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FDI and Labor Markets in General Equilibrium*

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March 2005

Abstract

International wage differences –driven by international technology or factor endowment differences– encourage the flow of Foreign Direct Investment from high- to low-wage countries. However, the access of high-technology firms may drive domestic wages up, dampening the incentives for FDI flows. A general-equilibrium model that emphasizes the joint determination of FDI flows and labor market outcomes yield several conclusions. First, an equilibrium with positive FDI inflows and wages above autarky levels is more likely in large labor-abundant technology-backward countries or when the fixed cost of foreign investment is low. Second, the conditions that depress autarky wages –technology differences and labor abundance– are those than enhance the equilibrium wage rate when FDI takes place. Third, FDI rises the relative cost of labor in the host economy, shifting the domestic production structure toward a more capital-intensive mix. Finally, the sectoral distribution of FDI flows does not depend upon differences in factor intensities, and it is solely determined by sectoral differences in the fixed cost of foreign investment.

Key Words: F15, F16, F2.

JEL: Foreign Direct Investment, Labor Markets, International Technology Differences.

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"Low wages and high tech [in China]. Combine the two and America has a problem."

Business Week, Dec 6, 2004

1 Introduction

The explosion of Foreign Direct Investment (FDI) in last decades has given rise to a broad literature on the determinants of multinationals. Because most FDI flows are between developed countries and of horizontal type¹ –firms that produce the same goods in different locations–, the literature has focused on the role of size, distance and trade costs (tariffs) on FDI flows in the context of the knowledge-capital model, that emphasizes the flow of knowledge rather than capital as the key component of FDI (Markusen, 2002; Helpman, Melitz and Yeaple, 2004). Under the premise that firms incur in significant costs of installing production facilities abroad, multinationals must have offsetting advantages, usually associated with some forms of knowledge capital. In such context, horizontal multinationals are more likely when transport cost or tariffs are high, meaning that there are advantages of avoiding those transport costs and locate close to consumption centers. Also, horizontal FDI is more probable when the host country is large because the potential gains from economies of scale more than compensate the fixed cost of foreign production.

Because international factor price differences encourage the whole movement of production processes toward one location (the low-wage country), models of horizontal FDI usually assume international factor price equalization. The role of wage differences is emphasized in models of vertical FDI, where the production process is fragmented; headquarters can be located in one country and production facilities in another (Helpman, 1984; Markusen, 2002). Assuming that these two components of the production process have different factor intensities, factor price differences encourage the location of headquarters in the country with lowest price of the factor used intensively in headquarters services, e.g., high-skilled labor, while unskilled-labor-intensive production facilities are located in the low-skilled-labor abundant country or in the largest

¹Brainard (1997) tests for the importance of factor price differences as an explanation for FDI, dismissing it in favor of explanations based on trade costs and size. This is the fundamental empirical support for models of horizontal FDI.

country, if trade costs exist (Markusen, 2002).

In Helpman's model, cross-country differences in factor endowments lead to cross-country differences in factor prices, generating room for multinationals to emerge in order to enjoy cost differences. Unless cross-country differences in factor endowments are too large—in which case there is no multinational activity in equilibrium and factor price differences remain—, foreign firms' investment leads to international factor price equalization. Moreover, the possibility of vertical multinationals enlarges the factor endowment set consistent with factor price equalization. Other papers have focused on the effects of multinationals and outsourcing on relative factor prices in home and host countries. In Markusen (2002), as in Feenstra and Hanson (1996a,b, 1997), the fragmentation of production processes raises the real wage of skilled labor both in the source and host countries. This is because production fragmentation in the source country raises relative demand for skilled labor, as part of the unskilled-labor-intensive production process is done abroad. In the host country, there is also a rise in relative demand for skilled labor because it is assumed that production in the increasing-returns sector is more skilled intensive than production of the constant-returns-to-scale product.²

This paper offers an alternative approach to study the labor market implications of FDI flows. In particular, it highlights the joint determination of FDI flows and factor market outcomes: while FDI flows respond to international differences in factor prices, these are simultaneously affected by the level and composition of foreign investment. In the context of a perfectly competitive two-sector two-factor model where factor price differences arise from international technological differences (Trefler, 1993), I analyze the role of wage differences on attracting FDI—defined as foreign capital embedded with the foreign advanced technology³— from high- to low-wage countries, as well as the effects that the access of technology-advanced

²These results are not inconsistent with those of Helpman (1984) because they are based on different assumptions regarding factor intensities of headquarters, production plants of the increasing returns good and production of the homogeneous product (Feenstra, 2004).

³This setting is similar to Mundell's (1957) analysis of capital flows in a Heckscher-Ohlin framework. However, in this paper domestic and foreign capital are not perfect substitutes because foreign capital is embedded with the foreign advanced technology. This is a fundamental distinction because equalization of domestic and foreign capital returns is not a necessary

foreign firms have on the labor market of technology-backward countries.

The model stresses two main equilibrium forces. On the one hand, international wage differences encourage foreign investment flows in search of low labor costs in order to obtain a higher return to capital. This cost advantage for foreign firms is however compensated by a fixed cost of producing abroad. In equilibrium, the return to capital of foreign-invested firms producing in the domestic economy must be equal to the international rental rate, that is the capital return of foreign firms producing in their source economies. The presence of a fixed cost of foreign production introduces increasing-return-to-scale features to foreign investment in an otherwise constant-return-to-scale world. Because of decreasing average costs, the incentives for foreign producers to bring capital and advanced technology to the low-wage country are unlimited, unless domestic wages respond to labor market pressures from foreign firms' presence. For any level of domestic wages there is a minimum scale of foreign firms' domestic production –and employment– that compensates fixed investment costs and make foreign production viable. This relationship represents foreign firms' demand for domestic labor.

The second equilibrium relationship is the residual supply of domestic labor available for foreign production. For any domestic wage rate there is an employment level of domestic firms consistent with equilibrium in the domestic capital market, which remains segmented from the international market. The difference between total labor supply and domestic firms' employment is available for foreign production, and it is an increasing function of the domestic wage rate. As long as foreign firms' presence bid domestic wages up marginally from their autarky level, domestic firms specialize in the production of the capital-intensive good. The higher relative cost of labor induces domestic firms to choose a more capital-intensive technique, lowering domestic labor requirements.

It turns that under certain conditions the equilibrium is characterized by no foreign investment and no labor market effects. This is the case when the minimum scale of foreign production that compensates the fixed cost of foreign production is greater than the residual labor supply at any wage rate. This is more likely if the international technology gap is small, if the technology-backward country is small or capital-abundant

equilibrium condition.

or if the fixed cost of foreign production is high enough. Contrary to Helpman (1984), an equilibrium with FDI is more likely when autarky factor price differences are high. Otherwise, there is an equilibrium with positive FDI and domestic wages above their autarky level.

Several elements characterize this equilibrium. First, wage pressures are greater in large labor-abundant technology-backward countries, as they are able to provide foreign producers a greater scale of production. Domestic wages end up being higher in those countries that allow foreign firms to enjoy more economies of scale. Interestingly, the conditions that depress income per capita in the pre-integration equilibrium are the same that enhance the wage and income gains in the low-wage host country when FDI flows are allowed for. Also, the rise in the relative cost of labor for domestic producers shift the production pattern toward a more capital-intensive mix, and this effect is greater in large labor-abundant countries.

Second, contrary to partial equilibrium thinking –where wage differences benefit more firms in labor-intensive industries, and hence foreign investment is larger in industries that use intensively the factor that is relatively cheaper in the host economy–, FDI will take place in the industry with lower fixed costs regardless on its factor intensity. Although wage differences benefit more foreign producers in labor-intensive industries, foreign firms in the domestic economy in capital-intensive industries are able to produce much more income with the same employment level, generating more resources to pay for the fixed cost. In general equilibrium these two forces compensate each other, and the sectoral distribution of FDI flows depends uniquely on the fixed cost of foreign production.

Third, welfare for domestic residents is always higher in the equilibrium with FDI. This is because the domestic economy is labor abundant relative to the factor intensity of the capital-intensive sector, that is the industry in which the domestic economy unambiguously specialize following a rise in wages beyond their autarky level. This implies that domestic residents are benefited from a rise in the relative cost of labor. However, the welfare effect of FDI flows on source countries is ambiguous.

Finally, I extend the analysis to the case where international factor price differences respond not only to technology differences but also to differences in factor endowments, so that in the pre-integration equilibrium the domestic economy is specialized in the production of the labor-intensive good. The main conclusions

aforementioned hold, although the possibility of multiple equilibria arises. In particular, under certain conditions there is a low-wage low-FDI equilibrium, where the domestic economy remains specialized in the labor-intensive good, and a high-wage high-FDI equilibrium in which the domestic economy specializes in the production of the capital-intensive product. In both cases, domestic wages are higher than their pre-integration level.

Before proceeding, some words are required to insert this paper in the literature of vertical and horizontal multinationals. First, this paper is not about multinationals but rather foreign investment. Because of the constant-returns-to-scale framework, we are not able to distinguish between firms and industries. FDI refers to capital and technology flowing from one country to another, and the model is silent regarding the identity of foreign producers, as the ownership of each unit of foreign capital is immaterial for the results. Second, this paper rules out vertical FDI –conceived as headquarters in one country and production facilities in another– because the production of the final good requires labor and capital only. Indeed, the goods produced by foreign firms in the domestic economy are the same as those produced in their source country, meaning that the paper implicitly takes a horizontal view of FDI. Although the size of the host country is a fundamental determinant of FDI in this paper –as it is for horizontal multinationals in general–, FDI arises in response to international differences in factor prices. This is a fundamental difference with the horizontal-multinational literature, which emphasizes that cost differences encourage the complete movement of production facilities to the low-cost country. By endogenizing the labor market effects of foreign firms' activity, this paper allows the coexistence of horizontal FDI activities and factor price differences.

The rest of the paper is divided as follows. Section 2 presents the model. It first discusses the pre-integration equilibrium when FDI is banned, and it then analyzes the effects of allowing international movements of capital and technology. In the first part I first focus on the case where there is production diversification in the pre-integration equilibrium, so that factor price differences are only determined by cross-country technology differences. The second part allows for production specialization and hence it provides a role for factor endowment differences in explaining initial wage differences. Section 3 concludes.

2 The Model

2.1 Segmented Factor Markets

Consider a small economy that produces the only two goods available: x and y .⁴ Both goods are produced with CRS production functions and two factors: labor L and capital K , which are internationally immobile. Sector x is capital-intensive, and relative factor endowment $\bar{k} = (\bar{K}/\bar{L})$ is such that both goods are produced. The zero-profit conditions for domestic producers in each industry are

$$\begin{aligned} p_x^* &= a_{Lx}w + a_{Kx}r \\ p_y^* &= a_{Ly}w + a_{Ky}r \end{aligned} \tag{1}$$

where p_i^* is the international product price of good $i = x, y$; w and r refer to the domestic return per unit of labor and capital respectively, and $a_{Fi} = a_{Fi}(w/r)$ represent factor requirements per unit of output, that depend on technology parameters and relative factor prices. Both zero-profit conditions jointly determine domestic factor prices and factor intensities. Production levels of x and y follow from imposing factor market clearing conditions given equilibrium factor usage.⁵

Consider that the domestic country is technology-backward with respect to a foreign country where product prices are set, meaning that after correcting for differences in relative factor prices, there are cross-country differences in average factor productivity. Analytically, international differences in average factor productivity can be expressed as

$$\begin{aligned} \frac{a_{Li}}{a_{Li}^*} &= (1 + \delta) \cdot l_i(\omega) \\ \frac{a_{Ki}}{a_{Ki}^*} &= (1 + \delta) \cdot k_i(\omega) \end{aligned} \tag{2}$$

where $\delta \geq 0$ measures a Hicks-neutral technology gap between the domestic and foreign countries (com-

⁴It is straightforward to extend the analysis to a multi-good multi-cone framework, and none of the results is altered. More on this below.

⁵The two conditions in equation (1) determine w and r . This is an equilibrium as long as $k_x(w/r) > \bar{k} > k_y(w/r)$ where $k_x(w/r) = a_{Kx}/a_{Lx}$ and $k_y(w/r) = a_{Ky}/a_{Ly}$.

mon across sectors), and $l_i(\omega)$ and $k_i(\omega)$ measure the effect of relative factor price ratios $\omega = (w/r) / (w^*/r^*)$ on average factor productivity, with $l_i(1) = k_i(1) = 1$ and $\partial l_i(\omega) / \partial \omega < 0$ and $\partial k_i(\omega) / \partial \omega > 0$. In equilibrium, because both countries face the same world product prices and Total Factor Productivity differences are similar across industries, $\omega = 1$ and international factor price differences are given by

$$\frac{w_a}{w^*} = \frac{r_a}{r^*} = \frac{1}{1 + \delta} < 1. \quad (3)$$

Assuming identical and homothetic preferences across countries, the trade pattern implicit in this equilibrium is that predicted of the traditional two-sector Heckscher-Ohlin model. Because productivity differences are similar across industries, the production pattern is uniquely determined by cross-country differences in factor endowments. Therefore, capital-abundant countries export the capital-intensive good while the opposite happens in labor-abundant countries.

2.2 Capital and Technology Flows

Factor price differences generate incentives for foreign producers to move capital and technology to the low-wage domestic economy in order to enjoy low labor costs. In particular, I consider that each unit of foreign capital is embedded with the foreign advanced technology. Despite the domestic return to capital is lower than the foreign return r^* , foreign units of capital in the domestic economy can obtain a capital return higher than r^* . Foreign firms however only have access to the domestic labor market, while the domestic capital market remains segmented. The rationale for this assumption is twofold. First, the assumption that technology is embodied in capital suggests that domestic and foreign capital are not perfect substitutes, as units of domestic capital cannot be employed with the advanced technology. This means that the return to domestic capital is endogenously determined. Second, if technology-advanced firms have access to all domestic factor markets, there is no room for domestic firms. To rule out this case we have to assume that some factors remain segmented from international competition; capital in this case.

The attractiveness of low domestic wages for technology-advanced foreign firms is however compensated with a fixed cost F_i of producing in a foreign country, meaning that foreign production in industry i in the

domestic economy will take place as long as

$$p_i^* \geq a_{L_i}^* w + a_{K_i}^* r^* + \frac{F_i}{q_i^*} \quad (4)$$

where w is the post-integration domestic wage rate and $q_i^* = K_i^*/a_{K_i}^*(w/r^*) = L_i^*/a_{L_i}^*(w/r^*)$ is the output of the foreign producer in the host country in industry i , where K_i^* is the amount of foreign capital in domestic industry i .⁶ As long as (4) holds with inequality there are incentives to bring as much capital as possible to enjoy decreasing average costs. This would be the case if the access of foreign firms to domestic labor markets does not pressure the domestic wage rate up (Findlay, 1978), meaning that prices are always higher than average costs, and hence the return to capital of foreign investment is higher than r^* .⁷

An equilibrium condition where the marginal unit of foreign capital is indifferent between producing in its home country or moving to the low-wage country means that (4) must hold with equality. This condition determines a relationship between the domestic wage rate w and foreign employment in industry i L_i^* : $L_i^* = f(w)$, which defines the minimum amount of foreign firms' employment L_i^* —and hence production—that is compatible with the zero profit condition at any level of w . The employment level in industry i by foreign firms consistent with equality in (4) is therefore implicit in the following expression:

$$p_i^* = a_{L_i}^* \left(\frac{w}{r^*} \right) w + a_{K_i}^* \left(\frac{w}{r^*} \right) r^* + \frac{F_i}{L_i^*} a_{L_i}^* \left(\frac{w}{r^*} \right). \quad (5)$$

After accounting for differences in foreign firms' average factor productivity due to differences in relative factor prices between the domestic and foreign countries,⁸ equation (5) is satisfied when

$$0 = \left[1 - \theta_{K_i}^* \sigma_i \left(\frac{w}{w^*} - 1 \right) \right] \cdot \left[\frac{w}{w^*} - 1 + \frac{F_i}{L_i^* w^*} \right]. \quad (6)$$

This equality —that implicitly defines $f(w)$ — holds if either of the terms in brackets is equal to zero. The first term in the right-hand-side of (6) cannot be zero for that requires $w > w^*$, meaning that foreign firms

⁶I assume the foreign economy is large enough so that capital outflows imbedded in FDI flows do not alter factor prices in the foreign economy.

⁷This is, for example, the case if there is a totally elastic domestic labor supply.

⁸Along an isoquant of a constant-return-to-scale production function it is possible to show that $\widehat{a_{L_i}^*} = -\theta_{K_i}^* \sigma_i (\widehat{w} - \widehat{r})$ and $\widehat{a_{K_i}^*} = \theta_{L_i}^* \sigma_i (\widehat{w} - \widehat{r})$ where $\widehat{x} = dx/x$ and σ_i is the elasticity of substitution between labor and capital. Therefore, $a_{L_i}^*(w/r^*) = a_{L_i}^*(w^*/r^*) \cdot [1 - \theta_{K_i}^* \sigma_i (w/w^* - 1)]$. Similar for $a_{K_i}^*(w/r^*)$. Replacing these expressions into (5) we obtain (6).

push the domestic wage rate beyond its level in the foreign country. This is not equilibrium because it requires that the zero-profit condition in industry i does not hold in the domestic and foreign countries simultaneously. The assumption that the foreign country is large enough means that for any size of foreign capital flows, the source country relative factor endowment remains within the cone of production diversification, and w^* and r^* are not affected, assuring that both zero-profit conditions hold. Also, if $\theta_{Ki}^* \sigma_i (w/w^* - 1) = 1$ it means that foreign firms producing in the domestic economy choose a capital-labor ratio such that average labor productivity is infinity.⁹ This is not reasonable.

Therefore, foreign firms' demand for domestic labor satisfies

$$w = w^* - \frac{F_i}{L_i^*}. \quad (7)$$

Equation (7) represents the minimum level of employment by foreign firms consistent with any domestic wage rate w . We should first notice that $\partial L_i^*/\partial w > 0$ and $\partial^2 L_i^*/\partial w^2 > 0$, meaning that the higher the domestic wage rate the higher the employment level by foreign firms consistent with zero-profits, and this effect is increasing on w . The intuition behind (7) is simple: a raise in domestic wages shrinks the cost advantage for foreign producers, and hence equilibrium requires a greater scale of foreign firms to move along the average cost curve. This is attained with a higher level of foreign firms' domestic employment L_i^* .

Three elements are worth emphasizing from (7). First, notice that for a given level of employment, foreign firms are able to bid wages up more in those industries with lower fixed costs, regardless of whether they are labor or capital intensive. This result runs against the intuition that firms in labor-intensive industries are more benefited from lower wages –through a greater impact on the capital return–, and hence that we should expect greater flows of foreign investment in labor-intensive industries if wage differences are the driving force encouraging FDI. However, one unit of labor in a foreign firms in industry i produces $1/a_{Li}^*$ units of good i and money income of $p_i/a_{Li}^* = w^*/\theta_{Li}^*$.¹⁰ This means that foreign producers in capital-intensive industries

⁹Recall that $a_{Li}^*(w/r^*) = a_{Li}^*(w^*/r^*) \cdot (1 - \theta_{Ki}^* \sigma_i (w/w^* - 1))$. If this expression is equal to zero average labor productivity of foreign firms producing in the domestic economy is ∞ .

¹⁰Assuming a Leontief production function (that is immaterial for the analysis), the zero profit condition for foreign producers of good i in the domestic economy can be written as $1 = (\theta_{Li}^* \frac{w}{w^*} + \theta_{Ki}^*) + \frac{F_i}{L_i^*} \frac{\theta_{Li}^*}{w^*}$ where $\theta_{Li}^* = a_{Li}^* w^*/p_i$ and $\theta_{Ki}^* = 1 - \theta_{Li}^*$.

can obtain more value of domestic employment than firms in labor-intensive sectors, so they can pay higher wages. In general equilibrium these two effects cancel each other out, and competition for domestic labor concentrates FDI in the industry in which foreign firms' impact on domestic wages is greatest, that is the industry with lowest F_i . This is a corollary of decreasing average costs of foreign production; it is optimal to concentrate FDI in one industry.

Second, because w never reaches w^* (for $F_i > 0$), the wage-rental ratio faced by foreign firms in the domestic country is lower than in the source country, meaning that foreign invested enterprises choose a more labor-intensive production technique than in their source economies. This is consistent with the empirical evidence presented by Lipsey and others.¹¹ Third, if $F_i = 0$, there is international wage equalization ($f(w)$ is vertical at $w = w^*$), and there are infinite levels of foreign investment consistent with foreign firms' zero profit condition. This does not mean that the equilibrium is undetermined, as becomes clear below.

Figure 1 depicts $L_i^* = f_i(w)$ for industries with different levels of F_i , where $f_i(0) = F/w^* > 0$; $f_i(w_a) = (1 + \delta)/\delta \cdot f_i(0)$ and $\lim_{w \rightarrow w^*} f_i(w) = \infty$. The relevant curve in equilibrium is the rightists, that is, the one for the industry with lowest F_i .

[Insert Figure 1]

The second equilibrium relationship follows from identifying the residual domestic labor supply available for foreign firms –as a function of domestic wages– consistent with domestic capital market clearing. By assuming that domestic capital is internationally immobile, the domestic capital market clearing condition determines domestic firms' employment, and the residual labor supply for foreign firms is the difference between total labor supply and domestic firms' employment. In other words, the size of foreign investment

The term in brackets in the right-hand-side reveals that firms in labor-intensive industries (high- θ_{Li}^*) are more benefited with $w/w^* < 1$ as they can reduce unitary costs by more. The second term is the ratio of money fixed costs of foreign production and money income that L_i^* units of labor in industry i can generate for foreign producers. This gives an advantage to foreign firms in capital-intensive industries, that can generate more money income with the same employment level than firms in labor-intensive industries. Equation (7) can be derived from manipulating this expression.

¹¹Lipsey, Kravis and Roldan (1982) and Kravis and Lipsey (1988). See also Lipsey (2002).

and employment is limited by the level of domestic employment consistent with equilibrium in the domestic capital market.

The level of domestic employment consistent with capital market equilibrium depends upon whether $w > w_a$ or $w = w_a$.¹² Consider first that $w > w_a$. If the access of foreign firms to the domestic labor market rises wages beyond w_a the labor-intensive domestic industry becomes non-competitive. Because the domestic capital market remains segmented from international markets –and hence the domestic return to capital is endogenously determined–, the rise in domestic wages pressures r down, rendering the labor-intensive industry uncompetitive. Specialization in the capital-intensive industry determines the level of domestic firms' employment based upon the factor intensity of industry x at domestic relative factor prices. Domestic capital market equilibrium therefore requires

$$\frac{a_{Kx}\left(\frac{w}{r}\right)}{a_{Lx}\left(\frac{w}{r}\right)} = \frac{\bar{K}}{\bar{L} - L^*} \quad (8)$$

where r is the endogenously-determined return to domestic capital –consistent with the zero-profit condition for domestic producers in the capital-intensive industry $p_x = a_{Lx}(w/r)w + a_{Kx}(w/r)r$ –, \bar{K} and \bar{L} represent domestic capital and labor endowments, and L^* is the employment level available for foreign firms. Using the definition of changes in average factor productivity for changes in relative factor prices –see footnote 8– (8) can be written as

$$\frac{k_x^a}{\bar{k}} \cdot \left(1 - \frac{L^*}{\bar{L}}\right) = \frac{1 - \sigma\theta_{Kx}^*\left(\frac{w}{w^*} - \frac{r}{r^*}\right)}{1 + \sigma\theta_{Lx}^*\left(\frac{w}{w^*} - \frac{r}{r^*}\right)} \quad (9)$$

where k_x^a is the pre-integration domestic capital-labor ratio in industry x (equal to k_x^*), σ is the elasticity of substitution between labor and capital in industry x and r is the post-integration domestic return to capital. Equation (9) implicitly defines a function $L^* = h(w)$ where $h(w_a) = \bar{L} [(k_x^a - \bar{k})/k_x^a]$ and $h(w_a) < h(w^*) < \infty$. After some algebra manipulation we get¹³

¹²If $w < w_a$ no labor will be employed by foreign firms because the autarky equilibrium is still viable, and workers would earn w_a .

¹³ $\frac{\partial h(w)}{\partial w} = \frac{\bar{K}\sigma}{k_x\theta_{Kx}w} > 0$ and $\frac{\partial^2 h(w)}{\partial w^2} = -\frac{\bar{K}\sigma}{(k_x\theta_{Kx}w)^2} \cdot \left(\frac{\partial(k_x\theta_{Kx}w)}{\partial w}\right) < 0$ for all σ .

$$\frac{\partial L^*}{\partial w} > 0 \quad \text{and} \quad \frac{\partial^2 L^*}{\partial w^2} < 0$$

A higher domestic wage rate w –and hence w/r – pushes industry x toward a more capital-intensive technique. Given \bar{K} , employment of domestic firms falls and hence domestic labor available for foreign producers increases. If $\sigma = 0$ –Leontief production function–, the right-hand-side of (9) is equal to 1, and the level of L^* that assures domestic capital market equilibrium is $L^* = h(w_a)$, that does not depend upon w .

Figure 2 depicts $h(w)$. Its position depends upon \bar{L} , \bar{k} and δ . The amount of labor available for foreign producers at any level of w increases with \bar{L} ($\partial h(w)/\partial \bar{L} > 0$) and it decreases with relative capital-abundance \bar{k} ($\partial h(w)/\partial \bar{k} < 0$). The intuition in both cases is the same: the larger or the more labor-abundant the domestic country is, the greater the labor force available for foreign firms at any w . Also, $h(w)$ depends positively on δ ($\partial h(w)/\partial \delta > 0$). For any level of w , the greater δ the lower the domestic return to capital, which implies a higher wage-rental ratio faced by domestic firms. As a consequence, domestic firms choose a more capital-intensive production technique in the capital-intensive industry and release more labor for foreign production. Finally, $h(w^*) < \bar{L}$ meaning that the upper limit for w is w^* .

[Insert Figure 2]

The vertical segment of $h(w)$ at $w = w_a$ follows from noticing that there is a range of aggregate employment by domestic firms consistent with positive domestic production of x and y and capital market equilibrium. With production diversification of domestic firms capital market clearing is possible as long as relative factor usage by domestic firms satisfies $k_y^a \leq \bar{K}/(\bar{L} - L^*) \leq k_x^a$. This condition implicitly determines the residual supply of labor for foreign firms consistent with domestic diversification.

The equilibrium in the domestic labor market is therefore reached when $h(w) = f(w)$, subject to $w \geq w_a$. If $h(w)$ and $f(w)$ do not intersect each other, as in panel (a) in Figure 3, there is no equilibrium with FDI and the domestic wage rate is w_a . Conceptually, the domestic economy is not able to provide a level of employment (and scale) to foreign firms that compensates the fixed cost of foreign production. This

equilibrium takes place under three conditions: (a) if the fixed cost of foreign investment is high enough (high $\min(F_i)$), (b) if the domestic economy is small and/or too capital abundant (low \bar{L} and high \bar{k}), and (c) if the technology disadvantage of the (potential) host country is small (low δ).¹⁴

[Insert Figure 3, panels (a) and (b)]

Panel (b) presents a case in which equilibria with positive FDI arises.¹⁵ There are two possible equilibria: a low-wage low-FDI one and a high-wage high-FDI equilibrium. In both cases the domestic economy specializes in the production of the capital-intensive good x and the equilibrium domestic wage rate is higher than w_a . However, it is possible to see that the low-wage low-FDI equilibrium is unstable while the high-wage high-FDI equilibrium is stable. Because $f(w)$ represents the minimum scale (measured in labor units) required by foreign firms at any given wage level and $h(w)$ represents the residual employment level available for foreign producers after imposing domestic capital market integration, the condition for a stable equilibrium is that $\partial f(w)/\partial w > \partial h(w)/\partial w$ at $f(w) = h(w)$. If $w_A < w < w_B$, the employment level of foreign firms is higher than its minimum required level to compensate the fixed cost, which means that price is higher than average cost. Because foreign firms have incentives to expand, the domestic wage rate increases until $w = w_B$. The opposite happens is $w < w_A$ or $w > w_B$, in which case the lack of foreign investment drive domestic wages down. Therefore, I focus the analysis on the only stable equilibrium B .¹⁶

Notice that domestic residents are unambiguously better-off in B compared to their autarky welfare level. Intuitively, this is because the capital-labor ratio of the capital-intensive good is higher than the capital-labor endowment of the economy, meaning that domestic residents are benefited with a rise in relative wages. Algebraically, income per capita is $y = w + r\bar{k}$ where (w, r) satisfy $p_x = a_{Lx}w + a_{Kx}r$. Totally differentiating both expressions yields $\partial y/\partial w = (k_x^a - \bar{k})/k_x^a$ that is greater than zero because $\bar{k} < k_x^a$.

¹⁴If $\sigma_i = 0$ the condition for an equilibrium with no FDI is $h(w^*/(1 + \delta)) < f(w^*/(1 + \delta))$, which implies $\bar{L} \left(1 - \bar{k}/k_x^a\right) < (1 + \delta/\delta) \cdot F_i/w^*$.

¹⁵If $f(w) = h(w)$ and $\partial f(w)/\partial w = \partial h(w)/\partial w$, there is a unique equilibrium with FDI.

¹⁶If $f(w)$ and $h(w)$ are such that A belongs to the vertical segment of $h(w)$, it is also the case that the only stable equilibrium is the high-wage high-FDI equilibrium with domestic specialization in the capital-intensive sector.

If the conditions for an equilibrium with FDI are satisfied, it is easy to see that domestic wages and foreign employment are higher the lower the fixed cost of foreign investment. Intuitively, a fall in fixed cost of foreign investment decreases the minimum scale compatible with foreign production. At the initial wage rate, foreign firms want to expand infinitely, which ends up pressuring domestic firms' employment down and domestic wages up. Likewise, a rise in \bar{L} or a fall in \bar{k} increases the residual labor supply faced by foreign firms at any wage rate. At the initial wage rate foreign firms are able to expand their production beyond their minimum required scale, pressuring domestic wages up and absorbing labor from the shrinking domestic capital-intensive sector, that responds to the rise in labor costs shifting toward a more capital-intensive production technique. A similar effect has a rise in the technology gap. By shrinking the domestic capital return, it rises the relative cost of labor for domestic firms, decreasing domestic employment and enhancing the expansion of foreign firms' production. As a result, domestic wages and foreign employment rise.

These results have important implications. First, notice that a greater technological disadvantage –that depresses the autarky wage rate– has an enhancing effect on domestic wages when FDI is allowed for. The likelihood of an equilibrium with FDI is higher in technology-backward countries, and the wage rate in an equilibrium with FDI is higher in technology-backward countries. This result contrasts with the result in Helpman (1984), where the likelihood of an equilibrium with multinational firms decreases as autarky factor price differences rise.

Second, if the conditions for an equilibrium with FDI hold, the rise in the relative cost of labor for domestic firms renders domestic producers uncompetitive in the labor-intensive industry, and makes the economy specialize in the capital-intensive industry. This change in comparative advantage toward capital-intensive sectors, that is stronger in large labor-abundant technology-backward countries, results from the assumption that technology is embedded in capital, so the domestic return to capital endogenously adjusts downward to assure domestic capital market equilibrium. However, we cannot say anything regarding the overall trade pattern of the host economy because we do not know the sectoral pattern of FDI, but it is possible that a country that was exporting the labor-intensive good in the pre-integration equilibrium end up exporting the capital-intensive good after FDI is allowed for.

In a more general setting, the idea that FDI flows from high- to low-wage countries shift the production structure of the latter toward more capital-intensive goods may have important welfare consequences on the former if recipients of FDI are large enough. The worldwide increase in production of capital-intensive goods can depress terms-of-trade of capital-abundant countries, with a negative welfare effect (see Samuelson, 2004). A more formal conclusion should however take into account the pattern of FDI flows and the change in production structure toward labor-intensive goods associated with a fall in K/L in source countries of FDI.

Finally, from a policy perspective, the idea that the fixed cost of foreign investment affects the likelihood and wage impact of foreign investment raises the question on the role that policies that affect F_i –like subsidies– can have on attracting FDI and enhancing the welfare gains for recipient countries. According to these results, for certain parameter values a fall in F_i –for example, through subsidies that affect the net value of F_i as faced by foreign firms– can have large effects on foreign investment, domestic wages and welfare.

2.3 Pre-integration Specialization

Up to this point we have assumed that domestic economy’s factor endowment is such that both x and y are produced when FDI flows are banned. This assumption implies that autarky factor price differences are only determined by technology differences (see (3)), and hence wage pressures from foreign firms’ penetration bring the domestic economy toward specialization in the capital-intensive good. In this section I extend the analysis to allow for factor endowment differences to affect autarky factor prices. In particular, I focus on a labor-abundant technology-backward economy that in autarky is specialized in the labor-intensive sector. Graphically, the initial equilibrium is depicted in Figure 4, where the equilibrium autarky domestic wage rate $w_a < w^*/(1 + \delta)$ is such that $\bar{k} = a_{Ky}(w_a/r_a)/a_{Ly}(w_a/r_a)$ where w_a, r_a satisfy $p_y^* = a_{Ly}w_a + a_{Ky}r_a$.

[Insert Figure 4]

The international wage gap w_a/w^* —that results both from technology differences and factor endowment differences— encourages the flow of technology-advanced foreign firms to the domestic economy. Foreign firms’ demand for domestic labor is given by (7), but the residual domestic labor supply available for foreign firms differs from $h(w)$. This is because the domestic economy may not necessarily specialize in the capital-intensive sector after foreign production is allowed for. Indeed, for small wage increases beyond w_a the domestic economy will continue specializing in the labor-intensive good. The residual domestic supply of labor available for foreign firms $L^* = h'(w)$ is implicitly defined as

$$\left\{ \begin{array}{l} \frac{k_y^*}{k} \cdot \left(1 - \frac{L^*}{L}\right) = \frac{1 - \sigma \theta_{Ky}^* \left(\frac{w}{w^*} - \frac{r}{r^*}\right)}{1 + \sigma \theta_{Ly}^* \left(\frac{w}{w^*} - \frac{r}{r^*}\right)} \\ \bar{L} \left(1 - \frac{\bar{k}}{k_x^*}\right) \geq L^* \geq \bar{L} \left(1 - \frac{\bar{k}}{k_y^*}\right) \\ \frac{k_x^*}{k} \cdot \left(1 - \frac{L^*}{L}\right) = \frac{1 - \sigma \theta_{Kx}^* \left(\frac{w}{w^*} - \frac{r}{r^*}\right)}{1 + \sigma \theta_{Lx}^* \left(\frac{w}{w^*} - \frac{r}{r^*}\right)} \end{array} \right\} \text{ if } \left\{ \begin{array}{l} w_a < w < \frac{w^*}{1+\delta} \\ w = \frac{w^*}{1+\delta} \\ \frac{w^*}{1+\delta} < w \leq w^* \end{array} \right.$$

If $w_a < w < w^*/(1 + \delta)$ the domestic economy remains specialized in the labor-intensive industry, and L^* is such that relative factor usage by domestic firms in industry y assures domestic capital market clearing. If $w = w^*/(1 + \delta)$ both x and y are competitive, and there is a range for L^* consistent with production diversification and capital market equilibrium. Finally, if $w > w^*/(1 + \delta)$, domestic producers in the labor-intensive industry are rendered uncompetitive and there is specialization in the capital-intensive industry, as in section 2.2.

Similar conditions to those discussed in section 2.2 determine the likelihood of an equilibrium with positive FDI. However, an equilibrium with positive FDI is more likely in this case because $h'(w) > h(w)$ for all w , as the lower capital-labor endowment of the domestic economy (consistent with pre-integration specialization) rises the residual labor supply for foreign firms at any wage rate. This implies that a labor-abundant country that is specialized in the production of the labor-intensive good in the pre-integration equilibrium has a higher possibility of attracting FDI than a country that is more capital abundant and that has a higher autarky wage rate.

Panels (a) and (b) in Figure 5 plot two examples in which an equilibrium with FDI exists. In panel (a), only B is an stable equilibria, and it has the same properties as the one in Figure 3(b). Foreign investment pressures domestic wages beyond the level consistent with production diversification ($w^*/(1 + \delta)$), and

the economy specializes in the production of the capital-intensive good, meaning that there is a shift in comparative advantage. As before, foreign firms' employment and domestic wages are higher if the fixed cost of foreign investment is low, if the domestic economy is large or labor-abundant, and if its technology gap is high.

[Insert Figure 5, panels (a), (b) and (c)]

In panel (b), there are two stable equilibria, and in both $w > w_a$.¹⁷ There is a low-wage low-FDI equilibrium A –with specialization in the labor-intensive good–, and a high-wage high-FDI equilibrium B in which the domestic economy is specialized in the production of the capital-intensive good. Although we cannot predict which equilibrium will actually take place, comparative statics reveal that around each equilibrium point, domestic wages are higher in large labor-abundant technology-backward countries.

Again, the condition that depress domestic autarky wages –technology differences and labor abundance– enhance the likelihood of an equilibrium with FDI and they also rise the wage rate in the case an equilibrium with FDI takes place. Also, the more labor-abundant a country is the greater its ability to attract foreign investment. However, in comparison with the case when countries are diversified in the pre-integration scenario, the change in the pattern of production and trade is less clear: the domestic economy can remain specialized in the production of the labor-intensive commodity.

These results are not limited to a two-good world. In a multiple-goods multiple-cones world (see panel (c) in Figure 5), in which the domestic economy produces one or two labor-intensive goods in the pre-FDI equilibrium, similar conclusions follow. If the conditions for an equilibrium with positive FDI holds, there might be one stable equilibrium or two stable equilibria: a low-wage low-FDI equilibrium and a high-wage high-FDI equilibrium. In the low-wage equilibrium, the domestic economy is specialized in the production of one labor-intensive commodity while in the high-wage equilibrium domestic firms produce a capital-intensive good. Whether the pattern of domestic production changes from its pre-integration equilibrium depends upon differences in factor intensities across commodities. With many goods that do not differ significantly

¹⁷In general, the maximum number of equilibria is 4, and at most two of them are stable.

in their factor intensities, small enough changes in relative factor prices produce a shift from one cone of diversification to another one, affecting the pattern of production. Therefore, unless $\min(F_i)$ is too low, in either equilibrium the domestic economy produces a commodity that is more capital-intensive than the one produced in autarky.

3 Conclusions

Foreign investment from high- to low-wage countries introduces pressures on domestic labor markets due to technological advantages of foreign firms. Unless the low-wage country is small or capital abundant, its technology gap is small or the fixed costs of foreign investment are high –in which case there is no FDI in equilibrium–, the access of technology-backward firms affects the domestic labor market and the patterns of comparative advantage. In particular, the domestic wage rate rises above its autarky level, rising the relative cost of labor for domestic producers and shifting the domestic production structure toward a more capital-intensive mix. The final pattern of production will also depend upon the sectoral distribution of foreign investment, that depends solely on the relative size of the fixed cost of foreign investment.

A first implication of the paper is that the likelihood of an equilibrium with foreign investment and labor market pressures is higher when the domestic economy is able to provide the necessary scale of production for foreign producers in order to compensate for the fixed cost of foreign production. This is more likely in large labor-abundant technology-backward countries or when the fixed cost of foreign invested is low. Once the conditions for positive FDI are satisfied, domestic wages rise above their autarky level, and the equilibrium wage rate is higher in large labor-abundant economies or economies with high technology gap. Interestingly, the conditions that determine that a country has low income per capita before capital and technology flows are allowed for –low productivity and a low capital-labor endowment ratio– are those that enhance the possible gains of FDI inflows.

Also, the change in relative factor prices in the domestic economy shifts the pattern of domestic production toward a more capital-intensive mix. As the domestic capital market remains segmented, wage increase

depress the domestic return to capital, rising the relative cost of labor for domestic producers. Some domestic factors must remain segmented from international competition if technology-backward firms are to remain viable when technology-advanced foreign firms have access to domestic factor markets. In this case, I have assumed that the capital market remains segmented, so its return adjusts downward to compensate for domestic technology backwardness. If foreign producers had access to all factor markets in the economy, technology-backward domestic producers cannot compete in any industry, and the paradigm of comparative advantage vanishes as absolute technology differences become relevant. In general, FDI rises the relative cost of the factor they have access to in the host economy, shifting the domestic production structure away from the goods that use intensively that factor.

The idea that FDI can shift the production pattern of labor-abundant technology-backward countries toward capital-intensive goods may have important welfare implications for the countries that are source of FDI. Following Samuelson (2004), a shift toward production of capital-intensive goods by poor countries—in this case not because they have access to the advanced country technology but rather in response to the change in domestic relative factor prices following the arrival of technology-advanced foreign firms—can have negative terms-of-trade effects on capital-abundant countries.

This result contrasts with the traditional idea that global integration—through of the appearance into the world economic system of large previously-closed labor-abundant countries—is associated with a fall in the relative price of labor-intensive commodities and hence a positive terms-of-trade effect for net importers of labor-intensive goods. The results in this paper suggest that the effects of capital and technology flows go in the opposite direction. The increase in relative wages in the host technology-backward labor-abundant country changes its pattern of comparative advantage toward capital-intensive goods. If this effect is large enough it generates a negative terms-of-trade effect on capital-abundant technology-advanced countries. The quantitative relevance of this mechanism requires further study, but it reveals that capital and technology flows have critical implications on production and trade patterns.

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Figure 1
Foreign Firms' Domestic Labor Demand

$$L^* = f(w; F_i)$$

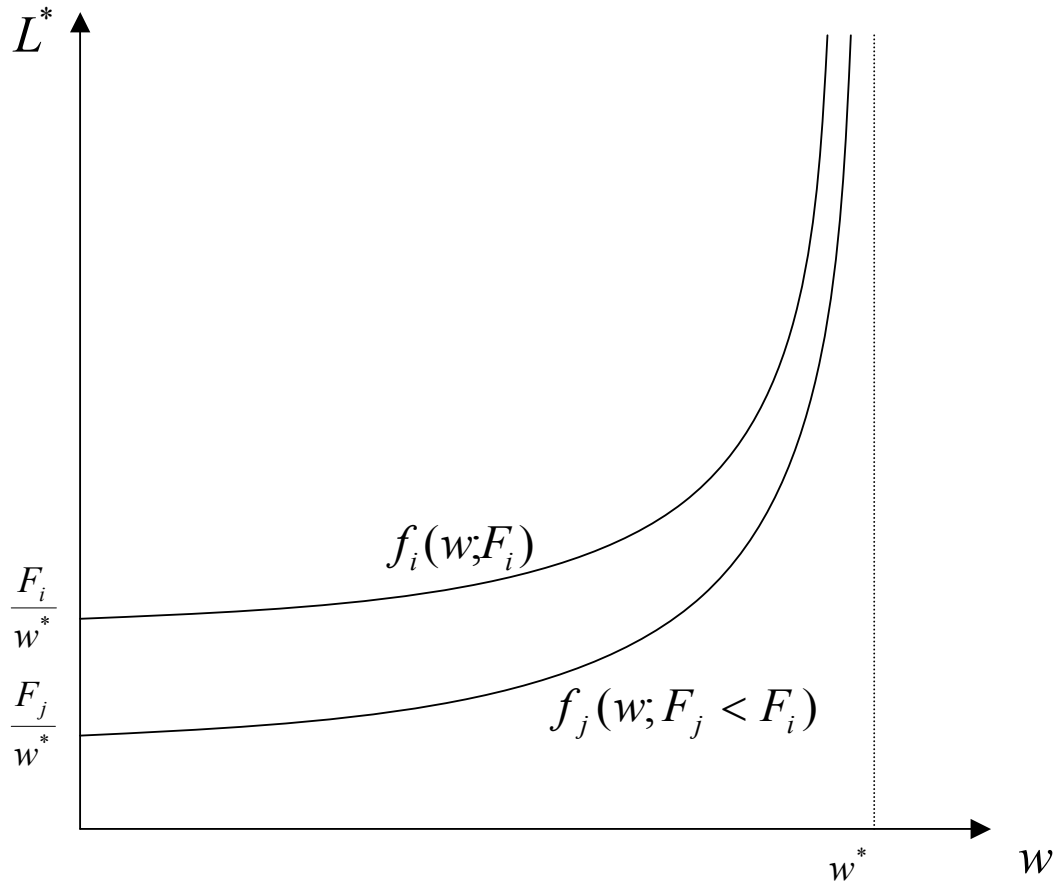


Figure 2
Residual Domestic Labor Supply for Foreign Firms consistent with Domestic Capital Market Equilibrium

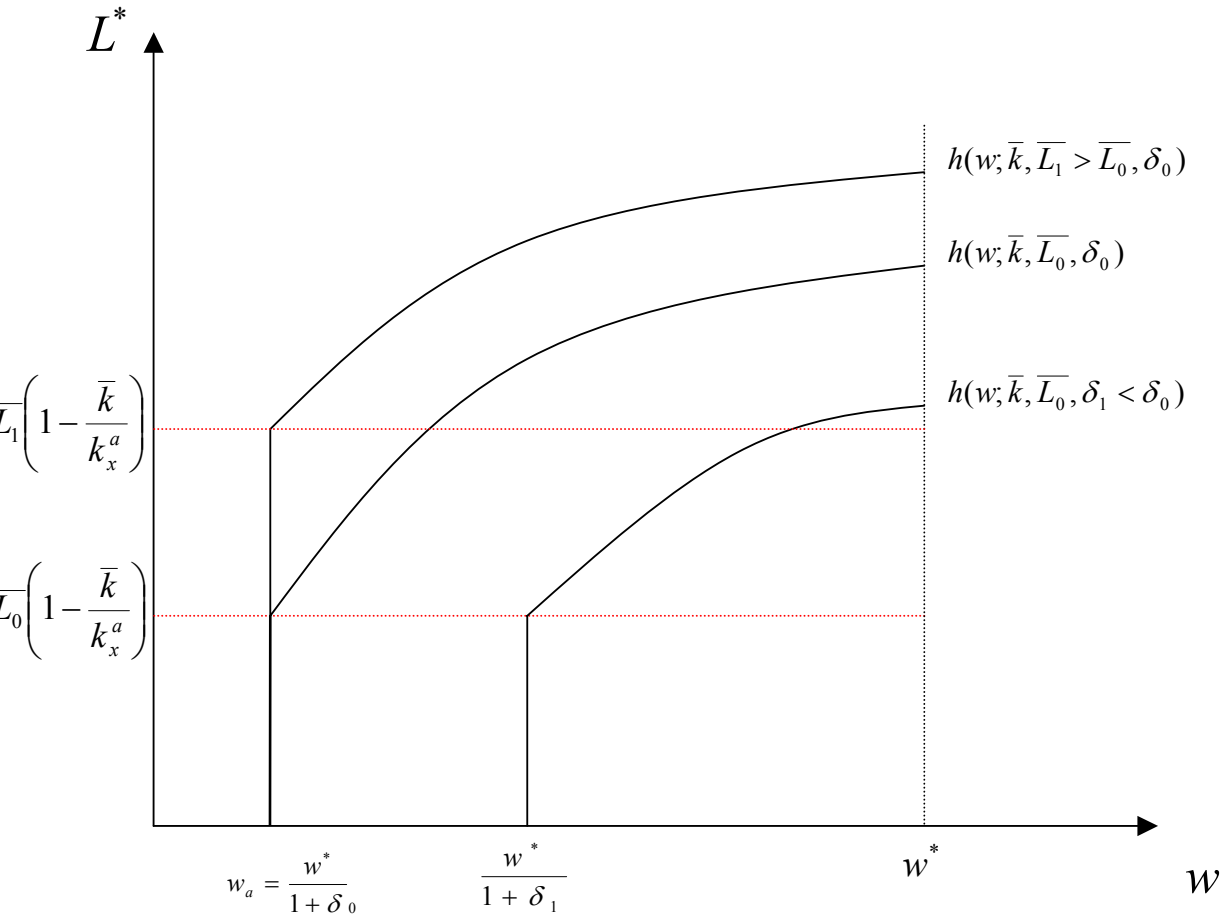


Figure 3, Panel (a)
Domestic Labor Market Equilibrium without FDI

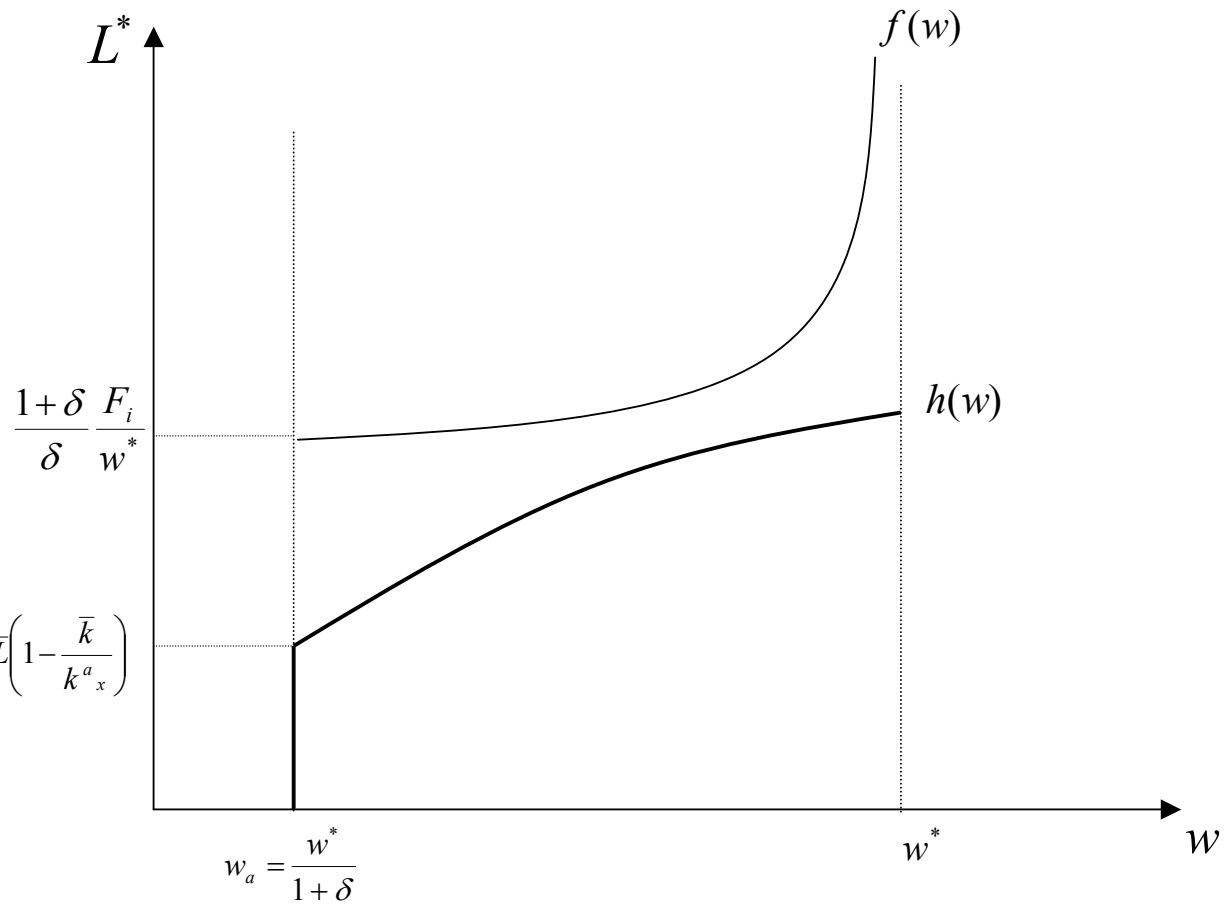


Figure 3, Panel (b)
Domestic Labor Market Equilibrium with FDI

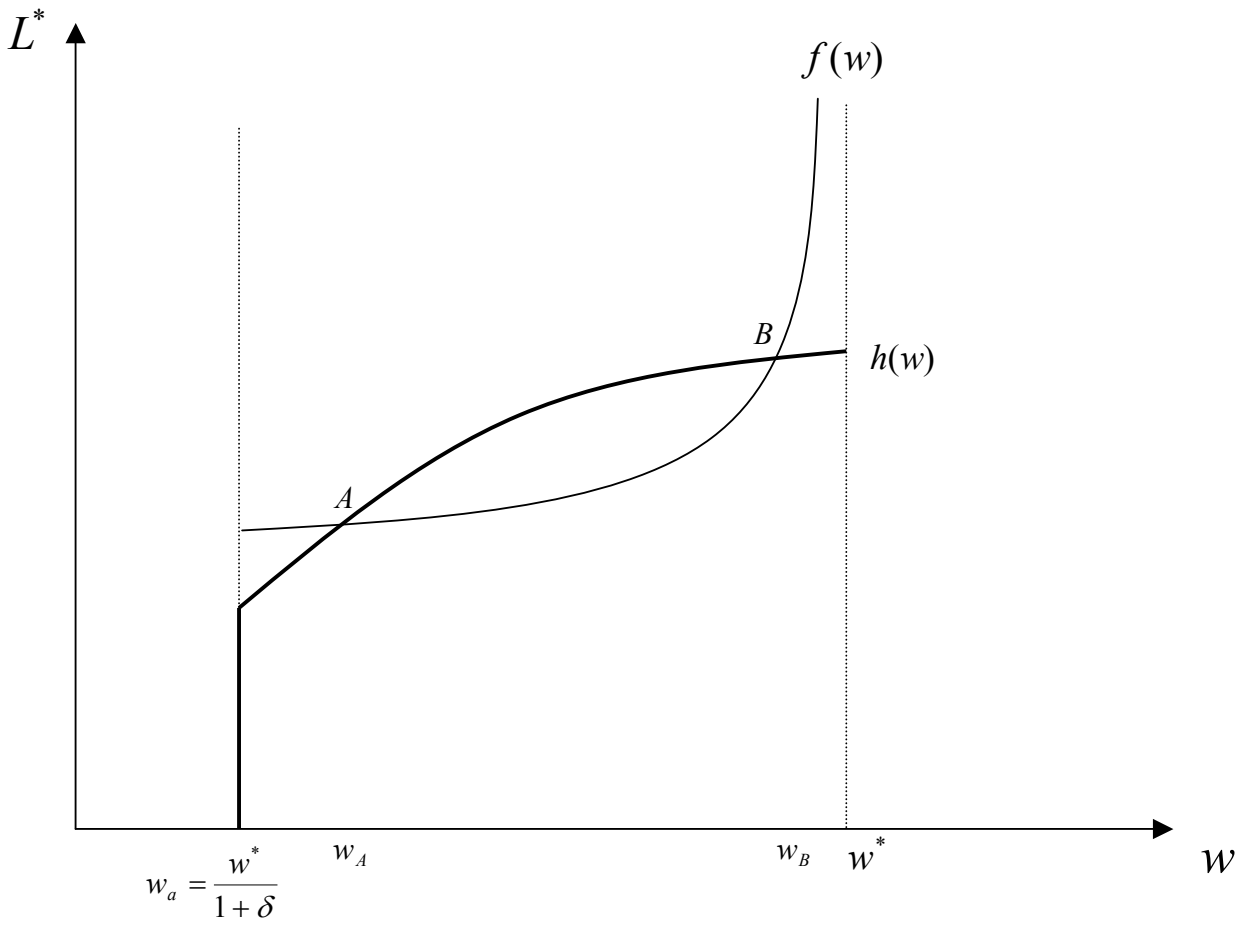


Figure 4
Pre-Integration Equilibrium with Domestic Specialization

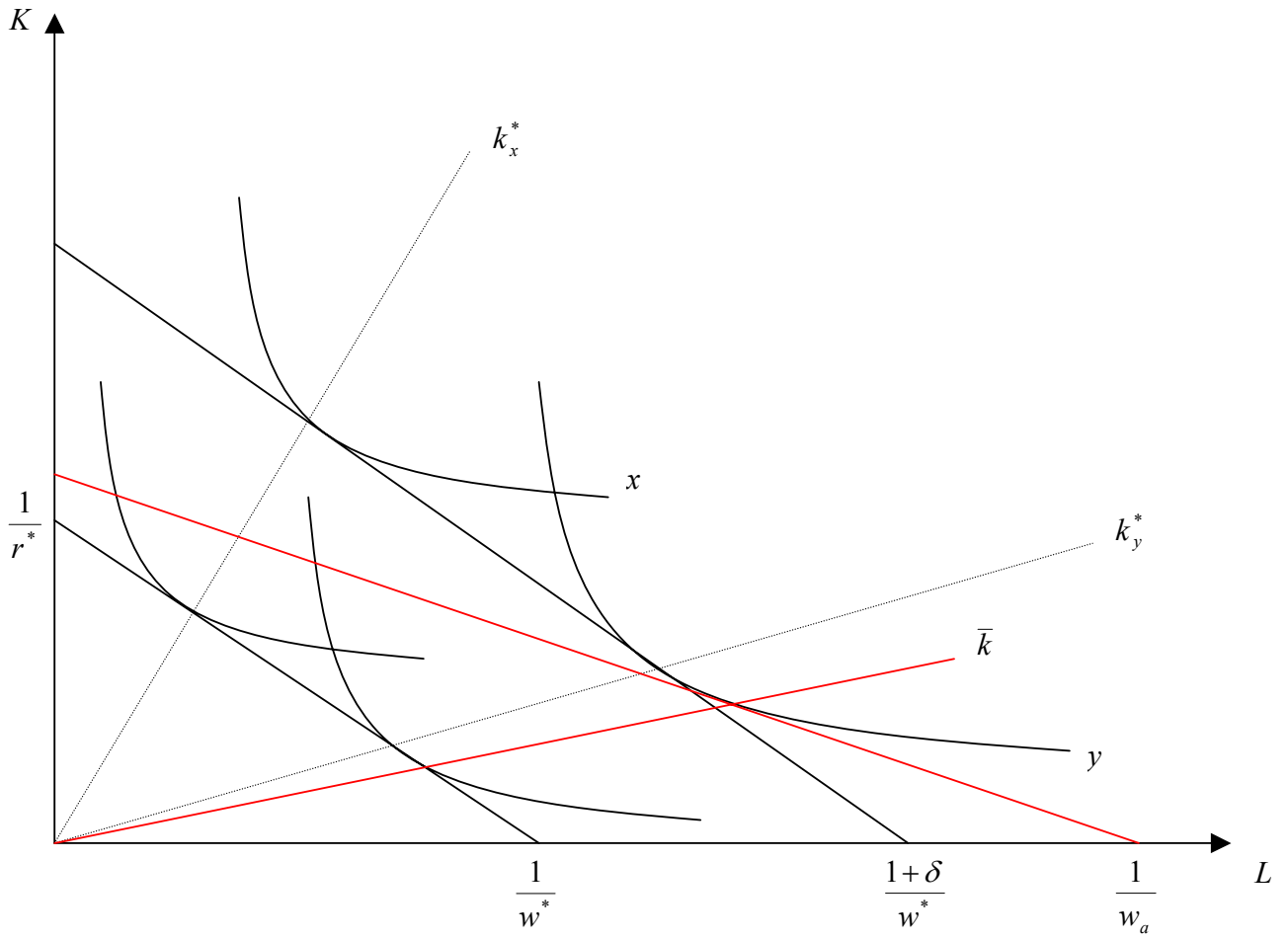


Figure 5, Panel (b)
Domestic Labor Market Equilibrium with Pre-Integration Domestic
Specialization: Two-goods Case
TWO STABLE EQUILIBRIA

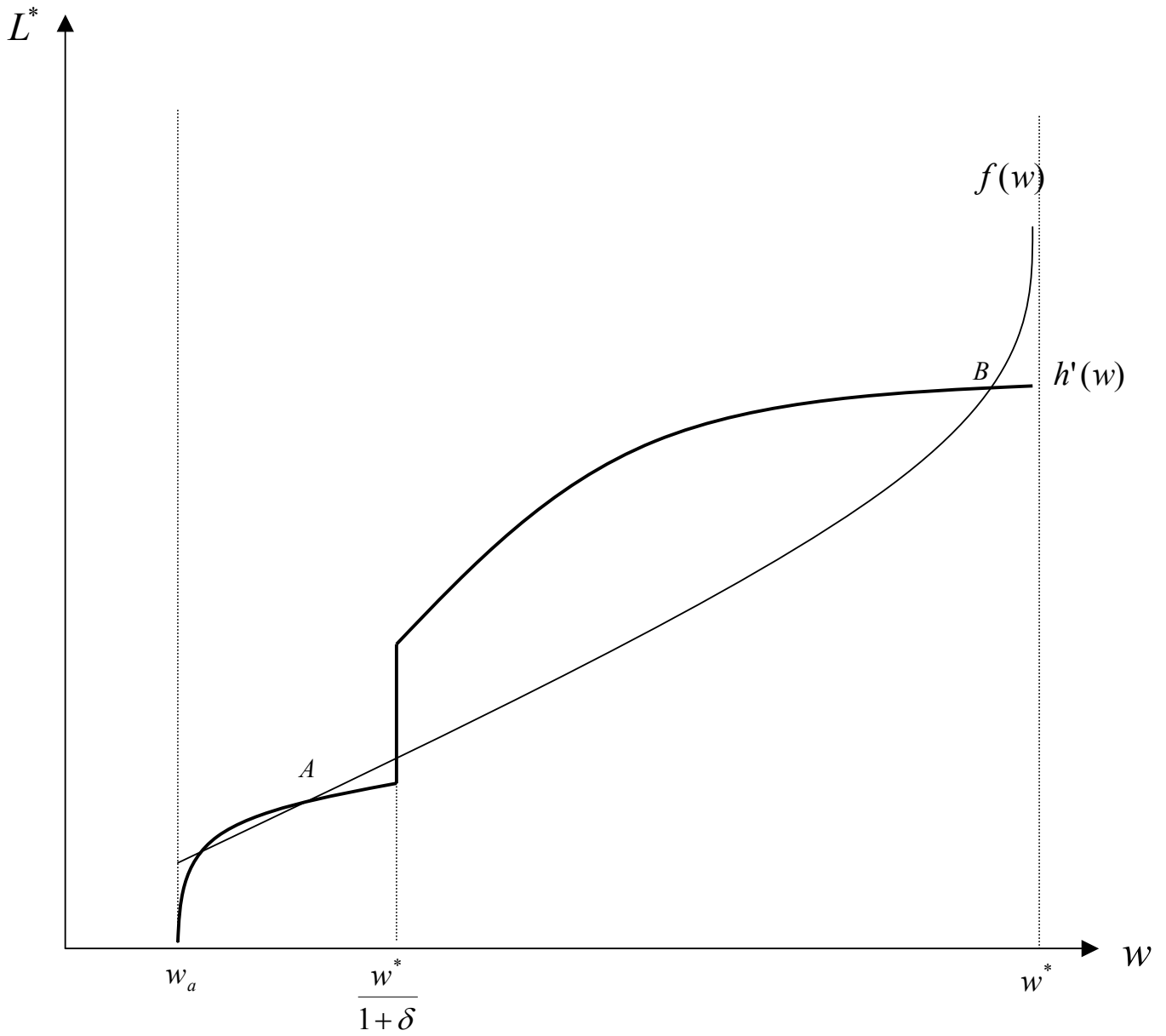


Figure 5, Panel (c)
Domestic Labor Market Equilibrium with Pre-Integration Domestic Specialization: Multiple-goods Case

