The Decision to Export in the Presence of Underemployment*

by

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Abstract

In a model with search generated unemployment and heterogeneity on both sides of the labor market, we show that firms that export will be bigger, more capital intensive and pay higher wages than other firms. We also show that there will be imperfect persistence in the decision to export and that liberalization increases the wage gap between high and low skill workers. We also explore the relationship between openness and productivity and show that in export-oriented markets openness can increase aggregate productivity while generating within-firm productivity *losses* for the weakest firms. Finally, we show that openness can lead to within-firm productivity gains for the weakest firms in import-competing industries.

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Even within narrowly defined industries, firms that produce similar products often use technologies with different levels of sophistication, employ different occupational mixes of workers and pay different wages. If one looks for patterns across firms, then recent findings suggest that firms that adopt more modern technologies tend to employ more highly-skilled workers and pay higher wages than their counterparts (Doms, Dunne and Troske 1997). The purpose of this paper is to show that by combining this insight with the fact that unemployed workers must search for jobs, we are able to develop a simple model of a product market that is consistent with a large number of the stylized facts about industry dynamics in open economies and the impact of openness on productivity and wages.

The stylized facts that we are concerned with can be found in two related strands of the literature. First, over the past decade a variety of firm and plant level industry studies have established that there are significant differences between firms that export and those that do not. Exporting firms are typically larger, more capital intensive, more productive and pay higher wages than their counterparts (Bernard and Jensen 1999a). These studies also indicate that there is "imperfect persistence" in the decision to export in that firms often change their export position from one period to the next (Roberts and Tybout 1997, Bernard and Jensen 1999a).[1]

Second, related studies have focused on the impact of openness on productivity at the firm and industry levels. One key finding is that openness tends to enhance productivity, although it is unclear why.[2] At least three possible explanations have been offered. First, openness may allow exporting firms to take advantage of scale effects as they expand. Second, there may be increases in total factor productivity at the firm level, perhaps due to "learn-by-exporting." Third, since more efficient firms tend to export, liberalization may lead to a

[1] These studies also find that firms typically export only a fraction of their output (Bernard and Jensen 1999a). This feature is absent from our model for reasons discussed in footnote 5 below.
[2] For a survey of this literature see Tybout (2003).

reallocation of market shares away from the least productive firms, resulting in higher aggregate productivity. It is important to note that in the latter case, there are no within-firm productivity gains, only an increase in average productivity at the industry-level.

Empirical studies do not offer much support for the scale effect explanation (Tybout 2003), and provide mixed findings for the two other theories. Aggregate productivity gains in export-oriented industries are largely attributed to the fact that (1) it is the relatively efficient firms that choose to export; and (2) openness seems to trigger a reallocation in market shares in favor of these firms (Bernard and Jensen 1999b; Pavcnik 2002). It has been difficult to find evidence of within-firm productivity gains in export markets (Clerides, Lach, and Tybout 1998; Bernard and Jensen 1999; and Aw, Chung, and Roberts 2000).[3] On the other hand, there is evidence of within-firm productivity gains in *import-competing* markets (Pavcnik 2002; Fernandes 2003; and Topalova 2004).

To explain these stylized facts, we develop a model of a perfectly competitive product market with labor-market frictions based on Albrecht and Vroman (2002). In this model, workers with different skill levels search across firms for a job while initially identical firms must choose the type of technology to adopt. In equilibrium, some firms adopt a basic technology, employ relatively low-skilled workers and pay low wages, whereas others adopt a modern technology, employ high-skilled workers and pay high wages. One of the key features of the model is that if the revenues generated by the two different types of firms are sufficiently close, it is possible for underemployment to emerge in equilibrium. This occurs when high-skill workers, who are better suited for employment at high-tech firms, accept low-tech jobs because they happen to match with them first. We show that, in this setting, when firms are given the opportunity to export their output, it is the largest, most productive, most capital-intensive firms

[3] One recent paper that does find some support for learning by exporting is VanBiesbroeck (2004).

(that also pay the highest wages) that face the strongest incentives to do so. Moreover, we show that imperfect persistence may arise when equilibrium is characterized by underemployment. This occurs whenever low-tech firms that are matched with high-skill workers prefer to export their output while low-tech firms that are matched with low-skill workers prefer to sell their output domestically. Thus, our model predicts that the weakest firms in the industry may change their export position when the skill mix of its employee base changes.

When we turn to the impact of openness on productivity, we find that the relationship is complicated by the fact that there are two types of equilibria that are possible. If high-skill workers are willing to accept low-tech jobs (so that some become underemployed), then we have a "Cross-Skill Matching" (CSM) equilibrium; whereas if they are not willing to do so, we an "Ex-Post Segmentation" equilibrium. If the economy starts in a CSM equilibrium and remains in one after liberalization, then we find that openness enhances productivity in export-oriented markets by reallocating markets shares in favor of high-tech firms. However, there are no changes in within-firm measures of productivity. As for wages, since openness increases the surplus created by high-tech matches, high-skill workers employed by high-tech firms gain from liberalization. This increases the outside opportunities for high-skill workers employed by low-tech firms, forcing the low-tech firms to increase the wages of these workers as well. On the other hand, since the number of low-tech firms shrinks, low-skill workers see their bargaining power eroded and may therefore lose from liberalization.

The fact that liberalization increases the spread between the revenues earned by two types of firms opens up the possibility that it could cause the economy to move from a CSM equilibrium to an EPS equilibrium. When this occurs, liberalization's impact on productivity and wages is somewhat different. The main reason for this is that when high-skill workers start rejecting low-tech jobs, the number of low-tech firms falls dramatically. As a result, the aggregate productivity gains can be quite large and the wages of the wages of low-tech workers fall. In addition, since low-tech firms can now only attract low-skill workers, there are within-firm productivity *losses* for these firms. Thus, this case yields a surprising prediction: openness can dramatically increase aggregate productivity in export-oriented industries while generating within-firm productivity losses for the weakest firms.

In the latter part of the paper we examine the impact of openness on productivity in import-competing industries. Since import competition *reduces* the gap between the revenues earned by the two types of firms, it opens up the possibility that liberalization could shift the market from an EPS equilibrium to a CSM equilibrium. If so, then the fact that high-skill workers start to accept low-tech jobs means that import competition will generate within-firm productivity gains for low-tech firms.

If we compare our work with previous contributions in this area, then we view our model as an extension of Melitz (2003), Bernard, Eaton, Jensen, and Kortum (2003) and Yeaple (2005). These papers attempt to explain why exporting firms are different from their counterparts, and generate aggregate productivity gains as the result of market share reallocations. In Melitz and Bernard et al, heterogeneity on the firm side is introduced by assuming that productivity is determined by a random draw. Firms make their exporting decision after learning their productivity, and, as in our setting, it is the high-productivity firms that choose to export. Openness then leads to a reallocation of market shares towards high-productivity firms and results in some low-productivity firms exiting the market.

Yeaple (2005) generates heterogeneity across firms in the same manner that we do: initially identical firms make technology choices with the knowledge that different choices allow them to employ different types of workers.[4] He shows that since the high-tech firms gain more from exporting, they have an easier time covering the fixed costs associated with doing so. Consequently, just as in Melitz and Bernard, et al, high-tech firms self-select into exporting. It is important to note that these three papers make no attempt to explain within firm productivity gains due to changes in openness, nor do they address the issue of imperfect persistence. Our model is able to generate these features due the unique manner in which the labor market is modeled. In addition, due to our labor market structure, our model and Yeaple's generate very different predictions about the impact of openness on industry wage profiles, an issue we discuss at greater length in the text.

We view our work as complementary to Trindade (2004), who makes one of the only attempts to explain the connection between openness and within-firm productivity gains in import-competing industries.[5] His explanation is quite different from ours and is based on a labor-leisure tradeoff decision made by managers of monopolistic firms. In his model, productivity is determined by managerial effort and managers, who are also consumers, value variety in consumption. Openness increases the rewards that can be attained by working hard, since it increases the total varieties of goods available. As a result, liberalization inspires managers to work harder, resulting in higher productivity.

The remainder of the paper divides into four sections. In the next section, we introduce the model and discuss the types of equilibria that may emerge. We explore the nature of the firms' export decisions in Section 3 and then turn to the connection between openness, productivity and wages in export-oriented markets in Section 4. At the end of Section 4 we

[4] We view this as a more satisfying approach since the firm-side heterogeneity is a direct result of profit-maximizing decisions made by the firms.
[5] See also Ederington and McCalman (2004) who explain productivity gains in import-competing industries at the result of technology diffusion.

discuss the impact of openness on productivity in import-competing industries. We summarize our findings and provide a brief conclusion in Section 5.

2. The Model

Our model is a straightforward extension of Albrecht and Vroman (2002) in which firms use both capital and labor to produce a homogeneous good which is sold in a perfectly competitive product market with free entry.[6] The labor market is characterized by trading frictions in that it takes time for unemployed workers and firms with vacancies to find each other. In addition, there is heterogeneity on both sides of the labor market with workers differing their skill levels and firms differing in the technologies that they choose to adopt.

On the supply side of the labor market, we have a continuum of risk neutral workers with a total measure of 1. A fraction q of these workers have low-skills, whereas the remainder have high-skills. The skill level of a worker is denoted by s_j where $j = L, H$.

On the demand side, firms can use one of two technologies to produce output. Firms that choose to adopt the basic (or low-tech) technology produce according to the following production function:

$$(1) \qquad f_L(k, s_j) = \begin{cases} k^{\alpha} s_L^{1-\alpha} & \text{if} \quad s_j = s_L \\ k^{\alpha} s_M^{1-\alpha} & \text{if} \quad s_j = s_H \end{cases}$$

where k denotes the amount of capital the firm rents and $s_M > s_L$. Note that, in terms of production, it matters which type of worker this firm hires since high-skill workers are more productive. For later use, we define $y_L \equiv f_L(k, s_L)$ and $y_M \equiv f_L(k, s_M)$ so that y_L is the output

[6] As mentioned in footnote 1, one other stylized fact is that exporting firms typically export only a fraction of their output (Bernard and Jensen 1999a). This feature will be absent from our model due to our assumption of perfect competition in the product market. We could generate this outcome by allowing for monopolistic competition, but have chosen not to do so in order to keep the analysis tractable.

produced by a low-tech firm that employs a low-skill worker and y_M is the output produced by a low-tech firm that employs a high-skill worker (the subscript *M* stands for "mismatch").

Firms that choose to adopt the modern (or high-tech) technology produce output according to the following production function:

$$(2) \qquad f_H(k, s_j) = \begin{cases} 0 & if \quad s_j = s_L \\ k^\alpha s_H^{1-\alpha} & if \quad s_j = s_H \end{cases}$$

where $s_H > s_M$ (so that high ability workers are better suited for employment at high-tech firms). Note that this firm can only hire highly-skilled workers – workers with low-skills would produce no output if they tried to use this technology. For later use, we define $y_H \equiv f_H(k, s_H)$.

The cost of creating a vacancy is *c*, regardless of which type of technology is adopted. After the risk neutral firms decide whether to enter, unemployed workers and firms with vacancies are randomly matched. Once these two are matched, the firm reveals its technology choice to the worker and makes a commitment to either exporting its output or sell it domestically. If the firm decides to hire the worker and the worker is interested in the job, then the two agents negotiate a wage rate and, after the negotiations are complete, the firm goes to the capital market and rents capital for that period.[7] The matching function is given by $m(u, v)$ where *u* denotes unemployment and *v* denotes vacancies. We assume that $m(u, v)$ is characterized by constant returns to scale and define $\theta \equiv \frac{v}{u}$ as our measure of market tightness. Then, with random matching, the arrival rate of vacancies for a typical worker is given by $m(\theta)$; whereas the arrival rate of workers for a typical firm is given by $z(\theta) \equiv m(\theta)/\theta$. We assume that

[7] The firm chooses to export whenever the surplus created from doing so is larger than the surplus created by serving the domestic market. Thus, since the firm and worker split the surplus generated by the match, they will have the same preferences concerning the firm's export decision.

$m'(\theta). > 0$ and that $m(\theta)/\theta$ is decreasing in θ (that is, $z'(\theta) < 0$). Finally, we assume that jobs are destroyed at rate δ.[8]

As Albrecht and Vroman (2002) demonstrate, there are two types of equilibria in this model, depending on whether high-skill workers are willing to accept low-tech jobs. If they are, then we have a "Cross-Skill-Matching Equilibrium" (CSM); whereas if they are not, we have an "Ex-Post Segmentation Equilibrium." A CSM typically exists if the wages that high-skill workers can expect to earn on the two types of jobs are not too different. Thus, whether these equilibria exist depends upon parameter values and expectations, but when they exist there is a unique equilibrium of each type. In some instances, the equilibria co-exist, whereas in other cases, the market equilibrium is unique. We provide more details on this issue below, but for now we assume that a cross-skill matching equilibrium exists. This means that high-skilled workers accept any job that is offered to them.

To describe the rest of the model, we start with the firms and use J_i (J_i^*) to denote the firm's value from filling a type *i* job and then selling the output domestically (exporting) (for *i* = *L, M, H)* and use V_i to denote the value of creating a type *i* vacancy (for *i* = *L, H*). Note that there are three types of jobs (since a low-tech vacancy can be filled by a high-skill worker, resulting in a type *M* job), but only two types of vacancies. Then, if we use *p* to denote the endogenously determined domestic price of the product; p^* to denote the exogenously given world price; γ to denote fraction of the unemployment pool with low-skills; w_i (w_i^*) to denote the wage earned by a worker in a type *i* job (for *i* = *L, M, H*) at a firm that sells its output

[8] Of course, the job will also be destroyed if either party decides to voluntarily dissolve the match. This approach to modeling the labor market is due to Pissarides (2000) and Mortensen and Pissarides (1994).

domestically (exports); r to denote discount rate, and set the price of capital equal to one, then we have the following asset value equations for the firms

(3) $rJ_i = py_i - w_i - k_i - c - \delta[J_i - V_i] \qquad for \quad i = L, H$

(4) $rJ_i^* = py_i^* - w_i^* - k_i^* - c - c^* - \delta[J_i^* - V_i] \qquad for \quad i = L, H$

(5) $rJ_M = py_M - w_M - k_M - c - \delta[J_M - V_L]$

(6) $rJ_M^* = py_M^* - w_M^* - k_M^* - c - c^* - \delta[J_M^* - V_L]$

(7) $rV_L = -c + z(\theta)\{\gamma \max(J_L, J_L^*) + (1-\gamma)\max(J_M, J_M^*) - V_L\}$

(8) $rV_H = -c + z(\theta)(1-\gamma)[\max(J_H, J_H^*) - V_H]$

In each case, the first term on the right-hand-side is the flow income earned by the firm. So, for example, a productive type i firm that sells its output domestically earns a flow profit of $py_i - w_i - k_i - c$; whereas a firm with a type i vacancy earns no revenue and incurs a flow cost of c to maintain its vacancy. The second term on the right-hand-side is the firm's expected capital gain (or loss) from changing its labor market status. For example, a productive type i firm that sells its output domestically loses its worker at rate δ and when this occurs the firms expected lifetime profits drop from J_i to V_i. On the other hand, low-tech firms fill their vacancy at rate $z(\theta)$ and their expected lifetime profit jumps to $\max(J_L, J_L^*)$ if they match with a low-skill worker (which happens with probability γ) or $\max(J_M, J_M^*)$ if they match with a high-skill worker. Note that a high-tech firm fills its vacancy at a lower rate of $(1-\gamma)z(\theta)$ since it can only employ high-skill workers.

We turn next to wage determination. We assume that wages are negotiated by the firm and its worker and that the solution is determined by the Generalized Nash Bargaining Solution. If we use β to denote the bargaining power of the workers and use U_j to denote the expected lifetime income of an unemployed worker with skill level j, then Albrecht and Vroman show that the wages are given by

(9) $$w_j = \beta(py_j - k_j - c) + (1-\beta)rU_j \qquad for \quad j = L,H$$

(10) $$w_j^* = \beta(py_j^* - k_j^* - c - c^*) + (1-\beta)rU_j \qquad for \quad j = L,H$$

(11) $$w_M = \beta(py_M - k_M - c) + (1-\beta)rU_H$$

(12) $$w_M^* = \beta(py_M^* - k_M^* - c - c^*) + (1-\beta)rU_H$$

Since there is free entry, firms enter until the expected return from creating a type i vacancy is zero. This implies that in equilibrium we must have

(13) $$V_i = 0 \qquad for \quad i = L,H$$

Once firms fill their vacancies, they go to the capital market and rent the profit maximizing amount of capital. Given that the price of capital is one, this implies that

(14) $$p\alpha y_i = k_i \qquad for \quad i = L,M,H$$

(15) $$p^*\alpha y_i^* = k_i^* \qquad for \quad i = L,M,H$$

Equations (14)-(15) allow us to define a new term Δ_j (Δ_j^*) which represents the revenue net of non-labor costs generated by a type j job when the firms sells its output domestically (exports). Thus, $\Delta_j \equiv py_j(1-\alpha) - c$ and $\Delta_j^* \equiv py_j^*(1-\alpha) - c - c^*$.

We now turn to the workers. Define N_i to be the expected lifetime income earned by a worker who is currently employed by a type i firm that sells its output domestically (for i =L, M,H); and, let N_i^* be the analogous term for the case in which the firm exports its output. Then, if we use ϕ to denote the fraction of vacancies posted by low-tech firms, then we have the following asset value equations for the workers

(16) $rU_L = \phi m(\theta)[\max(N_L, N_L^*) - U_L]$

(17) $rU_H = m(\theta)[\phi \max(N_M, N_M^*) + (1-\phi)\max(N_H, N_H^*) - U_H]$

(18) $rN_i = w_i - \delta(N_i - U_i) \qquad for \quad i = L, H$

(19) $rN_i^* = w_i^* - \delta(N_i^* - U_i) \qquad for \quad i = L, H$

(20) $rN_M = w_M - \delta(N_M - U_H)$

(21) $rN_M^* = w_M^* - \delta(N_M^* - U_H)$

As with the firms, the right-hand-side is the sum of flow income and the expected capital gain (or loss) from changing labor market status. For unemployed workers, flow income is zero, whereas employed workers collect wages. In (16)-(17), note that the job acquisition rate for a high-skill worker is $m(\theta)$ (since high-skill workers accept all jobs), whereas it is $\phi m(\theta)$ for low-skill workers (since they are only offered low-tech jobs). Moreover, an unemployed high-skill worker matches with a low-tech firm with probability $\phi m(\theta)$, in which case her capital gain is $\max(N_M, N_M^*) - U_H$; otherwise, she matches with a high-tech firm and gains $\max(N_H, N_H^*) - U_H$.

In equilibrium, high-skill workers will only be willing to accept low-tech jobs if

(22) $\max(\Delta_M, \Delta_M^*) - rU_H > 0$;

that is, if such a match creates positive surplus. Thus, this is the key condition that must be met for a CSM equilibrium to exist.

We now turn to the equilibrium conditions. In any steady-state equilibrium, it must be the case that the flows into and out of each employment state must be equal. For low-skilled workers this condition is given by

(23) $\delta E_L = (q - E_L)\phi m(\theta),$

where $E_L \equiv q - \gamma u$ denotes low-skill employment. The analogous condition that must hold for high-skilled labor is

(24) $$\delta E_H = (1 - q - E_H)m(\theta),$$

where $E_H \equiv 1 - q - (1-\gamma)u$ denotes high-skill employment.

Finally, it must be the case that the domestic product market clears. If we use $D(p)$ to denote aggregate domestic demand for this product, then we must have

(25) $$D(p) = Y(p, p^*)$$

where $Y(p, p^*)$ denotes the total output produced and supplied to the domestic market by all firms. Clearly, $Y(p, p^*)$ depends on the type of equilibrium we are in. For example, suppose that no output is exported. Then $Y(p, p^*)$ is simply equal to total output produced, which is given by

$$E_L y_L + E_H[\phi y_M + (1-\phi)y_H].$$

On the other hand, if the domestic market is served entirely by low-tech firms that employed low-skill workers, we will have

$$Y(p, p^*) = E_L y_L.$$

This completes the description of the model when high-skill workers are willing to match with low-tech firms.

We close this section by describing how the model would be altered in an EPS equilibrium. Since high-skill workers would be unwilling to accept low-tech jobs, (5)-(6), (11)-(12), and (20)-(21) would not apply. In addition, (7), (17) and (24) would have to be rewritten to take into account the fact that low-tech firms would only be able to hire low-skill workers. These equations would become:

(7') $rV_L = -c + z(\theta)\gamma[\max(J_L, J_L^*) - V_L]$

(17') $rU_H = m(\theta)(1-\phi)[\max(N_H, N_H^*) - U_H]$

(24') $\delta E_H = (1 - q - E_H)(1-\phi)m(\theta)$

Such an equilibrium exists if (22) fails to hold when evaluated in equilibrium.

There are two key features that determine when CSM and EPS equilibria exist. First, a CSM equilibrium will not exist if low-tech firms cannot afford to pay high-skill workers enough to convince them to stop searching for a high-tech job. This will occur if the revenue generated by a low-tech firm that matches with a high-skill worker differs significantly from the revenue generated by a high-tech job. This is important since, in the next section, we show that high-tech firms face a stronger incentive to export than low-tech firms. Thus, if liberalization results in high-tech firms exporting while low-tech firms do not, the increase in revenue generated when high-tech firms export can move the economy from a CSM equilibrium to an EPS equilibrium. The second important factor is expectations; and it is this factor that makes it possible to have CSM and EPS equilibria both exist for the same underlying parameters. To see this, note that if high skill workers are willing to match with low-tech firms, then the value from creating a low-tech vacancy will be high and a large number of such vacancies will be created. This would make it hard for high-skill workers to find high-tech jobs, making them more willing to match with low-tech firms. Thus, there are some situations in which self-fulfilling expectations can support equilibria of each type for a fixed set of parameters.

3. Characterizing the Exporters

We can now use the model to compare the characteristics of the firms that choose to export and those that choose to serve the domestic market. For simplicity, we assume that we are in a CSM equilibrium, although it should be clear that our basic message holds for all EPS equilibria as well. Our first set of results, reported in Lemma 1, tell us that high-tech firms always employ more capital, produce more output, and receive a bigger increase in total revenue from exporting than their low-tech counterparts. In addition, Lemma 1 points out that whenever a firm starts exporting, it rents more capital and produces more output.

Lemma 1: In any equilibrium with $p < p^*$, we have

(a) $k_H > k_M > k_L$ and $k_H^* > k_M^* > k_L^*$;

(b) $y_H > y_M > y_L$ and $y_H^* > y_M^* > y_L^*$;

(c) $k_i^* > k_i$ and $y_i^* > y_i$ for $i = L, M, H$.

(d) $p^* y_H^* - p y_H > p^* y_M^* - p y_M > p^* y_L^* - p y_L$.

Proof: From (1)-(2) and (14)-(16) it follows that for $i = L,H$, $k_i = (p\alpha)^{\frac{1}{1-\alpha}} s_i$ and $k_i^* = (p^*\alpha)^{\frac{1}{1-\alpha}} s_i$. Furthermore, $k_M = (p\alpha)^{\frac{1}{1-\alpha}} s_M$ and $k_M^* = (p^*\alpha)^{\frac{1}{1-\alpha}} s_M$. The remainder of the proof of (a)-(c) follows from straight-forward comparisons and our assumption that $s_H > s_M > s_L$. For (d), note that from (1)-(2) and (14)-(15) we have

(26) $$p^* y_i^* - p y_i = (\alpha)^{\frac{\alpha}{1-\alpha}} \left[(p^*)^{\frac{1}{1-\alpha}} - p^{\frac{1}{1-\alpha}} \right] s_i \qquad \text{for } i = L, M, H.$$

Since $p^* > p$ and $s_H > s_M > s_L$ we have our desired result. #

We are now in position to discuss the firms' export decisions. A type *i* firm will export if the surplus created by exporting exceeds the surplus created by serving the domestic market -- or, alternatively, if $J_i^* > J_i$.[9] From (3)-(6) and (13) we have

$$(27) \qquad J_i^* - J_i = \frac{p^* y_i^* - p y_i - (w_i^* - w_i) - (k_i^* - k_i) - c^*}{r + \delta} \qquad for \quad i = L, M, H$$

If we now use (9)-(12) to substitute for the wages and (14)-(15) to substitute for capital we obtain

$$(28) \qquad J_i^* - J_i = \frac{1-\beta}{r+\delta}\{(p^* y_i^* - p y_i)(1-\alpha) - c^*\} \qquad for \quad i = L, M, H$$

Equations (27)-(28) imply that

Proposition 1: High-tech firms face the strongest incentives to export while low-tech firms that employ low-skill workers face the weakest incentives to export.

Proof: A firm exports if $J_i^* - J_i > 0$ and from Lemma 1 part (d) and (28) we have

$J_H^* - J_H > J_M^* - J_M > J_L^* - J_L$. #

Our next result allows us to compare the wages paid by the firms. We find that high-tech firms pay higher wages than their low-tech counterparts and that a firm pays a higher wage whenever it decides to export.

Lemma 2: In any equilibrium with $p < p^*$, we have $w_H > w_M > w_L$, $w_H^* > w_M^* > w_L^*$ and $w_i^* > w_i$.

[9] Note that since the firm and worker split the surplus, they will both have the same preferences concerning the export decision.

Proof: If $U_H > U_L$ and $U_H^* > U_L^*$ then Lemma 2 follows immediately from (9)-(12) and Lemma 1. If we solve (16)-(21) for U_H and U_L and compare them, we obtain

$$U_H - U_L = \frac{(r+\delta)\Delta_H + \beta\phi m(\theta)(\Delta_H - \Delta_L)}{r[r+\delta+\beta\phi m(\theta)]} > 0$$

A similar expression holds for $U_H^* - U_L^*$. #

Putting Lemmas 1 and 2 together with Proposition 1 yields:

<u>Proposition 2</u>: In any equilibrium with $p < p^*$, exporting firms produce more output, are more capital intensive, and pay higher wages than those firms that do not export.

We turn next to the issue of persistence. Suppose first that in equilibrium we have $J_H^* - J_H > 0 > J_M^* - J_M > J_L^* - J_L$; then, all high-tech firms export and all low-tech firms serve the domestic market In this case, there is perfect persistence – a firm that exports today always exports tomorrow and no firm that serves the domestic market today exports tomorrow (note: there would also be perfect persistence trivially if no firm exports). Consider next the case in which $J_H^* - J_H > J_M^* - J_M > J_L^* - J_L > 0$. Clearly, this cannot occur in equilibrium, since there would be no output supplied domestically and the domestic product market would not clear.

This leaves us with the most interesting case (in terms of empirical relevance), in which $J_H^* - J_H > J_M^* - J_M > 0 > J_L^* - J_L$. If this string of inequalities holds, then we say that we have a "Cross-Skill Matching Equilibrium with Imperfect Persistence." Note that in this case a low-tech firm that employs a high-skill worker will export. But, if this firm loses its worker and replaces him/her with a low-skill worker, it will stop exporting. If we use $\pi_S(i)$ to represent the "export survival rate" (which is defined to be the probability that firm will export next period conditional on exporting today), then it follows that $\pi_S(H) = 1$ and $\pi_S(M) = (1-\delta) + \delta(1-\phi)m(\phi)$ (note that $\pi_S(L)$ is not defined). Similarly, if we use $\pi_B(i)$ to denote the "export birth rate" (which is defined to be the probability that a firm will start exporting tomorrow given that it is currently not exporting), then we have $\pi_B(L) = \delta\phi m(\theta)$ (note that $\pi_B(H)$ and $\pi_B(M)$ are not defined). Thus, combining these results with Proposition 2, we have,

<u>Proposition 3</u>: In any Cross-Skill Matching Equilibrium with Imperfect Persistence, the export survival rate is positively correlated with the wage the firm pays, whereas the export birth rate is negatively correlated with the wage the firm pays.

4. Openness, Productivity and the Wage Gap

We now turn to a slightly different issue – what is the impact of globalization on productivity and wages in export-oriented markets? To examine this, we start out by characterizing the equilibrium in a closed economy. We then assume that firms are given the opportunity to export their goods at the world price p^* (with $p^* > p$) and see how this alters the equilibrium outcome. To streamline the analysis we now assume that $s_M = s_L$ (the differences that would arise if $s_M > s_L$ are discussed in the footnotes). Note that if $s_M = s_L$, then $\Delta_M = \Delta_L$, $\Delta^*_M = \Delta^*_L$ and $J^*_M - J_M = J^*_L - J_L$. The last equality implies that low-tech firms always make the same export decision regardless of who they hire. However, note that low-tech firms always prefer to hire low-skill workers, since all workers are equally productive for such firms, but they can pay low-skill workers a lower wage.

To solve for the equilibrium in the closed economy, we follow the approach of Albrecht and Vroman. We begin by solving the steady state conditions (23) and (24) for u and ϕ to obtain

(29) $$u = \frac{\delta(1-q)}{(1-\gamma)[\delta + m(\theta)]}$$

(30) $$\phi = \frac{(1-\gamma)qm(\theta) + \delta(q-\gamma)}{\gamma(1-q)m(\theta)}$$

Note that (30) gives us ϕ as a function of θ and γ.

Our next goal is to show how to solve for the equilibrium value of θ, our measure of labor market tightness. To do so, we fix p at some initial value and then solve (3) and (5), making use of (14)-(15) and the fact that $V_L = V_H = 0$ (from eq. 13) to obtain

(31) $$J_i = \frac{\Delta_i - w_i}{r+\delta} \qquad for \quad i = L, M, H$$

Now, we can use (9) and (11) to substitute for the wages in (31). We obtain

(32) $$J_i = \frac{(1-\beta)[\Delta_i - rU_i]}{r+\delta} \qquad for \quad i = L, H$$

(33) $$J_M = \frac{(1-\beta)[\Delta_M - rU_H]}{r+\delta}$$

The next step is to substitute for the rU_j terms in (32)-(33). We begin with rU_L. From (16) and (18) we have

$$N_L - U_L = \frac{w_L}{r+\delta+\phi m(\theta)}$$

If we substitute this back into (16) and use (9) to substitute for the wage we obtain

(34) $$rU_L = \frac{\beta\phi m(\theta)\Delta_L}{r+\delta+\beta\phi m(\theta)}$$

Turn next to rU_H. Solving (17), (18) and (20) yields

$$rU_H = \frac{\phi m(\theta)w_M + (1-\phi)m(\theta)w_H}{r+\delta+m(\theta)}$$

If we then use (9) and (11) to substitute for the wages and solve we obtain

$$(35) \qquad rU_H = \frac{\beta m(\theta)[\phi\Delta_M + (1-\phi)\Delta_H]}{r+\delta+\beta m(\theta)}$$

Substituting (34)-(35) back into (32)-(33) yields (keeping in mind that $\Delta_M = \Delta_L$)

$$(36) \qquad J_L = \frac{(1-\beta)\Delta_L}{r+\delta+\beta\phi m(\theta)}$$

$$(37) \qquad J_M = \frac{(1-\beta)[(r+\delta)\Delta_L - \beta(1-\phi)m(\theta)\Delta]}{(r+\delta)[r+\delta+\beta m(\theta)]}$$

$$(38) \qquad J_H = \frac{(1-\beta)[(r+\delta)\Delta_H + \beta\phi m(\theta)\Delta]}{(r+\delta)[r+\delta+\beta m(\theta)]}$$

Note that, for any given *p,* (36)-(38) gives J_L, J_M, and J_H as functions of ϕ and θ.

We can now use the free entry conditions, along with (30) and (36)-(38), to solve for the equilibrium values of θ and γ for any given *p*. From (7), the zero-profits for a low-tech vacancy condition can be written as

$$(39) \qquad c = z(\theta)[\gamma J_L + (1-\gamma)J_M]$$

If we use (30) to substitute for ϕ in (36)-(37), then (39) is a single equation in two unknowns, θ and γ. This upward sloping curve is depicted in Figure 1 and shows combinations of θ and γ that are consistent the free entry condition for low-tech vacancies for a given *p*. Note that an increase in θ harms low-tech firms by making it more difficult to find a match, while an increase in γ benefits the firm by increasing its chances of matching with a low-skill worker (who earns a relatively low wage and produces just as much as a high-skill worker). It follows that any increase in θ must be accompanied by an increase in γ when this zero-profit condition holds.

From (8), the zero profit for a high-tech vacancy condition can be written as

$$(40) \qquad c = z(\theta)(1-\gamma)J_H$$

If we use (30) to substitute for ϕ in (38), then (40) is a single equation in two unknowns, θ and γ. This downward sloping curve is depicted in Figure 1 and shows combinations of θ and γ that are consistent the free entry condition for high-tech vacancies for a given p. Note that an increase in θ harms high-tech firms by lowering the arrival rate of workers, while a decrease in γ benefits the firm by increasing its chances of matching with a high-skill worker. It follows that any increase in θ must be accompanied by a fall in γ when this zero-profit condition holds. The equilibrium values for θ and γ in the Cross-Skill Matching equilibrium are determined by the intersection of (39) and (40), as depicted in Figure 1.

Now, suppose that we increase p. This increases the value of creating both types of vacancies (both V_L and V_H rise). To satisfy the free entry conditions, for each given γ, θ must increase so that firms find matches less frequently. This implies that both curves in Figure 1 shift to the right, as depicted by the blue curves. As a result θ increases as more vacancies are created. In the new steady-state there is greater employment of both types of workers and more firms of each type. In addition, existing firms expand by renting more capital and producing more output. Thus, total output is increasing in p. The intersection of the upward sloping supply curve with domestic demand for this product determines the equilibrium price in the closed economy. Provided that high-skill workers are willing to match with low-tech firms at this price (that is, provided that $\Delta_M - rU_H > 0$), we have a closed economy Cross-Skill Matching Equilibrium.

We now turn to the open economy. So, suppose that firms can now export their output at the world price p^*. W can solve for the open economy equilibrium using the same procedure as we used for the closed economy. The steady state solutions still yield (29)-(30) and (36)-(40) remain valid provided that we take into account which firms are now exporting. For example, if only high-tech firms export, then all Δ_H terms in (36)-(40) must be replaced by Δ_H^*. So, if we want to solve for the open economy domestic market supply curve, start by fixing *p*. Then for *p* such that $J_L^* > J_L$, all firms will want to export and domestic supply will be zero. Thus, the lowest price consistent with positive domestic market supply satisfies $J_L^* = J_L$ (note that at this price it must also be the case that $J_M^* = J_M$). If we use p_L to denote this price, then from (26) and (28) we have

$$(41) \qquad p_L = \left\{ (p^*)^{\frac{1}{1-\alpha}} - \frac{c^*}{s_L(1-\alpha)\alpha^{\frac{\alpha}{1-\alpha}}} \right\}^{1-\alpha}$$

At this price, low-tech firms are indifferent between exporting their output and supplying their output to the domestic market. It follows that the domestic market supply curve is horizontal at this price, with the upper bound given by the total output produced by low-tech firms.

Now, suppose that *p* is initially at p_L and then rises to a slightly higher value. The increase in *p* changes the preferences of the low-tech firms – they now strictly prefer to sell their output domestically. They also respond by renting more capital and producing more output. Moreover, this increase in *p* causes V_L to rise, resulting in entry by new low-tech firms. All of these factors lead to an increase in the supply of output to the domestic market. Note, however, that as long as the price increase is small, high-tech firms will continue to prefer to export all of their output.

As *p* continues to rise, the number of low-tech firms and their output both increase while all high-tech firms continue to export. However, when *p* reaches the point where $J_H^* = J_H$ the high-tech firms become indifferent between exporting all of their output and selling it domestically. From (26) and (28) the price that equates J_H^* and J_H, which we denote by p_H, is given by

$$p_H = \left\{ (p^*)^{\frac{1}{1-\alpha}} - \frac{c^*}{s_H (1-\alpha)\alpha^{\frac{\alpha}{1-\alpha}}} \right\}^{1-\alpha} \tag{42}$$

It follows that the domestic market supply curve is horizontal at p_H, with the lowest output level given by total low-tech output and the highest output level given by total production by all domestic firms. Finally, as p rises above p_H, output starts to increase again as existing firms expand and new firms enter. Note that for all $p > p_H$, all output produced by domestic firms is sold domestically – that is, exports drop to zero.

The open-economy domestic market supply curve is depicted by the upward sloping black curve in Figure 2.[10] The intersection of this supply curve with the domestic demand curve determines the open economy equilibrium in this market. Note that the supply curve for the closed economy is depicted by the red dashed line. Not surprisingly, liberalization leads to an increase in the domestic price. However, since $p_H < p^*$, as a result of liberalization, the price received by exporters rises more than the price received by non-exporters.

The increase in both prices leads to expansion by existing firms and new entry. However, since high-tech firms gain more than their low-tech counterparts, they expand by a greater amount and the overall fraction of firms using the modern technology rises.

[10] It should be clear that in the case in which $s_M > s_L$, there would be a third horizontal portion of the open economy supply curve at the price that makes low-tech firms employing high-skill workers indifferent between exporting and selling their output domestically.

To look at the impact on productivity and wages, we focus on the case in which the new domestic price falls strictly between p_L and p_H, so that all low-tech firms sell their output domestically while all high-tech firms export. Since liberalization increases the prices received by both types of firms, the surplus to be split between the firm and its worker increases. However, since the price increases more for the exporters, their surplus increases more. This leads to new entry by both types of firms, with relatively more new entry by high-tech firms. As a result, ϕ falls. The price increases also cause existing firms to expand by renting more capital, with the exports expanding more than their counterparts. As a result of this reallocation of market shares towards high-tech firms, aggregate productivity in the industry rises. But, at the firm level, any increase in productivity can be fully attributed to the increase in the stock of capital rented, thus there are no within-firm increases in total factor productivity.

As for wages, note that high-skill workers unambiguously benefit from these changes – the surplus that they share with their firm has increased (since p^* increased) and their bargaining position has improved (since ϕ fell). Thus, w_H rises. As for low-skill workers, their wages can rise or fall – the surplus created by low-tech firms has increased (since p increased) but their bargaining position has weakened. Thus, w_L can rise or fall. Finally, consider the fate of high-skill workers who are employed by low-tech firms. It should be clear that the wage earned by these workers must rise – the surplus created by low-tech firms has increased and the worker's bargaining position has improved (since w_H has increased and ϕ has fallen). Of course, all of these results depend upon the assumption that after liberalization high skill workers are still willing to match with low-tech firms – that is, we remain in a CSM equilibrium. We summarize these results in Proposition 4.

Proposition 4: Suppose that in the initial, closed economy equilibrium high-skill workers match with low-tech firms and that after liberalization they continue to do so. Then liberalization reallocates market shares in favor of high-tech firms and this leads to an aggregate increase in productivity at the industry level. In addition, liberalization increases the wages earned by high-skill workers regardless of who they are employed by; whereas the wages of low-skill workers might rise or fall. It follows that liberalization increases the gap in wages between what the highest paid and the lowest paid workers earn.

The fact that the wages paid by high tech firms rise faster than those paid by low tech firms opens up the possibility that after liberalization high-skill workers may no longer be willing to match with low tech firms. If this is the case, then liberalization switches us from a CSM equilibrium to an EPS equilibrium. When this switch occurs, the wages of high-skill workers increase but the wages of low skill workers fall. The reason for this is as follows. In the CSM equilibrium the wages of low-skill workers are propped up by the fact that high-skill workers are willing to match with low tech firms. This means that it is easy for low-tech firms to find a match and thus, a large number of low-tech jobs are created. This gives the low skill workers bargaining power and allows them to earn a relatively high wage. But, when liberalization causes the market to switch to a EPS equilibrium, it becomes much harder for low-tech firms to find a match, so fewer low-tech jobs are created (or, alternatively, low-tech firms exit after they lose their workers). As a result, the bargaining power of low skill workers falls and so does their wage.

As for productivity, the reduction in the number of low-tech firms coupled with the entry by new high-tech firms results in a big reallocation of market shares in favor of high-tech firms.

This can result in large aggregate productivity gains. However, this gain would be somewhat moderated by within-firm productivity *losses* for the low-tech firms *if* high-skill workers are relatively more productive when employed by low-tech firms (that is, if $s_M > s_L$). This follows from the fact that low-tech firms would no longer be able to attract these relatively productive workers and would have to produce all of their output using low-skill workers.

An example can be used to highlight the impact of openness on market shares and wages. Following Albrecht and Vroman (2002) we assume that the matching function is Cobb-Douglas in u and v so that $m(\theta) = 2\theta^{.5}$ and set our parameters at $\beta = \alpha = .5$, $r = .05$, $c = .3$, $q = 2/3$, and $\delta = .2$. Furthermore, we assume that $s_L = s_M = 2.0, s_H = 2.6$ and that the closed economy equilibrium price is given by $p = 1.3$. It is straight forward to check that with these parameters and this price level, high-skill workers are willing to accept low-tech jobs, so that we have a CSM equilibrium. In the closed economy, high-tech firms account for 7.2% of the output, $\phi = .832$ (so that only 17% of the vacancies are tied to high-tech firms), and the equilibrium wages are given by $w_L = .491$, $w_M = .517$, and $w_H = .643$.

Now suppose that trade is liberalized, that the world price for this product is given by $p^* = 1.5$, and that the fixed cost associated with exporting, c^*, is equal to .28. From (41) and (42), the new domestic price must fall between 1.3 and 1.5, with the equilibrium value depending on domestic demand. While it is straight-forward to check that high-skill workers are still willing to accept low-tech jobs for any price in this interval, high-tech firms are only willing to export their output if the domestic price falls between 1.3 and 1.349. Thus, we restrict attention to this price interval. Table 1 shows the impact of liberalization on the proportion of vacancies that are tied to low-skill firms (ϕ), the market share of the high-tech firms (denoted by MS_H), and the wages. For p close to 1.3, the impact on ϕ and the high-tech market share is quite large. This is due to two effects. First, since the domestic price does not change much low-tech firms do not expand, while the high-tech firms that are now exporting expand considerably. In addition, the fact that the high-tech firms are now earning much higher revenues than before, means that there will be considerable entry by new high-tech firms. The fall in ϕ weakens the bargaining power of the low-skill workers, resulting in a fall in w_L. High-skill workers gain from liberalization regardless of where they are employed, due to an increase in their bargaining power and the increase in the surplus generated by high-tech firms.

For high values of p, liberalization has a smaller impact, since it causes low-tech firms to expand as well. For example, for p = 1.345, ϕ falls by only a small amount from .832 to .816, while the high-tech market share rises from 7.2% to 7.9%. In addition, the increase in the domestic price increases the surplus to be shared by low-tech firms and their workers and this translates into higher wages for low-skill workers. High-skill workers gain less than they would have gained had p remained at 1.3, since the smaller reduction in ϕ translates into a smaller increase in their bargaining power.

Table 2 shows what can happen when liberalization pushes the economy from a CSM equilibrium to an EPS equilibrium. All of the underlying parameters are the same as those used to generate Table 1, except for c and c^*, which are both set equal to .1. In the initial closed economy equilibrium, the domestic price is 1.2, 72% of the vacancies are tied to low-tech firms, the high-tech market share is 11.9%, and $w_L = .580$, $w_M = .618$, and $w_H = .726$. It is easy to verify that at these wage levels, high-skill workers are willing to accept low-tech jobs.

Now, suppose that firms are given the opportunity to export their output at the world price of 1.27. Then if the domestic price remains close to 1.2, only high-tech firms will want to export; and, given the increase in the spread between the revenues earned by the two types of firms, high-skill workers will stop accepting low-tech jobs. Although no CSM equilibrium exists, an EPS equilibrium does exist, and it is characterized by fewer low-tech firms. This is due to the fact that when high-skill workers stop accepting low-tech jobs, low-tech firms have a more difficult time filling vacancies and thus, some low-tech firms exit the industry. As Table 2 indicates, this can lead to a big increase in the high-tech market share, which triggers an increase in aggregate productivity. This happens in spite of the fact that the low-tech firms become less productive. As for wages, low-skill workers suffer a moderate reduction in their nominal wage, while high-skill workers gain.

It is important to note that our predictions about the impact of openness on wage profiles differ significantly from those of Yeaple (2005). Although both models predict gains for high-skill workers from liberalization, Yeaple's model predicts nominal wage losses for workers earning *moderate* wages and no change in the wages earned by the least skilled workers in the economy. In contrast, our model predicts gains for workers earning high and moderate wages, with possible losses for those at the low end of the skill distribution. Our results are therefore consistent with recent empirical findings that (1) exporting is associated with increases in wage inequality between high-skill and low-skill workers, and (2) wages of the least skilled workers have declined over the last 30 years as markets have become more open (see, for example, Bernard and Jensen 1997, Harrison and Hanson 1999, and Baldwin and Cain 2000).

Although our main focus in this paper is on export-oriented industries, we close this section with a brief discussion of our model's predictions about the impact of openness on productivity in import-competing industries. Our main goal is to show that, consistent with the empirical evidence, openness can increase within-firm measures of productivity by changing the job market preferences of high-skill workers.

When the model applies to an import-competing industry, liberalization lowers the price received by all firms from p, the initial, closed-economy price, to p^*, the world price. This reduction in price causes all firms to contract by renting less capital, and narrows the gap between the revenues generated by the two types of firms. If high-skill workers are unwilling to accept low-tech jobs in the closed economy equilibrium, then the may become willing to do so once trade is liberalized. If this occurs, then total factor productivity of the low-tech firms rises with liberalization.

A simple example can be used to illustrate this possibility. Suppose, for example, that we use the same parameter values that generated Table 1, except that we set $s_M = 2.1$ so that low and high-skill workers are no longer equally productive in low-tech jobs. Then for $p > 2.7$, no CMS equilibrium exists because high-skill workers will reject all low-tech job offers. So, suppose that in the initial, closed economy equilibrium $p > 2.7$ and that $p^* < 2.7$. Then when liberalization occurs, there are two possible outcomes. If high-skill workers remain optimistic about finding high-tech jobs and high-tech firms do not become worried that high-skill workers will start to accept low-tech jobs, then the economy will simply shift to a new EPS equilibrium at a lower output price.

However, it is perhaps easier to imagine newly unemployed high-skilled workers hearing news about an increase in import penetration in their industry and becoming pessimistic about their job prospects.[11] If so, they might begin to accept low-tech jobs and the economy could converge to a CSM equilibrium instead. This new equilibrium would then be characterized by

[11] Recent survey research suggests that such a scenario is highly credible. For example, Scheve and Slaughter (2004) find that a significant portion of the US workforce fears that liberalization weakens job security.

low-tech firms that were, on average, more productive than they would have been in the closed economy. Thus, our model yields a fairly sharp prediction concerning within-firm productivity gains from liberalization in import-competing industries: these gains should tend to occur at the weakest firms in the industry and they should be negatively correlated with the firm's wage (in that low-wage firms are more likely to gain by matching with higher-skilled workers).

5. Conclusion

We have presented a model based on Albrecht and Vroman (2002) in which workers differentiated by ability search over firms for jobs. Initially identical firms are ex-post heterogeneous as some adopt a basic technology and pay low wages, whereas others adopt a modern technology, employ high-skill workers and pay high wages. As in Melitz (2003), Bernard, et al (2003), and Yeaple (2005), we find that exporting firms are typically larger, more productive, more capital intensive, and pay higher wages than their counterparts. In addition, as in Yeaple (2005), the firm-side heterogeneity in our model arises endogenously as a natural outcome of profit maximizing decisions.

Our paper departs from previous work in the manner in which the labor market is modeled. Building on the insights of Albrecht and Vroman (2002), we have shown that when firms and consumers are given the opportunity to trade in this market at world prices, industry dynamics are largely determined by two factors: the types of firms different workers are *willing* to match with and the types of matches that *actually* occur. In particular, we have shown that when high-skill workers are willing to accept low-tech jobs, imperfect persistent in the decision to export is a natural feature of equilibrium in that low-tech firms will export when they are matched with high-skill workers and they will sell their output domestically when matched with low-skill workers. Thus, our model yields strong predictions about how the export survival and birth rates will vary with firm level measures of productivity and wages.

We have also shown that when high-skill workers are willing to accept low-tech jobs, openness enhances productivity in export markets by reallocating market shares in favor of the most productive firms. In this case, openness has no impact of within-firm measures of total factor productivity. While these two results can also be found in Melitz (2003), Bernard, et al (2003) and Yeaple (2005), a new possibility emerges in our model due to the fact that openness alters the spread between the revenues earned by low-tech and high-tech firms. In export markets, this spread is increased, causing the wages offered by the firms to diverge; whereas in import-competing markets the spread is decreased, causing the wage gap to contract. As a result, liberalization may alter the job-market preferences of the high-skill workers. We have shown that in export markets, liberalization may cause high-skill workers to reject low-tech jobs. This then leads to large aggregate productivity gains due to market share reallocations and within-firm productivity *losses* for the weakest firms in the industry. In contrast, liberalization may cause high-skill workers to start to accept low-tech jobs in import-competing industries. This would lead to within-firm productivity gains at low-tech firms, an outcome that is consistent with recent empirical findings.

Our model also allows us to derive predictions about the link between openness and the wage gap between high-skill and low-skill workers that differ from Yeaple (2005). Since exporting increases the surplus generated by high-tech jobs, we find that high-skill workers employed by high-tech firms gain the most from liberalization. High-skill workers employed by low-tech firms gain as well, since their outside opportunities are enhanced by the increase in high-tech wages. Low-skill workers, on the other hand, will suffer nominal wage losses unless the domestic price rises significantly. The reason for this is that the shift in market shares away from low-tech firms (the only firms offering jobs that these workers qualify for) lowers the outside opportunities for low-skill workers and weakens their bargaining power. These results are consistent with recent empirical evidence that finds the wage gap between high-skilled and low-skilled rising as markets become more open.

Since our model makes yields many predictions about exporting, productivity and wages, there are a variety of ways to test it. However, we close the paper by suggesting one test that we find particularly intriguing. In a paper closely related to Albrecht and Vroman (2002), Acemoglu (1999) presents a model of a labor market in which high-skill and low-skill workers search across (possibly) heterogeneous firms for jobs. He shows that two types of equilibria can exist. In the first, which he refers to as a "separating equilibrium," some firms create high-tech jobs and match only with high-skill workers while other firms create low-tech jobs and match only with low-skill workers (thus, this is similar to the EPS equilibrium in the Albrecht-Vroman model). In the other equilibrium, which he refers to as a "pooling equilibrium," all firms create the same type of jobs and match with both types of workers. Acemoglu refers to these jobs as "middling" and shows that middling jobs will be offered only when the relative productivity of high-skill versus low-skill workers is not too great; otherwise, equilibrium entails separation. In the latter part of his paper, Acemoglu offers a variety of evidence that in many industries middling jobs have been disappearing and have been replaced by the type of jobs that would be offered in a separating equilibrium. If we apply the logic presented in this paper to Acemoglu's model, the conclusion is that openness should cause middling jobs to *disappear* in export-oriented industries and *appear* in import-competing industries. This follows from the fact that exporting increases the spread between the revenues that the two types of workers can generate, while import competition decreases this spread. In his empirical analysis, Acemoglu does not separate his industries into groups based on their trade status. Our paper suggests that doing so might allow for a direct test of our model's prediction that openness can alter the nature of the labor-market equilibrium.

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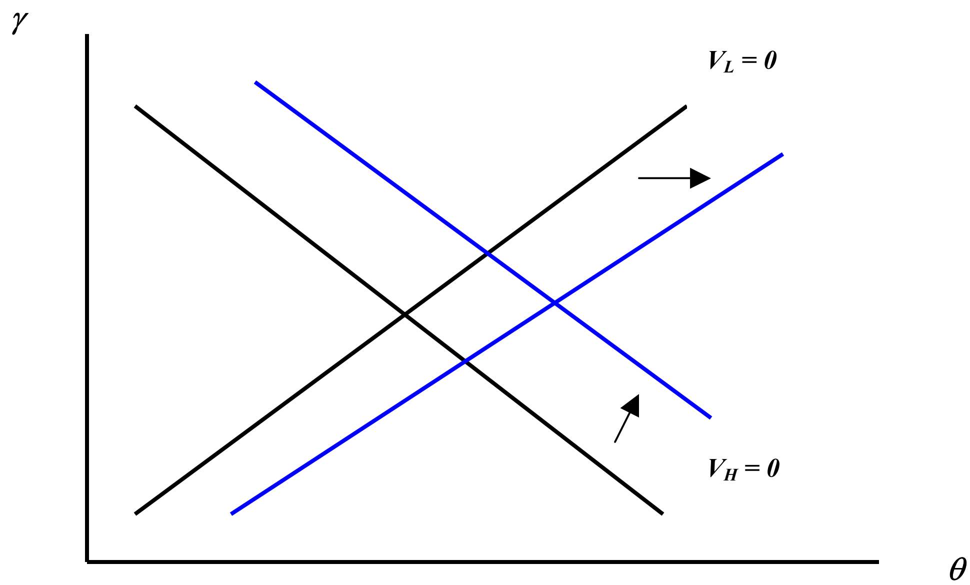

Figure 1

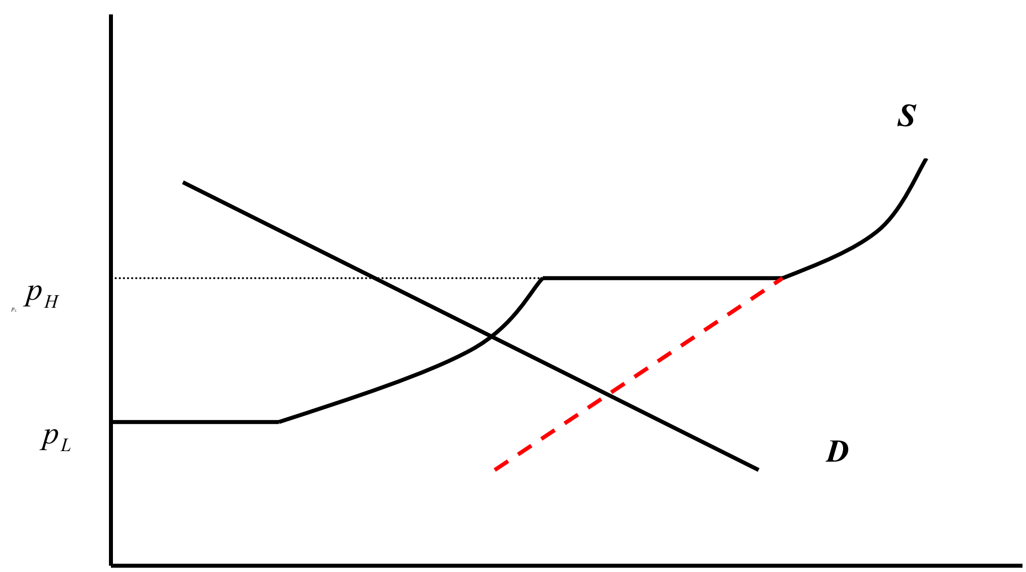

Figure 2

Type of equilibrium	p	p^*	ϕ	MS_H	w_L	w_M	w_H
Closed Economy CSM	1.3	NA	.832	7.2%	.491	.517	.643
Open Economy CSM	1.3	1.5	.703	12.8%	.484	.541	.891
Open Economy CSM	1.345	1.5	.816	7.9%	.547	.577	.857

Table 1

Type of equilibrium	p	p^*	ϕ	MS_H	w_L	w_M	w_H
Closed Economy CSM	1.2	NA	.720	11.9%	.580	.618	.726
Open Economy EPS	1.2	1.27	.554	40.4%	.571	NA	.761

Table 2