the range occupied by the nonclassical region.

Case C: $\gamma_H = \gamma_L$

The analysis for this case is obtained upon considering the analysis of Case A and taking the limit of m_L as it approaches m_H from above. The region covered by Region A2 then disappears. If the economy produces both goods, factor returns must lie entirely in Region A3, and relative returns to middlemen must be equalized between the two sectors.

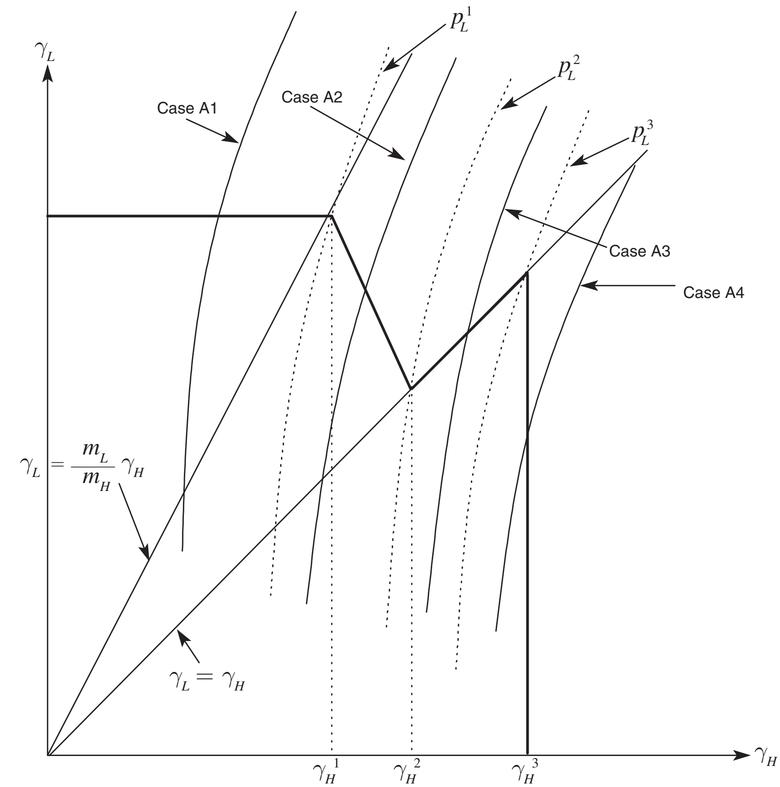

Figure 2. Factor Market Equilibrium: Case A

B. *Factor Market Equilibrium*

We are now in a position to characterize the factor market equilibrium for any given p_L, by putting together the condition that the supplier market clears (which incorporates reputation effects, occupational and sectoral choices by entrepreneurs), with the relation between prices and costs representing profit maximization by active middlemen in each sector.

The former is represented by the relation between relative factor returns that clears the factor market. The latter is represented by the upward-sloping relation (6) between relative factor returns in the two sector for any given product price p_L. Geometrically it is represented by the intersection of the corresponding relations between the two sets of relative factor returns. This is shown in Figure 2 for different values of p_L.

LEMMA 2:

1. *For any given $p_L > 0$, a factor market equilibrium exists and is unique.*

2. *In Case A where $m_L > m_H$, there exist thresholds $p_L^1 > p_L^2 > p_L^3$ such that:*

   (i) *Below p_L^3 the economy specializes in producing good H while above p_L^1 it specializes in good L. Between p_L^1 and p_L^3 both goods are produced.*

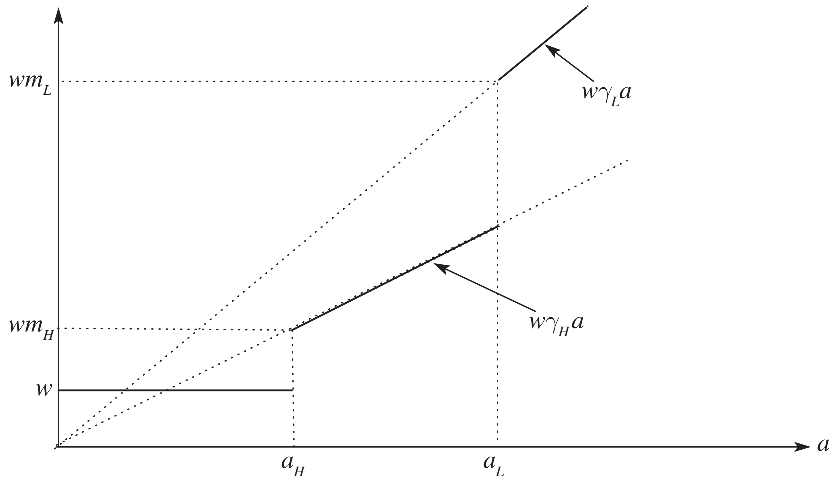

Figure 3. Income Distribution across Agents with Varying Abilities: Region A2 Equilibrium

(*ii*) *When* p_L *is between* p_L^2 *and* p_L^3, *relative factor returns are equalized in the two sectors* (*i.e.*, *the equilibrium lies in Region* $A3$).

(*iii*) *When* p_L *is between* p_L^1 *and* p_L^2, *the relative return of middlemen is strictly higher in the L-sector* (*i.e.*, *the equilibrium lies in Region* $A2$).

3. *In Case C where* $m_L = m_H$, *the preceding results obtain except that* $p_L^1 = p_L^2$, *so* (*iii*) *does not apply and the equilibrium lies in Region* $A3$ *whenever both goods are produced.*

Existence follows from the need for the price-cost relation (6) to intersect the factor-market clearing relationship at least once, while uniqueness follows from the steepness property of the former relation established in Lemma 1. The rest of the results in Lemma 2 follow straightforwardly from the description of the factor-market clearing condition.

The distribution of earnings across agents with varying abilities in the case where the equilibrium lies in Region A2 is illustrated in Figure 3. Agents with ability below the entry threshold a_H for the H-sector are suppliers who earn w. Between the thresholds a_H and a_L for the two sectors, the agents are H-sector middlemen, earning $\gamma_H wa$. By definition of the threshold $a_H = m_H/\gamma_H$, it follows that the earning of a H-sector middleman at this threshold equals wm_H, which strictly exceeds w as $m_H > 1$. Hence there is a discrete upward jump in earnings at this ability threshold for entrepreneurship. There is a similar discrete upward jump in earnings at the threshold a_L for entry of middlemen into the L-sector, owing to the difference in relative factor returns between the two sectors. The highest incomes accrue to middlemen in the L-sector, who manage the largest businesses in the economy. They are followed by H-sector middlemen, who manage smaller businesses, and finally suppliers who work as producers in both sectors.

C. *Comparative Static Properties of the Factor Market Equilibrium: Validity of the Stolper-Samuelson Result*

We are now in a position to consider the first key question of the paper: when does the Stolper-Samuelson relation hold? Specifically, what are the implications of changing product prices on relative returns to different factors? We focus on cases corresponding to lack of complete specialization in either good, i.e., where p_L lies between p_L^1 and p_L^3.

PROPOSITION 1:

(*i*) *If the factor market equilibrium is in Region A2 (where middlemen earn more relative to suppliers in the L-good sector compared with the H-good sector), a small increase in p_L will raise the earnings of middlemen relative to producers in the L-sector, and lower it in the H-sector.*

(*ii*) *If the equilibrium is in Region A3 with equal relative factor returns in the two sectors, a small increase in p_L will lower the relative return of middlemen equally in both sectors.*

Part (i) shows that the Stolper-Samuelson result is reversed in the "nonclassical" region where relative returns of middlemen are unequal, while it continues to hold in the classical region where they are equal. The relation between output price p_L and relative returns in the two sectors is illustrated in Figure 4. Focusing on the former region, it is evident that a rise in p_L shifts the relation between γ_L and γ_H characterizing price-cost equality in the two sectors to the left. Since the relation between them characterizing the factor market clearing condition is downward-sloping in Region A2, it follows that the relative return earned by middlemen must rise in L-sector and fall in H-sector. The price-cost relations (4, 5) then imply that both w and p_L/w rise. Hence the earnings of suppliers expressed in units of the H-good rises, but expressed in units of the L-good falls.[9]

The intuitive explanation of the increase in inequality within the L-sector is the following. The increase in p_L induces initially a rise in profitability of the L-sector, lowering entry thresholds into the L-sector, which allows some middlemen to move from the H to the L-sector. This increases demand for suppliers, for two reasons: (a) the L-sector employs more suppliers than the H-sector at any given set of factor prices, and (b) each L-sector middleman contracts with more suppliers as a result of the rise in p_L. The resulting upward pressure on the earnings of suppliers tends to reduce the earnings of middlemen relative to suppliers in both sectors. The drop in H-sector middleman profits will cause the demand for suppliers to slacken, as some low-ability H-sector middlemen will exit and become suppliers, and in addition each H-sector middleman contracts with fewer suppliers following the change in factor prices. The decline in earnings of L-sector middlemen caused by increased earnings of suppliers cannot, however, reverse the initial increase caused by the

[9] The effect on utility of suppliers thus depends on relative preferences in their consumption for the two goods: if biased in favor of the L-good sufficiently, they will be worse off.

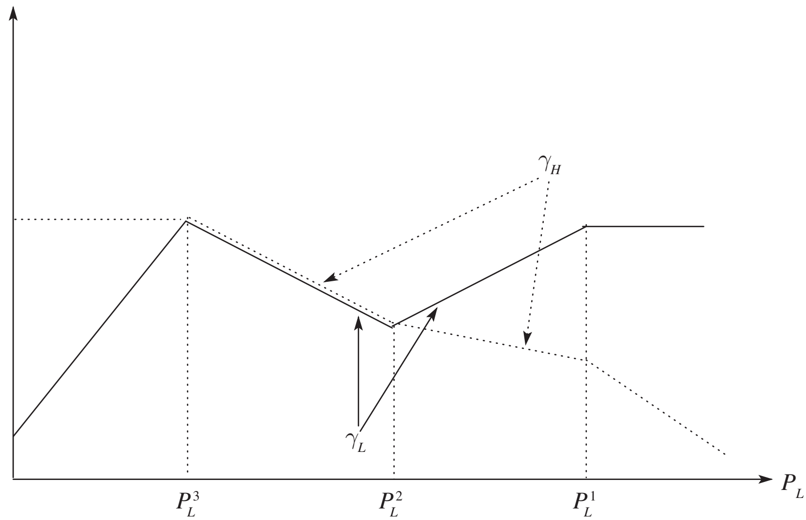

Figure 4. Effect of Changes in p_L on Relative Factor Returns

increase in the product price. Otherwise, a lower γ_L would slacken the demand for suppliers, accentuating the effect of the decline in γ_H. For the supplier market to clear, γ_L must rise.

The result resembles that in an exogenous specific factor model, where factors cannot move across sectors. However, a key difference is that in our model entrepreneurs move between sectors in response to output price changes, as observed empirically in the Ugandan and Mozambique contexts cited in the introduction. The newly entering middlemen are of lower skill than incumbents in the sector: for them to be able to function in the L-sector while meeting the moral hazard constraint, middlemen returns must rise relative to supplier earnings, since the latter serves as the punishment payoff associated with a loss of reputation.

The other difference from an exogenous specific factor model is that the Stolper-Samuelson result holds in the classical region where factor returns are equalized across sectors. In Case C with equal moral hazard across sectors, this applies to any equilibrium where both goods are produced. In this region there are no effective mobility barriers. The relation between relative factor returns in the two sectors consistent with supplier market clearing is upward-sloping; hence a leftward shift in the relation between relative factor returns consistent with price-cost equality implies that the relative earnings of middlemen must fall in both sectors. The logic is similar to that in the mobile-factor version of the Heckscher-Ohlin model, arising from the ability of (some) entrepreneurs to move freely between sectors. Entrepreneurs with skill above the threshold for the L-sector are indifferent between operating in the L and H sectors. A positive fraction of them are already operating in either sector. Hence, it is possible for a subset of these high-ability entrepreneurs to move into the L-sector out of the H-sector, without any change in the entry thresholds for sector L. Changes in relative earnings of middlemen result from a rise in supplier earnings, which owes to the shift of entrepreneurs into the L-sector, which generates higher demand for suppliers. Relative earnings of middlemen go down in step in both sectors.

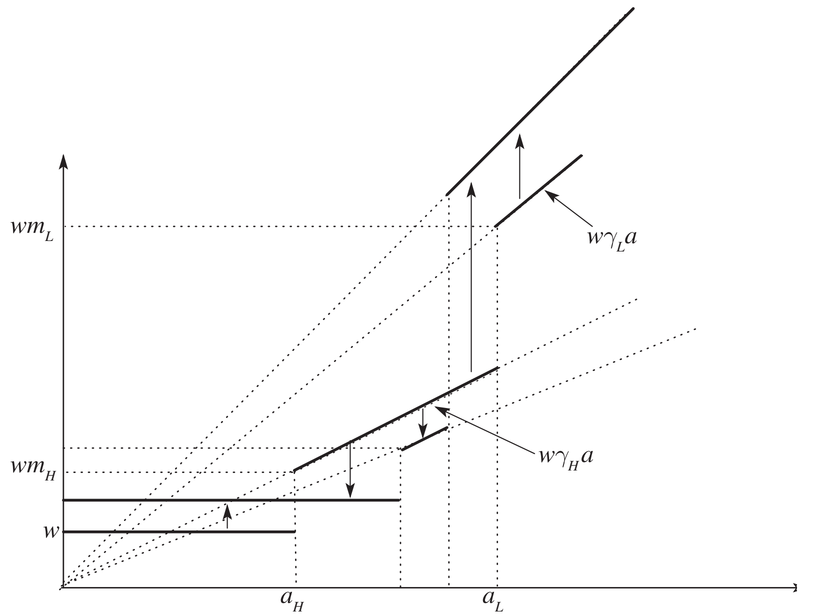

FIGURE 5. INCOME DISTRIBUTION CHANGES RESULTING FROM INCREASE IN $p_L \in (p_L^2, p_L^1)$

The detailed distributional effects of a rise in p_L in the anti-Stolper-Samuelson Region A2 are illustrated in Figure 5. This shows the distribution of earnings across agents with varying abilities, and how it changes as a result of an increase in p_L. There is a rise in incomes at the top (L-sector middlemen) and the bottom (suppliers), and a fall in incomes in the middle (H-sector middlemen). Within the L-sector, inequality in earnings between middlemen and producers rises. On the other hand inequality falls within the H-sector.

The output and distributive impact of a rise in p_L depend on induced entry and exit effects of middlemen, which in turn depends on the local behavior of the ability distribution. To illustrate this, consider the limiting case of a Leontief technology where we can ignore changes in factor proportions within any sector owing to changes in factor prices.

PROPOSITION 2: *Suppose the production function in each sector i exhibits perfect complementarity:* $X_i = \min\{n_i/\theta_n^i,\ a/\theta_a^i\}$ *for the high-quality good, and* $X_i = \min\{n_i/\theta_n^i,\ z_i a/\theta_a^i\}$ *for the low-quality good. Suppose also that the equilibrium is in Region A2. Then a small increase in* p_L *results in:*

(*i*) *no change in producer earnings w or outputs* X_L, X_H *in either sector, while* γ_L *rises and* γ_H *remains constant, if* $g(m_L/\gamma_L) = 0$ *and* $g(m_H/\gamma_H) > 0$.

(*ii*) *no change in* γ_L *or outputs* X_L, X_H *in either sector, while w rises and* γ_H *falls, if* $g(m_H/\gamma_H) = 0$ *and* $g(m_L/\gamma_L) > 0$.

This shows that relative rates of entry into the H and L-sectors (which depend on relative densities at the corresponding thresholds) influence effects on outputs and the distribution of benefits between middlemen and producers. When any one of the densities is zero, there will be no output effects at all. In case (i) there is no entry of middlemen into the L-sector following a rise in γ_L owing to "thinness" of the ability distribution at the threshold m_L/γ_L. Hence, changes in p_L will be associated with a zero output response, and none of the benefits of the rise in p_L are passed on to suppliers. In case (ii) by contrast, γ_L does not change at all while w rises, implying that both middlemen and suppliers gain equally. The failure of γ_L to change implies there is no entry into the L-sector. And a zero density at the entry threshold for the H sector implies that the rise in producer earnings does not lead to any exit of middlemen out of the H-sector into the category of suppliers. It follows that output effects of trade integration result only when densities at the corresponding entry thresholds are strictly positive in both sectors.

D. *Effect of Changes in Ability Endowment on Factor Market Equilibrium: Validity of the Rybczynski Result*

We now examine how comparative advantage varies with relative factor endowments. This is the issue addressed by the Rybczynski Theorem in classical trade theory.

Consider the effect of an increase in μ, the proportion of agents in the economy with skills. As shown in Figure 6, the $\gamma_L - \gamma_H$ frontier corresponding to the factor market-clearing condition (10) shifts inwards, owing to the resulting tightening of demand for suppliers. Excepting the case that $\gamma_H = \gamma_L$ is maintained before and after the change in μ, both γ_L and γ_H fall. What is the effect on the ratio X_L/X_H?

Since the H-good is more intensive in its use of management services, one would intuitively expect an increase in entrepreneurial ability endowment in the economy to raise the production of H relative to the L-good, as predicted by the Rybczynski theorem. This is indeed true in the "classical" Region A3. From equation (6), which is independent of μ, it is evident that a rise in μ leaves the relative returns to the two factors unchanged. Hence, the entry thresholds into the two sectors and the demand for suppliers from each active entrepreneur of the same ability are unaffected. Since the L-sector uses management services less intensively, it follows that the production of the L-good must fall, in order to allow the factor market to clear.

In the "nonclassical" Region A2, there will be an additional effect of a change in μ on relative factor returns in the two sectors. An increase in μ increases excess demand for suppliers, which tends to increase the earnings of producers. Since the L-sector uses management services less intensively, this tends to lower the relative return earned by middlemen in the L-sector by more than in the H-sector. However, the ratio γ_L/γ_H may still go up, if it was high enough to start with.[10] In that case, we obtain a countervailing effect which can raise X_L/X_H.

[10] Specifically, the tighter market for suppliers tends to lower γ_H, and the effect on the ratio γ_L/γ_H of a change in γ_H is

$$\frac{d\left(\frac{\gamma_L}{\gamma_H}\right)}{d\gamma_H} = \frac{1}{\gamma_H}\left[\frac{d\gamma_L}{d\gamma_H} - \frac{\gamma_L}{\gamma_H}\right],$$

which is negative if $d\gamma_L/d\gamma_H < \gamma_L/\gamma_H$, i.e., the initial value of the relative middleman return across the two sectors is high enough.

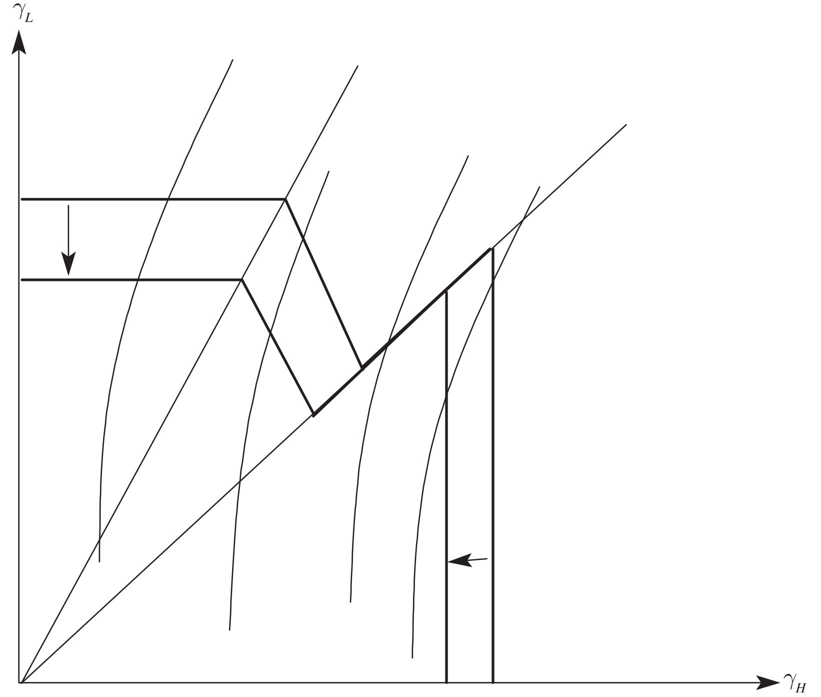

Figure 6. Effect of Increase in μ on Factor Market Equilibrium

To see this concretely, we consider the following example, where the density of the ability distribution does not fall too fast, and the production functions for both sectors have constant and equal elasticity of substitution.

PROPOSITION 3: *Assume that $a^2 g(a)/d(a)$ is increasing in a and production function for $i = L, H$ exhibit constant, equal elasticity of substitution $\kappa(\geq 0)$:*

$$X_i = F_i(n_i, a_i) = \left(k_i^{1/\kappa} a_i^{\frac{\kappa-1}{\kappa}} + n_i^{\frac{\kappa-1}{\kappa}}\right)^{\frac{\kappa}{\kappa-1}} \tag{11}$$

with $k_H > k_L$ (to ensure Assumption 1 is satisfied). Then in the factor market equilibrium:

(*i*) *If $\kappa \geq 1 - \log[k_H/k_L]/\log[m_L/m_H]$, an increase in μ has the effect of decreasing X_L/X_H for any $p_L \in (p_L^3, p_L^1)$.*

(*ii*) *If $0 \leq \kappa < 1 - \log[k_H/k_L]/\log[m_L/m_H]$, the increase in μ has the effect of reducing X_L/X_H for any $p \in (p_L^3, 1)$. Moreover, there exists $\overline{p}_L \in (1, p_L^1)$ such that X_L/X_H is increasing in μ for any $p > \overline{p}_L$.*

The Proposition shows that X_L/X_H falls if the elasticity of substitution is large (case (i)) and otherwise for values of p_L below 1, but not for values of p_L close

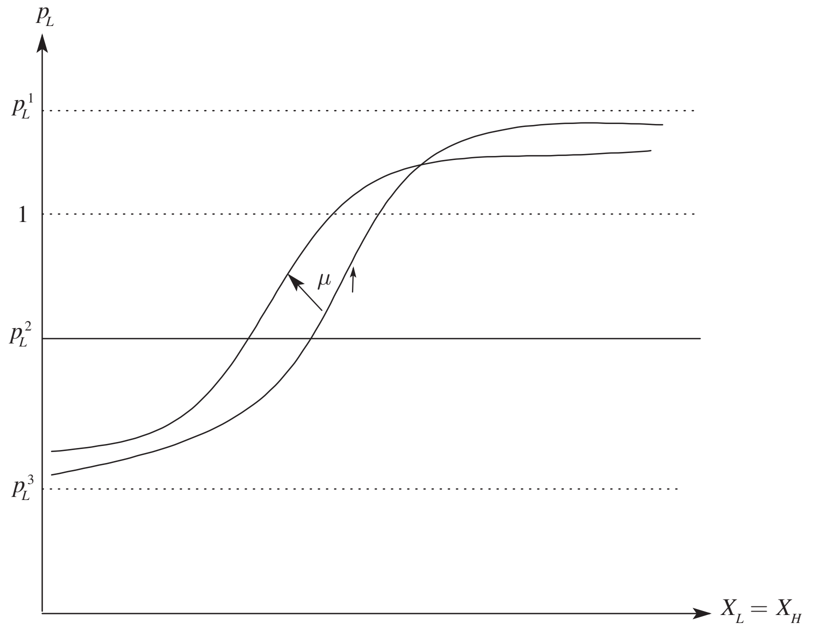

Figure 7. Effect of Increase in μ on $\frac{X_L}{X_H}$ in Factor Market Equilibrium

enough to p_L^1. In the latter case, the return earned by middlemen relative to producers in the L-sector is sufficiently high to start with that it increases as a result of the increase in the economy's endowment of entrepreneurial ability. This is strong enough to cause the relative production of good L to rise. Figure 7 provides an illustration of the effect on X_L/X_H. In the context of the open economy, this will provide an instance where the Leontief paradox appears, if a North and South country differ only in their ability endowments.

III. Economy-Wide Equilibrium

A. *Autarkic Economy*

We start by considering an economy which is closed to trade, as a prelude to the analysis of open economies.

We close the model of the autarkic economy by specifying the demand side. There is a representative consumer with a homothetic utility function $U = U(D_H, D_L)$, where D_H, D_L denote consumption of the two goods. The relative demand function is then given by

$$D_L/D_H = \phi(p_L),$$

where $\phi(p_L)$ is continuous and strictly decreasing in p_L. We assume that $\lim_{p_L \to 0} \phi(p_L) = \infty$ and $\lim_{p_L \to \infty} \phi(p_L) = 0$.

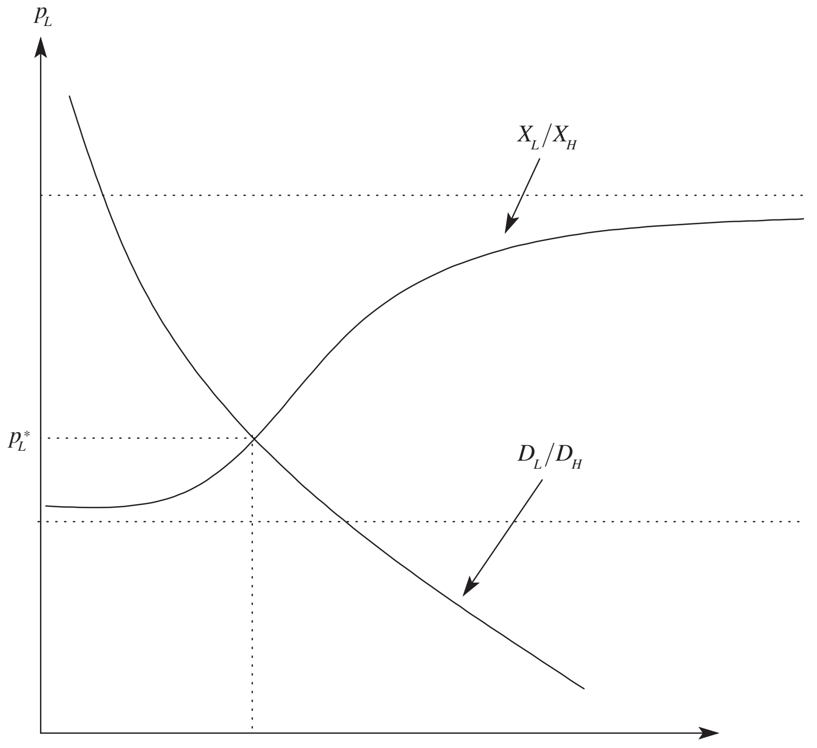

Figure 8. Autarkic Equilibrium

The economy-wide equilibrium is represented by equality of relative supply and relative demand:

$$D_L/D_H = \phi(p_L) = X_L/X_H, \tag{12}$$

where the dependence of relative supply X_L/X_H on p_L is provided by the factor market equilibrium described in the previous section.

LEMMA 3: *An autarkic equilibrium always exists, and is unique. It must satisfy* $p_L \in (p_L^3, p_L^1)$.

This follows from the fact that relative demand is continuous and strictly decreasing in p_L.[11] An autarky equilibrium $(p_L, \gamma_L, \gamma_H, w)$ is characterized by conditions of profit-maximization (4), (5); the factor market clearing condition (10), and the product-market clearing condition (12). It is illustrated in Figure 8.

[11] Relative supply is well defined (owing to uniqueness of the factor market equilibrium) for $p_L \in (p_L^3, p_L^1)$, and over this range is continuous and strictly increasing in p_L. Moreover, as p_L tends to p_L^3, relative supply of the L-good tends to 0 while relative demand is bounded away from zero. And as p_L tends to p_L^1, relative supply of L tends to ∞, while relative demand is bounded.

Now consider the effect on the autarky equilibrium of increasing μ, which will be helpful in determining patterns of comparative advantage when we extend the model to an open economy setting. While the effects of varying μ on X_L/X_H in the factor market equilibrium were seen above to be quite complicated, it turns out that the distributional effect on the autarkic equilibrium is quite simple: inequality within both sectors fall.

LEMMA 4: *A small increase in skill endowment μ lowers earnings of middlemen relative to suppliers in both sectors, while w and w/p_L both rise.*

B. *Free Trade Equilibrium and Lack of Factor Price Equalization*

Suppose there are two countries South S and North N, the former corresponding to the less developed country. They are identical in all respects, except that country N has a higher μ the proportion of skilled agents $\left(\mu^S < \mu^N\right)$. Lemma 4 then implies that in autarky middlemen earn less relative to suppliers in the North in both sectors.

In a free trade equilibrium (with zero transport costs), there will be a common equilibrium price p_L^T in the two countries, determined by

$$\frac{D_L^S + D_L^N}{D_H^S + D_H^N} = \frac{X_L^S + X_L^N}{X_H^S + X_H^N}, \tag{13}$$

where both relative demand and supplies in each country will depend on the common price. Once p_L^T is determined, the respective factor market equilibria of each country will determine the remaining variables in each country.

If the South has a comparative advantage in the L-good, trade integration will induce a rise in p_L in the South, with distributive effects as described in Proposition 1. If relative factor earnings differ across sectors, relative returns of middlemen will rise within the L-sector and fall in the H-sector in the South, and the opposite happens in the North. Hence *the initial gap in inequality in the L-sector across the two countries will be accentuated*, *while that in the H-sector will shrink.* On the other hand, if both countries are operating in the classical region with equal factor returns in the L- and H-sectors, they will decline in the South and rise in the North: in this case factor prices tend to equalize.

We summarize these results below.

PROPOSITION 4: *Suppose the South has a comparative advantage in the L-good.*

(*i*) *If factor returns differ across sectors* (*i.e.*, *Region A*2 *applies*) *within both countries under autarky and trade integration*, *the gap between inequality in the L-sector across the two countries grows while the gap between inequality in the H-sector narrows as a result of trade integration. In this case, free trade must be associated with unequal factor returns in each sector across countries.*

(*ii*) *If factor returns are equal across the two sectors* (*i.e.*, *Region A*3 *applies*) *under autarky and trade integration in both countries*, *the gap between* *inequality of earnings within either sector across countries narrows as a result of trade integration. In this case, free trade must be associated with equalization of factor returns across countries.*

C. *Offshoring*

If middlemen in the North earn less relative to producers as a result of failure of factor prices to equalize with trade, northern middlemen will have an incentive to offshore production to the South. The incentive to offshore can be measured by the difference in profits between the two countries earned by a middleman of given ability.[12] Our preceding results imply that trade integration will cause the incentive for North-South offshoring in the L-sector to go up, and in the H-sector to go down, when Region A2 applies and the South has a comparative advantage in the L-good.[13] Hence, our model predicts complementarity between trade integration and North-South offshoring in the L-sector, and substitutability in the H-sector.

We now examine the equilibrium implications of this type of offshoring, when there are zero costs to offshore, in addition to free trade in goods. The following proposition shows that the resulting equilibrium is identical to that in the completely integrated economy with $\mu^G \equiv \left(\mu^S + \mu^N\right)/2$, with factor prices equal across the two economies.

PROPOSITION 5: *With free trade and costless offshoring, the equilibrium is equivalent to that in the completely integrated economy with μ^G proportion of skilled agents. In this equilibrium, relative earnings of middlemen in each sector are equalized across countries. If the southern country has comparative advantage in the L-good under autarky, complete integration relative to autarky causes relative earnings of middlemen to fall (respectively rise) in each sector in the South (respectively North).*

In the integrated equilibrium, the absence of any trade or offshoring costs implies that entrepreneurs are indifferent which country to locate their operations. This implies that the structure of trade is indeterminate. This indeterminacy would be resolved in the presence of small trading and offshoring costs. Since the North has a higher endowment of entrepreneurial ability, net outsourcing from the North must be larger.

Proposition 5 indicates that *the distributional effect of full integration differs sharply from trade integration when the latter is associated with factor price disequalization.* If the South operates in Region A2 under autarky, trade integration

[12] Without loss of generality, a northern middleman producing in the South will sell in southern markets. This is obvious if transport costs are high enough to render trade unprofitable. If transport costs are low enough to generate trade, the difference in prices of any good across countries will equal the transport cost, implying that entrepreneurs will be indifferent between selling in either country.

[13] We have shown in this case that the South-North difference in inequality within the L-sector rises and the H-sector falls, as a result of trade integration. It is easy to check that the same property holds for the difference in profits in each sector: e.g., profits in sector L per unit of ability equals $\gamma_L w = \gamma_L/\left(\theta_n^H + \gamma_H \theta_a^H\right)$, using the price-cost relation (5) for the H sector. It follows that profits rise in the South because γ_L rises while γ_H falls. Conversely profits fall in the North as γ_L falls and γ_H rises.

raises the relative earnings of middlemen in the L-sector while complete integration lowers it. The reason is that in Region A2 there are restrictions on entry of middlemen into sector L, who must come from the pool of southern entrepreneurs. These entry restrictions are relaxed under trade integration only if the relative earnings of middlemen in this sector increases. With complete integration on the other hand, high-ability entrepreneurs from the North can enter the L-sector in the South. So relative middleman returns in the southern L-sector do not have to rise to induce this entry. The fact that middlemen earn more in the South motivates northern entrepreneurs to offshore operations to the South, which drives down middleman earnings in the South.

IV. Related Literature

A. *Related Empirical Evidence*

Berges and Casellas (2006) provide evidence from Argentinian consumer surveys showing the greater importance of brand names compared with labels, seals, and certification in consumer perceptions of food quality. Roth and Romeo (1992); Chiang and Masson (1988) describe the role of reputations of countries-of-origin in consumer perceptions. Rauch (2001) provides a survey of evidence concerning the role of social and business networks in trade, and intermediaries that arise in the absence of such networks. Banerjee and Duflo (2000), Dalton and Goksel (2011), and Macchiavello (2010) test models of reputation formation and their role in exports of Indian software, of cars to the United States, and Chilean wines to the United Kingdom, respectively. Hudson and Jones (2003) discuss problems faced by developing countries in signalling their quality to export markets, owing to the kinds of goods they specialize in, and lower rates of ISO-9000 certification.

Relatively little direct evidence is available concerning how product quality moral hazard problems vary across different categories of goods. Scandals over safety of Chinese exports of farm goods and toys have erupted in recent years, highlighting quality concerns for less skill-intensive goods exported from developing countries. Using data spanning a large number of countries, Hudson and Jones (2003) show ISO-9000 certification rates are highest in electrical and optical equipment, basic metal and fabricated metal products, machinery and equipment sectors. Conversely, agriculture and farm products, textiles, wood and pharmaceuticals have the lowest accreditation rates. Accreditation take up rates are also lowest in less developed countries. In a similar vein, Dobrescu and Schweiger (2008, table 1) shows that 14 percent of Slovenian manufacturing exporting firms in textiles/tobacco, wearing apparel, leather/shoes, and wood between 1995–2005 had ISO certification, compared with 36 percent in more capital intensive sectors (chemicals, rubber, machinery, communication equipment, instruments, and motor vehicles). However, these facts are only suggestive of the relative extent of moral hazard problems in different sectors, since direct evidence concerning this is intrinsically difficult to obtain.

An alternative is to examine the extent to which the ratio of middleman margins to retail prices vary across sectors, as our theory indicates this to be a key determinant of whether classical trade theory results are valid. Arndt et al. (2000) provide evidence of high middleman margin rates in agriculture, food processing, textiles, and leather in Mozambique ranging from 36 percent to 111 percent. In contrast these ranged between 11 and 26 percent in machinery, metals, fuels and chemicals, paper, wood, and mining. Nicita (2004) finds substantially lower rates of pass-through of border prices to producer prices in the case of cereals (32 percent), fruits (22 percent), vegetables (14 percent), oils and fats (22 percent), and sugar (26 percent), compared with manufactured goods (67 percent), textiles and apparel (54 percent). These suggest that middlemen margins are substantially higher in less skill intensive goods which are typically exported from South to North. However, most of these do not adjust for transport, storage, and distribution costs which tend to be higher for farm goods produced in remote areas. Nor do they adjust for risks borne by middlemen owing to price volatility, or quality defects in procured farm goods.

Corrections for transport and storage costs are made by Fafchamps and Hill (2008) in their study of gaps between border and farmgate prices for coffee in Uganda. Using monthly data they show only a small fraction of increases in export prices during 2002–03 was passed on to coffee farmers, and that the rising shares of middlemen could not be explained by accompanying changes in transport or storage costs. Instead, the main explanation they advance is consistent with the predictions of our theory: rising demand for coffee exports induced entry of a less efficient set of middlemen. Similar findings are reported by McMillan, Rodrik, and Welch (2003) in the context of rising trader margins for cashews in Mozambique during the 1990s: a falling ratio of farmgate to export prices was accompanied by an increase in the number of traders, especially informal unlicensed traders buying in smaller quantities directly from farmers' homes.

B. *Related Models*

Antràs and Costinot (2010, 2011) and Chau, Goto, and Kanbur (2010) develop similar models of middlemen margins based on an alternative model of search. These models assume that producers cannot sell to consumers directly, and must search for middlemen who can. These models are more appropriate for matching and trade in anonymous markets, rather than contexts involving repeat transactions and long-term supplier relationships. The allocation of bargaining power between producers and middlemen in these theories depends on the relative number of agents on either side of the market. The number of active middlemen is either exogenous, in which case trade liberalization has no effect on intrasector inequality. Alternatively, the number of active middlemen is endogenously determined by a free entry condition, where middlemen exercise market power and must earn margins to cover their fixed costs. In this case trade liberalization results in increasing entry of middlemen into the export sector which lowers their bargaining power, implying that the share of middlemen declines as border prices rise. This is opposite to what our model predicts, and contrary to the evidence in Fafchamps and Hill (2008) or McMillan, Rodrik, and Welch (2003). Moreover, Antràs and Costinot (2010, 2011) show effects of offshoring by northern traders may render southern producers worse off, if the bargaining power of the former is large enough. This is in contrast to our model where offshoring always makes southern producers better off. A common prediction, on the other hand, is that southern traders will be worse off as a result of offshoring. Clearly, models based respectively on search and on reputations have different implications for distributive effects of integration. This implies there is scope for using empirical evidence to discriminate among them, an important task for future research.

Similar to many recent trade models and consistent with empirical evidence (e.g., see the survey by Harrison, McLaren, and McMillan 2011), our model predicts southern entrepreneurs locating in the export sector are of higher ability than other entrepreneurs, and earn correspondingly more. An obvious extension of our model wherein reputations depend not just on the product characteristics but also the markets in which they are sold—specifically, where international reputations are harder to build than domestic ones—would imply that the productivity thresholds for exporting would be higher than for domestic production in *all* countries, not just in the South. In such a context, trade integration would generally raise inequality between exporting and nonexporting firms. In this respect our approach is similar to Helpman, Itskhoki, and Redding (2010), in which trade liberalization may raise inequality by inducing high productivity firms to search more intensively for high-ability workers.

In a similar vein, Costinot and Vogel (2010) model matching between heterogeneous productive tasks and workers of heterogeneous abilities. However their analysis generates generalized Stolper-Samuelson predictions when the source of trade is differences in factor endowments across countries. Matsuyama (2007) provides an alternative approach wherein the activity of exporting—involving transport, finance, marketing, and communication—is itself more skill-intensive than production. A rise in export activities owing to improved technology of transport or communication can then end up increasing the demand for skilled workers, and eventually the skill premium. Verhoogen (2008) provides an alternative theory and supporting empirical evidence that cars marketed in the United States are of higher quality than those in Mexico (owing to nonhomothetic preferences), whence increased exports of Mexican-produced cars to the United States following an exchange rate devaluation of the Mexican peso generated higher demand and relative wages of skilled Mexican workers. Zhu and Trefler (2005) provide evidence with a cross-country panel wherein the rise in skill premia across middle income and developing countries was positively correlated with a shift in export shares towards more skill-intensive goods. All these approaches stress the correlation between firm productivity and export activities, which generates rising inequality as an outcome of trade integration. This feature is shared by our approach, though it operates through a different (reputational) mechanism.

Other trade models with endogenous sorting of agents of heterogeneous abilities into different sectors include Mussa (1982); Matsuyama (1992); Ohnsorge and Trefler (2007); and Grossman (2004). Our theory differs in one important qualitative respect from all of these models: there is a discontinuous rise in profits of entrepreneurs at the thresholds for entry into each sector in our theory, while agent returns vary continuously with ability in the latter.

Differences between effects of trade integration and offshoring have been stressed by a number of recent papers, for reasons quite different from those in this paper. Feenstra and Hanson (1996) pioneered the literature on offsourcing and inequality, showing how inequality could rise in both North and South as a consequence of offshoring low-skill tasks in the North to the South where these are relatively high-skilled. Such a mechanism relies on heterogeneity of production worker skills, something our model abstracts from. In a model with a continuum of worker skills, Grossman and Rossi-Hansberg (2008) elaborate how offshoring can benefit domestic workers via employer cost-savings through better matching, that are passed on to workers in a competitive labor market. Antràs, Garicano, and Rossi-Hansberg (2006); Kremer and Maskin (2006) study related models in which agents of heterogeneous abilities sort into hierarchical teams. Inequality rises in the South in these models owing to the matching of high-ability agents in the South with worker teams from the North. Karabay and McLaren (2010) examine effects on risk and long term employer-employee contracting that coexist with spot markets. Our theory abstracts from risk considerations, or the possibility of some production tasks within any given sector being offshored while others are not. Instead, we emphasize how offshoring and trade integration may have opposite effects on inequality between entrepreneurs and workers, owing to differences in the associated entry patterns and pools of potential entrepreneurs that can enter any given sector.

Wynne (2005); Antràs and Caballero (2009, 2010) present trade models with financial frictions which affect production of one good more than another, with North countries less subject to financial frictions than South countries. Our model is based instead on frictions arising from quality moral hazard which affect different goods in different ways, where the nature of the moral hazard problem is assumed to be the same between North and South. These give rise to some features which are similar, though there are many differences in the detailed way in which these appear. Other shared features include the possibility of a Leontief paradox, complementarity between trade and capital flows, and the role of wealth distributions.

V. Concluding Comments

We have constructed a general equilibrium model of trade based on middlemen margins which arise endogenously to provide incentives to maintain product quality reputations. Entry thresholds, occupational and sectoral choices of agents are endogenously determined in an otherwise fully competitive model. The allocation of agents between production work and entrepreneurship is explained by their underlying endowment of entrepreneurial ability. In particular, the model explains why producers cannot directly sell to consumers—their lack of a credible reputation for quality—and must sell to intermediaries instead, those who have the requisite reputation.

If the severity of moral hazard problem differs markedly between different goods, middleman earnings relative to producer earnings must also vary in a corresponding way. The lack of equalization of relative factor returns is associated with restrictions on movement of middlemen across sectors, and the distributive effects of trade liberalization end up resembling a Ricardo-Viner specific factor model. Otherwise, there is enough intersectoral mobility to ensure that classical results of the mobile factor Heckscher-Ohlin model results obtain. Empirical evidence from some African countries where rising export prices were accompanied by rising gaps between export and farmgate prices are consistent with the predictions of the model, suggesting the need for fuller empirical testing of the model in future research.

The model explains incentives for northern countries to offshore their production to southern countries, and predicts the distributive implications of such offshoring to be the opposite of trade liberalization. Pass-through and output responsiveness to trade liberalization depends on underlying distribution of entrepreneurial ability which determines responsiveness of entry into middlemen businesses in response to increasing profit margins. The model suggests that policies encouraging entry responsiveness, such as regulatory reforms, or development of entrepreneurial abilities can enhance growth and pro-poor effects of globalization.

We abstracted from the realistic possibility that reputations may be market or country-specific in addition to being commodity-specific. For instance it may be harder to maintain a reputation in international markets compared with domestic markets, owing to the role of information networks that underlie word-of-mouth reputations. Such a model would create higher productivity thresholds for exports compared with domestic sales for any given commodity, providing an alternative to a number of recent explanations for export "premium" in productivity and earnings. Yet another possible extension would involve country-specific reputation thresholds, owing to differences in product quality regulations or their enforcement across countries. Such a model could be useful in examining the general equilibrium implications of changes in regulatory policy. A rich research agenda lies ahead.

Appendix: Proofs

PROOF OF LEMMA 1:

Implicitly differentiating (6) we obtain

$$\frac{d\gamma_L}{d\gamma_H} = p_L \frac{\theta_a^H}{\theta_a^L} = \frac{\theta_n^L + \gamma_L \theta_a^L}{\theta_n^H + \gamma_H \theta_a^H} \frac{\theta_a^H}{\theta_a^L} = \frac{\gamma_L + \dfrac{\theta_n^L}{\theta_a^L}}{\gamma_H + \dfrac{\theta_n^H}{\theta_a^H}} > 1,$$

with the second equality using (6), and the last inequality following from Assumption 1, $\gamma_L \geq \gamma_H$ and the fact that θ_n^L / θ_a^L is nondecreasing in γ_L.

PROOF OF LEMMA 2:

We start by writing the factor market clearing condition in various cases, which characterizes the relationship between relative factor returns in the two sectors, as well as the outputs in each sector.

Clearing of the factor market in Region A1 requires

$$\text{(A1)} \qquad \mu \left[\frac{\theta_n^L(\gamma_L)}{\theta_a^L(\gamma_L)} \right] d\left(\frac{m_L}{\gamma_L}\right) = \mu G\left(\frac{m_L}{\gamma_L}\right) + (1 - \mu).$$

The production levels will be $X_H = 0$, $X_L = \mu d\left(\frac{m_L}{\gamma_L}\right) / \theta_a^L(\gamma_L)$.

In Region A2 the corresponding condition is

$$\text{(A2)} \qquad \mu\left[\frac{\theta_n^L(\gamma_L)}{\theta_a^L(\gamma_L)}\right]d\left(\frac{m_L}{\gamma_L}\right) + \mu\left[\frac{\theta_n^H(\gamma_H)}{\theta_a^H(\gamma_H)}\right]\left[d\left(\frac{m_H}{\gamma_H}\right) - d\left(\frac{m_L}{\gamma_L}\right)\right]$$

$$= \mu G\left(\frac{m_H}{\gamma_H}\right) + (1 - \mu).$$

In this case, production levels are:

$$X_H = \mu[d(a_H) - d(a_L)]/\theta_a^H(\gamma_H)$$

$$X_L = \mu d(a_L)/\theta_a^L(\gamma_L).$$

In Region A3, the factor market clearing conditions are (denoting the production levels by X_L, X_H respectively)

$$\theta_n^L(\gamma)X_L + \theta_n^H(\gamma)X_H = \mu G(a_H) + (1 - \mu)$$

$$\theta_a^L(\gamma)X_L + \theta_a^H(\gamma)X_H = \mu d(a_H).$$

These equations are equivalent to

$$X_L = \frac{\theta_a^H(\gamma)[\mu G(a_H) + (1 - \mu)] - \theta_n^H(\gamma)\mu d(a_H)}{\theta_n^L(\gamma)\theta_a^H(\gamma) - \theta_n^H(\gamma)\theta_a^L(\gamma)}$$

$$X_H = \frac{-\theta_a^L(\gamma)[\mu G(a_H) + (1 - \mu)] + \theta_n^L(\gamma)\mu d(a_H)}{\theta_n^L(\gamma)\theta_a^H(\gamma) - \theta_n^H(\gamma)\theta_a^L(\gamma)}.$$

However, since only agents with $a \geq a_L$ have the option to become L-sector entrepreneurs,

$$X_L \leq \mu d(a_L)/\theta_a^L(\gamma),$$

which implies

$$\text{(A3)} \qquad \mu\left[\frac{\theta_n^L(\gamma)}{\theta_a^L(\gamma)}\right]d\left(\frac{m_L}{\gamma}\right) + \mu\left[\frac{\theta_n^H(\gamma)}{\theta_a^H(\gamma)}\right]\left[d\left(\frac{m_H}{\gamma}\right) - d\left(\frac{m_L}{\gamma}\right)\right]$$

$$\geq \mu G\left(\frac{m_H}{\gamma}\right) + (1 - \mu).$$

On the other hand, $X_L \geq 0$ implies

$$\text{(A4)} \qquad \mu\left[\frac{\theta_n^H(\gamma)}{\theta_a^H(\gamma)}\right]d\left(\frac{m_H}{\gamma}\right) \leq \mu G\left(\frac{m_H}{\gamma}\right) + (1 - \mu).$$

Inequalities (A3, A4) provide lower and upper bounds on the common γ. Note that (A3) is the inequality version of the factor market clearing condition (A2) in Region A2. Hence, the lower bound in Region A3 exactly equals the limiting relative factor returns in Region A2 as γ_L and γ_H approach each other (see Figure 1).

In Region A4, the factor market clearing condition is

$$\text{(A5)} \qquad \mu\left[\frac{\theta_n^H(\gamma_H)}{\theta_a^H(\gamma_H)}\right]d(a_H) = \mu G(a_H) + (1 - \mu).$$

The production levels are

$$X_L = 0$$

$$X_H = \mu d(a_H)/\theta_a^H(\gamma_H).$$

The entry thresholds depicted γ_H^1, γ_H^2, and γ_H^3 in Figure 1 are defined by the solutions to the following equations.

$$\mu\left[\frac{\theta_n^L\left(\frac{m_L}{m_H}\gamma_H^1\right)}{\theta_a^L\left(\frac{m_L}{m_H}\gamma_H^1\right)}\right]d(m_H/\gamma_H^1) = \mu G(m_H/\gamma_H^1) + (1 - \mu)$$

$$\mu\left[\frac{\theta_n^L(\gamma_H^2)}{\theta_a^L(\gamma_H^2)}\right]d(m_L/\gamma_H^2) + \mu\left[\frac{\theta_n^H(\gamma_H^2)}{\theta_a^H(\gamma_H^2)}\right]\left[d(m_H/\gamma_H^2) - d(m_L/\gamma_H^2)\right]$$

$$= \mu G(m_H/\gamma_H^2) + (1 - \mu).$$

$$\mu\left[\frac{\theta_n^H(\gamma_H^3)}{\theta_a^H(\gamma_H^3)}\right]d(m_H/\gamma_H^3) = \mu G(m_H/\gamma_H^3) + (1 - \mu).$$

The price thresholds which mark the transition between Regions A1, A2, A3, and A4 are calculated as follows:

$$p_L^1 = \frac{\theta_n^L\left(\frac{m_L}{m_H}\gamma_H^1\right) + \frac{m_L}{m_H}\gamma_H^1\theta_a^L\left(\frac{m_L}{m_H}\gamma_H^1\right)}{\theta_n^H(\gamma_H^1) + \gamma_H^1\theta_a^H(\gamma_H^1)}$$

$$p_L^2 = \frac{\theta_n^L(\gamma_H^2) + \gamma_H^2\theta_a^L(\gamma_H^2)}{\theta_n^H(\gamma_H^2) + \gamma_H^2\theta_a^H(\gamma_H^2)}$$

$$p_L^3 = \frac{\theta_n^L(\gamma_H^3) + \gamma_H^3\theta_a^L(\gamma_H^3)}{\theta_n^H(\gamma_H^3) + \gamma_H^3\theta_a^H(\gamma_H^3)}.$$

Now we are in a position to describe the factor market equilibrium, where the price-cost conditions characterizing profit maximization must be satisfied along with clearing of the supplier market. We consider the following price ranges A1, A2, A3, A4, and refer to Figure 1.

Region A1: $p_L \geq p_L^1$

In this case, there is an equilibrium with $\gamma_H \leq \gamma_H^1$, with complete specialization in product L, and production levels $X_L = \mu d(m_L/\gamma_L)/\theta_a^L(\gamma_L)$, $X_H = 0$. Since the price-cost relation (6) between γ_L and γ_H in the two sectors is upward-sloping, it is evident there cannot be any other equilibrium. In the interior of this range, equilibrium outputs are locally independent of p_L.

Region A2: $p_L^1 > p_L \geq p_L^2$

Here there is an equilibrium corresponding to the downward sloping stretch in the relation between γ_H and γ_L expressing factor market clearing. This follows from the fact that at p_L^1 there is an equilibrium corresponding to γ_H^1, and at p_L^2 there is an equilibrium corresponding to γ_H^2. Moreover, in this case there cannot be any other equilibrium owing to Lemma 1. For if there were another equilibrium, it would have to lie in the range $\gamma_H > \gamma_H^2$. But this would require the slope of the $\gamma_L - \gamma_H$ relationship expressing (6) to have a slope smaller than one somewhere above the 45 degree line, which is ruled out by Lemma 1.

In the interior of this range of prices, increasing p_L results in an increase in X_L and γ_L, and a decrease in X_H and γ_H.

Region A3: $p_L^2 > p_L \geq p_L^3$

Now there will be an equilibrium in which $\gamma_L = \gamma_H$. The same argument as in Region A2 ensures the equilibrium is unique. Note in particular that Lemma 1 ensures that the slope of the relation between γ_L and γ_H expressing (6) strictly exceeds unity even on the 45 degree line. Hence a tangency of this relation with the 45 degree line is ruled out. The equilibrium $\gamma_L = \gamma_H = \gamma^*$ is determined by the condition

$$p_L = \frac{\theta_n^L(\gamma^*) + \gamma^* \theta_a^L(\gamma^*)}{\theta_n^H(\gamma^*) + \gamma^* \theta_a^H(\gamma^*)}. \tag{A6}$$

It is evident that an increase in p_L will increase X_L, reduce X_H and the common γ^*. The latter results as the shift in production towards the L-sector raises the demand for suppliers, inducing a rise in w.

Region A4: $p_L < p_L^3$

In this case, there is a unique equilibrium with perfect specialization in sector H. The production level is $X_L = 0$ and

$$X_H = \mu d(a_H)/\theta_a^H(\gamma_H).$$

An increase in p_L in this region will raise γ_L, while leaving X_H, γ_H unchanged.

This concludes the proof of Lemma 2.

PROOF OF PROPOSITION 2:

With perfect complementarity in production, factor intensities within firms are independent of relative factor earnings in that sector. Moreover, $d(a)$ is locally constant if $g(a) = 0$. Then from the factor market clearing condition in Region A2, we obtain

$$d\gamma_L/d\gamma_H = -\frac{\left[\dfrac{\theta_n^H}{\theta_a^H} a_H + 1\right] a_H^2 g(a_H)\, m_L}{\left[\dfrac{\theta_n^L}{\theta_a^L} - \dfrac{\theta_n^H}{\theta_a^H}\right] a_L^3 g(a_L)\, m_H}.$$

This shows that γ_H and hence w do not change in case (i), while γ_L does not change in case (ii). The rise in γ_L in case (i) generates no entry into the L sector because $g(m_L/\gamma_L) = 0$. And the absence of any change in w and γ_H implies there is no entry or exit in the H sector. Hence, there is no output effect in case (i). In case (ii) there is no entry into the L sector because γ_L does not change, and there is no exit out of the H sector because $g(m_H/\gamma_H) = 0$.

PROOF OF PROPOSITION 3:

Step 1:

(i) If $\kappa \geq 1$, $d[\gamma_L/\gamma_H]/d\gamma_H = d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H > 0$ for any γ_H so that $\lambda(\gamma_H; p_L)/\gamma_H \geq 1$.

(ii) If $\kappa < 1$, $d[\gamma_L/\gamma_H]/d\gamma_H = d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H > 0$ if and only if $p_L < 1$ (and equivalently $\gamma_L/\gamma_H < (k_H/k_L)^{\frac{1}{1-\kappa}}$).

PROOF OF STEP 1:

From (6),

$$d[\gamma_L/\gamma_H]/d\gamma_H = (1/\gamma_H)\left[\frac{\gamma_L + \dfrac{\theta_n^L}{\theta_a^L}}{\gamma_H + \dfrac{\theta_n^H}{\theta_a^H}} - \frac{\gamma_L}{\gamma_H}\right],$$

which means that $d[\gamma_L/\gamma_H]/d\gamma_H > 0$ if and only if

$$\frac{\gamma_L \theta_a^L(\gamma_L)}{\theta_n^L(\gamma_L)} < \frac{\gamma_H \theta_a^H(\gamma_H)}{\theta_n^H(\gamma_H)}.$$

Under this production function in the proposition,

$$\frac{\theta_a^i(\gamma_i)}{\theta_n^i(\gamma_i)} = (\gamma_i)^{-\kappa} k_i$$

and

$$p_L = \frac{\theta_n^L(\gamma_L) + \gamma_L \theta_a^L(\gamma_L)}{\theta_n^H(\gamma_H) + \gamma_H \theta_a^H(\gamma_H)} = \left[\frac{k_L \gamma_L^{1-\kappa} + 1}{k_H \gamma_H^{1-\kappa} + 1}\right]^{\frac{1}{1-\kappa}},$$

In the case of $\kappa \geq 1$ and $\gamma_L \geq \gamma_H$,

$$\frac{\gamma_L \theta_a^L(\gamma_L)}{\theta_n^L(\gamma_L)} = (\gamma_L)^{1-\kappa} k_L < (\gamma_H)^{1-\kappa} k_H = \frac{\gamma_H \theta_a^H(\gamma_H)}{\theta_n^H(\gamma_H)},$$

implying $d[\gamma_L/\gamma_H]/d\gamma_H > 0$. In the case of $\kappa < 1$,

$$\frac{\gamma_L \theta_a^L(\gamma_L)}{\theta_n^L(\gamma_L)} < \frac{\gamma_H \theta_a^H(\gamma_H)}{\theta_n^H(\gamma_H)},$$

if and only if $\gamma_L/\gamma_H < (k_H/k_L)^{\frac{1}{1-\kappa}}$, which is equivalent to $p_L < 1$.

Step 2:

(i) If $\kappa \geq 1 - \log(k_H/k_L)/\log(m_L/m_H)$,

$$d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H > 0$$

holds for $p_L \in [p_L^2, p_L^1)$.

(ii) If $0 \leq \kappa < 1 - \log(k_H/k_L)/\log(m_L/m_H)$, for any $p_L < 1$,

$$d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H > 0,$$

and for any $p_L > 1$,

$$d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H < 0.$$

PROOF OF STEP 2:

First suppose that $m_L/m_H \leq [k_H/k_L]^{1/(1-\kappa)}$ and $\kappa < 1$, which are equivalent to $1 > \kappa \geq 1 - \log(k_H/k_L)/\log(m_L/m_H)$. If $p_L \in (p_L^2, p_L^1)$, since $m_L/m_H > \gamma_L/\gamma_H \geq 1$ is satisfied in an equilibrium of supply side, it implies $\gamma_L/\gamma_H < (k_H/k_L)^{1/(1-\kappa)}$ (or $p_L < 1$). From (ii) of Step 1, this means that

$$d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H > 0,$$

holds for $p_L \in [p_L^2, p_L^1)$. From (i) of Step 1, this inequality also holds for $\kappa \geq 1$. This completes the proof of (i).

Next take $0 \leq \kappa < 1 - \log(k_H/k_L)/\log(m_L/m_H)$. From (ii) in Step 1, for any $p_L < 1$,

$$d[\lambda(\gamma_H; p_L, 1)/\gamma_H]/d\gamma_H > 0,$$

and for any $p_L > 1$,

$$d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H < 0.$$

This completes the proof of (ii).

Step 3: Taking $p_L \in (p_L^1, p_L^2)$ as given, let us consider the effect of μ on

$$X_L/X_H = \frac{\theta_a^H(\gamma_H)}{\theta_a^L(\gamma_L)} \frac{d(a_L)}{[d(a_H) - d(a_L)]}.$$

We can use the following relationship.

$$d\left[\frac{\theta_a^H(\gamma_H)}{\theta_a^L(\gamma_L)}\right]\Big/ d\mu$$

$$= \frac{\theta_a^H(\gamma_H)}{\theta_a^L(\gamma_L)}\left[\frac{\theta_a^{H'}(\gamma_H)}{\theta_a^H(\gamma_H)} - \frac{\theta_a^{L'}(\gamma_L)}{\theta_a^L(\gamma_L)}\lambda_1(\gamma_H; p_L)\right] d\gamma_H/d\mu$$

$$= \frac{\theta_a^H(\gamma_H)}{\theta_a^L(\gamma_L)} \frac{\theta_a^{L'}(\gamma_L)}{\theta_a^L(\gamma_L)}\left[\frac{\gamma_L}{\gamma_H}\frac{\frac{\gamma_H\theta_a^{H'}(\gamma_H)}{\theta_a^H(\gamma_H)}}{\frac{\gamma_L\theta_a^{L'}(\gamma_L)}{\theta_a^L(\gamma_L)}} - \lambda_1(\gamma_H; p_L)\right] d\gamma_H/d\mu$$

$$= \frac{\theta_a^H(\gamma_H)}{\theta_a^L(\gamma_L)} \frac{\theta_a^{L'}(\gamma_L)}{\theta_a^L(\gamma_L)}\left[\frac{\lambda(\gamma_H; p_L)}{\gamma_H}\frac{\frac{\gamma_L\theta_a^L(\gamma_L)}{\theta_n^L(\gamma_L)} + 1}{\frac{\gamma_H\theta_a^H(\gamma_H)}{\theta_n^H(\gamma_H)} + 1} - \lambda_1(\gamma_H; p_L)\right] d\gamma_H/d\mu$$

$$< \frac{\theta_a^H(\gamma_H)}{\theta_a^L(\gamma_L)} \frac{\theta_a^{L'}(\gamma_L)}{\theta_a^L(\gamma_L)}\left[\frac{\lambda(\gamma_H; p_L)}{\gamma_H} - \lambda_1(\gamma_H; p_L)\right] d\gamma_H/d\mu < 0,$$

if $d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H > 0$. This relationship is using the fact that

$$\frac{\gamma_i \theta_a^{i'}}{\theta_a^i} = -\kappa \Big/ \left(\frac{\gamma_i \theta_a^i}{\theta_n^i} + 1\right),$$

and $d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H > 0$ if and only if $\gamma_L \theta_a^L(\gamma_L)/\theta_n^L(\gamma_L) < \gamma_H \theta_a^H(\gamma_H)/\theta_n^H(\gamma_H)$. Similarly, we obtain

$$d\left(\frac{d(a_H)}{d(a_L)}\right)\Big/ d\mu$$

$$= \frac{d(a_H)}{d(a_L)}\left[\frac{(a_H)^2 g(a_H)/\gamma_H}{d(a_H)} - \frac{(a_L)^2 g(a_L)/\gamma_L}{d(a_L)}\lambda_1(\gamma_H, p_L)\right] d\gamma_H/d\mu$$

$$> \frac{d(a_H)}{d(a_L)} \frac{(a_L)^2 g(a_L)/\gamma_L}{d(a_L)}\left[\frac{\lambda(\gamma_H; p_L)}{\gamma_H} - \lambda_1(\gamma_H; p_L)\right] d\gamma_H/d\mu > 0$$

if $d[\lambda(\gamma_H; p_L)/\gamma_H]/d\gamma_H > 0$. This is using the assumption that $a^2 g(a)/d(a)$ is increasing in a. This implies that

$$d(X_L/X_H)/d\mu < 0,$$

for $p_L \in [p_L^2, p_L^1)$ if $\kappa \geq 1 - \log(k_H/k_L)/\log(m_L/m_H)$ and for $p_L \in [p_L^2, 1)$ if $0 \leq \kappa < 1 - \log(k_H/k_L)/\log(m_L/m_H)$.

Step 4: Next, suppose $p_L \in (p_L^2, p_L^3)$. $\gamma_L = \gamma_H = \gamma^*$ is determined by

$$p_L = \frac{\theta_n^L(\gamma^*) + \gamma^* \theta_a^L(\gamma^*)}{\theta_n^H(\gamma^*) \quad \gamma^* \theta_a^H(\gamma^*)}.$$

γ^* is independent of μ. This means that $d\gamma^*/d\mu = 0$. We have only the direct effect of μ on X_L/X_H, which is negative.

From Step 3 and this step, this completes the proof of (i) and the first half of (ii) in the proposition.

Step 5: Finally, let us show the last part of (ii). Suppose that there does not exist $\overline{p}_L \in (1, p_L^1)$ so that X_L/X_H is increasing in μ for any $p \in (\overline{p}_L, p_L^1)$. Then p_L^1 has to be nondecreasing in μ. However,

$$dp_L^1/d\mu$$

$$= (p_L^1/\gamma_H^1)\left[\frac{\frac{m_L}{m_H}\gamma_H^1 \theta_a^L\left(\frac{m_L}{m_H}\gamma_H^1\right)}{\theta_n^L\left(\frac{m_L}{m_H}\gamma_H^1\right) + \frac{m_L}{m_H}\gamma_H^1 \theta_a^L \frac{m_L}{m_H}\gamma_H^1} - \frac{\gamma_H^1 \theta_a^H(\gamma_H^1)}{\theta_n^H(\gamma_H^1) + \gamma_H^1 \theta_a^H(\gamma_H^1)}\right] d\gamma_H^1/d\mu$$

is negative from part (ii) of Step 2. This is the contradiction.

PROOF OF LEMMA 4:

Suppose that an increase in μ raises p_L that the initial price level is in (p_L^2, p_L^1). Then as explained previously, taking p_L as given, the increase in μ causes γ_H and γ_L to decrease in the factor market equilibrium. On the other hand, the increase in p_L causes γ_H to fall and γ_L to rise. Therefore the total effect on γ_H is negative. Since equilibrium p_L rises, the equilibrium level of X_L/X_H must be lower. However, the right-hand side of

$$X_L/X_H = \frac{\theta_a^H(\gamma_H)}{\theta_a^L(\gamma_L)} \frac{d(a_L)}{[d(a_H) - d(a_L)]}$$

increases with a decrease in γ_H, which implies that the total effect on γ_L must be negative. From the price-cost relations, the effect on w and w/p_L must be positive. On the other hand, if the price level is in (p_L^3, p_L^2), the increase in μ does not have a direct effect on γ_H and γ_L for given p_L, and the effect on both through the increase in p_L is negative.

Next, consider the case where an increase in μ is associated with a fall in p_L. By Proposition 3 this is possible only if $p_L \in (p_L^2, p_L^1)$. Then the direct effect of μ taking p_L as given is negative for both γ_L and γ_H. On the other hand, the indirect effect through the decrease in p_L is negative for γ_L and positive for γ_H. Hence, the total effect on γ_L is negative. A symmetric argument to that in the previous paragraph also implies that the total effect on γ_H is negative.

PROOF OF PROPOSITION 5:

Suppose that $w^S \neq w^N$ with free trade and costless offshoring. If $w^S < w^N$, all entrepreneurs would hire only suppliers in country S. However, suppliers in country N do not have the option to become entrepreneurs, and would thus be unemployed, implying $w^N = 0$, a contradiction. Similarly, we cannot have $w^S > w^N$. With a common product price ratio p_L and the common w, middleman returns must be equalized in each sector across the two countries. These factor returns must clear the market for suppliers in the integrated economy, i.e., satisfy (10) with μ^G representing the proportion of skilled agents.

As shown in Lemma 4, in the region that $\gamma_L > \gamma_H$ holds in the equilibrium, the autarky levels of γ_H and γ_L are decreasing in μ regardless of its impact on p_L. Hence, $\mu^S < \mu^G < \mu^N$ implies a fall (resp. rise) in relative earnings of middlemen in each sector in the South (resp. North).

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