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Fragmentation, Efficiency-seeking FDI and Employment

by

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Fragmentation, Efficiency-seeking FDI, and Employment[‡]

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Abstract

The paper examines the impact of efficiency-seeking FDI on factor prices, employment, and output. We use a competitive equilibrium model of a single manufacturing sector and assume that its output is assembled from a continuum of intermediate goods (fragments). The production location of each fragment is determined endogenously. The analysis shows that when transportation costs or barriers to trade fall, companies start relocating labor intensive production processes to low-wage countries. But this does not necessarily hurt workers in the high-wage country. We find an employment depressing "relocation effect" and three employment enhancing effects: an "efficiency effect", an "offshore cost effect", and a "growth effect". Furthermore, we demonstrate that our model is capable of explaining *intraindustry* cross-hauling and that the extent of these two way capital flows has a major impact on the employment effects of production relocations.

Keywords: Globalization, Fragmentation, Efficiency-seeking FDI, Wages and Employment, Intraindustry Cross-hauling, Transportation Costs

JEL: F11, F15, F23

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1. Introduction

The dramatic increase in international capital mobility is one of the key characteristics and driving forces of the worldwide economic integration often described as globalization. On average, foreign direct investment flows (FDI) have outgrown both international trade and national outputs and multinational enterprises (MNEs) are playing an increasing role in the international division of labor. They have built complex production networks which enable them to react to fiercer competition on world markets by either expanding to new and dynamic markets or by optimizing their locational decisions on a global scale, i.e. moving plants to countries and regions where production costs are lower. From a high-wage, industrialized country's perspective the latter, efficiency-seeking motive is most likely to lead to an outflow of real capital to developing, low-wage countries.

Consequently, FDI inflows to developing countries have risen in both absolute and relative terms over the last years (UNCTAD, 1996, p. 4). They amounted to \$ 33.7 billion in 1990 and increased three-fold to \$ 99.7 billion in 1995 while their share of total FDI inflows has grown from 21 percent (1988-1992) to 32 percent in 1995. The Central and Eastern European Countries (CEECs) are experiencing especially high growth rates. Starting from a very low level at the beginning of 1990s FDI inflows have increased by a factor of approximately 40. According to UNCTAD (1997) this development is expected to continue as corporate restructuring in developed countries, aimed at improving efficiency and modernization, carries on.

Most of the developing countries that have experienced such an inflow of capital from the developed countries have benefited from it through more employment opportunities and higher growth rates (ILO, 1976; OECD, 1993; OECD, 1998). But does this in return mean that industrialized countries are losing jobs to their developing "locational competitors"? The

debate about the "giant sucking sound" of NAFTA in the US and the emergence of new competitors in the CEECs at a time of high unemployment in the industrialized European economies have renewed interest in this topic. Additionally, advances in technology have made it possible for MNEs to "slice up the value added chain" (Krugman, 1995, p. 333) and produce different production "fragments"¹ in different countries. As a consequence, MNEs are relocating mainly labor intensive manufacturing processes from high-wage countries to low-wage countries (FIAS, 1996; FIAS, 1997; Lemoine, 1998; OECD, 1993). This fact has fueled fears in the industrialized countries that efficiency-seeking FDI reduces demand for labor and that workers are left as the "losers" of globalization.

Empirical studies have tried to assess the employment effects of outflowing FDI with ambiguous results.² Apart from methodological shortcomings and poor data in most countries they also lack a sound theoretical foundation. If capital exports are a defensive strategy to cope with import penetration, the employment effects of FDI have to be compared with what would have happened if FDI had not taken place - a story statistical data cannot tell (McGuire, 1995, p. 132). Problems arise when one looks not only at the immediate and direct displacement effects of a particular relocation but tries to take into account indirect effects, such as increases in efficiency and economy-wide structural change. Most authors are well aware of these problems and discuss their implications for an assessment of the employment effects. Glickman and Woodward (1989, p. 175) argue that if FDI is production-oriented, domestic jobs are likely to be eliminated, but add in the next sentence that if defensive, market-preserving motives are behind the investment it "might" actually save jobs at home. According to Baldwin (1994, p. 31), most economists believe that a firm conclusion about the net employment effects of FDI is not possible because of the sensitivity of the results with respect to the assumptions made about what will happen in the absence of FDI. Madeuf (1995, p. 46) stresses the point that the jobs displaced due to the MNE's decision to relocate its

economic activity could as well have been lost in the marketplace due to a deprivation of the firm's competitiveness. Both changing patterns of comparative advantages and the search by firms for competitive advantages are possible explanations for job losses in the absence of plant delocalizations. For Agarwal (1997), relocation is of prime importance for employment effects of FDI. Efficiency-seeking outbound FDI that is meant to relocate the production capacity from the home base to another country reduces employment at home. However, the choice for the companies involved might not be between relocation and domestic production but between relocation and loss of home market. In this case, the competitiveness-strengthening effect must not be ignored.

This paper takes a closer look at the various labor market effects of efficiency-seeking FDI. We introduce a model of a single fragmented manufacturing sector with a continuum of intermediate goods (Dornbusch, Fischer, Samuelson, 1977, 1980; Feenstra, Hanson, 1996). In this setting, companies start relocating labor intensive production processes from a high-wage country to a low-wage country when "economic distance", i.e. transportation costs, barriers to trade etc., between the two locations falls. We assume that this spatial fragmentation does not lead to an organisational fragmentation (Venables, 1999), so that companies set up foreign affiliates via FDI. The locational decision for each fragment is determined endogenously and based solely on production costs. Therefore, the induced capital movements are efficiency-seeking.

The remaining of the paper is organized as follows. In section 2 we set up the model and derive the international allocation of intermediate production. A comparative-static analysis in section 3 yields the various employment effects of efficiency-seeking FDI before section 4 concludes the paper.

2. The Model

For the supply-side of the model we assume a single fragmented manufacturing sector X. The final product is assembled from a continuum of intermediate products $Q(z)$ with a fixed proportion $\alpha(z)$ indexed over the interval $[0,1]$. The production function of X for all $z \in [0,1]$ can be expressed as

$$(1) \quad X = \min\{Q(z)/\alpha(z)\}$$

and demand for each of the intermediate goods is a linear function of X:

$$(2) \quad Q(z) = \alpha(z)X$$

Each of the intermediate products $Q(z)$ is produced with a linear-homogeneous technology using capital and labor as substitutional factor inputs. However, because the production location will be determined endogenously, some of these intermediates are produced in the home country, using capital (K) and domestic labor (L), and some of them are produced abroad, using capital and foreign labor (L^*). Therefore, factor inputs depend on the production location and the production function takes on the form

$$(3) \quad Q(z) = Q(z; K(z), L(z))$$

if production takes place at home, or

$$(3^*) \quad Q^*(z) = Q^*(z; K(z), L^*(z))$$

in the case of offshore production (a star denotes a foreign variable).

Let labor be a location specific factor of production whereas capital is supposed to be mobile across countries. Furthermore, we assume that technology is embedded in capital and

can be transferred with it across national borders. Thus, production at home and production abroad both use the same technology.³

All intermediate products are arranged in that way so that their capital intensity $k = K/L$ for any given wage-rental ratio is strongly decreasing in z , i.e.

$$(4) \quad k(0) > k(z) > k(1)$$

with $k'(z) < 0$.

In a competitive equilibrium companies face a given wage-rental ratio ℓ/r and adjust their factor intensities to minimize production cost. With linear-homogeneous technologies cost per unit of output can be expressed as a function of input prices only. Therefore, production costs $q(z)$ per unit of $Q(z)$ are given by

$$(5) \quad q(z) = q(z; r, \ell) \quad (\text{production at home})$$

$$(5^*) \quad q^*(z) = q^*(z; r, \ell^*) \quad (\text{production abroad})$$

The first derivative of these cost functions with respect to a factor price yields the respective factor coefficient, so that $\partial q(z)/\partial r = q_r(z) = K(z)/Q(z)$ with $q_r(z) = q_r(z; r, \ell)$.

We now assume that companies do not have to produce all of their production fragments in the same country but instead have the option to split up their production process and relocate only some of their intermediate goods. When deciding about the location of a particular fragment, production costs at home and abroad play a major role. Suppose that "Home" is a high-wage industrialized country and "Foreign" a low-wage developing country, then the following inequality holds by assumption:

$$(6) \quad \ell > \ell^*$$

However, companies do not look at production cost only. Distance (transportation costs) and political costs (tariffs etc.) matter, too. These are included in what is called "total landed costs" (TLC). They consist of production cost, transportation cost, and possible tariffs (Levy, Dunning, 1993, p. 21). In our model these additional cost factors will be summarized in a parameter $t \geq 1$ and treated as location specific factor neutral cost so that $TLC = tq^*(z; r, \ell^*)$. If for a particular production process TLC abroad are lower than production cost at home, this process is relocated. Thus, necessary and sufficient condition for the relocation of intermediate production $Q(z)$ is:

$$(7) \quad q(z; r, \ell) > tq^*(z; r, \ell^*)$$

For a given set of factor prices, the location of an activity depends on t . If $t > \ell/\ell^* > 1$ so that $r < tr$ and $\ell < t\ell^*$, then the production process is located in the developed home country. On the other side, if $t = 1$ and, thus, $r = tr$ and $\ell > t\ell^*$, TLC are lower in the developing country. But if $\ell/\ell^* > t > 1$, i.e. if $r < tr$ and $\ell > t\ell^*$, then the location of this fragment depends on its factor intensities. In this case, the home country has a cost advantage for capital intensive production processes due to lower cost of capital whereas the foreign country has a cost advantage for labor intensive production processes due to the lower wage bill. Looking at the international allocation of all production processes, we can differentiate between three cases:

- (i) $t > \ell/\ell^* > 1$ all production processes at home
- (ii) $\ell/\ell^* > t > 1$ capital intensive production at home, labor intensive production abroad
- (iii) $t = 1$ all production processes abroad

The international allocation of production can be shown graphically in a K-L-diagram using unit-value isocost curves. These curves, the respective intercepts, and their slopes are given by

$$(8) \quad rK + \ell L = 1$$

with $(0, \frac{1}{r})$, $(\frac{1}{\ell}, 0)$, and $\frac{dK}{dL} = -\frac{\ell}{r} < 0$

$$(8^*) \quad t(rK + \ell^* L^*) = 1$$

with $(0, \frac{1}{tr})$, $(\frac{1}{\ell^*}, 0)$, and $\frac{dK}{dL^*} = -\frac{\ell^*}{r} < 0$.

The slope of the foreign unit-value isocost curve is flatter for all $\ell > \ell^*$ and independent of t . Changes in t merely shift the foreign unit-value isocost curve but do not change its slope.

For high values of t ($t > \ell/\ell^* > 1$) the foreign unit-value isocost curves lies completely beneath the home country's curve, indicating that for a given cost companies can produce more of all intermediate goods at home than abroad (figure 1a). Therefore, all intermediates are produced at home. As t decreases ($\ell/\ell^* > t > 1$) the foreign unit-value isocost curve is shifted upwards until it intersects with the home isocost curve (figure 1b). In this case, a production at home is still more efficient for all production processes to the left of the intersection, i.e. for capital intensive fragments, while labor intensive processes are relocated abroad for efficiency reasons. If t continues to fall and approaches one (figure 1c), all intermediate goods are produced abroad as the foreign country's unit-value isocost curve is shifted above the home country's isocost curve. Given the option to produce either at home or abroad, the relevant cost restriction are indicated by a thicker line.

[INSERT Figures 1a-1c here]

In what follows we will concentrate on the empirically relevant case (ii) and assume that $l/l^* > t > 1$. Because we have arranged the continuum of intermediate goods according to their capital intensities [see (4)] we are now able to identify which intermediates are relocated and which remain at home. Recall that the low-wage country has a cost advantage for labor intensive processes, i.e. for intermediate goods indexed by numbers of z close to 1, whereas intermediate goods indexed by very low numbers of z can be produced at lower cost in the high-wage country. It is possible to derive a critical value of z , denoted by \tilde{z} , such that $q(z) - tq^*(z) < 0$ for $0 \leq z < \tilde{z} < 1$ and $q(z) - tq^*(z) > 0$ for $0 < \tilde{z} < z \leq 1$. Thus,

$$(9) \quad q(\tilde{z}) - tq^*(\tilde{z}) = 0$$

This is shown in figure 2 (linearity is assumed for simplicity):

[INSERT Figure 2 here]

Having determined \tilde{z} , we can establish that all intermediate goods in the range $[0, \tilde{z})$ are produced at home and all intermediates between $(\tilde{z}, 1]$ are produced in the low-wage foreign country.

Now the production cost per unit of output of the final good X can be determined. They consist of the production costs or TLC, respectively, of all intermediate goods. With a continuum of intermediates, we take integrals so that total cost per unit of X are given by

$$(10) \quad c^x = \int_0^{\tilde{z}} q(z)\alpha(z)dz + t \int_{\tilde{z}}^1 q^*(z)\alpha(z)dz$$

The first term on the right hand side of (10) yields domestic costs and the second term yields TLC of offshore production, both per unit of X.

On the demand side of X we suppose that the home country is a small country on the world market and that it faces a perfectly elastic demand for the tradable good X. Thus, the price p of X is given exogenously. In a competitive equilibrium, this price equals cost per unit of output:

$$(11) \quad \int_0^{\bar{z}} q(z)\alpha(z)dz + t \int_{\bar{z}}^1 q^*(z)\alpha(z)dz = p$$

Finally, we introduce factor market restriction and derive demand functions for capital and labor from the respective production functions. Thus, equilibria are given by

$$(12) \quad X \left[\int_0^{\bar{z}} q_r(z)\alpha(z)dz + \int_{\bar{z}}^1 q_r^*(z)\alpha(z)dz \right] = K(r)$$

$$(13) \quad X \left[\int_0^{\bar{z}} q_\ell(z)\alpha(z)dz \right] = L(\ell)$$

The left hand side of (12) indicates that capital is mobile across countries and that the international allocation of capital and, thus, of productive activities within this industry is determined endogenously by the profitability of the two alternative locations. Additionally, the right hand side shows that the supply of capital K is also determined endogenously by the profitability of this sector as a whole, i.e. its rental rate. This can be attributed either to international intrasectoral capital mobility or, as we look at a partial equilibrium, to domestic intersectoral capital mobility in the form of structural change. We will assume that the elasticity of capital supply with respect to the rental rate lies in the closed interval between zero and positive infinity, so that $\varepsilon_{K,r} \in [0, \infty]$. The comparative-static analysis in section 3 starts with an inelastic supply of capital before investigating the impact of an elastic capital supply on the employment effects of FDI.

As the paper is concerned with FDI and employment, (13) introduces a labor supply function $L = L(\ell)$ with $\infty > L'(\ell) > 0$. In this setting, changes in employment are brought about by movements along a positively sloped labor supply curve. The functional relationship between the wage rate and employment can either be caused by mobility of the work force across sectors or by labor market distortions like efficiency wages. In the first case an increase of the wage rate increases the overall labor supply and leads to higher employment, while in the second case an increase of employment is triggered by a decrease of unemployment, while total supply of labor is constant.

No factor market restrictions are provided for the foreign wage rate, leaving its value exogenous. While the exogeneity of the foreign wage rate might be unrealistic in a two country setting (like US investment in Mexico), in the small country case ℓ^* has to be interpreted as an weighted average wage rate of all low-wage countries. Empirical evidence seems to support the assumption of the exogeneity of the relevant wage rate: As labor shortages arise in a particular developing country, and wages increase, efficiency-seeking FDI is simply re-routed to different low-wage countries.⁴

3. Comparative-Statics

(11)-(13) uniquely determine the rental rate r , employment L , and output of the final good X . We are now able to show the comparative-static effects of decreasing total landed costs on these variables (a hat denotes relative change). First, we assume that capital is inelastically supplied, i.e. $\epsilon_{K,r} = 0$.

Lemma 1: *If \tilde{z} as determined in (9) lies in the range $(0;1]$, then a fall of t leads to efficiency-seeking FDI from the high-wage country to the low-wage country, i.e. $d\tilde{z}/\hat{t} > 0$.*

Proof: A fall of t c.p. leads to an upward shift of the $q(z) - tq^*(z)$ curve in figure 2. The new intersection between the curve and the vertical axis, depicting the marginal fragment \tilde{z} , is at a lower z . Therefore, capital is moved from the high-wage country to the low-wage country to perform more productive activities in the developing country as a consequence of its lower TLC. Figure 3 illustrates this point:

[INSERT Figure 3 here]

Depending on whether the relocation affects the product market equilibrium (11) or the factor market restrictions (12) and (13), we distinguish between a relocation effect and an efficiency effect.

The Relocation Effect

Call $d\tilde{z}_{RE}$ the influence of production relocations on the factor market equilibria (see appendix), then we can derive lemma 2:

Lemma 2: $\hat{r}/d\tilde{z}_{RE} < 0$, $\hat{L}/d\tilde{z}_{RE} > 0$, $\hat{X}/d\tilde{z}_{RE} < 0$ if $[K(\tilde{z}) - K^*(\tilde{z})]/L(\tilde{z}) < K/L$. In the factor market, a relocation of labor intensive production processes from the high-wage country to the low-wage country results in a rise of the rental rate and a fall of employment. Output of the final good X increases. We call this effect the "relocation effect".

Proof: A mathematical proof is provided in the appendix. These results depend on whether $[K(\tilde{z}) - K^*(\tilde{z})]/L(\tilde{z}) \gtrless K/L$. The nominator on the left hand side, $K(\tilde{z}) - K^*(\tilde{z})$, equals the change in demand for capital due to the relocation of the marginal fragment \tilde{z} . The denominator, $L(\tilde{z})$, equals the respective change in demand for domestic labor, because domestic labor is not employed in foreign production (see figure 4). Thus, the left hand side $[K(\tilde{z}) - K^*(\tilde{z})]/L(\tilde{z})$ represents the relative change in demand for both factors of production due to the relocation of \tilde{z} . If a production process z is labeled labor intensive if it uses relatively more labor than the industry average, i.e. if $K(z)/L(z) < K/L$, then relative labor intensity of the marginal fragment is a sufficient condition for $[K(\tilde{z}) - K^*(\tilde{z})]/L(\tilde{z}) < K/L$ and, therefore, for the results derived above.

[INSERT Figure 4 here]

It should be noted, however, that both the rental rate and employment would fall if output did not increase. This is due to the fact that for a given output demand for both factors of production falls as a consequence of the relocation. Whereas the shortfall of demand for the location specific factor labor seems obvious, the decline of demand for capital is caused by the lower capital intensity of offshore-production due to the lower foreign wage rate. This means that the same output is produced with less capital (and more foreign labor). But as this sector faces a perfectly elastic demand for its final good, the output of X increases. Therefore, factor

price changes are determined by *relative* changes in the demand for these factors rather than by absolute changes. And as labor intensive production processes are relocated, relative demand for labor falls.

The Efficiency Effect

Call $d\tilde{z}_{EE}$ the influence of relocating \tilde{z} on the product market equilibrium (see appendix), then we can derive lemma 3:

Lemma 3: $\hat{r}/d\tilde{z}_{EE} < 0$, $\hat{L}/d\tilde{z}_{EE} < 0$, $\hat{X}/d\tilde{z}_{EE} < 0$. *The "efficiency effect" increases demand for all factors of production. Therefore, both the rental rate and employment rise at home. Final output also increases.*

Proof: The mathematical proof is provided in the appendix. As was shown in lemma 1, the optimal international allocation of productive activities changes when t falls. The old marginal fragment, denoted by \tilde{z}_0 in figure 3, is now clearly produced with lower costs in the foreign location, i.e. $q(\tilde{z}_0) > tq^*(\tilde{z}_0)$. Therefore, a relocation of \tilde{z}_0 saves on production cost, so that the final product can be sold at a lower price. If demand for the final product is perfectly elastic with respect to its price, as can be expected if the country or industry is small compared to the world market, output increases. This in turn boosts demand for all factors of production, so that the rental rate and employment rise.

The Offshore Cost Effect

So far we have analyzed the effects of the actual relocation of the marginal fragment \tilde{z} . However, the initial fall of t also leads to inframarginal changes which have no effect on the international allocation of production processes but do influence overall production costs:

Lemma 4: $\hat{r}/\hat{t} < 0$, $\hat{L}/\hat{t} < 0$, $\hat{X}/\hat{t} < 0$. A fall of t reduces costs for all production processes which have already been relocated abroad. This "offshore cost effect" increases output and, thereby, increases demand for all factors of production, too. As a result, the rental rate and employment rise.

Proof: Again, a mathematical proof is provided in the appendix. The impact of the offshore cost effect is very similar to the impact of the efficiency effect. Both effects foster factor demand by reducing production costs which, subsequently, leads to a higher final output. Due to the fact that distance costs fall, TLC of all offshore production processes decrease. The difference between the two effects is that the cost reductions due to the efficiency effect change the international allocation of production processes while the offshore cost reduction only applies to processes which have already been relocated. Therefore, the offshore cost reduction only enlarges an already existing cost advantage. Both effects are demonstrated in figure 5. As is shown in the appendix, the cost reductions due to the efficiency effect are represented by the triangle between the $[q(z) - t_1 q^*(z)]\alpha(z)$ -curve and the vertical axis from \tilde{z}_1 to \tilde{z}_0 , while the offshore cost reductions are given by the area between the two curves from \tilde{z}_0 to 1.

[INSERT figure 5 here]

As, generally, an increase in efficiency and the accompanying cost reductions have the same impact on factor demand as an increase of the final product price, corollary 1 is straight forward:

Corollary 1: *If an industry faces declining market prices due to import penetration from low-wage countries and, normally, would have to adjust to the new market conditions by*

reducing output and employment, fragmentation and relocation can cut costs and, thereby, preserve employment at home.

Total Impact and Intuitive Dynamics

Proposition 1: (i) $\hat{r} = \left(\frac{\hat{r}}{d\tilde{z}_{RE}}\right)d\tilde{z}_{RE} + \left(\frac{\hat{r}}{d\tilde{z}_{EE}}\right)d\tilde{z}_{EE} + \left(\frac{\hat{r}}{\hat{t}}\right)\hat{t} > 0$,

(ii) $\hat{L} = \left(\frac{\hat{L}}{d\tilde{z}_{RE}}\right)d\tilde{z}_{RE} + \left(\frac{\hat{L}}{d\tilde{z}_{EE}}\right)d\tilde{z}_{EE} + \left(\frac{\hat{L}}{\hat{t}}\right)\hat{t} \geq 0$,

(iii) $\hat{X} = \left(\frac{\hat{X}}{d\tilde{z}_{RE}}\right)d\tilde{z}_{RE} + \left(\frac{\hat{X}}{d\tilde{z}_{EE}}\right)d\tilde{z}_{EE} + \left(\frac{\hat{X}}{\hat{t}}\right)\hat{t} > 0$.

With an inelastic supply of capital, a fall of t and subsequent efficiency-seeking FDI from a high-wage industrialized country to a low-wage developing country lead unambiguously to (i) an increase of the rental rate and (iii) an expansion of final output. The impact on (ii) employment depends on the sizes of the relocation effect on one side and of the efficiency effect and the offshore cost effect on the other side.

As suspected, we see that the impact on employment is ambiguous. While the relocation effect has a negative impact, both the efficiency effect and the offshore cost effect increase employment. However, in spite of this ambiguity, some intuitive dynamics can be established.

Corollary 2: *The impact of wages and employment is likely to be negative if t is still high and only few processes have been relocated, whereas it is likely to be positive if t is low and most fragments are produced abroad.*

Proof: If only few processes have been relocated, the total value added of offshore production is low. Thus, a fall of t leads to only minor offshore cost reductions, and the offshore cost effect is small. Additionally, if \tilde{z} is high, a relocation of that fragment has a comparatively large effect on relative demand as it is highly labor intensive. Therefore, it seems reasonable to assume that the relocation effect dominates for high values of t . However, as t decreases

and more fragments are relocated, the offshore cost effect increases with the proportion of value added abroad. On the other side, the capital intensity of the marginal fragment increases as \tilde{z} moves left in figure 3. Thus, with an increasing internationalization of production the pure relocation effect has a less negative impact on labor demand. Therefore, as more and more capital intensive fragments are relocated, the relationship between relocations and employment reverses.

We have yet to prove that even with factor prices determined endogenously a decrease of t really leads to production relocations from an industrialized country to a low-wage developing country. Changes in factor prices triggered by relocations can alter locational cost advantages just like changes in total landed cost. For example, if relocations lead to a decrease of the wage rate in the industrialized country ($\hat{\ell} = \hat{L}/\varepsilon_{L,\ell}$) this might offset the initial cost advantage of the low-wage country and change location patterns. In this case, a relocation from the industrialized country to the developing country would increase production costs and lead to a drop of sales on the world market. However, as we showed in lemmas 2 and 3, output always increases. Thus, it can be established that lemma 1 holds even with factor prices determined endogenously.

The Growth Effect

Variations of the supply of capital change the sectoral capital stock K . The impact of such changes on r , L , and X are summarized in lemma 5.

Lemma 5: $\hat{r}/\hat{K} < 0$, $\hat{L}/\hat{K} > 0$, $\hat{X}/\hat{K} > 0$. *A growth of the capital stock leads to a falling rental rate, but fosters output and employment. We call this effect the "growth effect".*

Proof: A mathematical proof is provided in the appendix. If K increases, an excess supply of capital will push down the rental rate. As a consequence, production costs go down and output

is raised. Additional labor is needed to produce the extra output and this drives up demand for labor and, thus, employment.

Suppose now that changes in K are driven by the same incentives as intrasectoral locational decisions, i.e. by profitability. Then sectoral supply of capital depends positively on sectoral profits, so that $\varepsilon_{K,r} > 0$. When profits rise, the market gains in attractiveness for investors, and more companies enter. With an endogenous supply of capital, any exogenous change with an impact on the rental rate also brings about adjustments described in lemma 5. This means that a fall of transportation costs and/or tariffs that leads to a rise of the rental rate, as established in proposition 1, also bring about an inflow of capital. Therefore, the "growth effect" can be established as an additional effect triggered by a decrease of t .

We can now state proposition 2 which extends proposition 1 with respect to the endogeneity of the capital stock.

Proposition 2: *With an elastic supply of capital, (i) a fall of t leads to endogenous cross-hauling, and (ii) the impact of changes in t on factor prices, employment, and output depends on the size of the four effects as described in lemma 2 (relocation effect), lemma 3 (efficiency effect), lemma 4 (offshore cost effect), and lemma 5 (growth effect).*

As lemma 1 showed, a fall of t leads to production relocations from the high-wage industrialized country to the low-wage developing country. According to proposition 1, this in turn leads to an unambiguous increase of the rental rate. And if the supply of capital is determined by the rental rate, a rise of the rental rate triggers capital inflows. Therefore, we have two way capital flows. If at least some of the inflowing capital comes from abroad, then this model provides an endogenous explanation for intrasectoral cross-hauling.

We have already discussed the sizes of the various effects when capital is supplied inelastically. A comparison between the relocation effect and the growth effect shows that an inflow of capital is offsetting the impact of the relocation effect on factor prices and employment. To underline the influence of an endogenous capital supply, we now assume that capital is perfectly mobile and that the capital stock is indefinitely elastic ($\varepsilon_{K,r} \rightarrow \infty$). The impact of changes of t on the rental rate, employment, and output in this setting are summarized in lemma 6 and proved mathematically in the appendix.

Lemma 6: *With a perfectly elastic supply of capital,*

$$(i) \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{r}}{d\tilde{z}_{RE}} = 0, \quad \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{L}}{d\tilde{z}_{RE}} = 0, \quad \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{X}}{d\tilde{z}_{RE}} < 0$$

$$(ii) \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{r}}{d\tilde{z}_{EE}} = 0, \quad \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{L}}{d\tilde{z}_{EE}} < 0, \quad \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{X}}{d\tilde{z}_{EE}} < 0$$

$$(iii) \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{r}}{\hat{t}} = 0, \quad \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{L}}{\hat{t}} < 0, \quad \lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{X}}{\hat{t}} < 0$$

The rental rate is now fixed as it is determined on world markets. The rise of the rental rate as derived in proposition 1 is completely offset by additional capital inflows. These inflows of capital (growth effect), the cost reductions due to the efficiency effect and the offshore cost effect, as well as the releasing of resources by the actual relocation all have an increasing effect on final output. And, finally, we see that demand for domestic labor clearly increases as t falls, in spite of a relocation of labor intensive production processes to low wage countries. In fact, the impact of the relocation effect on factor prices and employment approaches zero as $\varepsilon_{K,r} \rightarrow \infty$. These results are summarized in proposition 3:

Proposition 3: *If capital is supplied perfectly elastic, then a decrease of t leads to (i) no changes of the rental rate, (ii) an increase in employment, and (iii) an output expansion. It also leads to (iv) intrasectoral cross-hauling.*

Table 1 summarizes the results of the comparative-static analysis. It reveals that with each additional effect that we derived the originally pessimistic view on the effect of relocations on sectoral employment has become more optimistic.

[INSERT Table 1 here]

4. Conclusion

We illustrated that the observable growth of efficiency-seeking FDI from high-wage countries to low-wage countries can be explained by a decrease of the "economic distance" between these two locations. Because developing countries have a comparative cost advantage in the production of labor intensive goods, companies in industrialized countries relocate mainly labor intensive production processes. However, we demonstrated that this phenomenon is not necessarily bad for workers in the high-wage country. While politicians, labor unions, and most of the public only look at the relocation effect and fear job losses, we identified the efficiency effect, the offshore cost effect, and the growth effect as employment increasing in the high-wage home country.

The relocation effect influences factor prices via changes in factor intensities. If labor intensive production processes are relocated, relative demand for labor falls for any given level of output of the final good. On the other hand, the employment enhancing effects change demand for the final good, and thus influence factor prices via changes in output. The analysis showed that the relative size of the two aggregate effects is determined by the degree of capital mobility. The impact of changes in factor intensities on factor market outcomes decreases as capital mobility rises. If capital is perfectly elastic, changes in employment are solely determined by changes in the output of the final good.

The analysis further revealed that fragmentation and relocation can lead to intrasectoral cross-hauling. Because profits rise if a sector saves on production costs via relocations, this sector becomes more attractive for investors worldwide. Therefore, investment in this sector increases. These two way capital flows within the same sector are very important for the positive employment effects. The additional capital boosts output of the final good and thus increases demand for labor.

Some limitations should be pointed out. Throughout the paper we assumed that factor intensity reversals do not occur. If a fragment was ranked capital intensive in the home country, it was assumed to be ranked capital intensive in the low-wage country, too. However, this does not have to be the case. If a particular production process can be characterized by an extreme substitutability of capital and labor, this process is likely to have a very high capital intensity in the high-wage country and a very low capital intensity in the low-wage country. It can thus be profitable for a company to relocate a capital intensive, but highly flexible production process to a low-wage country before relocating more labor intensive, but less flexible fragments. In this case, the relocation effect changes signs because a relocation of capital intensive processes reduces relative demand for capital and raises relative demand for labor.

While the model was used here for a positive analysis it could just as well be used in the future to analyze policy issues, such as taxation, in an environment with integrated production networks. However, it should be pointed out that the offshore cost effect is very sensitive to the exogenous shock that leads to further production relocations. If production relocations are not driven by a reduction of the "economic distance" between the two locations, but by an increase of domestic taxes, absolute offshore costs do not change. Instead, this sector has to cope with an increase of domestic costs. In this case, relocations can help companies to stay competitive on world markets (corollary 1), and dampen the impact of the tax increase on domestic employment.

Appendix

Total differentiation of (11)-(13) yields ($\hat{p} = \hat{\ell}^* = 0$):

$$(A1) \quad a_{11}\hat{r} + a_{12}\hat{L} = \hat{\Phi}_1$$

$$\text{with} \quad a_{11} = \left[\int_0^{\bar{z}} a^X(z)a^K(z)dz + t \int_{\bar{z}}^1 a^{X^*}(z)a^{K^*}(z)dz \right] > 0,$$

$$a_{12} = \frac{1}{\varepsilon_{L,\ell}} \left[\int_0^{\bar{z}} a^X(z)a^L(z)dz \right] > 0,$$

$$\hat{\Phi}_1 = -[a^X(\bar{z}) - ta^{X^*}(\bar{z})]d\bar{z} - t \left[\int_{\bar{z}}^1 a^{X^*}(z)dz \right] \hat{t}.$$

$$(A2) \quad (a_{21} - \varepsilon_{K,r})\hat{r} + a_{22}\hat{L} + \hat{X} = \hat{\Phi}_2$$

$$\text{with} \quad a_{21} = \left[\int_0^{\bar{z}} \lambda^K(z)\eta_{KK}(z)dz + \int_{\bar{z}}^1 \lambda^{K^*}(z)\eta_{KK}^*(z)dz \right] < 0,$$

$$a_{22} = \frac{1}{\varepsilon_{L,\ell}} \left[\int_0^{\bar{z}} \lambda^K(z)\eta_{KL}(z)dz \right] > 0,$$

$$\hat{\Phi}_2 = -[\lambda^K(\bar{z}) - \lambda^{K^*}(\bar{z})]d\bar{z}.$$

$$(A3) \quad a_{31}\hat{r} + a_{32}\hat{L} + \hat{X} = \hat{\Phi}_3$$

$$\text{with} \quad a_{31} = \left[\int_0^{\bar{z}} \lambda^L(z)\eta_{LK}(z)dz \right] > 0,$$

$$a_{32} = \frac{1}{\varepsilon_{L,\ell}} \left[\int_0^{\bar{z}} \lambda^L(z)\eta_{LL}(z)dz - \varepsilon_{L,\ell} \right] = \left[\frac{1}{\varepsilon_{L,\ell}} \int_0^{\bar{z}} \lambda^L(z)\eta_{LL}(z)dz - 1 \right] < 0,$$

$$\hat{\Phi}_3 = -\lambda^L(\bar{z})d\bar{z}.$$

Here, $a^i(z)$ denote factor shares, e.g. $a^K(z) = \frac{rK(z)}{q(z)Q(z)}$ or $a^{X^*}(z) = \frac{q^*(z)Q^*(z)}{pX}$, $\lambda^i(z)$

denote factor allocations, e.g. $\lambda^K(z) = \frac{K(z)}{K}$, and η_{ij} denote elasticities of the i^{th} factor

coefficient with respect to the price of factor j , e.g. $\eta_{KL}(z) = \frac{\partial q_r(z)}{\partial \ell} \frac{\ell}{q_r(z)}$. Cross factor

elasticities are positive ($\eta_{ij} > 0$) and own factor elasticities are negative ($\eta_{ii} < 0$). $\varepsilon_{K,r}$ and

$\varepsilon_{L,\ell}$ denote supply side elasticities of capital and labor, respectively.

We use matrices to express the simultaneous equations system given by (A1)-(A3). We obtain:

$$(A4) \quad \underline{\mathbf{A}}\vec{\mathbf{v}} = \vec{\boldsymbol{\phi}}$$

$$\text{with } \underline{\mathbf{A}} = \begin{pmatrix} a_{11} & a_{12} & 0 \\ (a_{21} - \varepsilon_{K,r}) & a_{22} & 1 \\ a_{31} & a_{32} & 1 \end{pmatrix}, \vec{\mathbf{v}} = \begin{pmatrix} \hat{r} \\ \hat{L} \\ \hat{X} \end{pmatrix}, \text{ and } \vec{\boldsymbol{\phi}} = \begin{pmatrix} \hat{\boldsymbol{\Phi}}_1 \\ \hat{\boldsymbol{\Phi}}_2 \\ \hat{\boldsymbol{\Phi}}_3 \end{pmatrix}$$

Solving for $\vec{\mathbf{v}}$ we obtain

$$(A5) \quad \vec{\mathbf{v}} = \underline{\mathbf{A}}^{-1}\vec{\boldsymbol{\phi}}$$

$$\text{with } \underline{\mathbf{A}}^{-1} = \frac{1}{\Delta} \begin{pmatrix} [a_{22} - a_{32}] & -a_{12} & a_{12} \\ -[(a_{21} - \varepsilon_{K,r}) - a_{31}] & a_{11} & -a_{11} \\ [(a_{21} - \varepsilon_{K,r})a_{32} - a_{22}a_{31}] & -[a_{11}a_{32} - a_{12}a_{31}] & [a_{11}a_{22} - a_{12}(a_{21} - \varepsilon_{K,r})] \end{pmatrix}$$

$$\text{and } \Delta = a_{11}a_{22} + a_{12}a_{31} - a_{12}(a_{21} - \varepsilon_{K,r}) - a_{11}a_{32} > 0$$

In order to distinguish the various effects of relocations we set $d\tilde{z}\{\hat{\Phi}_1\} = d\tilde{z}_{EE}$ and

$d\tilde{z}\{\hat{\Phi}_2, \hat{\Phi}_3\} = d\tilde{z}_{RE}$, so that

- $\hat{\Phi}_1 = -[a^X(\tilde{z}) - ta^{X^*}(\tilde{z})]d\tilde{z}_{EE} - t\left[\int_{\tilde{z}}^1 a^{X^*}(z)dz\right]\hat{t}$
- $\hat{\Phi}_2 = -[\lambda^K(\tilde{z}) - \lambda^{K^*}(\tilde{z})]d\tilde{z}_{RE}$
- $\hat{\Phi}_3 = -\lambda^L(\tilde{z})d\tilde{z}_{RE}$

Proof of lemma 2:

If $\hat{p} = \hat{\ell}^* = \hat{t} = \hat{K} = d\tilde{z}_{EE} = 0$ and $d\tilde{z}_{RE} \neq 0$, we obtain from (A5):

$$\frac{\hat{r}}{d\tilde{z}_{RE}} = \frac{1}{\Delta} a_{12} [\lambda^K(\tilde{z}) - \lambda^{K^*}(\tilde{z}) - \lambda^L(\tilde{z})]$$

$$\frac{\hat{L}}{d\tilde{z}_{RE}} = -\frac{1}{\Delta} a_{11} [\lambda^K(\tilde{z}) - \lambda^{K^*}(\tilde{z}) - \lambda^L(\tilde{z})]$$

$$\frac{\hat{X}}{d\tilde{z}_{RE}} = -\frac{1}{\Delta} \left\{ (a_{11}a_{32} - a_{12}a_{31}) [\lambda^K(\tilde{z}) - \lambda^{K^*}(\tilde{z})] - [a_{11}a_{22} - a_{12}(a_{21} - \varepsilon_{K,r})] \lambda^L(\tilde{z}) \right\}$$

Because of (6) it holds that $[\lambda^K(\tilde{z}) - \lambda^{K^*}(\tilde{z})] > 0$ and, thus, $\frac{\hat{X}}{d\tilde{z}_{RE}} < 0$.

If $[\lambda^K(\tilde{z}) - \lambda^{K^*}(\tilde{z}) - \lambda^L(\tilde{z})] < 0$, i.e. if $\frac{K(\tilde{z}) - K^*(\tilde{z})}{L(\tilde{z})} < \frac{K}{L}$ (the marginal fragment is labor

intensive), then $\frac{\hat{r}}{d\tilde{z}_{RE}} < 0$ and $\frac{\hat{L}}{d\tilde{z}_{RE}} > 0$.

Proof of lemma 3:

If $\hat{p} = \hat{\ell}^* = \hat{K} = \hat{t} = d\tilde{z}_{RE} = 0$ and $d\tilde{z}_{EE} \neq 0$, we obtain from (A5):

$$\frac{\hat{r}}{d\tilde{z}_{EE}} = -\frac{1}{\Delta}(a_{22} - a_{32})[a^X(\tilde{z}) - ta^{X^*}(\tilde{z})] < 0$$

$$\frac{\hat{L}}{d\tilde{z}_{EE}} = \frac{1}{\Delta}[(a_{21} - \varepsilon_{K,r}) - a_{31}][a^X(\tilde{z}) - ta^{X^*}(\tilde{z})] < 0$$

$$\frac{\hat{X}}{d\tilde{z}_{EE}} = -\frac{1}{\Delta}[(a_{21} - \varepsilon_{K,r})a_{32} - a_{22}a_{31}][a^X(\tilde{z}) - ta^{X^*}(\tilde{z})] < 0$$

All signs are derived by assuming that the $\alpha[q(\tilde{z}) - tq^*(\tilde{z})]$ -curve has been shifted upwards, so that $a^X(\tilde{z}) - ta^{X^*}(\tilde{z}) > 0$ holds. With linear-homogeneous technologies we have

$\eta_{ii} = -\eta_{ij}$. Therefore, $[(a_{21} - \varepsilon_{K,r})a_{32} - a_{22}a_{31}] > 0$ and $\frac{\hat{X}}{d\tilde{z}_{EE}} < 0$. It should be noted that if

(9) holds, so that $a^X(\tilde{z}) - ta^{X^*}(\tilde{z}) = \frac{\alpha}{p}[q(\tilde{z}) - tq^*(\tilde{z})] = 0$, all of these effects are obviously

zero.

Proof of lemma 4:

If $\hat{p} = \hat{\ell}^* = \hat{K} = d\tilde{z} = 0$ and $\hat{t} \neq 0$, we obtain from (A5):

$$\frac{\hat{r}}{\hat{t}} = -\frac{1}{\Delta}(a_{22} - a_{32})t \left[\int_{\tilde{z}}^1 a^{X^*}(z) dz \right] < 0$$

$$\frac{\hat{L}}{\hat{t}} = \frac{1}{\Delta}t[(a_{21} - \varepsilon_{K,r}) - a_{31}] \left[\int_{\tilde{z}}^1 a^{X^*}(z) dz \right] < 0$$

$$\frac{\hat{X}}{\hat{t}} = -\frac{1}{\Delta} t [(a_{21} - \varepsilon_{K,r}) a_{32} - a_{22} a_{31}] \left[\int_{\tilde{z}}^1 a^{X^*}(z) dz \right] < 0 \text{ as shown in the proof of lemma 3.}$$

To prove the graphical demonstration of the two cost reducing effects in figure 5 we denote production costs with $t = t_0$ as c_0^x and the respective costs with $t = t_1$ as c_1^x . Then, production costs for both cases can be expressed as follows:

$$(A6) \quad c_0^x = \int_0^{\tilde{z}_1} q(z) \alpha(z) dz + \int_{\tilde{z}_1}^{\tilde{z}_0} q(z) \alpha(z) dz + t_0 \int_{\tilde{z}_0}^1 q^*(z) \alpha(z) dz$$

$$(A7) \quad c_1^x = \int_0^{\tilde{z}_1} q(z) \alpha(z) dz + t_1 \int_{\tilde{z}_1}^{\tilde{z}_0} q^*(z) \alpha(z) dz + t_1 \int_{\tilde{z}_0}^1 q^*(z) \alpha(z) dz$$

Therefore, total changes in costs are given by:

$$(A8) \quad \Delta c^x = c_0^x - c_1^x = \int_{\tilde{z}_1}^{\tilde{z}_0} [q(z) - t_1 q^*(z)] \alpha(z) dz + (t_0 - t_1) \int_{\tilde{z}_0}^1 q^*(z) \alpha(z) dz$$

Comparing (A8) with $\hat{\Phi}_1$ in (A1) clearly shows that the first summand represents the cost reductions due to the efficiency effect t_1 while the second term yields the offshore cost reductions. In figure 5, the first summand of the right hand side of (A8) is given by the area between the $[q(z) - t_1 q^*(z)] \alpha(z)$ -curve and the vertical axis from \tilde{z}_1 to \tilde{z}_0 . Thus, this triangle shows the cost reductions due to the efficiency effect. To illustrate the offshore cost reductions in the same graph, we rewrite the last summand of (A8) so that

$$(A9) \quad (t_0 - t_1) \int_{\tilde{z}_0}^1 q^*(z) \alpha(z) dz = \int_{\tilde{z}_0}^1 [q(z) - t_1 q^*(z)] \alpha(z) dz - \int_{\tilde{z}_0}^1 [q(z) - t_0 q^*(z)] \alpha(z) dz$$

The right hand side of (A9) shows that cost reductions due to the offshore cost effect are given by the area between the two curves from \tilde{z}_0 to 1.

Proof of lemma 5:

If $\hat{p} = \hat{\ell}^* = \hat{t} = d\tilde{z}_{RE} = d\tilde{z}_{EE} = 0$ and $\hat{K} \neq 0$, we obtain from (A5):

$$\frac{\hat{r}}{\hat{K}} = -\frac{1}{\Delta} a_{12} < 0$$

$$\frac{\hat{L}}{\hat{K}} = \frac{1}{\Delta} a_{11} > 0$$

$$\frac{\hat{X}}{\hat{K}} = -\frac{1}{\Delta} (a_{11} a_{32} - a_{12} a_{31}) < 0$$

Proof of lemma 6:

As $\varepsilon_{K,r}$ goes to infinity, the determinant of \underline{A} increases to plus infinity $\left(\lim_{\varepsilon_{K,r} \rightarrow \infty} \Delta = \infty \right)$.

Thus, applying L'Hospital's rule where necessary, we obtain:

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{r}}{d\tilde{z}_{RE}} = \frac{1}{\lim_{\varepsilon_{K,r} \rightarrow \infty} \Delta} a_{12} [\lambda^K(\tilde{z}) - \lambda^{K^*}(\tilde{z}) - \lambda^L(\tilde{z})] = 0$$

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{L}}{d\tilde{z}_{RE}} = -\frac{1}{\lim_{\varepsilon_{K,r} \rightarrow \infty} \Delta} a_{11} [\lambda^K(\tilde{z}) - \lambda^{K^*}(\tilde{z}) - \lambda^L(\tilde{z})] = 0$$

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{X}}{d\tilde{z}_{RE}} = -\lambda^L(\tilde{z}) < 0$$

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{r}}{d\tilde{z}_{EE}} = -\frac{1}{\lim_{\varepsilon_{K,r} \rightarrow \infty} \Delta} (a_{22} - a_{32}) [a^X(\tilde{z}) - ta^{X^*}(\tilde{z})] = 0$$

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{L}}{d\tilde{z}_{EE}} = \frac{-1}{a_{12}} [a^X(\tilde{z}) - ta^{X^*}(\tilde{z})] < 0$$

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{X}}{d\tilde{z}_{EE}} = \frac{a_{32}}{a_{12}} [a^X(\tilde{z}) - ta^{X^*}(\tilde{z})] < 0$$

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{r}}{\hat{t}} = -\frac{(a_{22} - a_{32})}{\lim_{\varepsilon_{K,r} \rightarrow \infty} \Delta} t \left[\int_{\tilde{z}}^1 a^{X^*}(z) dz \right] = 0$$

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{L}}{\hat{t}} = \frac{-1}{a_{12}} t \left[\int_{\tilde{z}}^1 a^{X^*}(z) dz \right] < 0$$

$$\lim_{\varepsilon_{K,r} \rightarrow \infty} \frac{\hat{X}}{\hat{t}} = \frac{a_{32}}{a_{12}} t \left[\int_{\tilde{z}}^1 a^{X^*}(z) dz \right] < 0$$

Notes:

- ¹ The term "fragmentation" refers to "the splitting of a production process into two or more steps that can be undertaken in different locations but that lead to the same final product" as defined in Deardorff (1998).
- ² For an overview see OECD (1995) and ILO (1981, pp. 78-91).
- ³ Here, Ricardian differences in intangible technology create what Dunning (1988) calls the "ownership advantage" of domestic companies vis-à-vis competitors from low-wage countries. Because of its intangibility licensing agreements fail, and companies have to keep foreign production facilities integrated in order to exploit locational advantages abroad.
- ⁴ Japanese MNEs for example first moved their labor intensive production processes to Hong Kong, Korea, and Taiwan. When wages rose in these countries, they re-routed their investments to Singapore, Malaysia, and Thailand, and later to China, Indonesia, and Indochina (OECD, 1993; UNCTAD, 1995).

References

- Agarwal, Jamuna P. (1997):** Effect of Foreign Direct Investment on Employment in Home Countries, in: *Transnational Corporations*, 6, 1-28.
- Baldwin, Robert E. (1994):** The Effect of Trade and Foreign Direct Investment on Employment and Relative Wages, in: *OECD Economic Studies*, 23, 7-54.
- Deardorff, Alan V. (1998):** Fragmentation in Simple Trade Models, RSIE Discussion Paper No. 422, University of Michigan, Ann Arbor.
- Dornbusch, Rudiger; Fischer, Stanley; Samuelson, Paul A. (1977):** Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods, in: *American Economic Review*, 67, 823-839.
- Dornbusch, Rudiger; Fischer, Stanley; Samuelson, Paul A. (1980):** Heckscher-Ohlin Trade Theory with a Continuum of Goods, in: *Quarterly Journal of Economics*, 95, 203-224.
- Dunning, John H. (1988):** *Explaining International Production*, London.
- Feenstra, Robert C.; Hanson, Gordon H. (1996):** Foreign Investment, Outsourcing, and Relative Wages, in: Robert C. Feenstra; Gene M. Grossman; Douglas A. Irwin (Eds.): *The Political Economy of Trade Policy*, London, 89-127.
- FIAS (1996):** FDI News Industry Focus: The Electronics Industry, in: *FDI News 1*, <http://www.ifc.org/FIAS/pubs/fdinews/v1n3/industry.htm>, February 2000.
- FIAS (1997):** Apparel Production in the Caribbean, Central America and Mexico, in: *FDI News 2*, <http://www.ifc.org/FIAS/pubs/fdinews/v2n1/p5.htm>, February 2000.
- Glickman, Norman J.; Woodward, Douglas P. (1989):** *The New Competitors*, New York.
- ILO (1976):** *The impact of multinational enterprises on employment and training*, Geneva.
- ILO (1981):** *Employment effects of multinational enterprises in industrialised countries*, Geneva.
- Krugman, Paul (1995):** Growing World Trade: Causes and Consequences, in: *Brookings Papers on Economic Activity* 1, 327-377.
- Lemoine, Françoise (1998):** Integrating Central and Eastern Europe in the European Trade and Production Network, Working Paper No. 107, BRIE Working Paper Series, Berkeley Roundtable on the International Economy, Berkeley.
- Levy, David; Dunning, John H. (1993):** International Production and Sourcing: Trends and Issues, in: *STI-Review*, 14-59.
- Madeuf, Bernadette (1995):** Foreign Direct Investment, Trade and Employment Delocalisation, in: OECD (Ed.): *Foreign Direct Investment, Trade and Employment*, Paris, 41-65.
- McGuire, Sumiye O. (1995):** Foreign Direct Investment, Trade and Employment in the United States, in: OECD (Ed.): *Foreign Direct Investment, Trade and Employment*, Paris, 121-139.

- OECD (1993):** The Dynamic Asian Economies and International Direct Investment, in: OECD (Ed.): Foreign Direct Investment Relations between the OECD and the Dynamic Asian Economies, Paris, 31-54.
- OECD (1995):** Review of Recent Case Studies of Employment Effects of FDI, Annex 1 in: OECD (Ed.): Foreign Direct Investment, Trade and Employment, Paris, 140-145.
- OECD (1998):** Foreign Direct Investment and Economic Development - Lessons from Six Emerging Economies, Paris.
- UNCTAD (1995):** Foreign Direct Investment in Two Dynamic Regions: Asia and Latin America, in: OECD (Ed.): Foreign Direct Investment - OECD Countries and Dynamic Economies of Asia and Latin America, Paris, 23-36.
- UNCTAD (1996):** World Investment Report 1996: Investment, Trade and International Policy Arrangements, New York, Geneva.
- UNCTAD (1997):** World Investment Report 1997: Transnational Corporations, Market Structure and Competition Policy, New York, Geneva.
- Venables, Anthony J. (1999):** Fragmentation and multinational production, in: European Economic Review, 43, 935-945.

Figures and Tables:

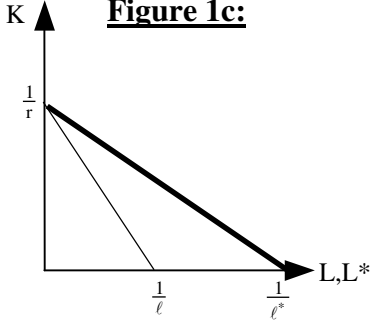
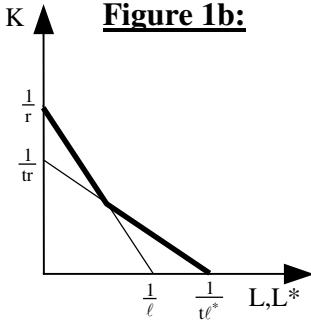
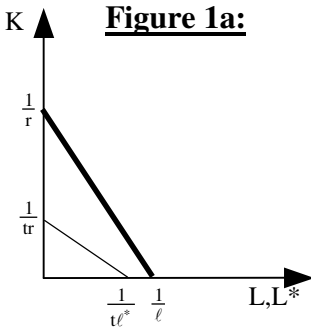


Figure 2:

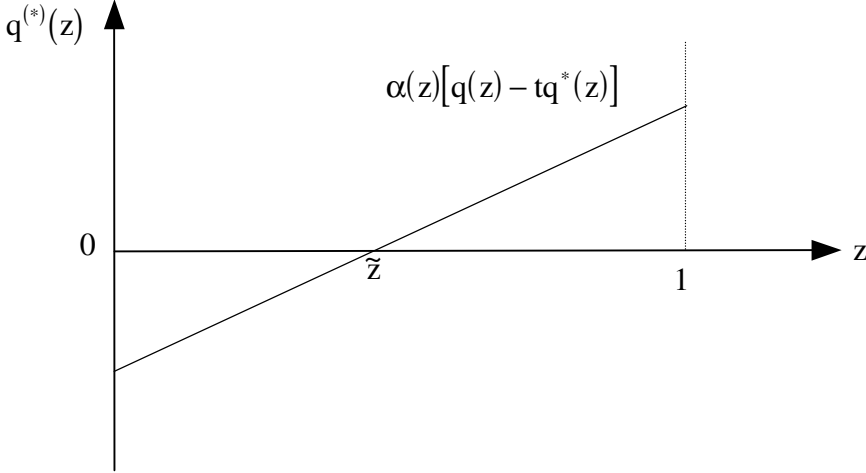


Figure 3:

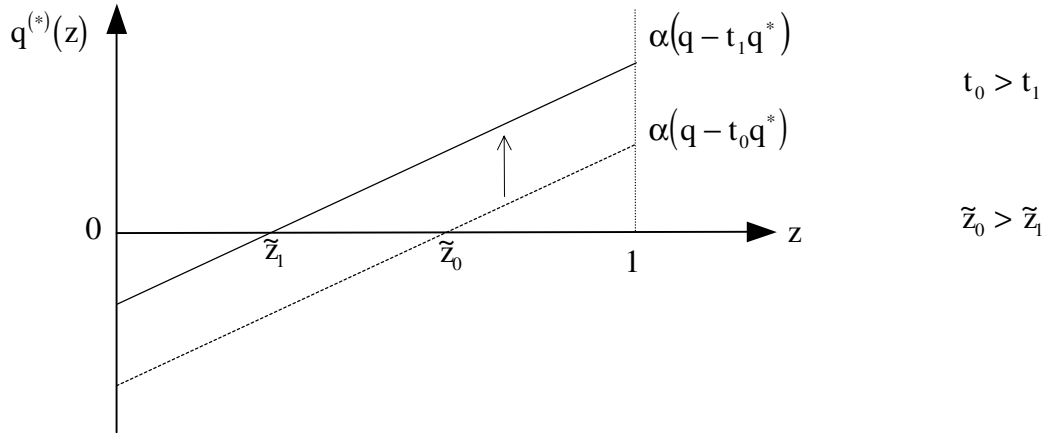


Figure 4:

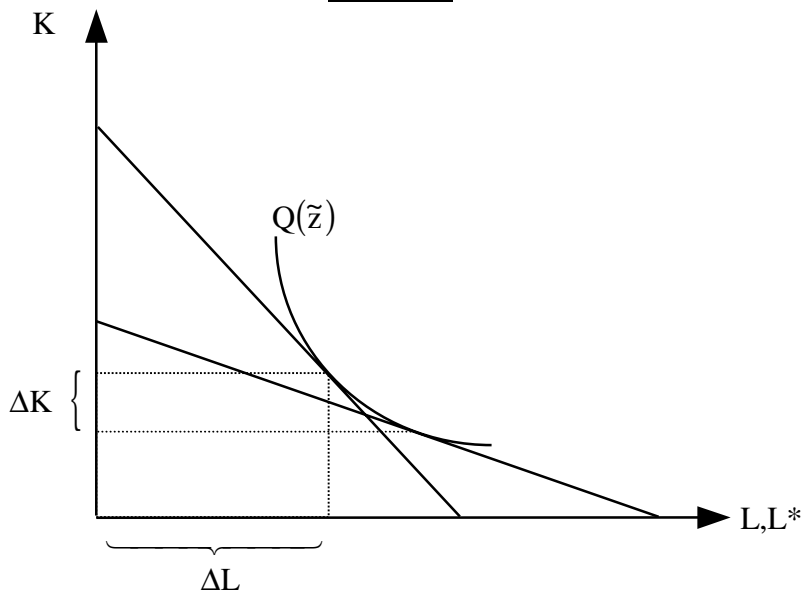


Figure 5:

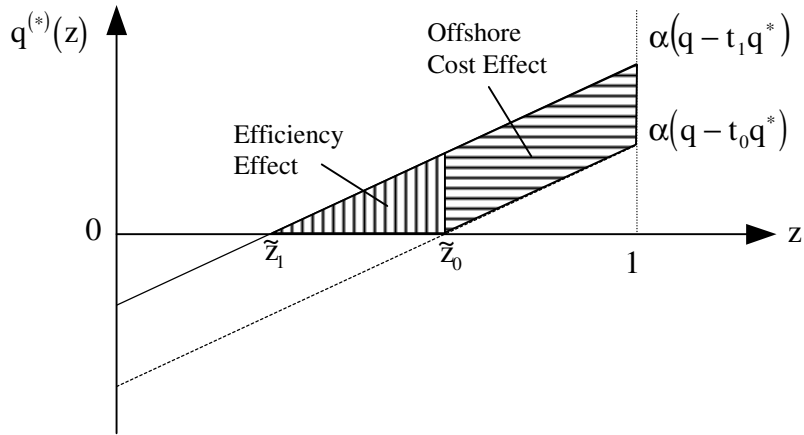


Table 1

Impact of $\hat{t} < 0$ on ...	\hat{r}	\hat{L}	\hat{X}
Relocation Effect	+	-	+
Efficiency Effect	+	+	+
Offshore Cost Effect	+	+	+
Growth Effect	-	+	+
$\epsilon_{K,r} = 0$	+	+/-	+
$\epsilon_{K,r} \rightarrow \infty$	0	+	+

Notes: "+", "+/-", "-", and "0" refer to positive, indefinite, negative, and zero effect of a decrease of t on the respective variable, the first four rows show the isolated impacts of the corresponding effects according to lemma 2, lemma 3, lemma 4, and lemma 5. The last two rows show the total impacts according to proposition 1 and proposition 3. $\epsilon_{K,r}$ is the elasticity of the capital supply with respect to the rental rate.