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THE INTERNATIONAL FRAGMENTATION OF THE VALUE ADDED CHAIN

THE EFFECTS OF OUTSOURCING TO EASTERN EUROPE ON PRODUCTIVITY, EMPLOYMENT AND WAGES IN AUSTRIAN MANUFACTURING

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The International Fragmentation of the Value Added Chain: The Effects of Outsourcing to Eastern Europe on Productivity, Employment and Wages in Austrian Manufacturing

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1 Introduction

Since the opening-up of the East at the beginning of the nineties Austria witnessed a massive re-orientation of trade and a substantial increase of foreign direct investment (FDI) both primarily to the neighboring transition countries. On the one hand, Austrian exporters gained access to new markets reachable at low transportation costs and relatively small trade barriers. Direct investing firms have been able to exploit first mover advantages (from the proximity and the special knowledge of the neighboring transition countries) and managed to gain - compared to the size of Austria - a prominent market position (see *Stankovsky - Pfaffermayr*, 1999). On the other hand, there are still huge differences in wages and productivity providing potentials for further specialization. Above all, with the neighboring transition countries specialization has developed beyond the conventional inter-industry trade in end products. Now more and more firms by splitting up their value added chain internationally outsource part of their production lines and import intermediates that have formerly been sourced domestically. This process of vertical fragmentation of the production processes occurs both via increased imports of intermediates and via subsidiaries which export intermediates back to the Austrian headquarters (or assemble the product for direct exports to third countries, mainly the EU-market). Austrian FDI into these countries now seems more and more efficiency seeking rather than market oriented and contributes to the process of fragmentation of production.

From an economic policy perspective it is an open question whether Austria gains or loses from this process of international fragmentation of production and whether there are distributional consequences with some groups gaining and others loosing in terms of their wages and/or employment prospects. Additionally, since the process of fragmentation exploits comparative advantages more intensively a deep restructuring process in Austrian manufacturing has been initiated. Whereas some, mostly labor-intensive production lines are closed down and delocated to low-wage countries, more high-skilled labor-intensive and capital-intensive ones are expanding.

From the perspective of a single firm, the deepening specialization inherent to the fragmentation process induces productivity gains, decreases costs and thus fosters the market position on the world markets. To some extent this gain in competitiveness is expected to increase also domestic production and thus some of the employment lost due to fragmentation may be compensated. On the other hand, firms which do not follow the international trend of fragmentation of production are likely to lose shares in world markets or even have to shut down altogether.

In the short-run, when structural change has not re-established a

new equilibrium in the labor markets, fragmentation is expected to reduce employment (to increase unemployment, respectively), if there is insufficient compensation by increased output in the domestically active production lines and if intersectoral movement of labor is hard to accomplish. As a response to enhanced international outsourcing (and trade volumes in general), economic policy thus has to seek measures to speed up structural adjustment, but also has to assist those groups loosing most in the course of these adjustment processes, so that the economy as a whole can gain from these new potentials of specialization at acceptable social and distributional costs.

This study takes a trade theory perspective and aims to empirically assess the effects of outsourcing to Eastern countries[1]. It is organized as follows: We first discuss the main arguments put forward by the theory of trade and multinational firms (MNE) about the determinants and the consequences of fragmentation for welfare, structural change, wages and employment. Based on the survey we then describe the main stylized facts concerning the volume and structure of trade in intermediates with the transition countries as well as intra-firm trade induced by efficiency seeking FDI, both measuring the extent of international fragmentation of production. Using a small panel of two-digit industries for the period 1990 to 1998, we econometrically investigate the effect of fragmentation on productivity and on relative demand for high-skilled and low-skilled labor in Austrian manufacturing. Additionally, we estimate mandated wage equations. The last section summarizes the main findings and discusses the implications for economic policy.

[1] Eastern countries comprise: East Central Europe (Hungary, Poland, Czech Republic, Slovak Republic); South East Europe (Albania, Bulgaria, Romania, former Yugoslavia and former USSR).

2 Causes, welfare and employment effects of the international fragmentation of the value added chain - a survey of the literature

2.1 Fragmentation in traditional trade theory models

2.1.1 The motives for fragmentation in traditional models

One of the major insights from traditional trade theory models is that countries gain from trade if the pattern of specialization follows the principle of comparative advantage. That is, countries engaged in trade specialize in the production of those goods in which they have a relative cost advantage vis-à-vis their trading partners. The rule is simple: goods will be produced where it is relatively cheapest to make them. Comparative advantages in turn may result from different sources. In Ricardian trade models international differences in production technologies (labor productivity) are the sole reason for cross-country differences in comparative production costs. Heckscher-Ohlin type trade models on the other hand, assume that technologies are the same across countries and comparative advantages are entirely due to differences in factor endowments or the relative abundance of factors of production. In the two-factor economy of the Heckscher-Ohlin world then, countries will tend to specialize in the export of goods whose production is intensive in factors with which they are abundantly endowed.

The key to understand how trade and specialization can be beneficial to countries is to think of trade as an indirect method of production. A country can produce a good directly, or indirectly by producing another good and trading it for the desired good. Trade and specialization are welfare enhancing, as long as the resource cost of producing the good indirectly through exports of another good (in which the country has a comparative advantage) is lower than the cost of producing it directly at home. Note however, that the welfare gains may be distributed unevenly as the abundant factors gain and the scarce factors lose from trade liberalization.

The same principles will in general hold if standard trade theory models are amended to allow for the separation of production into component stages. Indeed, fragmentation can be thought of as pushing specialization beyond the level of products and to open up new possibilities for exploiting gains from specialization. For example, if production stages are separable and factor intensities differ across stages, then the average factor intensity of the product tells us only that the country in question has a comparative advantage or disadvantage on average, which does not

mean that the entire product should or should not be produced in that country. Thus, if fragmentation occurs in conformity with considerations of comparative advantage, it can be expected to increase efficiency further and raise the gains from specialization and trade above those realized in the standard models which do not allow for fragmentation.

Thus, as with trade in final products, the Ricardian and Heckscher-Ohlin models give two motives for fragmentation: The first is the possibility to take greater advantage in cross country technology differences in productivity, leading to a Ricardian emphasis on technology and comparative advantage. Fragmentation can also occur in a pure HO-model without technology differences at all, then fragmentation occurs simply to take advantage of factor price differences between countries of different endowment structures ("fragmentation across cones"). The latter case also requires that at least one of the fragments must lie in a different cone than the original unfragmented technology[2].

In most of the models, fragmentation is considered as being costless, that is, any extra costs involved in producing components individually and shipping them are ignored, so that the separate costs of the components add up to the costs of the integrated process. However, consideration of these costs is important in the question when asking wether it pays to internationally split up the production process or not. The decision then involves a comparison of the size of the cost savings from exploiting different factor prices and/or technological differences as compared to the extra costs involved in using the fragmented technology (*Deardorff*, 2000b, *Kohler*, 2000a). The cost savings from differences in factor prices are higher the higher the relative usage of the factor that is cheaper or produced more efficiently in one of the countries. Liberalization of trade, services, FDI, technological progress in the service sector and improvements in transport and communication technologies playing a key role in the fragmentation process have contributed to significant cuts in cost of international coordination and can be expected to increase the amount of international fragmentation. *Harris* (1995, 2000) as well as *Jones - Kierzkowski* (1999, 2000) emphasize the decreasing costs of service links and international coordination. Especially the decrease in networking and communication costs in the last decade increased the opportunities to exploit gains from comparative advantage in producing

[2] A basic implication of the Heckscher-Ohlin framework is that countries specialize in a mix of goods most suitable to their relative factor endowments. If endowments differ by much across countries this mix of goods will differ and countries are said to be in different cones of diversification. The word "cone" thus refers to the set of factor endowment vectors that all select the same mix of products and each cone is associated with a different set of factor prices.

both final and intermediate goods (i.e. fragmentation).

Feenstra - Hanson (1996a) on the other hand see the extent of outsourcing to less advanced countries determined by North-South capital movements or technological improvements in the South. *Kohler* (2000a) explicitly models the interplay between factor price differences on the one hand and the costs of trading and communication, and productivity gaps on the other hand determining outsourcing in an East-West setting. In most of the theoretical literature, however, international fragmentation of the value added chain is not itself treated as an endogeneous event (determined by parameters within the model), but taken as an exogenous shock (see *Arndt,* 1996, 1997a, 1997b, 1999, 2000, *Deardorff* 1998a, 2000b)

Factor price differences and/or productivity gaps between countries emphasized by traditional trade theory are not the only possible explanations for international fragmentation. Scale economies and economies of specialization in component production, pertinent to the New Trade Theory can be seen as important driving forces for outsourcing activities especially among developed countries. We will come back to the main driving forces behind outsourcing and its effects in a New Trade Theory framework in a later chapter.

2.1.2 The effects of fragmentation in traditional trade theory models

Even if fragmentation may act welfare enhancing for the country as a whole, some production factors will become worse off. Also, as a consequence of fragmentation new patterns of production and trade may emerge with important effects on employment and wages. Indeed, it is one of the most widely spread fears, that outsourcing of labor-intensive production phases, and trade competition from low-wage countries in general, may hurt especially the low-skilled labor in the advanced countries, driving down their relative wages or causing unemployment in this labor market segment. The Heckscher-Ohlin model has been widely used as a framework in discussing these questions and can serve as a proper benchmark for a discussion on the effects of fragmentation on relative factor demand, relative wages, output and employment.

When discussing the effects of fragmentation in the Heckscher-Ohling model, it is very important to understand its basic features. We will first review the most important assumptions and implications of the even, two-factor-two-good Heckscher-Ohlin model (henceforth 2 x 2) and then see how these implications and features carry over to an analysis of the effects of fragmentation. However, as not all results from the two-dimensional framework generalize, consideration of possible extensions of

the basic model are important. Indeed, it is hard to come to any general conclusions as a review of the theoretical literature on fragmentation and the divergence in results will show.

The standard Heckscher-Ohlin model: In the following let A denote the inputs per unit of output matrix (factor intensities), q the vector of outputs, v the vector of endowments, p the vector of world prices, and finally, w the vector for factor rewards.

The most important assumptions of the standard Heckscher-Ohlin model can then be summarized as follows:

- Countries share a constant returns to scale, linearly homogeneous technology, where cost-minimizing inputs are denoted by:

$$A = A(w) \tag{1}$$

- Countries possess perfectly competitive markets, i. e. firms earn zero profits:

$$A'w = p \tag{2}$$

- Productive factors (e.g. capital, labor, or high-skilled and low-skilled labor) are fully employed, perfectly mobile from sector to sector within a country, but internationally immobile:

$$Aq = v \tag{3}$$

- There is an equal number of factors and sectors.
- Individuals share identical, homothetic preferences.
- In the small country case, it is assumed that the countries are small and open so that the commodity world price is taken as given and cannot be influenced by a country's own actions.

Output changes with constant technologies: A basic implication of the Heckscher-Ohlin framework is that countries specialize in a mix of goods most suitable to their relative factor endowments. From the above assumptions, the mapping of endowments into the output structure is a result of countries' maximizing output **value** subject to the full employment condition[3]:

$$Aq = v \tag{4}$$

Differentiation yields

$$Adq + dAq = dv \tag{5}$$

With constant factor prices and no technological progress we have,

$$dA = 0 \tag{6}$$

If the number of factors equals the number of products, this system can be inverted to solve for output as a function of endowments. Expressed in percentage changes (e.g. $\frac{dq}{q} = \widehat{q}$) this gives

$$\widehat{q} = B\widehat{v} \tag{7}$$

where B (i.e. A^{-1} in the symmetric case with an even number of goods and factors) denotes the factor shares matrix. The elements of B are known as the *Rybczynski* (1968) derivatives relating the effect of factor accumulation to changes in the output of each sector. Thus, following directly from this equation and the sign pattern of B one obtains the popular version of the Rybczynski Theorem:

> **Rybczynski Theorem:** Given no factor intensity reversal and diversification of production, at constant commodity (and therefore factor) prices, an increase in the supply of a factor will lead to a **more than proportional** increase in the output of the commodity that uses that factor intensively and a reduction in the output of the other commodity (this is the magnification effect involved in the Rybczynski Theorem).

[3]Note that in our case q denotes output value rather than output in real terms.

This strong result can only be derived in the simple, $2x2$ model and weakens considerably when generalized. However, the basic intuition of the Rybczinsky Theorem remains in a world with many goods and many factors. If the supply of one factor increases, the output of products intensive in this factor will tend to increase and the output of other products will tend to decrease. The precise effects on any particular output are not easily derived. Note that the Rybczynski result is preserved for movements within the diversification cone when the number of factors is larger than the number of goods but no longer holds in the opposite case. Whenever the latter is the case, the full employment condition alone is not enough to uniquely determine national outputs. This indeterminacy in outputs has been termed as the "Melvin indeterminacy" (*Melvin*, 1968).

Changes in factor prices with constant technology: If instead a country's problem is framed in terms of prices and wages ("the dual", *Mussa,* 1979), the alternative representation of the optimization problem implies that the vector of factor rewards (w) **is** found by minimizing the cost of total production ($w^{'}v$) subject to the zero profit condition:

$$A^{'}w \geq p \tag{8}$$

Differentiating this expression (since $dA^{'}w = 0$ for constant technology), produces

$$A^{'}dw = dp \tag{9}$$

Expressed in percentage changes this is:

$$\theta\widehat{w} = \widehat{p} \tag{10}$$

where θ is the input cost-share matrix whose elements θ_{ik} give the share of factor k in average costs incurred in the production of good i. Then, if θ is regular one may solve for factor price changes:

$$\widehat{w} = \theta^{-1}\widehat{p} \tag{11}$$

This describes the Stolper-Samuelson mapping of commodity prices into factor prices from which the following strong version of the Stolper-Samuelson Theorem derives.

> **Stolper-Samuelson Theorem:** A rise in the price of a good will **more than proportionally** increase the real reward of the factor used intensively in the sector and decrease the real reward of the other factor (this is the magnification effect involved in the Stolper-Samuelson Theorem).

A generalization to more (but an equal number of) goods and factors again weakens this strong result so that the precise effects on any particular factor is not easily derived without further assumptions about the production technology, but the basic intuition of the Stolper-Samuelson Theorem remains: international trade affects product prices across countries, and this affects factor prices within countries by influencing relative factor demands. At initial factor prices, any change in product prices (and/or technology) means that zero profit conditions do not longer hold. Producers expand output in sectors which have become profitable and reduce output in unprofitable sectors. Relative factor demand increases for those factors, which are intensively used in the expanding sectors, and it decreases for the factors intensively used in the shrinking sectors. To restore equilibrium, relative factor prices must adjust in response to these demand shifts. Note also, that in the case of more goods (sectors) than factors the Stolper-Samuelson result is not fundamentally altered within a given cone of diversification, while for more factors than goods **(sectors)** it is no longer valid (*Ethier*, 1984).

It is further important to note at this point, that factor rewards do not respond to changes in endowments unless they are accompanied by changes in commodity prices, a condition referred to as factor price insensitivity (*Leamer*, 1995). Though partial equilibrium analysis suggests, for example, that an increase in the supply of labor will reduce its reward, the general equilibrium approach of the Heckscher-Ohlin framework implies that changes in factor supplies are completely absorbed by alterations in the composition of outputs (structural change) and no changes in factor prices are needed to clear the factor markets. This is another important, specific and often misunderstood feature of the Heckscher-Ohlin model.

> **Factor price insensitivity**: Within a cone of diversification (see footnote 2), factor rewards do not respond to changes in endowments.

Changes in factor prices allowing for technological change: The starting point is again the zero profit conditions equating price with average costs for all perfectly competitive industries given in equation (8). Following *Leamer* (1998) by totally differentiating the zero profit

conditions, and allowing for technological change, expressing in percentage changes and using a summation notation we get:

$$\sum_k \theta_{ik}\widehat{w}_k + \sum_k \theta_{ik}\widehat{A}_{ik} = \widehat{p}_i \tag{12}$$

Note that with technological change allowed for, $dA'w = 0$ or $\widehat{A}_{ik} = 0$ no longer applies. The $\widehat{A}_{ik}$ (or dA) are interpreted as changes in input intensities at unchanged factor prices, and thus as technological change. Further acknowledging then that $\widehat{A}_{ik}$ is the difference between the percentage change of input k in sector i and output in this sector (note that scale effects are ruled out by assumption), that is

$$\widehat{A}_{ik} = \widehat{v}_{ik} - \widehat{q}_i \tag{13}$$

and defining the change in total factor productivity (TFP; primal Tornqvist index) by:

$$\widehat{TFP}_i = \widehat{q}_i - \sum_k \theta_{ik}\widehat{v}_{ik} \tag{14}$$

it is clear that $\sum_k \theta_{ik}\widehat{A}_{ik}$ can be interpreted as $-\widehat{TFP}_i$, so that we arrive at the following price equation:

$$\sum_k \theta_{ik}\widehat{w} = \widehat{p}_i + \widehat{TFP}_i \tag{15}$$

This is similar to the Stolper-Samuelson equation. In contrast to equation (11) it allows for Hicks-neutral technological changes (measured by $\widehat{TFP}$), which exhibit a similar effect on relative factor rewards as simple goods price changes do, holding market prices constant (see *Leamer,* 1998, *Feenstra - Hanson,* 1999, for the theory on the relationship between technological change and goods prices) . The equation characterizes the factor price changes "mandated" by a given set of commodity price changes plus some technological change and forms the basis for the so-called mandated wage regressions in the empirical trade and wages literature (see *Leamer,* 1998, *Baldwin - Cain,* 1997, *Krueger,* 1997, *Feenstra - Hanson,* 1999) : changes in industry prices are regressed on the level of sector cost shares for various factors of production. The coefficient estimates on the cost shares are then interpreted as the predicted

factor price (wage) changes, that are mandated by the change in product prices and/or change in technology to maintain zero profits in all sectors.

Three important points are worth noting at this stage. First, as already pointed out, the underlying Heckscher-Ohlin trade theory takes a long-run view and assumes fully flexible factor prices and perfect intersectoral mobility of factors, so that unemployment is impossible. Second, mandated wage regressions seem to suggest that goods prices are exogenous (given by world market prices) and can thus be influenced only by international trade, but this is only true for a small country. Note also that the Stolper-Samuelson mechanism holds whether product price changes are due to international trade or any other force (technological change). Thus, if technological changes are passed through to industry prices and productivity changes are happening across countries or happening in a large country which by virtue of its size can alter world prices the relation between international trade and industry prices is not that straightforward anymore. One needs a way to determine empirically what portion of the observed product price changes are attributable to international trade and what to technology. As *Feenstra* (1998) has noted, however, the distinction between trade versus technology becomes misleading in the case of increased trade through outsourcing. The reason for this is that outsourcing of labor-intensive production phases has a similar effect as sector-specific skill-biased technological change in that it reduces the demand for low-skilled relative to high-skilled labor (see also *Kohler*, 2000a). The third important point is, that the Stolper-Samuelson mapping describes no causal relationship, but a general equilibrium relationship between two sets of endogenous variables. Attributing causality from international trade (which itself is an endogenous phenomenon) to product price changes and factor price changes requires reference to some exogenous aspect of international trade. Thus, empirically, the important question is, what are the exogenous forces that jointly drive goods and factor prices.

Another important feature of equation (15) is that it is only the sector bias of technological change that matters for factor prices (TFP change is only indexed by i which stands for the sector, not by k standing for factors), the factor bias of that change is totally irrelevant. Thus, it does not matter whether technical change is labor saving or capital saving in character, it only matters which one of the sectors is influenced most. As we will point out later, this outcome in a $2x2$ economy relies on the assumption of exogenously given world market goods prices, and is also no longer valid in a more dimensional model.

Fragmentation in the simple two-dimensional Heckscher-Ohlin model: To summarize, there are three parameters which could in gen-

eral be thought of as influencing relative factor rewards: goods prices, endowments and technology. In the simple, two-dimensional Heckscher-Ohlin models described in the preceding chapter, world market goods prices change factor prices according to the Stolper-Samuelson Theorem. Endowment changes have no effect on factor prices, since all changes are absorbed by concomitant shifts in the output mix. The effect of changes in factor supplies on relative output and employment are captured by the Rybczynski Theorem. Finally, technology affects factor rewards only via its sector bias, the factor bias is totally irrelevant.

How do these specific implications of the simple Heckscher-Ohlin model carry over in an analysis of international outsourcing?

The first important thing to note is, that the effects of trade induced by outsourcing are shown to be like those of industry-specific, factor-biased technological change. Because outsourcing (transfer of activities in the production of a good to another country) changes the mix of activities done within industries and "the outsourced activities can be thought of as new intermediate inputs, which will shift the entire production function for activities done at home, and therefore show up in the industry aggregate production function as a change in total factor productivity" (*Feenstra - Hanson*, 1999, p. 917). This will generally be a non-neutral shift, as outsourcing will often involve the movement of low-skilled labor-intensive activities to low-wage countries, reducing the demand for low-skilled relative to high-skilled labor within an industry just as skill-biased technological change does. The impact of outsourcing on labor markets then must be seen as working through its effects on productivity.

Thus, fragmentation, like technical progress, has two types of effects. First, it has a factor saving effect. If it is the low-skilled labor-intensive production stage that is outsourced, this effect will be low-skilled labor saving. This in turn acts like an increase in a country's endowment of labor so that the effects on relative output and employment can be derived from one of the core Theorems of the Heckscher-Ohlin model, the Rybczynski Theorem: at constant commodity prices (and thus factor prices), an increase in the endowment of labor will increase the output of the labor-intensive sector, and decrease the output of the other sector. Intuitively, given constant commodity prices, we know that factor prices as well as input-output coefficients of both sectors are fixed. Thus, the labor-intensive sector must expand in order to absorb the additional labor. It must expand at the expense of the capital-intensive sector which contracts and thereby not only releases capital but also labor, meaning in turn that the rate of increase in low-skilled labor employment and thus the rate of increase in output in the labor-intensive sector is

greater than that in the labor endowment.

Besides factor saving, fragmentation is cost saving. For given commodity prices then costs fall relative to prices and increase that sector's profitability, so that factor prices have to adapt to guarantee zero profits in all sectors again. How factor rewards react, completely depends on the factor intensity of the industry in which fragmentation occurs. If fragmentation occurs at the labor-intensive end of the production spectrum it has the same effect as technological progress in the labor-intensive industry: the wage-rental-ratio increases. If fragmentation occurs at the capital-intensive end, the opposite is true. It is of no relevance, however, which one of the production stages is outsourced, the labor-intensive or the capital-intensive. This is the same as saying, that it is only the "sector bias" of outsourcing, that is in which of the sectors fragmentation occurs which matters for factor prices. This result directly carries over to the analysis of fragmentation.

For the effects of fragmentation on relative output and employment it is important to note that these changes in relative factor prices will in general induce firms to substitute away from the more expensive factor within industries. The effects of this substitution effect on employment can either be in line with the factor bias of outsourcing or work in the opposite direction depending again on, in which sector fragmentation occurs.

The effects of fragmentation on factor prices in the even HO-model, can be nicely summarized by the Lerner-Pearce diagram (*Arndt,* 1997a, 1997b, 1999) in Figure 1 and 2 (see also the appendix for a description of the Lerner-Pearce diagram). Since outsourcing of Austrian firms to Eastern Europe will most likely involve low-skilled labor-intensive production stages we will concentrate on this case in the following.

Outsourcing of the low-skilled labor-intensive fragment in the high-skilled labor-intensive industry: Figure 1 pictures the case where fragmentation occurs in the skill-intensive industry Y. L_s and L_u are high-skilled and low-skilled labor inputs, w_s and w_u are the respective wage rates.

The production of the high-skilled labor-intensive good can be decomposed into two separate production phases (k_{y1}, k_{y2}) differing in their factor intensities. The product's overall expansion path (k_y) then is the weighted average of the factor intensities of its stages. Outsourcing of the low-skilled labor-intensive production phase produces an inward and upward shift of the original unit-value isoquant of the capital-intensive industry(Y)[4]. It follows, that the original expansion path (k_y) repre-

[4]It is assumed that the production of the outsourced component ceases completely

senting the overall factor intensity of production of the final product shifts to the expansion path of component production that is kept in the country (k_{y1}) at the initial wage ratio. As a result, factor prices react and the low-skilled-to-high-skilled wage ratio (w_u/w_s) decreases. This, in turn, causes some substitution away from the more expensive factor, high-skilled labor. The expansion path of component production remaining in the country thus shifts to $k_{y1}^{'}$.

The effects of outsourcing on output and employment can be analyzed with the help of the second picture in Figure 1. It shows the original expansion paths, k_x and k_y, as well as the expansion paths following fragmentation ($k_{y1}^{'}$ and $k_x^{'}$). With factor endowments given by point E, the original output mix in the economy is given by X_0 and Y_o, respectively. The output mix shifts from X_0 and Y_0 to X_1 and Y_1 as a response to outsourcing of the low-skilled labor-intensive production phase in the high-skilled labor-intensive industry. However, the effect of outsourcing on output and employment in both industries is ambiguous, depending on the relative magnitude of two opposing forces:

- The "factor saving effect" which after fragmentation of the low-skilled labor-intensive production phase above, shifts the factor proportions in the country towards high-skilled labor at the initial high-skilled-to-low-skilled wage ratio (negative impact on employment of low-skilled labor).

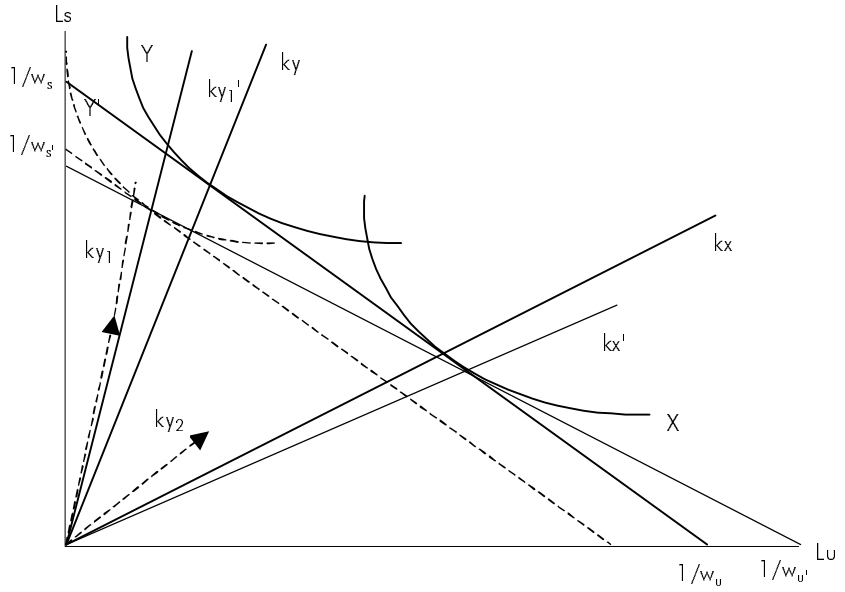
- The "substitution effect" which, after the wage ratio reacts (w_u/w_s) decreases (high-skilled labor becomes more expensive), induces a substitution away from the now more expensive factor towards more low-skilled labor (positive effect on low-skilled employment).

Generally, if the substitution effect dominates and the expansion path in the fragmenting high-skilled labor-intensive sector is more intensive in the use of low-skilled labor than the original path, there will be an expansion of both, output and employment in that industry, while the other contracts. If the new expansion path is more high-skilled labor-intensive than the old one, as is the case shown in Figure 1(b), employment of low-skilled labor goes down in that sector but increases in the other. Output could be increasing in both sectors, or declining in the fragmented high-skilled labor-intensive sector and expanding in the low-skilled labor-intensive sector. Thus, although it cannot be ruled out that offshore procurement will cause jobs of low-skilled to be exported, it is far from the obvious and necessary outcome.

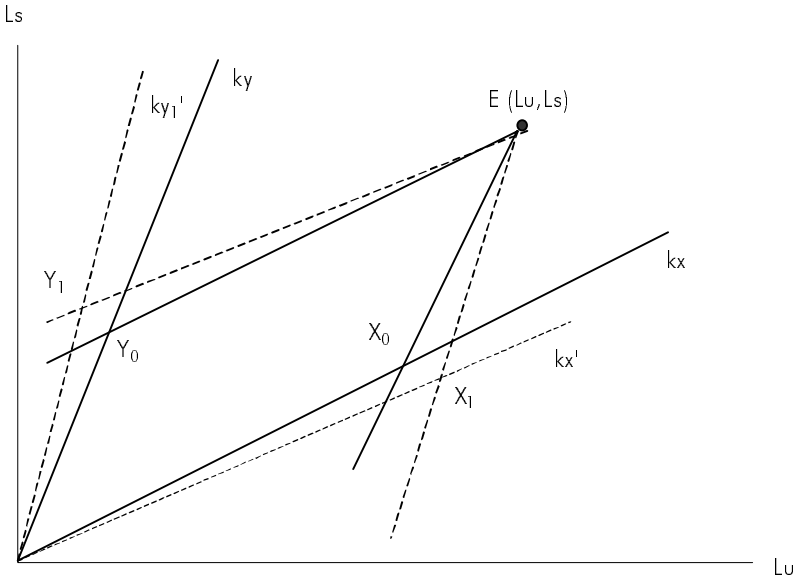
so that the country imports the intermediate product produced by the outsourced activity to produce the final product.

Figure 1: Outsourcing of the low-skilled fragment in the high-skilled labor-intensive sector

(a) Factor price effects



(b) Output and employment effects



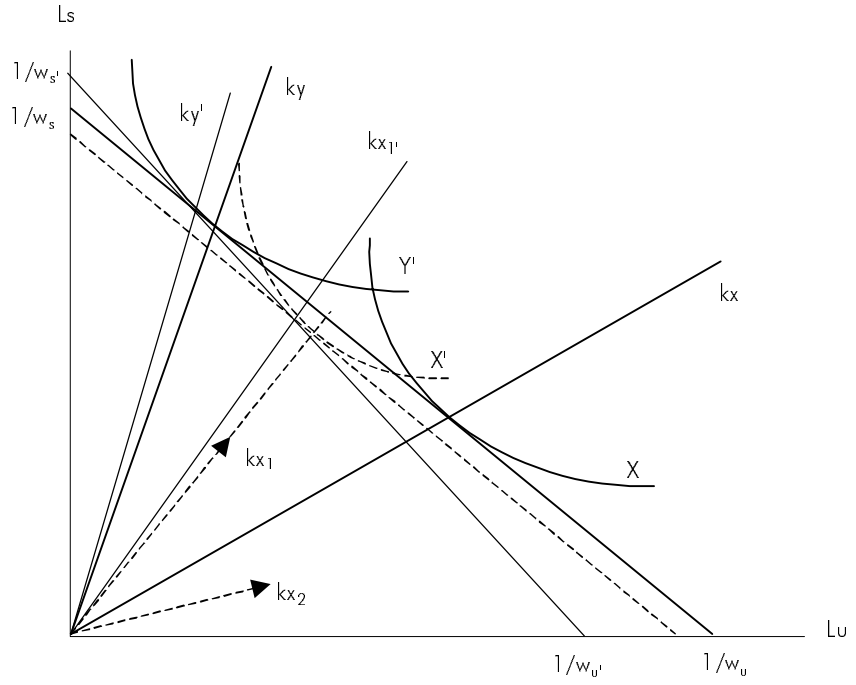
Outsourcing of the low-skilled labor-intensive fragment in the low-skilled labor-intensive industry: In Figure 2, the high-skilled labor-abundant country outsources the low-skilled labor-intensive production phase of its import-competing low-skilled labor-intensive industry. As a result of fragmentation, the low-skilled-to-high-skilled wage ratio increases. Furthermore, employment and output in the fragmenting industry increase, employment and output in the other sector decrease. In this case, the factor saving effect of fragmentation and the substitution effect due to the cost saving effect of fragmentation work in the same direction in the fragmenting industry. Both substitute away from low-skilled labor towards a more high-skilled labor-intensive expansion path. The offset low-skilled labor is absorbed by the low-skilled labor-intensive industry, which expands output and as a result is in need for more high-skilled labor. In addition, the more high-skilled labor-intensive the new expansion paths become due to the substitution effect, the more high-skilled labor the low-skilled labor-intensive industry will draw from the other sector (which in turn also became more high-skilled labor-intensive), and the higher will the output loss be in the other sector. Thus, offshore procurement by the low-skilled labor-intensive import industry in advanced countries may be a way to strengthen the import industry and in many cases may even guarantee its survival.

As long as world prices are given and unchanged by the introduction of fragmentation as is assumed so far, a country cannot lose from it and fragmentation is clearly welfare enhancing (*Arndt*, 1997a, 1997b, 1999). We have seen that fragmentation increases the output of the fragmented product for given endowments of a country and thus increases its production possibilities, as long as the resource cost of producing the component that is outsourced indirectly through exports of the other component (in which the country is then specialized) is lower than the cost of producing it directly at home. A production possibility frontier for the two goods X and Y is drawn in Figure 3 (TT'). As a result of fragmentation in sector X, the production possibility frontier shifts outward in the direction of the fragmented good. Production moves from Q to Q'. As also shown in the figure, fragmentation increases the world consumption of both goods and thus, for given world goods prices (the price line P_w does not turn) clearly increases welfare.

Extensions to the basic Heckscher-Ohlin set-up and other models: So far we have considered the case of a small, open economy, which takes commodity prices as fixed and have further assumed an equal

Figure 2: Outsourcing of the low-skilled fragment in the low-skilled labor-intensive sector

(a) Factor price effects



(b) Output and employment effects

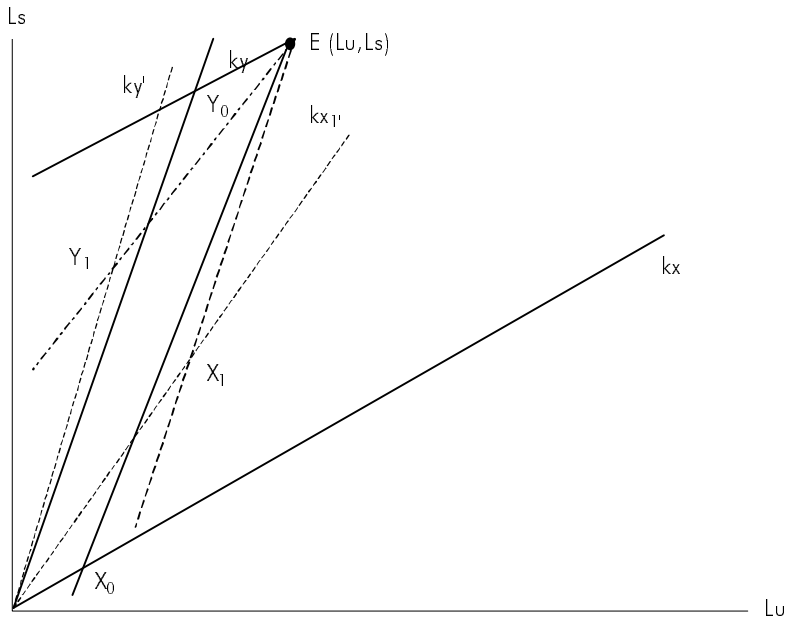
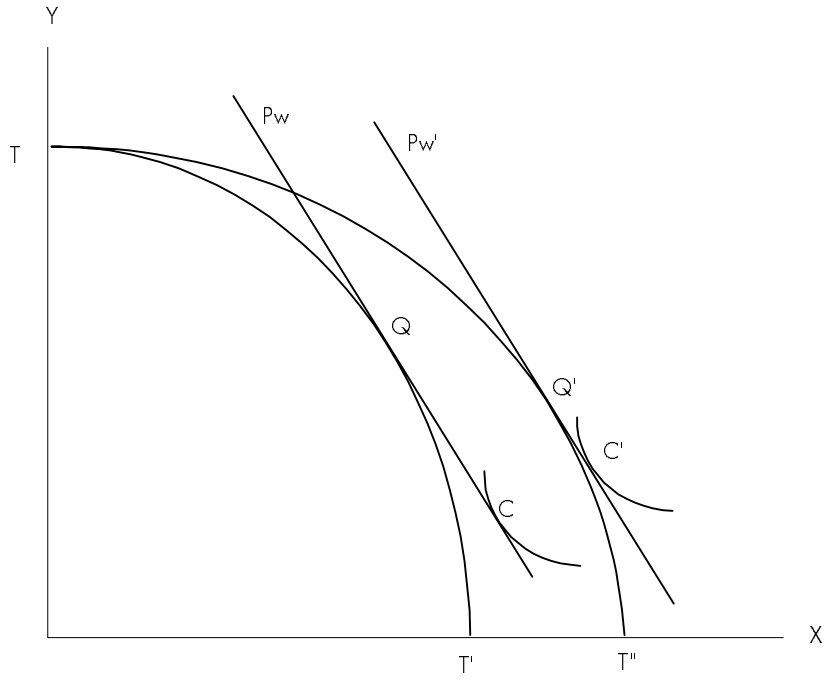


Figure 3: The welfare effect of outsourcing

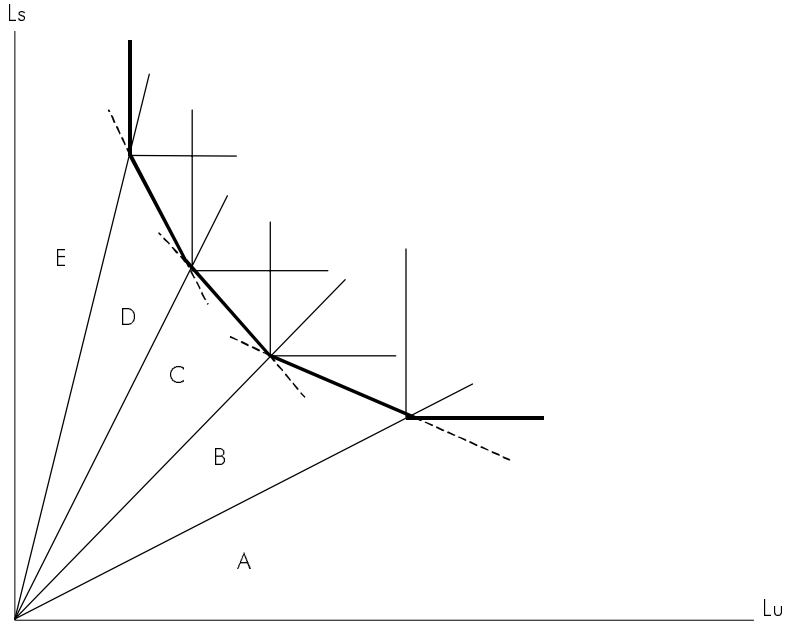


amount of factors and sectors, and perfect mobility of all factors between sectors. As to factor price effects, given these assumptions of the simple Heckscher-Ohlin model, one can derive the following simple rules: International outsourcing in the high-skilled labor-intensive sectors increases the relative wage of the low-skilled; outsourcing in low-skilled labor-intensive sectors increases the high-skilled/low-skilled wage gap, but no losses in jobs are to be expected among the low-skilled; finally, outsourcing will always increase total welfare. These conclusions exactly picture the results in a series of papers by *Arndt* (1996, 1997a, 1997b, 1999, 2000) who relies exactly on the assumptions of the simple Heckscher-Ohlin model discussed in the preceding chapter. Unfortunately, it turns out that these assumptions are crucial in determining the effects of fragmentation on factor prices in this model framework. Answers are not as clear-cut, when relaxing any of the key assumptions of the model and as a result, hardly any two studies come up with the same results. Thus, while in Arndt, US outsourcing to Mexico can be an alleviating factor in relative wage trends of high-skilled and low-skilled workers, the wage gap is predicted to increase in the *Feenstra - Hanson* (1996a) model of North-South outsourcing. The key features of their model are that it involves not only two but a continuum of production

phases for a good, that goods prices are viewed as endogenous and that the results for factor prices as well as fragmentation itself are driven by an increase in the capital endowment of the South. A single manufactured good is produced from the assembly of a continuum of intermediate inputs that are in turn produced using, in different amounts, high-skilled workers, low-skilled workers and capital. The model developed is similar to the Heckscher-Ohlin model with a continuum of goods (*Dornbusch et al.*, 1980) only that the continuum of activities considered belongs to a single industry. If factor prices are not equalized between the countries, then the North specializes in inputs that are relatively intensive in high-skilled labor (R&D, marketing) and the South specializes in inputs that are relatively intensive in low-skilled labor. Capital accumulation in the South or any neutral technological change in the South relative to the North, raise the critical ratio of high-skilled-to-low-skilled labor dividing the Northern and Southern activities. This involves the transfer of activities from the North to the South and can be interpreted as an increase in outsourcing by Northern firms. As a consequence, the relative demand for high-skilled labor increases in both countries. In the South, the range of input production expands towards inputs that use a relatively high ratio of high-skilled-to-low-skilled labor; in the North, the activities outsourced are the ones that use relatively large amounts of low-skilled labor. As a result, the average skill-intensity increases in both regions, leading to higher relative demand of high-skilled labor and increases in the relative wage of the high-skilled in both regions. On the other hand it is possible that real wages of both groups increase.

Deardorff (2000b) considers a version of the Heckscher-Ohlin model with more goods than factors and endogenous goods prices. In this framework, the effect of fragmentation on relative factor rewards depends on the factor intensity of the fragments that remain in the outsourcing country in relation to both, the original technology and the average intensities of the processes in use in each country before fragmentation. Outsourcing of the low-skilled labor-intensive fragment of one of its goods to a low-wage country will increase the wage gap between high-skilled-to-low-skilled labor in the North if, first, the original technology of the integrated product was more low-skilled labor-intensive than the average of other processes - because then a relatively large amount of low-skilled labor is set free, increasing high-skilled wages relative to low-skilled wages, and secondly, the production of the remaining fragment is sufficiently skill-intensive relative to the original good so that more high-skilled workers are demanded than were set free by cancellation of production of the original good and wages for the high-skilled have to rise.

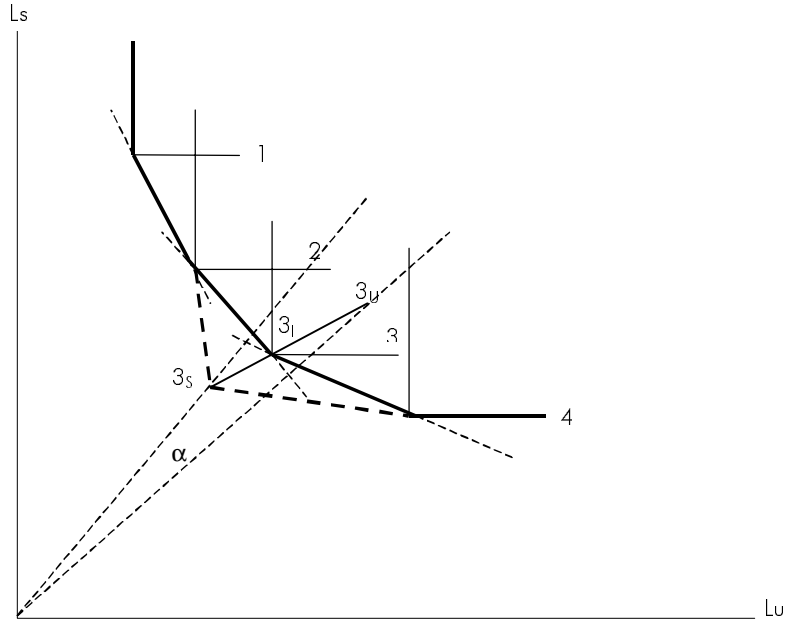
Figure 4: Hicksian composite unit-value isoquant



Jones - Kierzkowski (2000) introduce a model with more goods than factors and exogenous goods prices in which international fragmentation may cause the country to alter the composition of its production (a switch between cones of diversification). In such a world one could imagine countries with dissimilar relative endowments to specialize in a different mix of goods with different wages and other factor prices associated with each mix of products (i.e. each cone of diversification). Figure 4 pictures this situation. Note that within each cone of diversification, the factor price insensitivity condition holds, that is factor rewards do not respond to changes in endowments and the standard reasoning of the even Heckscher-Ohlin model holds. Thus, a world populated by countries with dissimilar relative endowments may contain more than a single region of factor price insensitivity. The conceptual tool is the Hicksian composite unit-value isoquant - represented by the bold line in Figure 4 - consisting of several different linear segments along which the standard 2x2 reasoning holds and "end"-sections along which the country is completely specialized.

With given goods prices, fragmentation would not alter factor returns if it kept the country within the same cone of diversification, or along

Figure 5: Outsourcing in a model with more goods than factors



a particular line segment of the Hicksian unit-value isoquant, but cause factor price changes if it causes the country to alter the composition of its production (movement to another linear segment). Similarly, biases in technical progress could cause a switch from one production mix to another, and thus affect relative factor prices.

In specific, *Jones - Kierzkowski* (2000) consider a model in which fragmentation shifts production stages to countries with higher productivity and thus allows for a greater application of Ricardian comparative advantage. Thus, the shape of the Hicksian unit-value isoquant is determined by technology and the high-skilled endowment of a country at given world prices. Endowments, however, determine the relevant part of this isoquant for each country, that are the production pattern and relative factor prices. Figure 5 reproduces their results[5].

The effect of factor prices is shown to depend on an interplay between the endowment and output structure of a country and the fac-

[5] The shape of the isoquants reflects the assumption of the authors that production technologies of components as well as the integrated product display fixed input coefficients, so that there is no factor substitution in response to changes in factor prices.

tor intensity of the fragments remaining in the country which replace the original integrated activity. Within the cone of diversification of the fragmented activity, denoted by (α), it is the factor intensity of the fragmentation activity (that is whether the labor-intensive or the capital-intensive production phase survive) that is important for the effect on factor prices. Within this cone (α), if it is the high-skilled labor-intensive phase ($3s$) that survives (or alternatively, the low-skilled labor-intensive stage ($3u$) that is outsourced), as shown in the picture the low-skilled-to-high-skilled wage ratio falls. Outside the cone of diversification of the fragmented activity, the factor bias has no influence, and as in the simple Heckscher-Ohlin model considered by *Arndt* (1997a, 1997b, 1999), if fragmentation occurs at the labor-intensive end of the production spectrum (as for countries originally producing goods 2 and 3) the wage-rental-ratio increases and employment of labor in that industry increases as well. If fragmentation occurs at the capital-intensive end (as for countries originally producing product 3 and 4), the opposite is true, the wage-rental-ratio decreases and employment in the fragmented industry decreases as well (increasing in the labor-intensive industry).

Finally, *Kohler* (2000a), relying on results from the theory of effective protection, views the effects of outsourcing on factor prices as working through changes in imputed (effective) prices of the value added components remaining at home at given final goods prices. For a given final output price, cheaper intermediate inputs increase the value added generated by any given level of primary inputs employed in the domestically produced fragments. He assumes sector-specific Ricardian technological differences between the domestic and the foreign economy as well as different endowments with non-equalized factor prices. The fragment remaining in the country is interpreted as a downstream activity relying on the outsourced, upstream fragment. The magnitude of the effective price change for the value added activity remaining in the country depends on the cost savings induced by international fragmentation. It increases with the extent of factor price differences between the countries, the share of the factor which is relatively cheaper abroad in the fragmented activity as well as the substitutability of production factors in the fragments, while it decreases with any trading or communication costs involved and technology gaps between the countries. He arrives at the following Theorem: factors which are used relatively intensively in the remaining domestic value added chain of the industry and which observe the greatest cost savings (effective price increase) through outsourcing will, on average, receive a more than proportional increase in their rental. The crucial point is, that the factor price effect of outsourcing does not depend on the composite factor intensity of the outsourcing

industry, but on the skill intensity of the fragments staying within the country relative to the domestic high-skilled endowment.

Jones - Kierzkowski (2000) also discuss the effects of fragmentation on factor prices when the assumption of perfect mobility of factors between sectors in the Heckscher-Ohlin model is relaxed. The perfect mobility assumption emphasizes the long-run nature of the model applying in a period of time over which there is no attachment of factor to sectors. In a shorter period of time, factors are less mobile (workers need to learn other skills, machines need to be adapted, etc.). A model which takes up this idea to some extent is the specific-factors model. The easiest example is the 3x2 specific-factors model with two specific factors (capital specific to sectors), one mobile factor (labor) and two goods.

Jones - Kierzkowski (2000) show, that if fragmentation within such a framework rules out the production of the low-skilled labor-intensive component, this produces an excess labor supply and wages decrease relative to returns on all types of specific factors (physical capital, high-skilled labor). If the specific factor-intensive component is outsourced wages of low-skilled labor increase relative to all sector-specific rentals. The factor bias of international fragmentation therefore has a direct bearing on factor returns in this model.

But this tells the story about the effects of fragmentation on the ratio of relative factor rewards not about real factor rewards. Fragmentation, like technical progress has two types of effects. First, if it is the low-skilled labor-intensive production phase that is outsourced there is a low-skilled labor saving effect (=supply of low-skilled labor increases) which depresses (w_L). On the other hand (w_L) will be positively affected by productivity effects of fragmentation in any sector. If factor substitution possibilities are sufficiently large that latter effect will be larger than the former, leading to an increase in the real (w_L), even if the return to capital increases by more. *Jones* (1996) has shown that for a small open economy, which takes goods prices as given on the world market, real (w_L) increase even in the case in which technological progress is purely low-skilled labor saving in the same relative amount in each sector, if elasticities of substitution in production are sufficiently high, exceeding the ratio of capital shares to labor shares.

Kohler (2000b) additionally identifies conditions under which international fragmentation in a specific-factors model leads to welfare gains for the whole economy so that the above mentioned incomes lost in some parts of the economy are overcompensated in the aggregate by income gains in other parts. One of these conditions is that there are no market imperfections. Market frictions, like inflexible wages leading to unemployment may offset that welfare gain. He further shows that

the downward pressure on wages due to outsourcing can be mitigated if at least some of the specific capital is set free too and may be used in the production of the remaining fragment and thereby increasing the productivity of labor used in the remaining value added chain. For the same reason, outsourcing is thus more likely to be harmful to domestic labor if it is associated with direct investment (domestic capital used in outsourced capital rather than being set free, is moved across the border to work with foreign labor).

2.1.3 What are the main messages of traditional trade theory?

Given the above survey on the theoretical literature on the effects of international outsourcing in traditional trade theory, it seems that much depends on the specific details assumed. One common feature in that literature is the notion, that international fragmentation of the value added chain has the same effects on an economy as industry-specific, factor-biased technological change. Outsourcing of low-skilled labor-intensive production phases is thus expected to reduce the demand for low-skilled relative to high-skilled labor within an industry just as skill-biased technological change would.

A comparison of the specific assumptions made in the literature shows that models of fragmentation within the standard trade theory framework primarily differ in the way with which any possible factor bias of outsourcing can influence relative factor rewards. For a small open economy, which takes world prices as given (it cannot by itself change that price) the factor bias of that change (i.e. whether it is labor saving or capital saving) is of no relevance at all to wages and other factor rewards. The reaction of wages depends solely on the factor intensity of the outsourcing industry. If fragmentation occurs in the labor-intensive industry it acts like technological progress in that sector and will increase wages. The opposite is true if it is the capital-intensive industry that outsources.

We can identify four possible routes by which the factor bias can influence wages and other factor rewards and by which results are then no longer influenced by the factor intensity of the outsourcing industry, but by the factor intensity of the remaining fragments.

1. Viewing (both intermediates and final) goods prices as endogenous means that a country is considered as large enough to influence world prices by its own actions. Then changes in factor supplies induced by outsourcing of production phases change the relative price of a good through their influence on outputs, and change factor rewards according to the Stolper-Samuelson Theorem. Both *Feenstra - Hanson* (1996a) and *Deardorff* (2000b) assume endoge-

nous goods prices. Furthermore, if fragmentation does change the world market price of the good, then it can lower the welfare of a country by turning its terms of trade against it. As the output of an industry which engages in fragmentation can increase, its price on the world market decreases, moving the terms of trade in the country's favor if the fragmented good is the import good, but turning the terms of trade against it if the outsourcing industry represents the country's export sector. Looking at Figure 3 again, a negative terms of trade effect would make the price line in the figure steeper and welfare might decrease if this terms of trade effect outweighs the shift in production possibility frontier. On the other hand a positive terms of trade effect can increase welfare even further.

2. The second route by which the factor bias of fragmentation can matter, is that outsourcing in a model with more goods than factors may lead to a significant change in the output structure of an economy (for example, specialization in human capital-intensive industries and abandonment of low-skilled labor-intensive industries) so that the country ends up in a different cone of diversification associated with a different set of factor prices.

3. Some factors are sector-specific and cannot be adopted immediately in another industry, which is a very likely situation if effects of outsourcing are to be analyzed in the short-run. The Heckscher-Ohlin model thus applies to very long-run thinking and results are applicable to a period of time over which there is no attachment of factors to sectors and any change in factor supplies (induced for example by factor-biased effects of outsourcing) can be absorbed by structural changes.

4. The fourth route to give factor bias of outsourcing a role to play is to view outsourcing as a change in the effective price of the value added components remaining in the country (see *Kohler*, 2000a, 2000b). For a given output price then, cheaper intermediate inputs increase the value added generated by any given level of primary inputs employed in the domestically produced fragments.

The effects of outsourcing on the output and employment structure of countries are influenced by two things: the factor bias of the changes induced by outsourcing and the substitution between factors as a consequence to factor price changes. The factor bias affects the output structure according to the Rybczynski Theorem. Thus, if outsourcing

involves the low-skilled labor-intensive production phase it has a low-skilled labor saving bias in the home country. The relative supply of low-skilled labor is increased and the output structure of the outsourcing country will change toward higher shares of low-skilled labor-intensive industries. The substitution effect will induce substitution within an industry away from the more expensive factor, and thus like the factor price changes which induce this shift, will depend on which industry fragments. It will work in the same direction as the factor bias or in the opposite direction. In general, outsourcing of low-skilled labor-intensive production stages by the low-skilled labor-intensive import industry will increase output and employment of that sector. Output and employment effects, when outsourcing of low-skilled labor-intensive production stages occurs in the high-skilled capital-intensive industry, produce ambiguous results, so that relative output and employment might shrink in the fragmenting industry, but it is not the general result. Again, these results only apply to the long-run, in the short-run the involved structural changes can induce some unemployment. Note, however, that these results only are due to the even (same number of goods and factors) Heckscher-Ohlin model. In a model with more goods than factors a unique determination of output (and employment) becomes impossible (Melvin indeterminacy). In contrast to an identification of factor price effects, much more model structure is therefore needed to identify effects of outsourcing on output and employment.

2.2 Fragmentation in New Trade Theory and economic geography models

2.2.1 New Trade Theory models with horizontal product differentiation

Traditional trade theory has highlighted two motives for international fragmentation: factor price or endowment differences and/or Ricardian productivity differentials across countries. If production processes differ in factor intensity or can be split up such that different countries are especially productive in fulfilling a certain task in the value added chain then additional gains can be accrued by pushing specialization beyond the product level. A third motive is that a splitting up of the production process into more and more specialized tasks can be seen as an increase in the division of labor and thus lead to gains stemming from economies of specialization à la Adam Smith. *Ethier* (1979, 1982) emphasized this latter idea in his model of (intra-industry) trade in differentiated intermediate products. His model belongs to the class of New Trade Theory models with economies of scale, product differentiation and imperfect

competition as its key elements. The New Trade Theory is fundamentally a theory of intra-industry trade (IIT) which involves an exchange of differentiated goods that fall into the same product category (German Mercedes for British Jaguar). Indeed, the bulk of total international trade takes place among industrialized countries despite the fact that these countries share similar factor endowments and production technologies and it is the New Trade Theory that has been developed to explain this phenomenon. The basic framework of these models was introduced by *Krugman* (1979) and *Helpman* (1981). Imperfect competition is assumed to take the form of monopolistic competition with free entry and exit of firms driving profits to zero. Further key assumptions are: internal economies of scale in the production of each variety of a good; a perfect symmetry across varieties in production as well as consumption; each consumer derives utility from product variety and for a given income, utility increases not only with the consumption level of each good, but also with the number of varieties. These assumptions ensure among other things that each firm will produce a unique variety; it never pays to copy a rival. Furthermore, output levels and prices will be the same across varieties[6].

These assumptions also serve as the building block for the Ethier model but his approach differs from the basic framework in an important way. The first is that the monopolistic competition framework is applied to explain the impact of scale economies at the intermediate input level and thus explains intra-industry trade in inputs rather than final products. A distinctive feature of his model is that there are two different

[6]A peculiar feature of the Krugman (1979) model is its assumption that every consumer likes some of every variety. Thus, consumers optimize welfare by maximizing the number of varieties consumed and variety is desirable in and of itself. This is often also referred to as the "love of variety approach" in the spirit of *Dixit - Stiglitz* (1977). Another approach to model the demand for variety is based on the work of *Lancaster* (1979, 1980) and was introduced in international trade by *Helpman* (1981). It is based on a "most preferred variety" utility function. Consumers differ over their preferred variety and if a consumer purchases a variety that is different from his ideal choice, this variety yields a smaller utility than one unit of the most preferred one. Quantities of varieties other than the preferred one have to be discounted, with the discount factor higher, the higher the "distance" of the consumed variety to the preferred variety is. This approach is more complex than the former and has been used rather less in the literature. Note, that while in the Krugman "love of variety" approach international trade is always beneficial to all, international trade in the most preferred variety approach of the Helpman model is beneficial on average but potentially harmful to some consumers (see also *Helpman - Krugman*, 1985, *Wong*, 1995).

A third dimension of intra-industry trade refers to goods in a narrow product group, which are vertically differentiated (i.e. goods differ in quality, see *Grossman - Helpman*, 1991).

sources of increasing returns to scale in production. The model involves two goods, one which is produced under constant returns (agriculture) and the other under increasing returns (manufactures). The output of the manufactured good is modelled to involve two stages characterized by two distinct forms of economies of scale. First, primary resources are used to produce differentiated intermediate inputs (components) under internal economies of scale. Then the differentiated components are combined to produce the final manufactured good under external economies of scale. More specifically, the production function for finished manufactured goods displays constant returns to scale for a given number of varieties, but increasing returns in the number of inputs. Thus, a larger variety of components reflects a greater division of labor and greater economies of specialization à la Adam Smith. The greater the number of varieties in inputs the lower the cost of production of the final product. As trade gives each country access to the other's components and no transportation costs of any kind are assumed, external economies of scale are international in scope, they do not require a concentration of the industries in any one country. To take account of this international aspect, Ethier calls them "international returns to scale".

It is important to see that to take advantage of economies of specialization it would pay to produce an infinite amount of varieties but that the presence of scale economies at the level of the individual plants in the intermediates production constrain the degree of specialization. Variety must be traded off against cost: producing all conceivable varieties would involve too great a loss of economies of scale, producing just one variety at huge scale would violate too much the economies of specialization.

In this model then, trade becomes a way of extending the market and exploiting economies of scale at the individual plant level. Trade also increases the number of varieties of components that producers can choose from, which is beneficial as there are increasing returns to specialization. To see this, remember that the symmetry assumption for all the varieties produced ensures that no firm will produce the same variety in equilibrium. Then, if two countries produce identical varieties under autarky and start to trade, there will be an immediate gain by pooling the production of each at one of the countries and reaping the scale economies. If on the other hand the varieties are not identical, producers in each country have the home and the foreign varieties to choose from, which increases economies of specialization. The equilibrium will probably be somewhere in between, so that trade in intermediates raises welfare by both increasing choice and reducing costs.

Although the differentiated components are modelled as separate hor-

izontally differentiated inputs, they are best interpreted as indexing the level of inputs provided by distinct suppliers in the value added chain. As the number of varieties in the model increases, the level of input specialization and thus fragmentation is increased. But note also that the fragmented tasks in this sort of model do not differ in factor intensities as has been assumed in the analysis of international outsourcing in a Heckscher-Ohlin framework. Differentiation occurs along a horizontal dimension referring to different varieties of a product that are of similar quality and that are produced via basically the same technology.

It is also important to see that while this model is able to predict the volume of intra-industry trade in intermediate products the pattern of that trade is indeterminate. There is nothing in this model which tells us which country will produce which variety of the components as long as these components are producible via the same production function and there is thus no factor endowment or technology basis for trade as long as trade in intermediates is not subject to transportation costs. That is, it does not matter whether a particular variety is produced in the home or the foreign country as long as both countries are assumed to have identical technologies in producing the differentiated products and as long as there are no costs involved in transporting these varieties across countries. All it says is that there will be increased fragmentation, it is not clear which varieties will be displaced by very similar foreign rivals and which will remain in the country.

As to income effects, it is usually argued that adjustment costs due to structural changes following trade liberalization are lower when the emerging trade is of the intra-industry type[7]. If factor intensities between sectors are similar then a transfer of labor from one sector to another is possible without complete retraining of the work force. It is easier to transfer and adapt resources within industries than to switch them from one industry to another. *Krugman* (1981) addresses the income-distribution effect of intra-industry trade and formally shows that the more similar the countries are, the larger the intra-industry trade therefore is, the more likely it is that everyone benefits from it and thus that intra-industry trade poses fewer adjustment problems than in the standard case of inter-industry trade. This is a result that runs counter to the prediction of the Stolper-Samuelson Theorem of the standard Heckscher-Ohlin model where the scarce factor is to lose from trade. It can be explained intuitively by the fact that in the models of the New Trade Theory, trade provides gains over and above that from special-

[7]See for instance *Balassa* (1966), *Caves* (1981), *Krugman* (1981), but also *Hamilton - Kniest* (1991) introducing a measure of marginal intra-industry trade and the literature following that, for instance *Bruelhart* (1994).

ization according to comparative advantage, from increased variety and better exploitation of scale economies. Thus, if changes in relative factor rewards are not too large, these extra gains could make everyone better off. And finally, the more similar countries are and the more important scale economies are - a state giving rise to the prevalence of intra-industry trade - the more likely this is to be the case (scarce as well as abundant factors gain from trade).

2.2.2 New Trade Theory models with vertical product differentiation

The above predictions do not carry over to a model in which specialization involves vertically differentiated products where the capital-labor-ratio or skill requirements alter in the process of specialization. Models of vertical product differentiation in contrast to the models of horizontal product differentiation within the New Trade Theory assume that different varieties require different factor proportions in production and provide an explanation of intra-industry trade in a quasi Heckscher-Ohlin setting with each country producing the varieties most suiting its endowments (*Finger*, 1975, *Falvey*, 1981, *Falvey - Kierzkowski*, 1985). The central assumption of the respective models is that a higher (human) capital-labor-ratio results in the production of higher quality. From this follows that (human) capital-abundant countries export relatively high-quality products, while labor-abundant countries export relatively low-quality products. The implications of models of vertical product differentiation are quite different from the models incorporating horizontal product differentiation as they predict a positive relationship between the difference in factor endowments and vertical IIT, as well as a positive correlation between the difference in countries' per capita incomes, demand and vertical IIT. The analysis of outsourcing would then proceed much in the same way as in the standard Heckscher-Ohlin model and its extensions.

2.2.3 Economic geography, transportation costs

The most distinctive element of economic geography models is the interaction of increasing returns with transport costs across countries (or regions). In such a world increasing return activities are predicted to locate in the larger market. Market size then becomes the basis for trade and differences in the production structure between countries. Note that without transport costs in an increasing returns model specialization patterns would still be indeterminate as in the New Trade Theory models reviewed before. The basic framework was again provided by

Krugman (1980, 1991a, 1991b)[8].

Krugman - Venables (1995) and *Venables* (1996) provide an application of the *Ethier* (1982) model of costless trade in differentiated intermediate goods in the area of economic geography. The interaction between transport costs and trade in intermediates creates country-specific external economies which may lead to an agglomeration of economic activity. Note that in the original Ethier model with costless trade in intermediates it is not necessary for the industries to concentrate in only one country in order to realize economies of specialization.

Starting from an initial situation of high trade barriers, these authors study the impact of declining transportation costs on incomes and production patters of two regions, the North and South. They model three sectors, one of which is perfectly competitive producing a costlessly tradable good (agriculture). The two others are monopolistically competitive and vertically linked. The upstream industry is providing an intermediate good to the downstream firm which in turn supplies consumption (manufactures). There is a single primary (homogeneous) factor at each location, labor. Both upstream and downstream firms produce under increasing returns to scale and are subject to transportation costs.

The predictions of this model framework are as follows: Initially transport costs are so high that each region produces its own supply of all goods. As transport costs decline, two-way trade in the increasing returns to scale (IRS) good (including intermediate inputs) emerges and demand for the industries' products starts to matter for an industry location. If the North happens to have a larger manufacturing sector, given transportation costs, that region becomes a more attractive place to locate intermediate inputs production (backward linkage). On the other hand, with transportation costs incurred in shipping goods, costs of the final goods sector depend on the location of intermediate supplying firms (forward linkage). The closer a downstream firm locates to the market where many upstream firms are, the more it saves in transport costs. This will lower production costs in manufacturing and expand that sector, which in turn will make that location even more attractive to locate intermediate inputs production. Through vertical linkages of firms in the manufacturing sector, a circular causation sets in. Demand and cost linkages of vertically integrated firms constitute the driving force for the agglomeration of activities.

As the size of the manufacturing industry in the North increases, this will give rise to wage differentials between the North and South because factor market competition takes over, but - as to real wages - partly

[8] For an overview on the main features and implications of economic geography models see *Wolfmayr-Schnitzer* (1999).

also because of differences in price indices as transportation costs have to be incurred in a different amount of goods in the two locations[9]. As a consequence, the South will have lower real wages.

As transportation costs decline further, the importance of being close to the market and, hence, the importance of forward and backward linkages diminishes. Producers will start to consider to take advantage of the lower wage in the South, if the transportation costs are low enough, and begin to expand manufacturing there at the cost of the North. This in turn will cause wages to rise in the South and to fall in the North, leading to a convergence of income. Thus, the relationship between the level of transportation costs and income as well as the degree of geographical concentration of production are shown to be U-shaped: very high and very low transportation costs would favor dispersion, intermediate levels, a concentration of increasing return activities.

Most of the economic geography literature assumes that the countries (regions) under consideration are a priori identical or differ only in size. If, however, the larger country also happens to have a comparative advantage in one or the other form in the increasing returns to scale industry, the centripetal forces in the model will be reinforced. If instead relative factor endowments favor production of IRS products in the smaller country, the centrifugal forces in the model would be attenuated, although, in early stages of trade liberalization, firms will start to relocate to the larger market even if this goes against the direction of net trade predicted on the basis of relative factor endowments. Under autarky, each country's share of industry would equal its share of world endowments.

Hanson (1994, 1996) directly considers the consequences of trade liberalization on the vertical organization (or fragmentation) of an industry under location-specific external economies and specifically discusses the effects of international fragmentation on the domestic location for the surviving production segment and thus the regional consequences of fragmentation within a country. He considers only one industry, but whose production process is assumed to involve two distinct stages with variation in the resource intensity across production stages: design, which itself involves many specialized, high-skilled labor-intensive subsidiary services, each produced under increasing returns to scale, and assembly, a routine low-skilled labor-intensive task performed under constant returns to scale. The individual inputs produced in the first stage ("design") are assumed to be subject to high transport costs, so that they

[9] As the proportion of locally produced varieties, which are priced lower than imported varieties due to transport costs, rises, the price index in this country goes down.

are not traded. For the final assembled product as well as the composite input from stage 1 (ready-to-assembly components) these costs are not sufficient to prevent them from being traded. This allows input production and assembly to occur in different locations. There are two countries: Foreign, which is large (size proxies for development) and has a single region, and Home, which has two regions, North and South, and is smaller.

Under these assumptions the input producers of stage 1 will always prefer to concentrate production in one place and to locate where demand for their inputs is highest, and this in turn will be higher the larger the concentration of the other input producers already is. As there are also some transport costs assumed in shipping the composite input, all else equal, assembly firms will also prefer to locate in the same region.

Consider first the geographical structure of production in the (small) Home which is modelled to have two regions. Consider further that production of IRS activities of stage 1 are concentrated in the Southern region. Eventually, factor prices in the South will be driven up relative to the other region. For sufficiently large wage differentials, some assembly firms will prefer to move to the North, despite transport costs[10]. In this process then, the South becomes the industry centre, with firms engaged in both stages of production, while the North specializes in assembly. Relative to the North the South has higher wages and higher returns to other factors as well as high employment.

If trade is opened with the Foreign (the large country), trade recreates the regional production network on a global scale: the large country (with higher demand) becomes the industry centre, the small country specializes in assembly. Assembly in turn will concentrate in the North of the small country if that region is assumed to have relatively better access to the foreign market and thus the relatively lowest transportation costs. Transport costs will again fix the relative wage differentials between the North and the South, but inversely to the autarky case, North will now have the higher wages and higher employment than the South. Not only will jobs be shifted from the large to the small country, there will also be a substantial relocation of production within the small country.

2.2.4 What have we learned?

Scale economies and economies of specialization in component production, pertinent to the New Trade Theory, can be seen as important driv-

[10] Transport costs of composite inputs fix the size of the regional nominal wage differential. To keep firms in both locations, the North has to offset its locational disadvantage by lower production (wage) costs.

ing forces for outsourcing activities especially among developed countries with more or less equal endowments, technologies and incomes. In the New Trade Theory framework, fragmentation is beneficial because of potential gains to specialization which implies a greater division of labor. Fixed costs, or economies of scale at the plant level limit the degree of specialization and trade can relax that limitation. However, without any additional assumptions (comparative advantages, transportation costs) this framework cannot predict the pattern of fragmentation across countries, that is, whether a specific specialized task is outsourced to supplying firms within the country or to firms in a foreign country. Economic geography models predict that in the presence of transportation costs unusually strong demand (market size) for a class of goods, which are produced under increasing returns to scale can give rise to agglomeration forces and lead to a concentration of downstream and upstream firms in one country (or region within the country), which in effect would dampen international outsourcing activities and give a big role to geographic proximity. If the countries under consideration were also to differ in their relative endowments, then, at least for intermediate levels of transportation costs, agglomeration forces could be so strong as to lead to a pattern of specialization that runs counter to comparative advantage and it would not pay to internationally outsource production phases.

As to income effects in New Trade Theory models the prediction is that the more similar the countries are, the larger the portion of trade which is of the intra-industry type and the lower are adjustment costs due to structural change following fragmentation. If changes in relative factor rewards are not too large, gains over and above those from specialization according to comparative advantage, stemming from increased variety and better exploitation of scale economies could make everyone better of. A result that runs counter to the prediction of the Heckscher-Ohlin model where the scarce factor is to lose from trade induced by international fragmentation.

Economic geography models give some predictions on wage differences (or more generally, factor price differences) across countries or regions within a country. The redistributive effects of trade between factors within these countries are not discussed. It predicts that the country/region which has the larger domestic market will have a higher nominal as well as real wage rate for intermediate levels of transportation costs because of an agglomeration of activities and the consequent competition for the factors of production. Transportation costs fix the relative wage differentials between the countries, and regions within a country. In a closed economy wages in regions within a country are de-

creasing in transportation costs relative to the industry center. In an open economy, regional wages are determined by the region's access to the foreign market. Note that relative factor prices between the small and the large country/region will only diverge if production factors (labor or capital) are assumed to be internationally immobile. If there is migration from the small to the large country, this will tend to equalize wages across countries as the incoming labor force eases the competition for factors in the industry centre. But note also, that this would only reinforce the tendency to concentrate production in one place, and the U-shaped impact of trade liberalization on the size of the industry in the small country would not come into effect.

These predictions do not carry over to New Trade Theory models of vertical product differentiation which assume that different varieties require different factor proportions in production and similar to the Heckscher-Ohlin model each country produces the varieties most suiting its endowments. The analysis of outsourcing and predictions on income effects would then proceed much in the same way as in the standard Heckscher-Ohlin model and its extensions.

2.3 Fragmentation and vertical integration across multinational firms

2.3.1 The decision to organize vertical production stages within the firm

The theory of multinational firms (MNEs) and trade concentrates on those parts of the international fragmentation which take place within the organization of the firms. MNEs set up affiliates for different production stages in several countries and combine (or assemble) them - via intra-firm trade - to an end product which may be supplied to markets in several countries. Besides cost differences which make it attractive for firms to fragment production into several stages across countries according to comparative advantage, it has additionally to be more attractive for them to do this within their own organization (i.e. within the boundaries of the firm) rather than contracting these tasks out. In contrast to the pure theory of trade an additional condition has, therefore, to be introduced. In terms of *Dunning's* (1979, 1988) terminology this condition is referred to as the internalization decision, which says that a precondition for firms to become a MNE, i.e. organizing production internationally within the firm, is that this form of organization of production yields higher profits than outsourcing part of it to foreign firms via contracts. In this case the fragmentation of the value added chain is accomplished by vertical foreign direct investment and it is simulta-

neously the decision for vertical integration across borders. In contrast, horizontal FDI which is mainly analyzed in the models of MNEs and trade by *Markusen - Venables* (1996, 1998) refers to the case when production of the same product occurs in several, foreign and domestic plants. Here MNEs are modelled as multi-plant firms which trade-off transportation costs induced by exports or more generally market proximity to fixed plant set-up costs. The impact on the industry structure, wages and employment of the home country for these types of FDI are quite different as will be demonstrated below.

There are several reasons for the internalization of production (or the organization of the fragmentation of the value added chain across countries within the firm) and, hence, for the existence of vertically integrated MNEs. They are analyzed in the huge literature on vertical integration of firms (see *Perry*, 1989 for an overview) and applied in theories of vertical FDI. The most important arguments for internalization put forward are the following:

Ownership-specific advantages: *Caves* (1996) mentions that in many cases production is based on ownership-specific assets (like know-how or knowledge capital, a high-skilled and trained workforce, organizational know-how etc., see also *Markusen,* 1995, 1998). For these firm-specific assets markets often do not exist or are inefficient because the assets are intangible and not codified or, if so, returns cannot fully be appropriated because of opportunistic behavior of potential trading partners. *Caves* (1996) formulates this nicely: "I have a piece of knowledge that I know will be valuable to you. I try to convince you of this value by describing its general nature and character. But I do not reveal the details, because then the cat would be out of the bag, and you would be free to use the knowledge without paying for it". The buying firm will thus be tempted not to reveal its true willingness to pay for the piece of knowledge. The selling firm will be tempted to overvalue its knowledge and ask for a high price. So the volume of market transaction is likely to be inefficiently low or the intangible asset is used exclusively within the firm. In the present context this means that the selling firm will become a MNE.

Transaction-specific investments: In many cases the set-up of new production lines for some components requires transaction-specific investments (e.g. the special adaptation of the machines to fit the specific needs of the outsourcing firm). Transaction-specific investments are to some extent useless and generate lower returns once the outsourcing contract breaks down. The firm contracting for the outsourced production thus has no possibility to rely on the market as an outside option

once the transaction-specific investments are made. So the contracting parties act in bilateral monopoly and have to bargain about the value added from the contract. Depending on the information structure and the bargaining power, transaction-specific investments may be suboptimal (*Tirole*, 1988). It can be shown that this problem is the more severe the more the investment is specific to the transaction and the less it can be used for other purposes. (see *Tirole*, 1988 and *Pfaffermayr*, 1996 for a simple example).

Information asymmetry: The inability to observe the effort of the contracting party creates an information asymmetry and a principal agent problem which may likewise lead to internalization. *Pfaffermayr* (1996) provides an example of a downstream firm in the foreign market which supplies additional services and where its effort remains unobserved. Principally, a similar model can be formulated for the outsourcing of production of intermediates to an upstream firm. It can be shown that, if there is demand uncertainty and both the principal and the agent are risk averse, the optimal contract will include both a fixed fee and profit sharing. So it will account for an optimal mix of efficiency and optimal risk sharing. In the absence of risk aversion the effort of the agent would be highest if the agent gets all the profits and pays a fixed fee to the principal (here it is a prerequisite that the principal can observe profits of the agent). Whether vertical integration is preferred depends on the costs of service provision under the two forms of organization, the differences in the degree of risk aversion and the degree of risk itself.

Transaction costs: Additionally, the decision of firms to establish affiliates abroad and to become a MNE is determined by the fact that complete contingent contracts which foresee all future contingencies often cannot be formulated (see *Lyons*, 1996). Long-term outsourcing contracts often suffer from the impossibility to observe the effort of the contracting parties and to enforce the contracts in the court. All these impediments of setting up and enforcing contractual relationships can be summarized by the term transaction costs (*Williamson*, 1975, 1985) and it is assumed - although this is in many cases empirically unobservable - that when the transaction costs of the outsourcing decision are higher than the internal coordination costs of vertical integration across borders a MNE will come into existence.

The arguments above suggest that firms compare the cost savings from fragmentation under an integrated structure (i.e. becoming a MNE) with those arising in a contractual framework analysis. This implies the assumption of costly fragmentation: due to transaction costs

fragmentation uses more resources than the integrated production, as discussed in the general equilibrium models (see chapter 2.1.1 and *Deardorff*, 1998). "What matters is the size of cost savings from exploiting different factor prices compared to the costs of the extra resources required" (*Deardorff,* 2000b, p. 6).

2.3.2 The effects of fragmentation in an international oligopoly

Looking at two firms in a partial equilibrium framework, the main direct effects of the outsourcing of parts of the production activities to foreign affiliates can easily be analyzed in a simple two-stage game. To do this, assume an oligopoly with two firms located in the home and foreign country, respectively. The supplied quantity of the respective end product is denoted by s and S. Whereby, capital letters refer to the foreign country. The two firms compete in an integrated market under Cournot (i.e. quantity) competition. That means in the second stage of the game firms decide about the optimal quantity of production given the decision of the other firm. In the first stage the two firms decide whether to fragment production or not. The game can easily be solved by backward induction. In the Nash equilibrium both firms decide optimally given the production and fragmentation decision of the other concurrent firm and for both there is no reason to change this decision.

In the simplest case firms can split up production into two fragments (see *Brainard - Riker*, 1997b and *Deardorff*, 1998a for a similar approach) which are combined to an end product by a limitational technology without additional costs: $s = \min[s_1, s_2]$ with $s_1 = l_H/a$ and $s_2 = l_L/b$. $l_i, i = H, L$ denotes high-skilled and low-skilled labor, respectively. The same technology is assumed for the foreign firm with the exception that in the asymmetric case it either pays lower wages or employs labor more productively. a and b are the input requirements defined as the amount of high-skilled and low-skilled labor necessary to produce one unit of the intermediate product. The fragmentation of production as it is modelled here is comparable to Deardorff's (1998) model of a small open Ricardian economy. He likewise assumes that production can be split into to two fragments and the country may specialize in the production of one fragment according to its comparative advantage. However, in the partial equilibrium model discussed here, wages are exogenously given and it is assumed that firms have a potential to reduce costs if they fragment production. So fragmentation may be either costless or costly, the only assumption needed is that unit costs of the end product are lower[11].

Given these assumptions the cost function for the case of no frag-

[11] Remember, fragmentation is defined as costly if the fragmented production structure uses more resources than the integrated one.

mentation, i.e. the whole production takes place in Home (Foreign), reads:

$$c^I(s) = (w_H a + w_L b)\, s \tag{16}$$

and

$$c^I(S) = (W_H A + W_L B)\, S \tag{17}$$

It should be emphasized that marginal costs depend on both wages and productivity, and firms remain competitive in high-wage countries if high productivity compensates for the higher wages. We assume that firms can shift activity 2, which uses low-skilled labor-intensively to affiliates in third countries outside the integrated market with the lower wage rate $\overline{w}_L$ for low-skilled labor (possibly also lower low-skilled labor productivity $1/\overline{b}$) and re-import the intermediate (i.e. assembly takes place in the home and foreign country, respectively). Generally firms will decide for a fragmented organization of production if it yields a cost advantage, i.e.

$$c^I > c^F = \left(w_H a + \overline{w}_L \overline{b}\right) s \tag{18}$$

$$C^I > C^F = \left(W_H A + \overline{w}_L \overline{b}\right) S \tag{19}$$

In line with the literature on strategic FDI, firms have do bear additional fixed cost f (F) if they decide to fragment their production, since they have to invest directly abroad to set up production lines for activity 2.

To simplify further, demand is assumed linear $(A - s - S)$, so that the two-stage game can easily be solved analytically. We do not consider welfare effects from lower prices, but take account of the profits and the amount of low-skilled labor employed under both production regimes. This assumption is equivalent to assuming that the whole production is sold at a third market, as mentioned above.

Firms interact strategically in a two-stage game. In the first stage they decide on whether to outsource low-skilled labor-intensive activities and in the second stage they compete in quantities (Cournot). The appendix provides a full derivation of the equilibria and the derived propositions.

Symmetric case: In the symmetric case both firms face the same marginal costs for the integrated organization ($w_H a = W_H A; w_L b = W_L B$) and thus also in the fragmented case. Several propositions can be derived, which allow a first assessment of the effects of fragmentation from the firms point of view.

First, note that fragmentation of production will occur if the fixed investment costs are relatively low in comparison to the reduction in marginal costs. If it is cheaper to open plants abroad and thus to delocate low-skilled labor-intensive activities without significant investments, firms will choose this strategy more likely for a given reduction in marginal costs. Conversely, the degree of the reduction in marginal costs induced by fragmentation increases the likelihood of a fragmented production structure.

Since in the fragmented equilibrium overall marginal costs decrease for both firms by the same amount, output of the firms will be higher and prices lower. In the symmetric case no firm gains market shares, if both go for a fragmented production structure. The increase in output implies that part of the loss in low high-skilled jobs at the domestic location is compensated by the increased demand for high-skilled labor. Whether the gain is higher than the loss depends on the production technology. If the high-skilled labor-intensive activity 1 uses more high-skilled persons per unit of output than activity 2 uses low-skilled ones, total employment (i.e. high-skilled and low-skilled workers) may be even increased in the domestic location, although the share of high-skilled workers increases. Generally, this is an empirical question and will be analyzed in the empirical part of the study. The model suggests, however, that those firms which have implemented a fragmented production structure should have been able to increase overall production, overall productivity and profits compared to those firms which did not.

The model suggests that there are intermediate cases (see the Figures 11 and 12 in the appendix), where outsourcing of activity 2 to the low-skilled wage country only pays for one firm. This situation occurs if fixed plant set-up costs are relatively high compared to the potential of cost reduction. In the simple game theoretic set-up there exist multiple equilibria for these parameter combinations. It does not pay for the competing foreign firm to choose a fragmented organization, if the home firm has done it (and vice versa). The firm, which fragmented production first, gains market shares, which compensate for the loss in the employment of low-skilled workers to some extent. The compensation of lost low high-skilled jobs will be higher as compared to the symmetric equilibrium. This resembles the first mover advantage where the first actor gains, but the second loses.

Asymmetric case: Assume that the home firm originally operates with a cost disadvantage in activity 2 due to high wages for low-skilled workers. This disadvantage can be eliminated by fragmentation. The increase in production then is not only determined by the cost reduction but also by the decrease in the cost difference to the competing foreign firm. For certain combinations of fixed set-up costs and cost savings due to fragmentation the home firm is now able, besides increasing its output, to reduce its efficiency disadvantage and to gain market shares due to fragmentation. So the compensation by the gain of high-skilled jobs for the loss of low-skilled jobs is more likely as compared to the symmetric case.

Summing up, if firms interact strategically in an oligopolistic market fragmentation will occur if cost savings are sufficiently high compared to the fixed investment costs and it will arise as an equilibrium strategy where both firms chose a fragmented production structure. There may, however, exist situations where marginal costs differ. In this case the high-cost firm is able to gain competitiveness and thus market shares by outsourcing some of the activities. Since in general output increases along with cost reductions part of the employment loss may be compensated, although the employment structure changes. Whether or not it is more than compensated remains an empirical question, however.

2.3.3 Vertically integrated MNEs and trade in a monopolistic competition framework

In analyzing vertical integration across borders, or the emergence of MNEs in a general equilibrium we assume that internalization is always preferable. *Helpman* (1984) and *Helpman - Krugman* (1985) were the first authors who formulated a model of trade and vertical MNEs which allows to analyze the effects of fragmentation. *Deardorff* (1998a) discusses fragmentation in a Heckscher-Ohlin model without MNEs which leads to the same structure. He argues that his approach is merely an extension of Helpman's (1984) model, which leaves the organizational structure (MNEs versus single firms) unexplained. In essence, in the $2x2$ HO-model fragmentation of the production process for a good into two intermediates (fragments) with different factor intensities leads to a 3-goods-2-factors model where the pattern of output and trade is indeterminate in the sense of *Melvin* (1968). So additional assumptions are needed. We will come back to this point below.

Helpman - Krugman (1985) extend the traditional model of monopolistic competition used in the New Theory of Trade to include vertically integrated MNEs. There are two countries (Home and Foreign), two factors of production (labor and (human) capital) and two goods. One

is a traditional, homogeneous good produced under constant returns to scale and one is a modern horizontally differentiated good produced under increasing returns to scale (love of variety approach). The modern product uses labor, (human) capital along with intermediates and headquarter services which are produced themselves with labor and capital under increasing returns to scale, but at different factor proportions. The following ranking according to labor intensity is assumed: The homogeneous good is most labor-intensive, then comes the production of the final product (assembly) and then the production of the intermediate. Headquarter services use (human) capital most intensively.

Intermediates and headquarter services are specific in the sense that they can only be used for a particular variety. Especially, the assumption of economies of scale in both the production of a variety and of intermediates implies that both are concentrated in a single firm making vertical integration likely (see above). *Helpman - Krugman* (1985) assume internalization and consider only integrated (multinational) firms and no arms length trade in intermediates and/or services.

Structure of trade and production: Since impediments to trade are not considered, the model boils down to the traditional model of intra-industry trade with factor price equalization, if the trading partners' factor endowments are not too different (and lie in the cone of diversification). In this case inter- and intra-industry trade in end products alone induce factor price equalization and fragmentation does not occur. MNEs and thus fragmentation of production only come into existence, if the countries are sufficiently different endowed rendering factor price equalization impossible when firms are using only domestic resources. This means fragmentation of production is based on comparative advantages and MNEs exploit wage differences.

Helpman - Krugman (1985) do not provide an explanation on how many firms become a MNE, rather they assume that the number of foreign establishments determined in a way that minimizes foreign involvement, and that the first activities to be shifted to subsidiaries are product lines of finished goods[12]. The production of the intermediates is the last one to be separated from the headquarter. This assumption accounts for the stylized fact that final assembly is most labor-intensive and done in low-wage countries. Principally, the model can be set up in a way that intermediates are more labor-intensive than assembling the final product and thus the first activity to be delocated.

[12] Actually, the number of firms which become a MNE is indeterminate and it is assumed that the smallest possible number of firms becomes a MNE. This resembles the $3x2$ model as mentioned above (*Melvin*, 1968, see also *Helpman - Krugman*, 1985).

Figure 6: Factor Box, Equilibrium with MNEs in the Helpman-Krugman Model

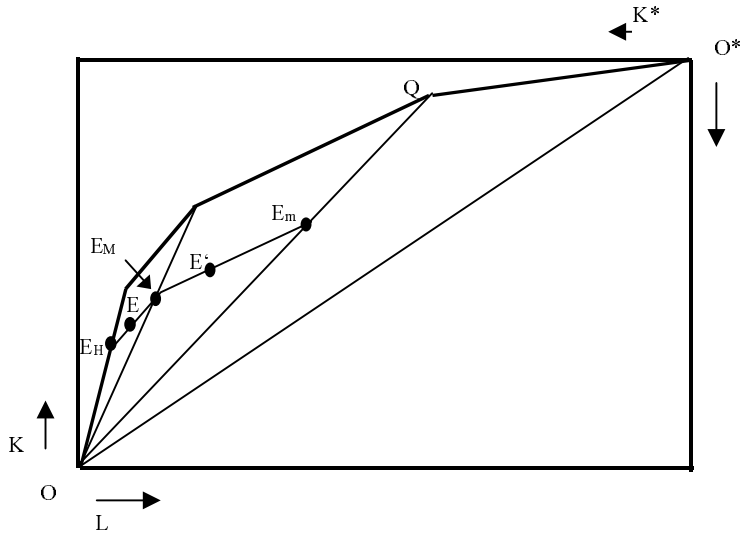


Figure 6 (*Helpman - Krugman*, 1985, p. 244) shows the typical equilibrium with MNEs and trade as equilibrium phenomena where the relatively human capital rich country (Home) hosts the headquarters of MNEs and the other country (Foreign) which is relatively better endowed with labor hosts the subsidiaries. Point E represents this assumption about endowments. The following allocation of resources and thus production and trade structure emerges:

- Home allocates resources in relation of the vector OE_H to headquarter services. Note this vector is the steepest as this activity is most (human) capital-intensive.
- $E_H E$ is devoted to the production of intermediates and the resources of Home are fully employed.
- The MNEs based in Home employ resources in Foreign, namely $E_H E_M$ in the production of intermediates, and $E_M E$ to produce the final products. Note that the production of both is accomplished in the foreign affiliates, some of them produce just the final good and some the intermediate product in addition.
- Foreign allocates O^*Q resources to the homogeneous goods industry in which it is specialized and QE_m to the manufacturing sector where part of the production takes place in single vertically integrated exporting firms and some in downstream affiliates.

Under the assumption of equal, homothetic preferences this gives a rich trade structure with inter- and intra-industry trade as well as intra-firm trade:

- The (human) capital rich country imports the homogeneous good and varieties of the differentiated good (intra-industry trade) including those produced by the foreign affiliates.
- It exports headquarter services, intermediates and if the endowment point lies in a more eastward direction (E') some varieties produced by integrated exporting firms.
- Controlling for country size, the volume of trade is larger the larger the difference in factor endowments.
- The number of MNEs and likewise intra-firm trade increases as differences in factor endowments widen. However, when differences get too large the shifting of production lines of intermediates to the foreign country reduces the share of intra-firm trade while maintaining a constant overall volume of trade.
- Generally, it holds that the existence of MNEs increases the volume of trade (via intra-firm trade), thus home and foreign production of the MNEs are complements. Whether intra-industry trade is also enlarged depends on whether intermediates and finished products are classified in the same category of products as it is usually the case in the trade statistics.

Concerning the effects on relative wages, two aspects should be mentioned. First, MNEs exist only in the case where endowments are sufficiently different rendering factor price equalization impossible. Without MNEs, relative wages would be higher[13] in Home or, if the simple case of linear technologies is assumed, not all the (human) capital could be employed. Subsidiaries are therefore always established in low-wage countries and MNE-activity is one-way.

Secondly, from the home country's point of view the prediction of shifts in the distribution of income away from labor to (human) capital is the most important result. Increasing (costless) fragmentation of production induces a shift of labor-intensive production lines to low-wage countries and thereby enhances the possibility of factor price equalization. Formally, *Deardorff* (1984) shows that in the general case of many

[13] *Deardorff* (1998a) argues that we actually don't know what happens in the case of no fragmentation. But it seems plausible that Home produces only the (human) capital-intensive differentiated good and Foreign both goods.

products and many factors factor price equalization requires that factor endowments are more similar than factor requirements. This holds in the sense that "the set of vectors that can be constructed from all parts (or all) of the factor endowment vectors - called the 'factor endowment lense'- must lie inside the analogous set of vectors defined by the factors used in the integrated world equilibrium - the 'factor use lense' " (*Deardorff*, 1998a, p. 18). Hence, a downward pressure on wages relative to the returns on (human) capital has to be expected with fragmentation of production within MNEs. In the short-run, although not explicitly modelled, increasing fragmentation may induce unemployment in the low-skilled segment of the labor market and exert pressure on structural change toward more high-skilled labor-intensive or capital-intensive segments in the value added chain. This parallels the analysis based on increasing trade in intermediates resulting from the deeper specialization induced by fragmentation.

The Helpman - Krugman model discussed above does not include impediments to trade and investments. It analyzes a frictionless integrated equilibrium. Especially, it was criticized for this as it cannot explain two-way MNE-activity between equally endowed countries, the most important form of MNE-activity we observe. *Brainard* (1993) and *Markusen - Venables* (1996, 1998) among others introduce transportation costs (defined in a wide sense as costs of lacking proximity to the market) and fixed plant set-up costs to analyze the relationship between MNE-activity and trade. Their main focus is on horizontal FDI (see *Wolfmayr-Schnitzer*, 1999 for an overview). So these models are only partly useful for the questions of interest here. We therefore discuss only *Markusen* (1998) who describes the most comprehensive model along these lines. The starting point is that firms incur significant costs of doing business abroad relative to domestic firms in those countries, so they possess some ownership advantages or firm-specific assets in addition to the locational and internalization advantages discussed above (*Dunning*, 1979, 1988). In the case of horizontal FDI (i.e. MNEs produce the same goods and services in each of several locations) firms trade-off location-specific advantages - saving transport costs or exploiting a large market potential in the host country (proximity advantage) - and fixed investment costs. Vertical multinationals in contrast are encouraged by low rather than high trade costs. As in the Helpman-Krugman model vertical MNEs arise when stages of production have different factor intensities and countries have different relative factor endowments so that the MNEs are able to exploit factor-price differences across countries and gain from the fragmentation of production.

The model in *Markusen* (1998) permits both, vertical and horizontal

MNEs. Similar to the Helpman - Krugman model described above the model set-up includes:

- two homogeneous goods, X and Y;
- two countries h and f;
- two factors: low-skilled labor L and high-skilled labor H;
- a homogeneous product Y produced under constant returns to scale using low-skilled labor-intensively for a competitive market (marginal cost pricing);
- a good X produced under increasing returns to scale using high-skilled labor more intensively. In this sector MNEs may arise with headquarters and plants geographically separated. Firms can have plants (as the producing unit) in one or both countries. The differentiated products are subject to transportation costs. Note that headquarter services are most high-skilled labor-intensive.

Depending on the trade-off between transportation costs and fixed plant set-up costs the model endogenously distinguishes between six types of firms:

- mh, mf (multinationals with headquarters located in h or f, respectively, and plants in both countries);
- nh, nf (national single plant firm with headquarter and plant in home or foreign, respectively);
- vh, vf (vertically integrated MNEs, headquarter in h, plant in foreign vh and vice versa for vf. So fragmentation of production occurs insofar as each firm operates at two locations with different activities. Intra-firm trade in intermediates is excluded however.

The assumptions about fixed costs are crucial for the results. m-firms have higher fixed costs than v-firms, but not twice as high, so that besides plant level economies of scale there are also firm-level (multi-plant) economies of scale,which for example, come from product development and the possibility to use the same design in another plant without additional costs. If firm level scale economies do not exist multinationals (two-plant firms) never would emerge, if there were no plant level economies there would never be v-firms in equilibrium. On the other hand, v-firms and n-firms are assumed to have the same total fixed

costs, they just differ where they incur those fixed costs: n-firms only in one country, v-firms in both countries.

Markusen (1998) describes which types of firms are active in equilibrium and discusses the underlying determinants. Especially, he is able to analyze the effects of MNEs on the structure of production, the volume and pattern of trade. The main contribution of his model lies in the possibility to investigate the impact of reduced barriers to trade and investment, which is not possible in the Helpman - Krugman model. Since the model cannot be analytically solved, most of the results are based on simulations of specific parameter values.

The equilibrium configurations are mainly determined by trade costs. For high to moderate trade costs the results are the following: m-firms are dominant when countries are similar in both size and relative endowments. If countries are very different in those respects n-firms located in the larger country are dominant, especially when the larger country is also high-skilled labor-abundant. With very different factor endowments, but similar size of the countries - the case relevant in the present discussion- v-firms located in the high-skilled labor-abundant country are dominant.

The direction of trade is determined by relative factor endowments (the high-skilled labor-abundant country has advantage in X production) and relative country size (in the presence of plant economies of scale, the larger country has an advantage in X production). For a country which is large and high-skilled labor-abundant the two determinants work in the same direction, and it is a net-exporter of product X. A relatively small high-skilled labor-abundant country (where v-firms would dominate) then would be a net-importer of X and an exporter of managerial services and headquarter services. Factor endowments and country size pull in opposite directions.

For very low to zero transport costs (trade liberalization) no m-firms are active as no firm will want to set up an additional plant when trade is nearly costless. If countries are similarly endowed, factor price equalization will occur and there is no incentive for v-firms to enter. Outside this factor price equalization set, v-firms exist when countries are very different in size and in factor endowments as in the Helpman - Krugman model.

In the absence of transportation costs country size is no longer an advantage. Countries will engage in intra-industry trade in X when countries are similar in relative endowments. The high-skilled labor-abundant country remains a net-exporter of X. Outside the factor price equalization set the logic of the Helpman - Krugman model remains in tact, factor prices are different in the absence of MNEs and this stimu-

lates v-firms to enter. Still, as long as factor endowment differences are not too extreme n-firms stay to exploit the high-skilled labor abundance and countries will then export both X and headquarter services. As factor endowment differences become too extreme though the pattern of trade in goods reverses, the headquarter services become concentrated in the high-skilled labor-abundant country, production of X in the other country and fragmentation occurs. Thus, investment liberalization may lead the high-skilled labor-abundant country to import the high-skilled labor-intensive good and to export headquarter services instead.

Although the model of *Markusen* (1998) is highly simplified, it provides valuable additional insights. First, it demonstrates that the volume of trade barriers in relation to fixed investment costs - besides differences in endowments - form an important determinant for the existence of MNEs. What comes in additionally is that in the presence of trade costs country size matters, so that these models can rationalize market-oriented FDI in large countries. In this case trade barriers may form important determinants of factor price differentials, especially if countries are similarly endowed. Additionally, it predicts that vertical MNEs and thus fragmentation remain if trade costs - since they are assumed to refer only to end products - are reduced. So in broad terms the economic logic of the Helpman - Krugman model remains valid even in the presence of transportation costs.

2.3.4 What have we learned ?

International fragmentation of production also occurs within the organization of firms leading to the emergence of MNEs. It has been argued that there must be additional conditions for firms choosing to internalize these activities rather than using market transactions. We mentioned the public good characteristics (within the firm) of ownership advantages, transaction-specific investments, information asymmetries and - more generally - transaction costs as factors making internalization more likely. In a simple two-stage game we have shown that fragmentation may arise as an equilibrium phenomenon if cost savings are sufficiently high. Then part of the employment lost because of fragmentation may be compensated by output expansions induced by the cost savings. Additionally, firms with cost disadvantages are more likely to choose a fragmented structure and in this way are able to gain competitiveness and increase their market share.

In the general equilibrium framework it has been illustrated that vertically integrated MNEs arise if countries are very different and factor price equalization is impossible. Countries well endowed with (human) capital specialize in headquarter services and (human) capital-intensive

intermediates whereas labor-intensive intermediates are produced in affiliates in labor rich countries. The emergence of MNEs increases the possibility of factor price equalization and is likely to exert a downward pressure on wages relative to the returns on (human) capital. This parallels the analysis based on increasing trade in intermediates resulting from the deeper specialization induced by fragmentation. The work of Markusen suggests that in broad terms the economic logic of the Helpman - Krugman model remains valid for the analysis of vertical MNEs even in the case of transportation costs, but additionally highlights the role of trade barriers and market size as determinants of MNE-activity.

3 The empirical analysis of fragmentation

Empirical works on international fragmentation can be split into two groups. The first tries to access the magnitude of international outsourcing and the determinants of the country and industry pattern of fragmentation and introduces several different measures of outsourcing. The second group of papers goes beyond that and sets out to analyze the impact of international fragmentation on employment and relative wages. Although there now exists a quite voluminous literature on trade and wages - especially for the US and the UK and less so for the rest of the European countries - there are only very few empirical studies that directly address the impact of international outsourcing and the consequent trade in intermediates[14].

3.1 The magnitude of international outsourcing- a comparison of measures

In the strand of empirical literature that tries to access the magnitude of international outsourcing several different approaches as well as data sources have been used to measure the extent of international fragmentation.

International outsourcing first of all generally not only refers to an international splitting up of production processes that occurs within a multinational firm but also between firms that are completely independent from each other. In line with the trade models, the usual presumption is that outsourcing of production leads to increased imports of intermediate products. Accordingly, outsourcing is measured by the amount of all imported intermediates that are used in the production of domestic firms, in addition to intra-firm trade of multinationals. Note, however, that besides an increase in intermediate imports outsourcing can also lead to increased imports of final products, if outsourcing occurs at the final stage of production and the final good is re-imported. On the other hand, the mapping between outsourcing and imports is not that clear at all. Outsourcing could also involve a setting where the assembly of a product is done in a foreign country, but the final manufactured good instead of being re-imported is directly shipped to a third country. International fragmentation then would not lead to higher imports it would instead lead to smaller exports of the outsourcing country. It is clear that there exists no single indicator on international outsourcing that can take account of all these aspects and activities under the heading of outsourcing. Despite that, all measures adopted in the lit-

[14] For an overview on the trade and wages literature and the conflicting methodologies see *Huber - Wolfmayr-Schnitzer* (2000).

erature indicate that international outsourcing has increased in the last two decades and has become quite important (see e.g. *Feenstra*, 1998, *Yeats*, 2000, *Campa - Goldberg*, 1997, *Hummels et al.*, 1998, *Diehl*, 1999 and *Görg*, 1999).

There are four main sources of information from which outsourcing indicators have been constructed in the literature: Input-Output (I-O) tables or "proxies" thereof from statistics of input purchases by firms, international trade statistics, statistics on inward and outward processing trade and FDI statistics.

3.1.1 Outsourcing indicators based on Input-Output tables

Indicators based on the information of I-O tables probably come closest to the definition of international outsourcing. These tables indicate, in a matrix fashion, the value of intermediate inputs that each manufacturing industry purchases from every other industry. For some countries I-O tables provide further information whether intermediate inputs are imported or produced domestically. For countries in which the input purchase statistics do not provide this distinction between imported and domestically produced intermediates, the usual procedure adopted to calculate imported intermediates for each industry is to multiply the purchase of each type of input by its economy-wide import share in total consumption. That is, imported intermediates of industry i are given by:

$$\sum_{j=1}^{N} \text{Input purchases of good } j \text{ by industry } i \cdot \left[\frac{\text{imports of good } j}{\text{consumption of good } j}\right]$$

where consumption of good j is measured as shipments plus imports minus exports.

Feenstra - Hanson (1996b, 1999) performed this calculation for the US in combining the import data on final goods with the Census data on input (material) purchases to construct I-O tables. Note that the underlying assumption in the calculation of imported intermediate inputs is that all sectoral import ratios of intermediate inputs of a certain type are the same as the total import ratio. Furthermore, the authors distinguish between a broad measure and a narrow measure of outsourcing. The former is defined to include purchases of an industry from any other industry, the latter includes only purchases of an industry from industries which are in the same (statistical) industry class. The estimated imported inputs of each industry are then expressed relative to total

intermediate input purchases (imported and domestic). Finally, averaging over all industries the authors find for the US that the "broad" outsourcing indicator increased from 5.3 percent in 1972 to 12.1 percent in 1990. The "narrow" outsourcing indicator increased from 2.2 percent to 5.7 percent over the same period.

Campa - Goldberg (1997) as well as *Hummels et al.* (1998) also calculated outsourcing indicators that are based on the information of I-O tables for selected OECD countries. *Diehl* (1999) made the same calculation for Germany. Table 1 summarizes the results for selected industries and countries[15]. The outsourcing indicator is the share of the value of imported inputs in gross production. The figures in Table 1 indicate marked increases of international outsourcing in the countries considered with the exception of Japan. International fragmentation in Japan stayed at a comparable low level over the entire period and has been increasing in only a few of the industries. This might be due to shortcomings in the measurement. The indicator referred to above does not include outsourcing with assembly in the foreign country and a direct shipment of the final good to third countries. However, this is known to be a characteristic feature of Japanese trade.

Table 1: Share of Imported Intermediate Inputs[1)] in Manufacturing Industries of Industrial Countries

	USA	Canada	United Kingdom	Germany	Japan	Austria	
	1995	1993	1993	1990	1993	1990	1998
				Shares as percent			
Manufacturing	8.2	20.2	21.7	15.2	4.1	17.5	21.7
Chemicals	6.3	15.1	22.5	16.7	2.6	26.6	19.8
Machinery	11.0	26.6	31.3	10.3	1.8	30.2	36.4
Road vehicles	15.7	49.7	32.2	14.0	2.8	33.3	40.3
Electrical products	11.6	30.9	34.6	11.8	2.9	21.2	28.9
Leather products	20.5	21.8	35.6	24.2	2.6	32.2	32.2
Clothing	3.2	21.6	24.2	24.6	4.8	25.5	28.0

Source: Campa - Goldberg (1997), Diehl (1999) and own calculations for Austria. - 1) Percent of gross output value; only inputs of manufactures. Except for Germany and Austria, imports of intermediate inputs are crude estimates based on total intermediate input coefficients (domestic and imported inputs) and the respective input sectors' import shares in apparent consumption.

The UK shows an especially large increase in foreign outsourcing and like Canada fragmentation has been at a relatively high level as

[15] For a detailed description of our outsourcing measure based on the Austrian I-O table see chapter 4.1 and appedix 8.3.

compared for example to the US. The trends in overall manufacturing are also present for the individual industries with road vehicles exhibiting an especially high growth in foreign outsourcing. Chemicals show the lowest share of imported intermediates. Our calculations for Austria show that fragmentation has already been at a comparably high level of 17.5 percent in 1990 and has been increasing since to 21.7 percent in 1998.

Hummels et al. (1998) also calculate imported intermediates from I-O tables for OECD countries. In contrast to the outsourcing measures discussed above they use imports of intermediates as a fraction of total trade, which are both imported and then embodied in the exports of a country. In their terminology, imports of intermediate goods only count as outsourcing if the good produced with the imported intermediates is exported later. They perform their calculation of vertically specialized trade for nine OECD countries over the period 1968 to 1990. They first find that for every country but Japan, vertical trade as a share of total trade has increased throughout the period. Taking all countries together, in 1990, vertical specialization-based trade amounted to 14.5 percent of all trade in these countries which implied a 20 percent increase from the late sixties and seventies. The magnitude of vertical specialization however is found to vary widely across countries in 1990, being lowest for Australia, Japan and the US, where only about 7 percent of total trade is vertically specialized trade, relatively low for Germany (16.3 percent) and highest for the Netherlands (34.7 percent) and Denmark (25.2 percent). A pattern which shows that some of the world's largest economies have the lowest shares of vertically specialized trade. Furthermore, the authors find that the industries for which vertical trade is most important include the motor vehicles, shipbuilding, aircraft industries, as well as the industrial chemicals and non-ferrous metals sectors, those with the least are the agriculture, wood products and paper products industries.

3.1.2 Outsourcing indicators based on international trade statistics

In simpler approaches, information on trade in intermediate products is gathered directly from trade statistics either by looking at trade in raw materials and semi-finished goods or at intra-industry trade. Both are only rough proxies for outsourcing, since trade in final and intermediate goods (parts and components) are not systematically separated in the trade classification systems and measures on intra-industry trade also include trade in differentiated final products. *Yeats* (2000) uses the Standard International Trade Classification (SITC) system of the UN trade statistics to gather information on trade in parts and components

to form a subgroup of "intermediates". He finds that the coverage of product groups composed solely of parts and components to be most extensive within the machinery and transport equipment sector (SITC 7), but that outside this sector meaningful tabulations of the magnitude of trade in parts cannot be made. Furthermore, while it seems to be at least possible to derive the magnitude, composition and direction of trade in parts and components of the machinery and transport sector, there is no information from this approach about which are the consuming industries that buy the imported intermediate products, so that the interrelationship among industries remains unknown. *Yeats* (2000) finds for the year 1995 that 30 percent of total world trade in machinery and transport equipment is trade in parts and components and that trade in these intermediate goods was growing at a faster pace than the overall product group. Trade in intermediate products of the transport and machinery sector has become important for both, the OECD countries and countries in the developing world, most notably Mexico and China. Most of the intermediates trade within the machinery and transport sector is accounted for by parts of motor vehicles, parts of office machinery, telecommunications equipment and arts of switch gear. These four product groups are shown to account for over 70 percent of total trade in components within the industry.

3.1.3 Outsourcing indicators based on outward and inward processing trade statistics

Another indicator used in the literature to measure the amount of international outsourcing is the extent of so-called outward processing trade to indicate whether a country is a source for fragmentation. Alternatively, inward processing trade measures to what extent a country is the basis for fragmentation. This kind of trade is subject to a special customs arrangement and involves the export of intermediate goods for further processing in a foreign country which can then be re-imported with total or partial tariff exemption. Although this would actually be a very good indicator for the extent of outsourcing, and is especially useful when comparing a cross-section of countries and industries, its major drawback is that it will be very sensitive to changes in content requirement regulations, tariffs and other trade related regulations, so that their comparability over time is very limited. The existence of free trade areas or trade unions (EU), as well as the low average level of most favored nation (MFN) tariff provisions, reduce the incentive to utilize these tariff provisions so that a large part of outward processing trade (OPT) is not reported and will lead to a downward biased estimate of the extent of international fragmentation.

Görg (1999) provides an analysis of US inward processing trade (IPT) in EU-countries and the determinants for the distribution across industries and EU-member countries. The data show that IPT as a percentage of total imports from the US has been increasing most intensively for the peripheral EU-countries, increasing from 14 percent to 24 percent between 1988 and 1994[16]. Ireland exhibited the most notable increase. In the core countries, the metals, industrial machinery, and transport equipment sectors received the highest percentages of US IPT, while for the peripheral countries the most important IPT sectors were the leather industry, the electronic and the non-metallic mineral sectors. He finds that comparative advantages of countries are important determinants for the sectorial distribution of US IPT as predicted by theory. Affiliates of US multinationals in the peripheral EU-countries are used as a base for fragmentation, while this seems not to be the case with US FDI in the core EU-countries. That is, US affiliates in the European periphery process the intermediate goods shipped to them by the US parent, and re-export them to destinations outside the EU. This part of affiliate production is thus not intended to serve the European market.

Graziani (2000) analyzes OPT in the textiles and clothing industry and provides evidence that subcontracting of EU countries is targeted mainly to the Mediterranean countries (Tunisia and Morocco) and especially to Central and Eastern European countries. More than 80 percent of EU clothing imports from and 60 percent of textile exports to Eastern Europe were represented by OPT in 1995. *Baldone et al.* (1997) show that the share of Central and East European countries in overall OPT originating in the EU increased from 35 percent to 42 percent in the period 1988 to 1994. Germany is the most important subcontractor to Eastern and Central Europe, accounting for three quarters of total EU OPT with the region. Germany is followed by Austria.

Stankovsky (1995) analyzed Austrian OPT with the Central and Eastern European transition countries (CEEC) for the period 1988 to 1994. He finds that the share of the CEEC in total OPT increased from 14 percent to 61 percent over that period. As it is shown for other countries within the EU, subcontracting to transition countries is most intensive for the Austrian textiles and clothing sector. 1994 as much as 85 percent of total Austrian OPT in this sector was accounted for by the CEEC. Specialization indices for individual CEEC reveal that besides processing in textiles and clothing, in 1994 Hungary was an important base for fragmentation for the Austrian food and shoe industry,

[16] Countries in the periphery include: Greece, Ireland, Portugal and Spain. The core of the EU is defined to consist of Belgium, Denmark, France, Germany, Italy, Luxembourg, Netherlands and UK.

the Czech Republic and Poland for machinery, the Slovak Republic for the chemical and the metal sector and Slovenia for chemicals, basic metals and machinery.

3.1.4 Outsourcing indicators based on foreign direct investment and intra-firm trade statistics

The international fragmentation of production partly takes place within the organization of the firm, and this must be seen as covering part of an overall outsourcing measure. Insights on the amount of outsourcing within the boundaries of MNEs could be gained from FDI statistics and especially from indicators of intra-firm trade. Both measures, however, exclude all non-equity forms of foreign activities.

The main disadvantage of statistics on FDI is that they do not provide any details on the purpose of FDI. Hence, it is impossible to distinguish between horizontal and vertical MNEs on the basis of FDI data. Especially, FDI intended to service foreign markets or FDI undertaken to shift production stages to countries with lower costs cannot be observed. Statistics on intra-firm trade may be a more informative indicator. The main problem with this indicator is the involvement of transfer prices which may lead to an under- or overstatement of the figures depending on tax laws, tariffs etc. Additionally, from the statistical point of view it is not always clear what constitutes a MNE (in particular an affiliate[17]) and which trade flows should be classified as intra-firm trade.

For reasons of data availability studies on intra-firm trade mostly refer to the US, Japan or Sweden. For the US an early study (*OECD*, 1993) shows that over one third of merchandise trade is intra-firm trade and that, contrary to what one would expect, the overall share of intra-firm trade did not increase between 1977 and 1989. Figures of trade from US parents to their foreign affiliates indicate that the share of intra-firm exports in total exports is higher than the corresponding figure for imports. Furthermore intra-firm trade is mostly concentrated in technology- and (human) capital-intensive industries like machinery, electronics and electrical equipment and transportation equipment industries. US affiliates purchases from their foreign parents are increasing as a share of total imports and are mostly related to wholesale (see *Yamawaki*, 1991). That means a reasonable part of intra-firm trade results from forward integration where parent firms export intermediate goods to downstream affiliates. The provision of service and distribution is the prime example. Fragmentation of production inducing intra-firm imports from an upstream affiliate seem to be smaller. For the US the biggest share com-

[17] Usually, for the parent firm the equity share in a foreign plant has to be above 10 percent to count as an affiliate.

prises imports from Canadian affiliates. Intra-firm imports from Mexico, although initially small in size, experienced highest growth which inter alia motivated the research on the effects of fragmentation (*Feenstra - Hanson,* 1996a, 1999).

More recent evidence on intra-firm trade provides *Braunerhjelm* (1998) for Swedish MNEs where a detailed dataset based on questionnaires from the Research Institute of Industrial Economics (IUI) is available. Swedish MNE intra-firm exports account for about 30 percent of total exports 1970 and this share increased to approximately 60 percent in 1994. Intra-firm imports of the Swedish parents from their foreign affiliates have been considerable smaller than intra-firm exports of the parents to the foreign affiliates and have increased during the eighties and nineties. In contrast inter-firm exports decreased, although the trend reversed from 1990 to 1994. *Braunerhjelm* (1998) argues that horizontal and vertical integration cannot be fully dismantled, rather it is a matter of degree. He likewise uses the intra-firm trade as a proxy for the importance of vertical integration of production across borders. However, he concentrates on vertical forward integration and looks at the determinants of intra-firm exports in his econometric exercise. In present content this is less relevant, so we don't report on the econometric findings.

These empirical regularities suggest that intra-firm imports are an appropriate indicator of fragmentation of production. However, it seems only reliable if a classification by the industries of the affiliates is available (to sort out intra-firm imports for wholesale trade) and/or if the figures refer to intra-firm trade which is from low-wage countries. We should bear in mind, however, that it captures only part of the degree of international fragmentation.

3.2 Empirical studies on the impact of outsourcing

Empirical papers on the impact of outsourcing on the production structure and labor markets of countries have been very rare so far. One example is *Hanson* (1994, 1996) who applies a model of regional production networks based on external economies to the Mexican apparel industry. We shortly reviewed the structure of the theoretical model in chapter 2. According to this theory, increasing return activities which are themselves part of the production chain of a product and are subject to transportation costs agglomerate in the industrial center. In the agglomeration, wages will be driven up to a point where it pays to relocate constant return activities of the value added chain into peripheral regions with lower wages. Furthermore, in a closed economy wages in the periphery are decreasing in transportation costs relative to the in-

dustrial center while in an open economy regional wage differences are determined by access to the foreign market. To test this latter hypothesis for the Mexican apparel industry, *Hanson* (1994, 1996) regresses regional relative apparel industry wages on transport costs from any region to the industrial center in Mexico City. Transport costs are measured in terms of distance[18]. He obtains observations for 31 Mexican states for 5 years (1970, 1975, 1980, 1985, 1988), whereby for Mexico, the first four years correspond to a closed economy and the latter year corresponds to an open economy. The estimates support the hypotheses: regional relative apparel wages decrease with the distance from Mexico City during the pre-trade years while opening to trade implied not only a substantial relocation of production within Mexico but also a reduction of wages in Mexico City relative to those states along the Mexican-US border. Apparel wages are highest for border states close to California (Los Angeles), which is the largest apparel industry center in the US, outside New York.

Feenstra - Hanson (1996b) empirically implement the North-South outsourcing model developed in *Feenstra - Hanson* (1996a). The main prediction from this model is, that a flow of capital from the North to the South, or equally, any technological progress in the South acting as the main driving force for outsourcing by Northern firms results in an increase in the relative demand of high-skilled labor in both countries. To test this hypotheses for the US, the annual change in the US non-production wage share (proxy for wages of high-skilled labor) is regressed on the change in the volume of outsourcing in the two periods 1972 to 1979 and 1979 to 1990. In a second exercise then this regression is re-estimated by adding a set of control variables (change in the capital-output ratio and in real output) which were also used by *Berman et al.* (1994). Outsourcing is measured by total purchases of imported intermediates of an industry as a percent of total expenditures on non-energy material purchases. Note that the impact of trade induced by outsourcing is measured in volume terms while the Heckscher-Ohlin theory of trade in final products provides little basis to do so: relative labor demand as well as wages are determined by relative goods prices, thus the labor market is affected by trade only to the extent that it changes these prices, the volume of trade is totally irrelevant. The authors justify their methodology in an analysis of outsourcing by pointing to the fact that international fragmentation, acting like factor-biased technological change, reduces the unit labor requirements for low-skilled labor.

[18] Distance is measured by the average hours required to travel by a first class passenger bus from the capital of a specific state to the industrial center Mexico City.

The regressions can thus be seen as a reduced form of the relationship between outsourcing and input requirements for high-skilled labor. The regression results are different for the two periods considered. While the correlation between outsourcing and the wage share of non-production workers turns out to be insignificant for the seventies, it is positive and highly significant for the eighties. According to these estimates outsourcing in the eighties can account for some 40 percent to 50 percent of the increase in the non-production worker wage share in the US.

In *Feenstra - Hanson* (1999) the authors refine the outsourcing measure to include only purchases of an industry from within the same (statistical) industry class which they identify as the "narrow measure of outsourcing". Using this measure and including high-tech investments as an additional variable the regression on the non-production workers wage share in *Feenstra - Hanson* (1996b) is re-estimated for the eighties. This results in a contribution of (narrow) outsourcing to the total shift in non-production workers wage share of 11 percent to 15.2 percent. The difference between the narrow measure and the broad measure of outsourcing, which represents those imported intermediate inputs that come from outside the same industry class, contributed by 2 percent to 7.9 percent. High-tech investment, depending on how it is measured accounts for 5.3 percent to as much as 31.5 percent of the total change of the change in the non-production wage share in the eighties[19].

Feenstra - Hanson (1997, 1999) adopt the so-called "mandated factor price regression" approach in the empirical trade and wages literature to study the impact of outsourcing on the high-skilled-to-low-skilled wage gap in the US for the period 1979 to 1990. The Heckscher-Ohlin theory and the Stolper-Samuelson link between product prices and factor prices form the basis for these mandated wage regressions: changes in industry prices are regressed on the level of sector cost shares for various factors of production. The coefficient estimates on the cost shares are then interpreted as the predicted factor price (wage) changes, that are mandated by the change in product prices to maintain zero profits in all sectors. However, they depart in an important way from the usual procedure adopted. They show, that when the price regression is fully specified, taking into account inter-industry wage differentials, due e.g. to variation in factor quality or industry specific rents, the

[19] The authors rely on different data sources to measure high-tech investments and in addition differentiate between high-tech capital and computer investments. The first data source are real investments from the Bureau of Labor Statistics. The perpetual inventory method is applied to caluclate the capital stock. The share of capital services attributable to high-technology equipment and computers respectively is then measured by multiplying with ex post rental prices and as an alternative with ex ante rental prices. A second data source are computer expenditures from the Cencus.

estimated coefficients just reproduce the factor price changes actually observed in the data. The coefficients therefore only summarize how prices and productivity co-move with factor prices, and do not allow to calculate the effect of international trade on factor prices. Treating industrial prices as well as productivity changes as endogenous, the authors therefore propose a two-step estimation procedure. As a first step the features that contribute to changes in prices and productivity are disentangled. That is, price and productivity changes are decomposed into portions attributable to outsourcing and high-tech investment, isolating the individual effects. Then, as a second step, a mandated price regression is estimated that relates the price and productivity effects due to outsourcing to factor prices alone (see also *Leamer*, 1998 for a similar approach). Changes in productivity are measured by the growth in the Tornqvist index of total factor productivity (TFP) which is defined as the difference between the growth in output and the cost-share weighted growth in inputs. The resulting estimates in *Feenstra - Hanson* (1999) from the first step regression point to a significantly positive impact of outsourcing as well as high-tech investments on combined TFP and industry price changes. The corresponding mandated factor price changes due to outsourcing are significantly negative for low-skilled workers and physical capital and positive for high-skilled workers. Outsourcing thus contributed to an increase in the high-skilled-to-low-skilled wage gap in the US labor market. While the sign pattern stays the same, the exact effects and the relative role of trade induced by outsourcing and technology changes measured by high-tech capital turn out to be quite sensitive to its measurement (see footnote 18).

Anderton - Brenton (1999) analyze the possible detrimental effects of outsourcing on low-skilled workers in the UK by lowering their wage-bill share and employment share in the textiles and the non-electrical machinery sectors over the period 1970 to 1986. As a (very rough) proxy for outsourcing the authors simply use the share of imports in total UK consumption by industry, disaggregating UK imports according to low-wage and industrialized countries. Following *Machin - vanReenen* (1996) the wage-bill share equation is derived from a translog cost function, taking capital as a fixed factor of production, and high-skilled and low-skilled labor as variable factors. While their results indicate that total import penetration has no significant effects on the relative wages and employment of the low-skilled, they find a negative effect of import penetration from low-wage countries on both, the relative wage-bill and employment shares of the low-skilled. If R&D is included to proxy technological changes, the low-wage country import penetration remains strongly significant. Including a relative price term - i.e., the price of

UK imports (total imports, imports from industrialized countries and imports from low-wage countries) relative to the UK domestic price for the same product - both turn out to be statistically significant. This suggests that the relative price effect captures other effects in addition to the increase in import penetration. The authors interpret the relative price effect to capture the threat of increased competition from low-wage countries which alone may encourage firms to restrain wages and may have made it easier to obtain the agreement of their workforce for doing so.

Egger - Egger (2000) present a model where a single homogeneous good is produced with low-skilled and high-skilled labor. Three countries are involved: a small high-skilled labor-rich Home, a small low-skilled labor-rich Foreign and a large rest of the world (ROW), which is similarly endowed as the Home. Intermediates trade with Foreign is impeded to some extent by the presence of trade costs. The good can be produced either internally (using both high-skilled and low-skilled workers at Home) or vertically fragmented across borders but within multinational firms (using only high-skilled labor in the downstream activity at Home and all low-skilled labor in the relative cheaper location abroad). As compared to the internal process, fragmented production uses some additional amount of high-skilled labor, which is interpreted as assembling costs. In contrast to other models of outsourcing, both internally and fragmented producing firms are coexisting in the fully competitive market at Home. Shrinking trade costs and relatively low wage costs for low-skilled labor abroad are identified as the most important determinants of outsourcing. The model is used to envisage the determinants and the home country effects of Austrian outsourcing to the CEEC and the former Soviet Union member countries at the 2-digit NACE industry level. The theoretical model is strongly confirmed by the empirical results: First, Austrian outsourcing to the East is positively affected by shrinking trade costs and low unit labor costs abroad. Secondly, systems estimation results imply that a 10 percent increase in outsourcing to the East accounts for an approximately one percent change in the relative employment in favor of high-skilled labor. Given that outsourcing to the East grew by about 11 percent p.a. in the last decade, an increase in relative employment of about one percent can be attributed to outsourcing. This corresponds to about one quarter of the overall average change in relative employment p.a. for the last decade (see also chapter 5 below for evidence concerning Austrian manufacturing along this line).

Most studies on the effects of MNE-activity either look on the effects on trade patterns or - more recently - on the relationship between domestic (parent) labor demand and that in foreign affiliates to derive evidence

on the effects of vertical and horizontal FDI. These studies treat labor at the different locations of a MNE as separate factors of production which contribute to production for the world markets. The majority of the studies concentrate on the US, because for the US the most comprehensive database is available from the Bureau of Economic Analysis (BEA). In contrast, studies looking on the impact of MNE-activity on wages seem to be not available so far. In the following we concentrate on employment effects and report the findings of the most important studies.

Lawrence (1994) summarizes and (to some extent extends) previous research on the relationship between the wage performance in developed countries and international competition with low-wage countries. The paper mainly refers to the US and argues that the poor wage performance in the eighties mainly reflects poor productivity performance rather than the pressure from increased competition with low-wage countries. Secondly, he presents evidence rejecting the view that the Stolper-Samuelson effects are important in the US, Germany and Japan, since prices of labor-intensive products did not decline in relative terms. Although wages of high-skilled workers increased in the US, the ratio of production and non-production workers grew faster in the eighties than before suggesting skill-biased technological change as the main reason for the changes in relative wages. The third section of the paper is particularly relevant here as it looks at employment and wages in the US parents and their foreign affiliates. The development at home and abroad has been remarkably similar: Employment fell both in the US parents and in the foreign affiliates located in developed countries and grew only modestly in developing countries. The relative compensation of non-production workers (which are proxies for low-skilled labor) in the affiliates in both the developed and the developing countries increased and the ratio of (high-skilled) production-to-non-production workers fell. Additionally, Lawrence argues that the growing imports and/or sourcing of US MNEs from affiliates in developed countries are too small to account for a significant share of the relative wage changes. However, he does not provide econometric evidence to support his view.

Brainard - Riker (1997a) investigate econometrically to which extent the expansion of offshore production by US MNEs reduces labor demand at home and at the other offshore locations. They use a panel of US multinationals and their foreign affiliates from BEA covering the period 1983 -1992. They estimate a translog cost function with the share of the wage-bill in variable costs at Home and the corresponding cost of aggregates of foreign affiliates shares as dependent variables. They find that foreign affiliate employment modestly substitutes at the mar-

gin for US parent employment. But there is much stronger substitution between workers in affiliates in alternative low-wage locations. In contrast, as proposed by the theory of vertical MNEs the vertical division of production implies that affiliate activities in high-wage and low-wage countries complement each other. For example, if wages in developing countries, such as Mexico, are falling by 10 percent, US parent employment falls by 0.17 percent, while affiliates in other developing countries lay off 1.6 percent of their work force in response.

The second related paper of *Brainard - Riker* (1997b) differs in its empirical set-up as vertical relations are explicitly accounted for in the conceptual approach. They look only at the production structure of affiliates and exclude the parent in the US. The conclusions from this study are similar to the ones above mentioned: affiliate employment of US-based multinationals in developing countries appear to be complementary to affiliate employment in developed countries consistent with the hypothesis that MNEs decompose production across borders into complementary stages that differ in skill intensity. In contrast, between affiliates in countries with similar workforce in skill levels there is competition and thus substitution.

The paper of *Slaughter* (2000) more explicitly addresses the issue of the fragmentation of production by MNEs and tests whether the transfer of production stages from US-headquartered parents to foreign affiliates has contributed to the within-industry shift in US relative labor demand towards high-skilled workers. He finds that MNE transfers can generate within-industry skill-upgrading as does outsourcing (*Feenstra - Hanson*, 1996, 1998) and skill-biased technological change. However, MNE transfers do not require that output is send back to the US and in this respect it is a broader measure of outsourcing than Feenstra and Hanson's which only captures those production stages which are transferred back to the home country. Using the BEA-database matched with the NBER-manufacturing productivity database he finds that both parents and affiliates exhibit decreasing employment, but affiliates shares increase. Overall, MNEs seem to have shifted production jobs (which are proxies for low-skilled labor) towards affiliates and non-production (high-skilled) jobs towards parents. In the econometric exercise a translog-cost function is estimated with the change in the US share of the high-skilled worker's wage-bill of the parent firms as the dependent variable and as explaining variable he includes changes in US relative wages, the capital-labor ratio, output and time dummies and as well as a measure of MNE transfers as additional explaining variable. The estimation results suggest that, although significant in size, the MNE transfers do not exert a significant effect on US relative labor demand. He concludes that there

is more empirical support for horizontal MNE models.

Using the same database at the industry level *Bruno - Falzoni* (2000) set up a dynamic labor demand model which explicitly allows for costs of adjustment. As the other studies it treats labor in different locations as separate factors of production. *Bruno - Falzoni* find that employment in Canadian and Latin American affiliates is quasi fixed and secondly that due to the slow input adjustment the complementary/substitutional relationship between the US parent and affiliate employment in Latin America is reversed in the long-run (substitution in the short-run, complementarity in the long-run). Again, complementarity is interpreted as evidence of vertical integration across borders. Thirdly, substitution prevails (both in the short-run and the long-run) between locations in the Western hemisphere (North and South America and in Europe). According to the interpretation of the authors this supports the hypothesis that proximity to final markets matters more than low costs and fragmentation of production for the decision where to locate production (i.e. horizontal investments are still dominating in this case).

Evidence for European countries is scarce - mainly because of lacking detailed data at the firm level. *Braconier - Ekholm* (1999) use panel data on Swedish multinationals and, similar to the papers of *Brainard - Riker* (1997a, 1997b), estimate cross elasticities of labor demand in different locations of Swedish MNEs. In line with the other studies they argue that the relationship between employment in different parts of a MNE depend on whether wage changes lead to a relocation of activities or simply to changes of marginal costs and/or demand of inputs in other parts of the firm. They consider two types of labor demand equations: relations between parents and foreign affiliates and those between different foreign affiliates. As in *Braindard - Riker* (1997a, 1997b) there is substitution between employment in the Swedish parts of the firm and that in high-wage countries, but - if any - a complementary one between that in low- and high-wage countries. They interpret these findings as an indication that foreign affiliate activity in low-wage countries is mainly directed at the vertical decomposition of production stages where affiliates serve each other by intra-firm trade.

Pfaffermayr (1999) provides a simple framework for estimating the determinants of relative labor demand (abroad in relation to that at home) bilaterally and thus differs from previous papers. The econometric specification is based on the assumption that in the case of horizontal investment goods trade is an imperfect substitute for foreign production. With respect to vertical investments in services and distribution, labor demand of foreign affiliates is solely dependent on relative market size. Vertical integration across borders to set up cost saving fragmented

production could not be explicitly accounted for, since there is no information in the data to capture this third component. The estimates are based on bilateral, industry level data on foreign affiliates and the domestic activities of Austrian manufacturing firms covering the period 1990 to 1996, the ten most important host countries and seven industrial sectors.

With respect to the mainly European high-wage countries the econometric estimates suggest elastic substitution between employment in domestic and foreign plants by Austrian firms at the margin as a response to changes in relative wages in several industries. But there is no substitution by affiliate employment in low-wage countries (CEEC). Industries in these countries may well reveal high relative labor demand and they can be expected to do so, even if low foreign wages rise faster than domestic ones, especially during the transition phase. This evidence is also in line with the hypothesis that in these countries FDI mainly aims to fragment production. Additionally, the estimates suggest that affiliate employment generally gains importance if relative wages remain constant: The relative employment figures (affiliate relative to overall domestic) are significantly increasing in foreign demand for Austrian products which is defined as exports plus affiliate sales.

4 The main stylized facts for Austrian manufacturing

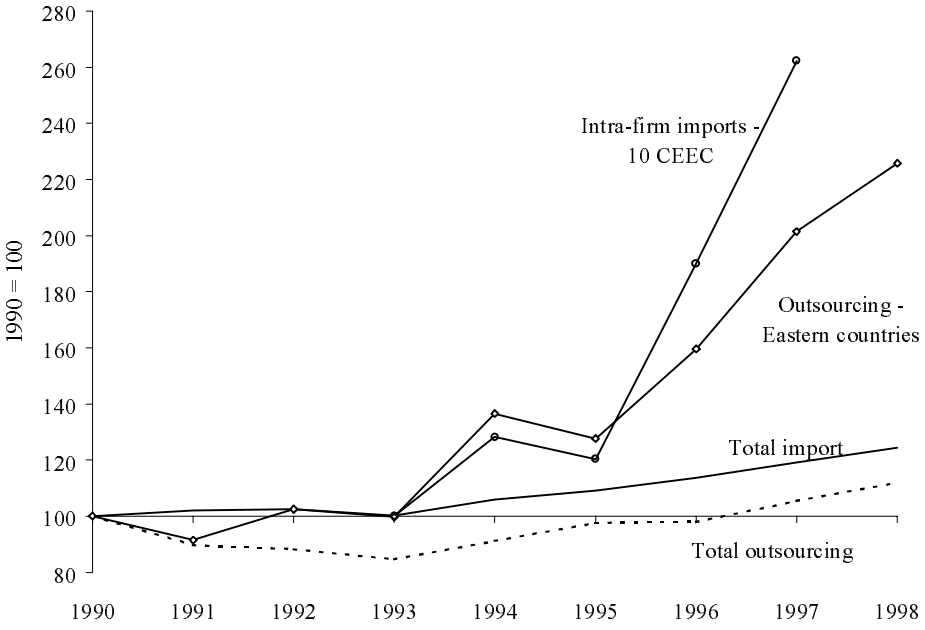
In the nineties Austrian manufacturing experienced a markable increase in both export and import growth which significantly surpassed that of gross production. The result was an increase in export (import) openness in terms of gross production of about 3.9 percent (2.8 percent) p.a. As a possible force towards higher x-efficiency more openness would be expected to stipulate some impact on the (skill-specific) labor market in terms of wages and employment (see *Greenaway et al.*, 1999). Additionally, the direction of exports and imports provides some relevant information as e.g. openness vis-à-vis low-wage (maybe specialized in low-skilled labor-intensive goods production) trading partners could differ in its effect on the labor market from openness to high-wage (maybe specialized in high-skilled labor-intensive goods production) countries.

Table 2: Openness in Austrian Manufacturing 1990 - 1998

	Total export	Total import	Export to Eastern countries	Import from Eastern countries	Outsourcing to Eastern countries
	Shares in gross output as percent		Shares in total export as percent	Shares in total import as percent	Shares in gross output as percent
1990	43.8	48.7	10.1	5.9	0.6
1991	43.1	49.6	10.8	6.2	0.5
1992	43.3	49.9	11.5	6.5	0.6
1993	42.4	48.8	12.7	6.8	0.5
1994	44.5	51.6	13.6	7.7	0.8
1995	48.1	53.1	14.1	7.0	0.7
1996	49.9	55.4	15.4	8.2	0.9
1997	55.1	58.0	17.7	9.3	1.1
1998	59.5	60.6	16.6	10.0	1.2
			Average annual percentage change		
1990/1998	3.9	2.8	6.4	6.8	10.7

In the case of Austria, openness in the manufacturing sector vis-à-vis the East increased substantially more than vis-à-vis the rest of the world (including the EU-member countries). Moreover, this increase was even larger for imports than for exports. The share of the Eastern countries in overall manufacturing imports increased by 6.8 percent p.a., that of exports by about 6.4 percent p.a. on average between 1990 and 1998. This increase in imports is also due to the enlargement of outsourcing activities of Austrian firms. Within the same period we observe an increase in outsourcing to the East in terms of Austrian

Figure 7: Openness in Austrian Manufacturing, 1990 - 1998



gross production by 10.7 percent p.a. Since the fall of the Iron Curtain outsourcing activities, like FDI activities, developed far more dynamic than trade in final goods.

4.1 Magnitude of international outsourcing

Several different approaches as well as data sources have been used to measure the extent of international fragmentation of production. Chapter 3.1 provides an overview.

We use an indicator of outsourcing which is based on the Austrian I-O table. In contrast to other countries' I-O tables the Austrian one provides direct information on imported intermediates. However, information on imported intermediate inputs within each industry is usually not further disaggregated by importing countries so that it is not possible to directly distinguish between intermediate imports from advanced and less advanced countries. We derive a regional breakdown of intermediate imports by multiplying each type of imported input for each industry by the respective countries' (regional) import shares for total imports. That is, imported intermediates purchased by industry i, from country (country group) c are given by:

$$O_{iC} = \sum_{j=1}^{N} MI_{ij} * \frac{M_{jc}}{M_j} \tag{20}$$

where MI_{ij} denotes imports of intermediate good j by industry i and $M_{jc}/M_j$the share of imports of good j from country (group) c in total imports of good j (see the appendix on further details). Note that the underlying implicit assumption in the calculation of intermediate imports by country groups is that for each good the countries' import shares are the same across input purchasing sectors. We divide between the following three regions: the East, OECD and the rest of the world.

An I-O table for Austria is available for 1990 and a preliminary version for 1995 which we constructed from the usual make and absorptions matrices. Information from these two years were taken to construct a time series for imported intermediate flows for the in between years as well as 1997 and 1998. Details are described in the appendix. The aggregation level for industries in the I-O table is the NACE 2-digit level and we exclude services from the analysis.

This is the best measure of outsourcing we could derive with the available data. We should bear in mind that this indicator is a rough one when interpreting the empirical evidence.

Following the work by *Feenstra - Hanson* (1996b, 1999) it is possible to obtain a broad and a narrow measure of intermediate imports from the I-O table. While the broad measure includes purchases from an industry from any other industry, the narrow measure of outsourcing is obtained by including only purchases of an industry from industries which are in the same 2-digit industry class. Overall, narrow outsourcing took a value of 9.3 percent in 1990 and increased only slightly to 10.4 percent in 1998. Throughout the paper we will only use the narrow measure as our main indicator of outsourcing as it best captures the idea of outsourcing. For example, we do not define the sourcing of packaging material by the food industry to reflect fragmentation of the value added chain as would be the case if we took the wide measure. This is even more important as we have to rely on the relatively high aggregation level of 2-digit industries.

Austrian international outsourcing to the East grew at an average rate of 10.7 percent p.a. over the period 1990 to 1998 and thus increased significantly stronger than for any of the other regions considered. It reached a level of 1.2 percent in 1998, which accounted for a regional share of 12 percent (Table 5) in total intermediate imports. Within the group of Eastern countries, trade in intermediates has most dynamically developed for East Central European countries, which accounted for a

share of 8.6 percent in total Austrian intermediate trade in 1998, compared to 2.1 percent and 1.3 percent for South East Europe and the former USSR.

Table 3: Manufactured Intermediate Inputs and International Outsourcing in Austrian Manufacturing 1990 - 1998

	Total inputs	Imported inputs	Imported inputs from the OECD	Imported inputs from Eastern countries	Imported inputs	Imported inputs from Eastern countries
	Shares in gross output as percent				Shares in total inputs as percent	
1990	16.18	9.33	8.27	0.55	27.75	1.64
1991	14.39	8.36	7.39	0.50	27.17	1.64
1992	13.96	8.23	7.22	0.56	27.03	1.85
1993	13.40	7.90	6.86	0.55	26.36	1.83
1994	13.43	8.50	7.20	0.75	28.12	2.49
1995	14.05	9.11	7.93	0.70	28.39	2.19
1996	13.68	9.13	7.81	0.88	28.66	2.76
1997	13.64	9.83	8.23	1.11	30.57	3.45
1998	13.71	10.44	8.67	1.24	31.70	3.77
	Average annual percentage change					
1990/1998	-2.05	1.42	0.60	10.71	1.67	10.99
	Difference in percentage points					
1990/1998	-2.47	1.12	0.40	0.69	3.94	2.13

The observed increase in total international outsourcing is mainly accounted for by a structural shift in outsourcing, that is, a substitution between formerly domestically sourced inputs and international purchased inputs, rather than increased fragmentation per se. This can be seen by a comparison between the share of total material inputs in gross production which has been decreasing over the period 1990 to 1998 and the share of imported inputs in total material inputs which has been rising. At the industry level, substitution away from domestic inputs to foreign inputs is most pronounced for food products, apparel, leather, wood, pulp and paper, chemicals and the communication equipment industry. Total materials as a share of gross output increased only in some industries (e.g. basic metals, office machinery and computers). Again, the shift towards a higher share of internationally sourced inputs is mainly due to increased outsourcing to the East, which was especially pronounced in the communication equipment industry.

International outsourcing is most prominent and way above average in the production of other transport equipment, basic metals and com-

munication equipment, but also important for the motor vehicle industry, the leather, chemical, paper, the computer and textile industry. Out of those industries the communication equipment industry as well as the basic metals and the electrical machinery industries are the sectors for which outsourcing to the East has also become relatively important over the last period. One can observe the highest increases in outsourcing to Eastern countries as a share of total outsourcing by industry for those sectors as well as for the clothing industry (Table 4). The respective country shares stood well above 15 percent in 1998. Apart from those industries the East, while remaining an important sourcing country for the refined petroleum industry, is an important provider of inputs for wood products, the leather industry as well as for non-metallic mineral products (Table 5).

A comparison over time shows that the industries that had a relatively high imported intermediates share in 1990 were still the most important outsourcers by 1998 (see the bottom row of Table 4)[20]. While the relative pattern of total international outsourcing across industries has been very stable over time this is not true for outsourcing to the East as indicated by the lower Spearman correlation coefficient of 0.58. Industry rank correlations for Eastern countries with other regions show that the industry structure of outsourcing to the East has become more similar to total international outsourcing, with the correlation coefficient increasing from 0.50 to 0.75 over the period 1990 to 1998.

4.2 Magnitude and development of intra-firm trade

The international fragmentation of the value added chain also takes place within the organization of firms and it must be seen as part of the outsourcing measure introduced above. MNEs set up affiliates in several countries to perform different stages of production and to combine (or assemble) them to an end product thereby generating intra-firm trade. As argued in chapter 3 intra-firm imports can be used as a rough proxy of the amount of fragmentation of production within MNEs.

Information on intra-firm imports is available from the Austrian National Bank's database which provided data for 10 manufacturing industries (combined from the 2-digit level, see *Austrian National Bank*, 1999) covering the period 1990 to 1997[21]. Concerning the interpretation of the data a few remarks are in order. First, there are a few manufacturing

[20] This comparison is done using Spearman Rank Correlation Statistics. These statistics measure the correlation between two variables based on the ordinal positions of the observations, without otherwise considering the level of the variables.

[21] We are grateful to Rene Dell'mour from the Austrain National Bank for the provison of the data.

Table 4: Development of Austrian Outsourcing [1] to Eastern Countries by Industry, 1990 - 1998

	1990		1998		1990/1998		1990/1998	
	Total outsourcing	Outsourcing to Eastern countries	Total outsourcing	Outsourcing to Eastern countries	Total outsourcing	Outsourcing to Eastern countries	Total outsourcing	Outsourcing to Eastern countries
	Shares in gross output as percent				Difference in percentage points		Average annual percentage change	
Basic metals	17.17	1.35	31.55	5.73	14.39	4.38	7.91	19.82
Communication equipment	24.50	0.13	30.20	4.67	5.70	4.54	2.65	56.16
Leather	19.45	1.44	17.23	2.75	-2.22	1.31	-1.50	8.40
Electrical machinery	9.35	0.30	13.92	2.39	4.57	2.10	5.10	29.70
Wood, products	4.16	0.88	5.01	1.51	0.85	0.63	2.35	6.97
Textiles	21.97	0.55	14.92	1.41	-7.06	0.87	-4.73	12.57
Other transport equipment	5.33	0.08	40.62	1.32	35.29	1.24	28.89	41.66
Pulp and paper	13.60	0.84	15.37	1.27	1.77	0.43	1.54	5.31
Clothing	2.57	0.13	4.44	0.89	1.87	0.76	7.08	27.33
Motor vehicles	18.82	0.11	17.47	0.87	-1.35	0.77	-0.93	29.90
Chemicals	22.31	1.39	16.24	0.80	-6.08	-0.59	-3.90	-6.66
Other non-metallic mineral products	3.85	0.17	4.87	0.68	1.02	0.51	2.98	18.99
Fabricated metal products	5.00	0.18	4.82	0.58	-0.17	0.40	-0.44	15.65
Machinery and equipment n. e. c.	6.77	0.17	5.48	0.39	-1.29	0.22	-2.60	10.96
Furniture; manufacturing n. e. c.	1.98	0.05	3.40	0.37	1.42	0.32	7.02	27.28
Office machinery and computers	6.82	0.02	15.27	0.25	8.45	0.24	10.60	41.80
Coke, refined petroleum, nuclear fuel	3.38	2.24	0.72	0.24	-2.67	-2.00	-17.63	-24.49
Food products and beverages	2.90	0.36	3.45	0.22	0.54	-0.14	2.17	-5.80
Rubber and plastic products	1.16	0.02	2.75	0.19	1.59	0.17	11.43	31.12
Medical instruments	5.63	0.03	5.61	0.15	-0.02	0.12	-0.04	21.04
Publishing, printing and reproduction	0.61	0.00	0.32	0.01	-0.29	0.00	-7.75	9.40
Tobacco products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total manufacturing	9.33	0.55	10.44	1.24	1.12	0.69	1.42	10.71
Industry rank correlation with 1990 [2]			0.869	0.577				
Industry rank correlation of outsourcing to the East with total outsourcing [2]		0.495		0.753				

1) Imported intermediates purchased from within the same statistical industry category. - 2) Spearman correlation coefficient.

Table 5: Regional Structure of Austrian Outsourcing by Industry, 1990 - 1998

	1990			1998			1990/1998		
	OECD	Outsourcing to Eastern countries	other countries	OECD	Outsourcing to Eastern countries	other countries	OECD	Outsourcing to Eastern countries	other countries
	Shares in total imports of manufactured intermediate inputs						Difference in percentage points		
Coke, refined petroleum, nuclear fuel	33.3	66.2	0.5	66.7	33.1	0.2	33.4	-33.2	-0.2
Wood products	72.1	21.2	6.7	67.0	30.2	2.8	-5.1	9.0	-3.9
Clothing	76.6	5.0	18.2	59.9	20.0	19.9	-16.6	15.0	1.6
Basic metals	90.7	7.9	1.4	79.6	18.1	2.2	-11.1	10.3	0.8
Electrical machinery	93.6	3.2	3.1	77.9	17.2	4.8	-15.8	14.0	1.7
Leather	76.8	7.4	15.7	68.3	16.0	15.7	-8.5	8.5	0.0
Communication equipment	81.5	0.5	17.9	71.3	15.5	13.2	-10.2	14.9	-4.7
Other non-metallic mineral products	93.7	4.4	1.9	82.9	14.0	2.3	-10.8	9.6	0.4
Fabricated metal products	93.9	3.6	2.4	83.9	12.1	3.3	-10.0	8.4	0.8
Furniture; manufacturing n. e. c.	87.9	2.7	9.4	79.7	10.9	9.4	-8.2	8.1	0.0
Textiles	86.7	2.5	10.8	80.2	9.5	10.2	-6.6	7.0	-0.6
Pulp and paper	92.5	6.2	1.3	88.1	8.3	3.6	-4.4	2.1	2.3
Machinery and equipment n. e. c.	96.5	2.5	1.0	91.0	7.0	1.7	-5.5	4.6	0.7
Rubber and plastic products	96.1	1.9	1.9	89.9	7.0	3.0	-6.2	5.1	1.1
Food and beverages	76.8	12.4	10.7	89.4	6.5	4.1	12.6	-5.9	-6.6
Motor vehicles	99.2	0.6	0.2	93.4	5.0	1.5	-5.8	4.4	1.3
Chemicals	91.8	6.2	2.0	92.7	4.9	2.3	0.9	-1.3	0.3
Other transport equipment	93.9	1.5	4.6	93.0	3.3	3.7	-0.8	1.7	-0.9
Medical instruments	94.1	0.6	5.3	90.9	2.7	6.1	-3.1	2.1	0.9
Publishing, printing and reproduction	98.4	0.7	0.9	96.3	2.6	1.0	-2.1	1.9	0.1
Office machinery and computers	85.9	0.2	13.9	87.3	1.6	11.1	1.4	1.4	-2.8
Tobacco products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total manufacturing	88.6	5.9	5.4	83.0	11.9	5.0	-5.6	6.0	-0.5

firms which are classified as holdings in the service sector and are not included. The unit of observation of the survey is the ultimate owner of the foreign affiliate which is sometimes a holding without activities in manufacturing[22]. Therefore, there may be an underestimation of foreign activities. Second, the foreign affiliates are classified by their activity abroad and not according to the activity of the parent firm. This rules out vertical FDI in services and distribution and makes intra-firm imports compatible with the narrow measure of outsourcing (intermediate manufactured imports). Horizontal FDI, however, cannot be identified, so we concentrate on intra-firm imports of goods from the 10 Central and Eastern European accession countries (10 CEEC) to measure the extent of fragmentation within the firm.

Table 6: Regional Structure of Austrian Intra-firm Imports 1993 - 1997

	Western countries[1)]	10 CEEC	Total
	Shares in gross output as percent		
1993	0.01	0.12	0.34
1994	0.02	0.15	0.33
1995	0.02	0.14	0.48
1996	0.02	0.22	0.56
1997	0.04	0.31	0.93
	Average annual percentage change		
1993/1997	30.9	27.2	28.4

1) EU15, Switzerland, USA and Canada.

At the beginning of the nineties intra-firm imports from the 10 CEEC (as was FDI into these countries in general) have been negligible in size, but looking at the period 1993 to 1997 illustrates dynamic growth at 27.2 percent p.a. stemming from both, increases of intra-firm imports of existing firms and the increasing number of new affiliates. In 1997, the year with the latest available figures, in most industries, intra-firm imports mainly came from the 10 CEEC, with the chemical and oil sector forming the only exception. The intra-firm trade balance with the 10 CEEC amounted to 2.6 bn ATS (the biggest contribution 1.8 bn ATS comes from the chemical and oil sector) and it was only negative in the textiles, wood and metal industries. That means FDI to the 10 CEEC also generated a relatively large volume of intra-firm exports.

[22]The domestic manufacturing activities are organized in a separate corporation also owned by the holding in this case.

Table 7: Regional Structure of Intra-firm Imports by Industry in 1997

	Western countries[1)]	10 CEEC	Other Eastern countries	Other countries	Total
			Shares as percent		
Food, beverages, tobacco	0.0	83.6	16.4	0.0	100.0
Textiles, clothing	15.8	83.8	-	0.4	100.0
Wood	0.1	99.9	-	-	100.0
Paper, printing	0.0	99.7	-	0.3	100.0
Chemicals, rubber, mineral fuels	2.6	3.3	-	94.1	100.0
Non-metallic mineral products	20.0	69.3	0.3	10.3	100.0
Metal products	15.9	74.7	0.0	9.3	100.0
Machinery	10.4	49.4	0.4	39.7	100.0
Office, electr. mach., communication equipm.	3.4	76.3	0.6	19.6	100.0
Motor vehicles, other transport equipment	-	-	-	-	-
Furniture, manufacturing nec	0.0	35.9	63.3	0.7	100.0
Total	4.3	23.0	1.0	71.7	100.0

Source: Austrian National Bank. - 1) EU15, Switzerland, USA and Canada.

Table 8: Austrian Intra-firm Trade Balance by Regions and Industry in 1997

	Western countries[1)]	10 CEEC	Other Eastern countries	Other countries	Total
			mn ATS		
Food, beverages, tobacco	49.5	90.7	-30.5	38.5	148.2
Textiles, clothing	369.4	-113.1	-	171.5	427.8
Wood	22.5	-259.4	-	-	-236.9
Paper, printing	0.0	898.4	-	19.0	917.4
Chemicals, rubber, mineral fuels	2,565.4	1,770.5	-	-7,100.7	-2,764.8
Non-metallic mineral products	0.7	118.9	81.9	-35.6	165.9
Metal products	849.4	-43.5	2.2	875.0	1,683.1
Machinery	33.7	99.0	39.3	558.4	730.4
Office, electr. mach., communication equipm.	1,318.3	20.5	12.5	375.3	1,726.6
Motor vehicles, other transport equipment	-	12.0	-	26.1	38.1
Furniture, manufacturing nec	115.6	1.8	-29.9	281.5	369.0
Total	5,324.5	2,595.8	75.5	-4,791.0	3,204.8

Source: Austrian National Bank. - 1) EU15, Switzerland, USA and Canada.

The database is too small for a more detailed econometric analysis. The relation between foreign activities and domestic performance can only be assessed on a descriptive basis. We observe that employment in the parent firms and in foreign affiliates grew complementarily at a rate of 10.4 percent and 9.2 percent p.a., both mainly driven by new investors coming into the sample. In contrast, overall employment in

total manufacturing decreased by 2.3 percent on average. However, the five sectors with the highest increase in intra-firm trade witnessed an above average decrease in overall domestic employment. A significant shift to more high-skilled labor-intensive domestic production occurred only in one of these five sectors (electronics) and to a smaller extent in non-ferrous minerals. The correlations in Table 9 indicate a loose relationship between domestic and foreign employment. The only (weak) stylized fact is that growth of foreign activities in the 10 CEEC tends to increase the skill intensity of domestic production, but it does not seem to be associated with a decrease in domestic employment.

Table 9: Correlation between Domestic and Foreign Employment Activities in the 10 CEEC
(Growth rates)

	Domestic employment				Skill intensity of production	
	Total		Parent firms with FDI in the 10 CEEC		High-skilled/Low-skilled	
	Pearson	Kendall-t	Pearson	Kendall-t	Pearson	Kendall-t
Outsourcing	-0.04	-0.02	-0.07	-0.12	0.18	0.14
Employm. in foreign aff.	-0.08	-0.07	0.41 **)	0.38 **)	0.23 *)	0.16 *)
Intra-firm imports	-0.01	0.02	0.03	0.09	0.07	0.05

**) significant at 5 percent; *) significant at 10 percent.

4.2.1 Outsourcing and total factor productivity growth

According to the theory of international trade, outsourcing may affect the home country by increasing its overall productivity. *Feenstra - Hanson* (1997, 1999) show that empirically the effects of outsourcing are similar to those of a (possibly non-neutral) technical change.

As a measure of productivity growth we use the Tornqvist-index of total factor productivity (TFP) which is defined as the volume of output in relation to an index of inputs (weighted by shares in total variable costs, see appendix). In contrast to labor productivity this index additionally accounts for increases in capital and intermediate inputs. Over the period 1991 to 1998 we observe a median increase of the TFP by 0.9 percent p.a., (Table 11 below).

There are differences in TFP growth, however not significant, across industries with the highest productivity increases in refined petroleum, electrical machinery, communication equipment and medical precision instruments and decreases in office machinery (which seems to be an outlier) and textiles. At the pure descriptive level, no differences in TFP growth between those industries with a high and a low outsourcing ratio to the East can be detected. Below, we analyze this issue in more

detail econometrically, controlling for industry-specific and time-specific effects as well as for other exogenous determinants.

We do not analyze the impact of fragmentation on structural change in detail. However, looking at the growth rates of real value added reveals pronounced changes in industry structure in the nineties. Textile, apparel and leather undergo a deep restructuring process with real value added shrinking by 2.3 percent up to 7.5 percent p.a.; the other transport equipment industry is also shrinking on average. The highest growth rates can be found in refined petroleum[23], in the technology-intensive and human capital-intensive industries (NACE 29 to 32) and in the motor vehicles sector. With respect to the degree of outsourcing, Table 11 below indicates that the industries with a high degree of outsourcing to the East are at least partly those which are under pressure of restructuring and exhibit slower growth. According to the Kruskal-Wallis test the growth differentials are not significant, however.

4.3 Outsourcing and the labor market

4.3.1 Relative wages and employment of high-skilled and low-skilled workers

One of the central issues in the debate on potential detrimental effects of increased trade on national labor markets has been whether increased trade has hurt low-skilled workers by lowering their wages and increasing the high-skilled-to-low-skilled wage differentials. For Austria Table 10 reveals virtually no rise in relative wages but a quite large increase in the high-skilled-to-low-skilled employment ratio of 4.4 percent p.a. on average over the period 1990 to 1998 (see Figure 8).

[23] The figures for this sector have to be interpreted with care, since there seem to be problems in the recalculation of the years before 1996 according to the NACE classification.

Figure 8: High-Skilled-to-Low-Skilled Employment and Wages, 1990 - 1998

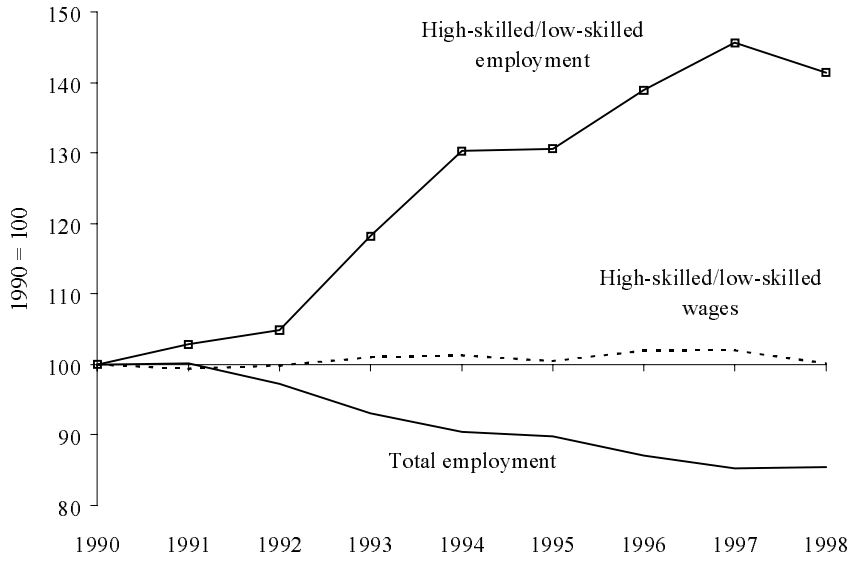


Table 10: Growth of Total Employment and Ratio of Wages and Employment of High-Skilled and Low-Skilled Workers in Austrian Manufacturing

	Total employment	Ratio of high-skilled and low-skilled workers	
		Wages	Employment
1990	100.0	1.39	1.54
1991	100.1	1.39	1.59
1992	97.2	1.39	1.62
1993	93.0	1.41	1.83
1994	90.4	1.41	2.01
1995	89.8	1.40	2.02
1996	87.0	1.42	2.15
1997	85.2	1.42	2.25
1998	85.4	1.40	2.19
	Average annual percentage change		
1990/1998	-2.0	0.0	4.4

As a first glance at the possible impact of fragmentation, we split the data into industries with high outsourcing and industries with low outsourcing to the East and perform a Kruskal-Wallis test to see whether there has been a systematically different development across these industry groups in such variables as (value added) prices, wages of low-skilled

and high-skilled workers, cost of capital, value added and employment (Tables 11, 12). While we find no significant differences in the development of wages and any of the other variables considered, outsourcing results to make a difference to employment. High outsourcing industries have been subject to significantly higher negative employment responses than low outsourcing industries. That outsourcing leads to negative volume effects rather than price (wage) effects is consistent with the following hypothesis: under unionized wage setting mechanisms and a preference for not too large high-skilled-to-low-skilled wage differentials, possible negative impacts of trade are more likely to be absorbed in form of employment losses. While disaggregation of employment into skill types shows significantly higher employment losses for low-skilled workers, a significant difference between low and high outsourcing industries results only for high-skilled employment. Note however, that the difference in the median of employment changes across the two industry groups is higher for low-skilled workers than for high-skilled workers.

Table 11: Outsourcing to Eastern Countries

	Median of log change of					
	TFP	Value added	Total employment	Low-skilled workers	High-skilled workers	Test on difference between low-skilled and high-skilled workers (two sided p-value)
Degree of outsourcing						
high - above ind. average	0.009	0.019	-0.014	-0.026	-0.012	0.02
low - below ind. average	0.009	0.013	-0.026	-0.033	-0.018	0.00
total	0.009	0.017	-0.023	-0.030	-0.016	
Difference between high and low outsourcing, Kruskal-Wallis test, p-value	0.580	0.790	0.080	0.140	0.080	

Table 12: Outsourcing to Eastern Countries

	Median of log change of				
	Value added prices	Wages of low-skilled workers	Wages of high-skilled workers	Cost of capital	Test on difference between low-skilled and high-skilled workers (two sided p-value)
Degree of outsourcing					
high - above ind. average	0.017	0.044	0.044	-0.011	0.700
low - below ind. average	0.014	0.043	0.041	-0.016	1.000
total	0.015	0.043	0.041	-0.014	0.810
Difference between high and low outsourcing, Kruskal-Wallis test, p-value	0.850	0.760	0.390	0.800	

4.3.2 The labor content of Austrian intermediate imports from the Eastern countries

A distinguishing feature of the literature on the labor market impacts of trade is the diverse set of methodologies and empirical strategies. One of these are factor (labor) content calculations (e.g. *Borjas et al.*, 1997, *Wood*, 1994, 1998). Basically, this is an exercise which amounts to computing the quantity of labor embodied in net-trade. Thereby, one may estimate the effect of trade on the demand for (high-skilled and low-skilled) labor at given factor prices by comparing these figures with a hypothetical situation without any trade. Alternatively, one may compare it to a situation, where trade is reduced to a level of some earlier year, assuming technologies as constant. More specifically, while for exports one calculates the actual labor content, a counterfactual factor content is calculated for imports, that is, how much of labor would have been employed to produce domestically the goods that are imported.

We calculated the labor content of intermediate imports from the East. The results are displayed in Table 13 and give the additional amount of labor (persons) that would have been demanded in 1990 and 1995 if intermediate imports from Eastern countries were reduced to zero and substituted by domestic input production. Having in mind all the possible sources of bias, and given wages and factor supply, we see that in both years the effects on labor displacements from outsourcing to the East are relatively small affecting in total 3,880 employees in 1990 and 5,362 in 1995. The third column in Table 13 gives an alternative calculation of the labor content of intermediate imports from the East by applying 1990 sectorial input coefficients to 1995 imports (the assumption being that these would more correctly reflect the technology before outsourcing to the East became important). We see that estimates for 1995, applying this alternative calculation go up by 1,865 persons to 7,227.

Factor content calculations have been subject to wide criticism for a number of reasons, so that the figures should be interpreted with due care to their limitations and the underlying assumptions. Apart from theoretical considerations and criticisms widely discussed in *Deardorff - Hakura* (1994), *Deardorff* (2000a), *Kohler* (1999), *Leamer* (2000) and *Krugman* (2000), there is an important problem in the empirical application. The results depend crucially on the assumptions made in calculating the labor content of the hypothetical domestic production that would substitute for intermediate imports (see e.g. *Wood*, 1991, 1998). Factor contents of imports are estimated from domestic sectoral factor input coefficients. This assumes that all imports are competing, that is, imported intermediates in a given statistical category are taken

to be goods of the same type, and in particular of the same labor and/or skill intensity as those produced in the corresponding domestic sector. This is an assumption specifically unreasonable for outsourcing to the East where it is more likely that the most labor-intensive and most low-skilled labor-intensive fragments of production are outsourced so that the factor intensities of the outsourced fragment certainly differ from those of the integrated process as well as from the fragment remaining in the country[24]. This is an important source of underestimation of the impact of outsourcing on labor demand. The higher the level of statistical aggregation at which factor input coefficients are observed the higher the degree of underestimation.

On the other hand, there is also a possibility of overestimation, that could arise, if domestic equivalents of imports are higher priced, which would deter consumers so that the impact of labor displacement is overstated.

Furthermore, the above described calculation of factor contents does not take into account the adjustment processes on the labor and product markets induced by outsourcing. So, the calculated figures can at very best only be interpreted as "very short-run" effects of outsourcing with complete inter-sectoral immobility of factors and constant wages (see *Kohler*, 1999).

[24]Note that the fragmentation technology, i.e. the corresponding input coefficients, are unobservable both in the domestic and foreign country at the 2-digit industry level.

Table 13: Labor Content of Intermediate Inputs Imported from Eastern Countries

	1990	1995	1995 (1990 input coefficients)
		Persons	
Food and beverages	393	211	262
Textiles	247	349	416
Clothing	46	71	140
Leather	195	195	266
Wood products	505	690	849
Pulp and papter	206	154	234
Publishing, printing and reproduction	0	0	0
Coke, refined petroleum, nuclear fuel	89	13	18
Chemicals	651	412	469
Rubber and plastic products	31	42	83
Other non-metallic mineral products	104	271	340
Basic metals	726	1,343	2,037
Fabricated metal products	193	450	556
Machinery and equipment n. e. c.	203	305	332
Office machinery and computers	0	0	0
Electrical machinery	179	441	590
Communication equipment	38	205	294
Medical instruments	9	23	26
Motor vehicles	28	88	130
Other transport equipment	6	18	47
Furniture; manufacturing n. e. c.	31	79	136
Total manufacturing	3,880	5,362	7,227
High outsourcing industries	3,383	4,582	6,192
Low outsourcing industries	497	780	1,035

5 Econometric estimates of the impact of outsourcing for Austrian manufacturing

In the empirical analysis below we concentrate on Austrian manufacturing industries and look at the effects of the fragmentation on productivity, skill-specific employment and (mandated) wages using a small panel of two-digit industries covering the period 1990 to 1998. The choice of this databasis is mainly dictated by the availability of the data, but also by the fact that outsourcing is mostly concentrated in the manufacturing sector. The appendix provides information on the definition and the sources of the variables we use in the econometric exercises.

5.1 Productivity effects

To analyze the impact of outsourcing on changes in total factor productivity we specify an econometric equation which is based on a translog production function (see appendix). The dependent variable is the Tornqvist-index of TFP growth and we concentrate on the effects of intermediate imports as a measure of fragmentation. Data on intra-firm trade are too highly aggregated and cannot be used in the econometric exercise.

Outsourcing is introduced as the lagged ratio of our proxy for intermediate purchases from Eastern countries relative to total expenses for intermediates. The full specification of the translog function as proposed, for example, in *Feenstra - Hanson* (1997) cannot be estimated since the interaction terms of outsourcing and inputs which should capture non-neutral technical change induced by outsourcing are highly collinear rendering precise estimation impossible. Rather we introduce two interaction terms of the outsourcing measure with dummies, the first taking the value 1 if an industry is classified as skill-intensive[25], $D_{high-skill}$, and the second taking the value 1 if it is capital-intensive[26], $D_{capital}$. Additional controls are included to avoid that all productivity changes are erroneously associated with outsourcing. Summing up, the estimated specification reads:

$$\Delta TFP_{it} = \beta_o + \beta_1 O_{it} + \beta_2 O_{it} D_{high-skill} + \beta_3 O_{it} D_{capital} + \beta_4^{'} \mathbf{X}_{it} + \mu_i + \lambda_{t+} \varepsilon_{it} \qquad (21)$$

where i is the index for two-digit industries and t the time index. The

[25] Industries are classified as using high-skilled labor intensively, if the ratio of high-skilled workers and real value added is above average.

[26] Industries are classified as capital-intensive if their capital-output ratio is above the average of total manufacturing.

controls in $\mathbf{X}$ comprise the R&D-to-output ratio as well as general export and import openness with respect to Eastern countries as additional controls. μ_i are fixed industry effects capturing exogenous neutral technological progress. λ_t denote fixed time effects, which control for yearly influences like the business cycle and technical progress common to all industries. Additionally, we account for outliers by introducing outlier dummies whenever the studentized residuals turn out to be greater than 3 in the basic specification (see *Belsley et al.*, 1980).

Table 14: Pooled Regressions for Total Factor Productivity Growth

	Log change in TFP		Log change in p^V+TFP-e_i	
	β	t-value	β	t-value
Outsourcing to Eastern countries - base	0.54	2.4 **)	0.86	1.6 *)
Interaction with $D_{low\text{-}skilled/high\text{-}skilled}$	-0.12	-0.2	-0.47	-0.3
Interaction with Outsourcing*$D_{capital/employment}$	0.31	1.0	0.04	0.1
Prediction (weighted average across industries and time)	0.009		0.023	
Predicted overall effect of outsourcing compared ot 1990 (weighted average across industries and time)	0.002		0.002	
Statistics N=18, T=8				
R^2	0.57		0.59	
σ	0.01		0.04	
Reset-Test, F-test	1.32	(3, 103)	1.56	(3, 104)
Heteroskedasticity, χ^2	1.62	(1)	1.81	(1)
Normality, χ^2	1.44	(2)	10.99 **)	(2)
F-tests				
Time dummies	2.5 **)	(7, 106)	1.35	(7, 107)
Industry dummies	1.6 *)	(16, 106)	2.73 **)	(16, 107)
Interaction terms	0.5	(2, 106)	0.04	(2, 107)

Note: Control variables for export and import openness, R&D intensity (all insignifcant), outsourcing to OECD significantly negativ), outlier dummies, fixed industry and time effects are not reported. NACE 16, 30, 35 and 36 are omitted because of data quality because the majority of observations within the 2-digit industry level have been classified as outliers (absolute value of studentized residuals above 3). Standard errors are Heteroskedasticity robust using the White-procedure (White, 1980). - (**) significant at 5 percent; *) significant at 10 percent.

The estimation results in Table 14 indicate that outsourcing exerts a significant, positive, technologically neutral effect on TFP growth[27]. Note the Tornqvist-index implicitly controls for changes in inputs and

[27] We also estimated fixed effects regressions without additional control variabales as robust median regressions in order to assess the sensitivity of our estimates. For both equations we derive comparable results.

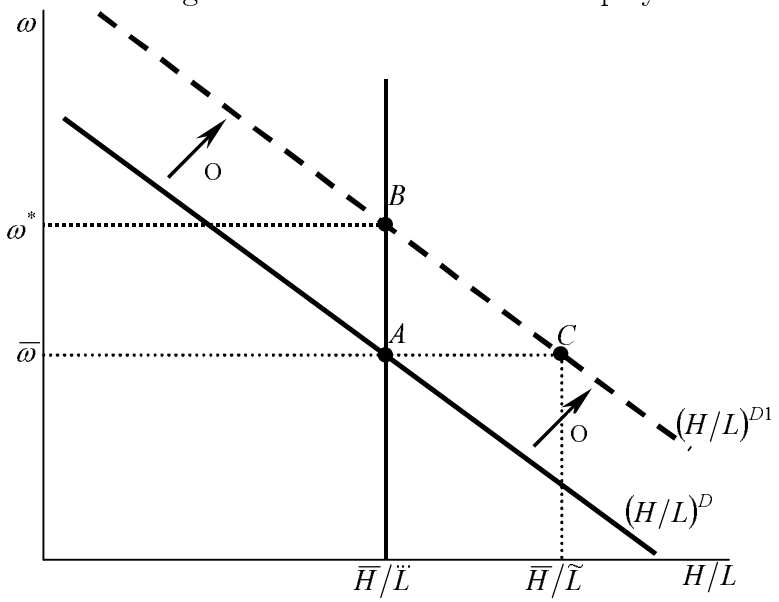
in their intensity in usage (change in weights) as a result of changes in technology induced by outsourcing. So specification 2 is measuring only overall changes in production technologies. The interaction terms suggest that the positive impact of outsourcing is possibly more pronounced in high-skilled labor and capital-intensive industries than in low-skilled labor-intensive industries. However, the parameters could not be estimated precisely and so it is impossible to draw firm conclusions on this. In assessing the impact of outsourcing, we ask what would be the effect on TFP growth, if outsourcing is reduced to its 1990 level and compare the difference in the prediction of the estimated equation. Table 14 shows that on average 0.2 percent of the 0.9 percent average increase in TFP can be attributed to outsourcing.

5.2 Outsourcing and the effects on skill-specific employment

The literature on the labor market effects of increased openness (mostly measured either in terms of overall trade or multinational activities, less often directly in terms of trade in intermediates, i.e. outsourcing) to a large extent focusses on the effects on wages. This is driven by the fact that traditional trade models assume full factor market clearing in the sense that there is perfect inter-sectoral (not international) labor mobility, wages are fully flexible and unemployment is impossible. Under such circumstances the Heckscher-Ohlin model of trade allows for a valid analysis of the effects of trade (and also multinational activities, if the model is extended to non-perfect market structures, see *Helpman*, 1984 and 1985, *Helpman - Krugman*, 1985, *Markusen - Venables*, 1996, 1998 among others) on factor income e.g. of the high-skilled labor relative to the low-skilled labor. This type of analysis was seen to be suitable for integration processes which occur without large changes of factor employment (for instance as in the case of Northern American integration with the foundation of NAFTA). In such a case it is sufficient to concentrate on the effects of falling trade barriers and other trade impediments on relative factor rewards. However, it was mentioned several times (*Krugman*, 1995, *Wood*, 1998) that for countries - usually associated with Europe - which are facing some form of wage rigidities this might be incomplete an analysis. In that case one would have to allow for the possibility of a change in relative factor employment (high-skilled versus low-skilled in our case). Rigidities of relative wages between the high-skilled workers and the low-skilled workers in Europe often are associated with preferences for not too large wage differentials and unionized wage-setting mechanisms within the respective economies.

The stylized facts for Austria give some support to a theoretical

Figure 9: Outsourcing and the effects on relative employment and wages



foundation which is based on the latter arguments, remember the small rise of relative wages and the large increase in relative employment of high-skilled workers and low-skilled workers over the last decade.

In this chapter we will search for the effects of fragmentation (outsourcing) on the relative employment of high-skilled-to-low-skilled labor by Austrian industries. In order to isolate this effect, we also have to control for changes in other variables which would generate a similar impact on this relation. Therefore, we estimate the effect on high-skilled relative to low-skilled employment in a particular "typical" industry averaging out industry-specific effects. The specification is based on the well-known labor supply and demand diagram (Figure 9) which for our purpose is drawn for relative employment.

Initially, the economy faces the relative labor demand curve $(H/L)^D$. As usual, $w = w_H/w_L$ refers to the relative wage rate of high-skilled and low-skilled labor. What are the candidates for a shift of the depicted relative labor demand curve? The literature provides us with a couple of explanations:

1. Non-neutral (low-skilled labor augmenting) technological change tends to change the input mix and shifts the relative labor demand curve outwards.

2. Increased efficiency in the production process might change the input factor mix, increase exports and presumably shift relative demand outwards.

3. Increased competition via imports in final goods might reduce relative demand for that factor which is more extensively contained in imports resulting in either an inward or an outward shift of the relative labor demand curve (this remains an empirical question).

4. Increased competition from foreign suppliers of intermediates might (at least relatively) reduce the demand for that factor which is intensively used in the production of intermediates. Hence, outsourcing into low-wage countries would presumably result in an outward shift of the relative demand curve.

In the case of opening-up of the East the driving forces behind arguments (2) - (4) could be the decline in tariff and non-tariff barriers to trade, increased multinational activities, etc.

Of course, the effect on relative employment (H/L) and wages (w_H/w_L) crucially depends on the shape and slope of the relative labor supply curve. As mentioned above, traditional models of trade assume a vertical (relative) labor supply curve which is due to fully flexible relative wages. Hence, any outward shift in relative labor demand (e.g. because of increased outsourcing) would only cause an increase in the wages for high-skilled relative to low-skilled employees (from $\overline{\omega}$ to ω^* in Figure 9), leaving relative employment unchanged (at $\overline{H}/\ddot{\overline{L}}$). In contrast, if relative wages were fully rigid this would be due to an infinitely elastic relative labor supply curve. Therefore, any shift in relative labor demand would result in a change in relative employment (from $\overline{H}/\ddot{\overline{L}}$ to $\overline{H}/\tilde{L}$) leaving relative wages unchanged (at $\overline{\omega}$). However, if there is some wage rigidity in the economy, the new equilibrium after an exogenous outward shift of relative labor demand would take place somewhere between point B (i.e. zero-elastic relative labor supply) and point C (i.e. infinitely elastic relative labor supply) in the above Figure. We would therefore expect a rise in both relative employment and relative wages in favor of high-skilled employment.

In order to isolate the effect of outsourcing on relative employment between the high-skilled labor and the low-skilled labor , we have to control for the effects of the several explanatory variables which are capable to shift relative labor demand. Hence, industry-specific openness to exports and to imports, and the capital-output ratio enter the equation. On the other hand, fixed industry and time effects are included in order to control for exogenous non-neutral technological progress (reflected by

time effects) and to be able to interpret the coefficients "within" industries. This leads to the following econometric specification estimated with a panel of two-digit industries for the period 1990 to 1998:

$$\ln \frac{H_{it}}{L_{it}} = \beta_0 + \ln \frac{w_{Hit}}{w_{Lit}} + \ln XOP_{it} + \ln MROP_{it} + \ln KY + \ln O_{it} \quad (22)$$
$$+\mu_i + \lambda_t + \varepsilon_{it}$$

where subscript i refers to industry and t to time (years). XOP is export openness and $MROP$ is import openness (measured in terms of gross production), where the "R" indicates that this measure contains only imports minus outsourcing to Eastern countries. KY is the capital-output ratio. Finally, O is our outsourcing measure[28] and μ_i and λ_t are group-specific (industry and time) fixed effects.

Of course, relative wages and relative employment face an endogeneity problem and the same holds true for outsourcing to the East, as we presume that this is production which intensively uses low-skilled labor. We therefore instrument both variables (in an alternative specification we treat outsourcing as exogenous) to obtain unbiased and consistent estimation results. We find trade impediment measures (applied most favored nation tariff rates, TB, and non-tariff barriers to trade, NTB) as well as union power measures (degree of organization of trade unions, ORG, median firm size, $MSIZE$, and price cost margins, PCM) to be appropriate instruments from a theoretical point of view (see *Egger - Egger*, 2000).

[28] Of course, fragmentation of the value added chain is to some extent arm's length and to some extent it is of an intra-firm type. In the analysis of the effects on relative employment we do not distinguish between the two and remember that trade statistics do not discriminate between intra-firm and other trade.

Table 15: Skill-Specific Relative Labor Demand and Outsourcing in Austria 1990 - 1998
Two-Stage Least Squares Estimation Results (Dependent Variable is High-Skilled Relative to Low-Skilled Employment in Heads)

	Specification I[1)2)]		Specification II[1)3)]	
	β	Std. error	β	Std. error
Dependent Variable[4)]				
Relative wage rate (RWAGE)	-0.07	0.850	-1.36	1.232
Export openness (XOP)[5)]	0.28	0.066 **)	0.20	0.070 **)
Import openness (MROP)[5)]	-0.36	0.069 **)	-0.25	0.086 **)
Capital intensity (KI)	-0.22	0.096 **)	-0.07	0.115
Outsourcing (OUT)	0.08	0.031 **)	0.02	0.209
Constant	1.49	0.717 **)	1.34	0.755 *)
Statistics (N=20; T=9)[6)]				
Observations		179		179
Adj. R^2		0.98		0.98
Time effects: F (8, 146)[7)]		0.89		1.31
Industry effects: F (19, 146)[7)]		464.45 **)		311.49 **)
Outlier Effects: F(3, 143)[7)]		-		-
Normal Distribution I: adj. χ^2 ()[8)]		4.64		4.64
Normal Distribution II[9)]		0.43		0.43
Instrument Relevance: R^2_p (RWAGE)[10)]		0.26		0.19
Instrument Relevance: R^2_p (OUT)[10)]		0.57		-
RESET: F(3, 144)[11)]		6.69 **)		6.69 **)

1) Outsourcing to Eastern countries measured as percent of intermediate inputs. - 2) Relative wages and outsourcing are instrumented by unit labor costs in Eastern countries (ULCOST), organization degree of trade unions (ORG), price cost margin (PCM), median firm size (MSIZE), trade barriers (TB), non-tariff barrier dummy (NTBD), non-tariff barrier interaction term (NTBI). - 3) Only relative wages are instrumented by organization degree of trade unions (ORG), price cost margin (PCM), median firm size (MSIZE). - 4) All variables are in logs. Parameter estimates for fixed time and industry effects as well as for outlier dummies are not reported in order to save space. - 5) Exports (imports) as percent of industry gross output. - 6) Degrees of Freedom in parentheses. - 7) F-tests for testing the restriction of joint zero parameters for the respective effects (outlier dummies, fixed time and industry effects). - 8) Combined Skewness/Kurtosis test for normality, Royston (1991). - 9) Shapiro-Wilk W test for normal data (Royston 1991). - 10) Partial R^2 diagnostics testing for instrumental relevance, Shea (1997). - 11) Ramsey RESET test using powers of the fitted values of the dependent. **) significant at 5 percent; *) significant at 10 percent.

The econometric estimates provide the following relatively robust results:

- an increase in overall export openness increases relative employment in favor of high-skilled labor;
- an increase in overall import openness increases relative employment in favor of low-skilled labor;
- an increase in outsourcing increases relative employment in favor of high-skilled labor.

This on the one hand supports the stylized fact that Austria seems to act as an importer of relatively skill-intensive goods from abroad. On the other hand, it is an exporter of skill-intensive goods itself. Outsourcing works in the same direction as was supported by other empirical contributions (see e.g. *Anderton - Brenton*, 1999 and the overview in chapter 3). However, this has nothing to say about the impact of outsourcing on overall employment which - as mentioned above - depends on general equilibrium effects. But it can help to underpin the role of labor market policy in the process of increasing integration. In so far as Eastern enlargement would be related to outsourcing (via the reduction of trade impediments and differences between standards, etc.) one would expect a ceteris paribus decrease in the relative demand for low-skilled labor. This would claim for accompanying labor market policies (e.g. financial support for training and education programs, etc.) in order to minimize welfare losses for the respective people in the adjustment process.

5.3 Induced mandated wage changes

In this chapter we analyze the impact of outsourcing to the East on the labor market from another angle. We ask, how outsourcing to the Eastern countries would affect relative wages of high-skilled and low-skilled labor in a hypothetical world of fully flexible wages and no unemployment. In the light of specific labor market developments in Austria (virtually no increase in relative wages of high-skilled workers, but a relatively large rise in relative employment) one could then ask, to what extent possible negative pressures from outsourcing to the East on wages of high-skilled and low-skilled labor are absorbed in the form of employment losses due to the inflexibility of wages.

Mandated factor price regressions, which are sometimes also referred to as "price studies" have been widely used in the empirical trade and wages literature to study the impact of trade competition from low-wage countries in general[29] and outsourcing to low-wage countries in specific (*Feenstra - Hanson*, 1999), on the high-skilled-to-low-skilled wage gap. The theoretical framework for these studies is the production side of the standard, perfectly competitive Heckscher-Ohlin trade theory model and the Stolper-Samuelson link between product prices and factor prices, which was reviewed in chapter 3 of this study. In applying the mandated wage regression framework to estimate the effects of Austrian outsourcing to Eastern countries on factor prices, we adopt the two-stage estimation procedure as proposed by *Feenstra - Hanson* (1997, 1999)[30]. Thus, in a first step we decompose price and productivity changes into portions

[29] For an overview see *Slaughter* (1999) and *Huber - Wolfmayr-Schnitzer* (2000).
[30] See chapter 3.2 and the appendix for further details.

attributable to structural variables according to :

$$\Delta \ln p_{it}^{V} + \Delta TFP_{it} + e_{it} = \gamma_o + \gamma_1 O_{it} + \gamma_2 O_{it} D_{high-skilled} + \gamma_3 O_{it} D_{capital} + \gamma_4 \mathbf{X}_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (23)$$

which regresses the change in industry value added price (p^V) and total factor productivity (TFP) corrected for inter-industry wage differentials (e) on outsourcing to the East (O), interaction terms of outsourcing to the East with dummies for high-skilled labor-intensive industries ($OD_{high-skilled}$) and capital-intensive industries ($OD_{capital}$) and a variable $\mathbf{X}$ comprising the R&D-to-output ratio as well as overall export and import openness with respect to Eastern countries as additional control variables. μ_i and υ_t are industry and time specific fixed effects. Subscript i refers to industry and t to time (years) effects and Δ indicates first differences. The last term on the left hand side (e_{it}) corrects for inter-industry wage differentials and is defined as $e_{it} = \frac{1}{2}(\upsilon_{i,t-1} + \upsilon_{ti})'(\Delta \ln w_{ti} - \Delta \ln \omega_t)$ where υ_{ti} is the vector of cost shares of primary inputs, $\Delta \ln w_{ti}$ are industry-specific factor price changes and $\Delta \ln \omega_t$ the average factor price change across industries. Note that the right hand side of equation 23 is identical to that one in equation 21 explaining total factor productivity. See the appendix for an exact derivation of regression equation 23. An important point is that outsourcing besides influencing total factor productivity and thereby indirectly influencing the product price, has a direct feedback on product prices through its factor bias. So the coefficient on outsourcing resulting from the first regression includes a component measuring the direct effect of outsourcing on productivity, a second one measuring how much of that productivity influence is passed through to prices, and a third component measuring the direct impact of outsourcing on prices (see appendix and *Feenstra - Hanson*, 1997, 1999)[31].

The corresponding estimation results are reported in the third and fourth column of Table 14 above. Our results are consistent with that of TFP growth indicating a pronounced positive and neutral impact of outsourcing on combined TFP and industry price changes. Directly estimating the pass-through coefficient of TFP growth on price changes (not reported) shows that the direct effects of outsourcing on value added prices are small. Instead, the major impact comes from the indirect effect via productivity growth.

[31] Note that under the assumption of exogenous prices the pass-through coefficient, as well as the direct impact of outsourcing due to the factor bias of outsourcing would both be zero.

As a second stage we isolate the impact of outsourcing to the East on price and productivity changes (also reported in column 3 of Table 14). That is, we calculate the difference between the overall prediction of equation 23 and the prediction for a hypothetical situation where outsourcing is constrained to its 1990 value other determinants being constant. We denote this by $(\Delta \ln p_{it}^{V,O} + \Delta \ln TFP_{it}^{O} - \Delta e_{it}^{O})$. The prediction for overall growth is 2.3 percent for the typical industry out of which 0.2 percent (about one tenth of this overall change) are attributable to the outsourcing effect. Taking these results as a left hand side variable, we regress this decomposed price and productivity change arising from outsourcing on the primary factor cost shares in order to estimate the mandated changes in factor prices consistent with outsourcing alone. This regression is specified as follows:

$$\Delta \ln p_{it}^{V,O} + \Delta TFP_{it}^{O} - \Delta e_{it}^{O} = \omega' cs + \varphi_i + \psi_t + \xi_{it} \qquad (24)$$

where cs denotes cost shares for low-skilled and high-skilled labor and capital. φ_i and ψ_t capture group-specific (industry and time) fixed effects. The vector of coefficients, ω, obtained from this regression represents the change in primary factor prices that are explained (mandated) by outsourcing to the East. That is, the wage changes caused by a change in outsourcing to the East (in our case to the value of 1990) which should be observed if factor markets were perfect (no unemployment and the HO-model holds). Although the regression diagnostics indicate some specification problems (possibly arising from endogeneity) and the estimates thus should be interpreted with care, we derive sufficiently robust results which are consistent with the hypotheses. In accordance with *Feenstra - Hanson* (1997, 1999), mandated factor price changes are significantly negative for low-skilled workers and physical capital and positive - as expected - for high-skilled workers. However, the effect on the latter is less robust and possibly overestimated as the median regression in Table 16 indicates.

Table 16: Pooled Mandated Wage Regressions

	Log change in p^V+TFP-e_i due to outsourcing		Median regressions[1)]	
	β	t-value	β	t-value[2)]
Wages of low-skilled workers[1)]	-0.11	-2.5 [**)]	-0.14	-2.4 [**)]
Wages of high-skilled workers[1)]	0.08	2.2 [**)]	0.02	0.4
Rental rate of capital[1)]	-0.15	-4.3 [**)]	-0.23	-4.5 [**)]
Statistics				
N=17, T=8				
R^2	0.94		-	
Pseudo-R^2	-		0.58	
σ	0.03		-	
Reset-Test, F-test	14.90 [**)]	(3, 99)	-	
Heteroskedasticity, χ^2	28.00	(1)	-	
Normality, χ^2	10.11 [**)]	(2)	-	
F-tests				
Time dummies	4.24 [**)]	(7, 102)	3.35 [**)]	(7, 109)
Industry dummies	72.22 [*)]	(15, 102)	11.85 [**)]	(15, 109)

Note: Outlier dummies, fixed industry and time effects are not reported. Standard errors Heteroskedasticity robust using the White-procedure (White, 1980). NACE 16, 27, 30, 35 and 36 are omitted because of data quality or because the majority of observations within the 2-digit industry level have been classified as outliers (absolute value of studentized residuals avbove 3). - 1) Deviation from total mean. - 2) Based on residuals from bootstrapping (200 replications).

Compared to the actual movement of high-skilled and low-skilled wages in Austria these results give some indication that the existing wage flexibility has been insufficient to prevent some employment losses that were due to outsourcing to the East. To a certain extent wage policies aiming at more equality seem to have worsened the employment prospects especially for low-skilled labor consistent with our findings in calculations on relative labor demand.

6 Conclusions and policy implications

Since the opening-up of the East at the beginning of the nineties, Austria witnessed a massive reorientation of trade and a substantial increase of FDI to the neighboring transition countries. In that process, specialization has developed beyond the conventional inter-industry trade in end products by splitting up the value added chain and outsourcing part of the production lines. International fragmentation of production occurs both via increased imports of intermediates and via subsidiaries which export intermediates back to the Austrian headquarters (or assemble the product for direct exports to third countries, mainly the EU-market).

The Fall of the Iron Curtain was accompanied with a markable reduction in transportation costs for Austrian trade with the Eastern economies. Additionally, it was followed by a substantial decrease in communication and networking costs. The complex system of the rules of origin in the European Union until the early nineties has also played an important role and led to inefficient sourcing of inputs and especially intermediate goods. The progress towards simpler pan-European rules and the process of Eastern European enlargement are expected to increase the importance of fragmenation further and open up new potentials of specialization. Both developments motivate firms to split up their production lines and outsource mainly the labor-intensive production stages - according to the comparative advantages - to the low-wage Eastern countries.

This study aims to assess the effects of outsourcing in Austrian manufacturing to the East on productivity, relative demand for employment and wages of high-skilled and low-skilled labor. In the qualitative dimension, great emphasis is placed on the in-depth theoretical treatment of fragmentation, which seems to be a new phenomenon of globalization which is not easily grasped with established patterns of thought and interpretation. The theory section of the study wants to develop a general understanding of the policy challenges emerging form the deepening East-West integration and highlight a well-balanced view of the relavant trade-offs and policy options. In broad terms, models along the lines of traditional trade theory suggest the following general qualitative findings:

- The international fragmentation of production and outsourcing is commonly associated with the loss of jobs in the domestic (high-wage) country and their transfer to low-wage countries. Contrary to this perception, economic theory emphasizes that under conditions of well-functioning markets without distortions the international fragmentation of production generates new potentials of

specialization which increase overall welfare of both the outsourcing and the receiving country, at least in the longer run. While there exists a variety of forms of organizing the international fragmentation of production (arm's length by increased trade in intermediates, FDI, etc.), the overall positive effect does not depend on the specific form of outsourcing.

- At the individual firm level, outsourcing offers productivity gains. At the industry level, outsourcing generates a process of restructuring and in this way also leads to aggregate productivity gains. Domestic resources are set free through the outsourcing of some production processes, and are redeployed in other industries/production processes more efficiently. In general, the overall positive welfare effect is the higher the easier (faster) this reallocation of resources is accomplished. Policy challenge is to facilitate and to foster this process of structural change.

- Regardless the overall benefit, the restructuring caused by outsourcing induces potentially troublesome internal redistribution effects which primarily work through changes in relative factor rewards. Since mostly low-skilled labor-intensive production lines are outsourced to low-wage countries, the relative factor rewards are most likely to change in favor of high-skilled labor. These distributional effects are highlighted in nearly all theoretical models of international fragmenation. However, it is argued that the relative winners are principally able to compensate the loosers (e.g. by a suitable scheme of income redistribution).

As already mentioned, the theoretical models of fragmentation take a long-run view and assume competitive labor markets (i.e. full employment). Hence, they are only useful to analyze the long-run effects on the structure of production and trade as well as on relative factor rewards. In the short-run and under the more realistic assumption of some wage rigidities, we have to expect that the increased outsourcing may temporarily exert effects on relative employment of workers with different skill-levels as well (again in favor of the high-skilled).

Theory does not allow an unambigous determination of the the distributional effects of outsourcing, but it remains an empirical question with a theory guided look at the data. Additionally, the aggregate gains are not easy to estimate. However, the purpose of the present study is to undertake first steps in this direction and provide a careful and in-depth investigation into the empirics of international fragmentation in the case of Austria. We follow the approach of *Feenstra - Hanson* (1996, 1999),

for which empirical results are only available for a few countries so far. Here, we estimate the impact of outsourcing to the East on productivity and (mandated) wages in Austrian manufacturing. Moreover, we look at the impact on relative employment of high-skilled and low-skilled labor.

Austrian manufacturing experienced a marked increase in both export and import growth during the nineties. It significantly surpassed that of gross production and in this way enhanced openness to trade in Austrian manufacturing. This phenomenon was even more pronounced for economic relations with the Eastern countries than with the rest of the world.

It should be mentioned that the phenomenon of outsourcing is rather difficult to measure emprically and there exists a variety of concepts in use. We measure outsourcing by a narrow indicator based on the Austrian Input-Output table, which indicates the value of intermediate imports that each manufacturing industry purchases from the same foreign industry This measure of outsourcing reveals the following stylized facts for the case of Austria:

- In the quantitative dimension empirical evidence indicates that Austrian openness in the manufacturing sector vis-à-vis the East increased substantially more than vis-à-vis the rest of the world (including the EU-member countries). The share of the Eastern countries in overall manufacturing imports increased by 6.8 percent p.a., that of exports by about 6.4 percent p.a. on average between 1990 and 1998. Outsourcing from the East and FDI activities - although low in levels - have been rather dynamic forces since the Fall of the Iron Curtain and have been important enough to exhibit an impact on the Austrian economy. Between 1990 and 1998 we observe an increase in outsourcing to the East in terms of Austrian gross production by 10.7 percent p.a. Outsourcing activities, like FDI activities, developed far more dynamic than trade in final goods.

- The observed increase in outsourcing to the East is mainly due to a substitution between formerly domestically sourced inputs and international (non-East) purchased inputs, rather than increased fragmentation per se. Substitution away from domestic inputs to foreign inputs is most pronounced for food products, apparel, leather, wood, pulp and paper, chemicals and the communication equipment industry. Total materials as a share of gross output increased only in some industries (e.g. basic metals, office machinery and computers).

- The comparison over time shows a stable pattern across industries for total international outsourcing, that is, the industries that had a relatively high imported intermediates share in 1990 were still the most important outsourcers by 1998. In contrast, the industry structure of outsourcing to the East changed significantly over the period becoming more similar to Austrian sourcing from other countries. Looking at the correlations with domestic activities motivates our empirical analysis which shows that outsourcing to Eastern countries is related to changes in the volume and structure of employment in Austrian manufacturing. At the descriptive level, there seems to be almost no relation to relative factor prices.

The econometric analysis using a small panel of industries over the period 1990 to 1998 derives three main results concerning the within industry effects of outsourcing[32].

- Outsourcing to the East significantly improves domestic growth in total factor productivity (possibly more pronounced in high-skilled labor-intensive and capital-intensive industries) and fosters the competitiveness of Austrian manufacturing firms.

- It significantly increases domestic employment of high-skilled labor relative to low-skilled labor.

- Estimates of the mandated wage regressions lead to the conclusion that in the presence of perfect factor markets wages would be lower for the low-skilled workers and higher for the high-skilled workers in response to outsourcing. As wages are not fully flexible one would expect to observe both (less pronounced as compared to the competitive labor market) wage and employment effects.

The main conclusion then is that the overall labor market effects from outsourcing to the Eastern countries on the volume of employment are small. The most important impact will be on the structure of employment and wages (low-skilled versus high-skilled labor) as it is widely discussed in the literature on trade versus technical progress as the sources of increasing wage differentials (or unemployment of low-skilled labor). Insofar as outsourcing goes hand in hand with an improved relative supply of high-skilled labor, these effects may be minor even in the long-run, however. Additionally, it is not always clear, how the impact of skill-biased technical change can be disentangled from the impact of outsourcing.

[32]Since we use a panel apporach with fixed industry and time effects, differences between the industries are not considered but captured by the fixed effects.

The majority of the related literature on this topic has only been concerned with the effects on wages (having in mind the US situation) and less with the employment effects (being in the center of European interests). However, independent of the causes of the pressures on the labor market (either trade or technological progress) and the expected effects (either mainly on wages or employment), most researchers agree that there is a substantial need for labor market policies which facilitate the adjustment process to the new equilibrium. The latter would be one with a higher proportion of high-skilled employees. There seems to be a consensus that trade restrictions and protection are inadequate measures to avoid increasing wage differentials and unemployment (*Krugman*, 1995, *Wood*, 1995, *Deardorff*, 1999). Similarly, subsidization as an instrument to maintain previous employment and avoid industrial restructuring should be avoided. Researchers also widely agree about the possible measures which are capable to ensure, that along the adjustment process distorting distributional effects on relative wages and/or employment (both in favor of the high-skilled labor) are kept as small as possible. In the literature the following policy measures in this debate are discussed. Of course not all of them are feasible for the specific Austrian situation, but they provide a useful point of departure for a more informed discussion.

- Upgrading the labor force skills (*Burda - Dluhosch*, 1998) also by government action to improve education and training is ranked highest in the agenda (in order to fasten and amplify the skill acquiring process; *Wood*, 1995).

- The deregulation of consumer services should enable this sector to absorb former production workers. This could also help to reduce possible income inequalities as it would tend to exhibit rising wages in flexible labor markets (*Burda - Dluhosch*, 1998).

- Tax cuts, cash supplements to wages, better public services and other subsidies to improve the living standards of workers who take low-paying jobs (*Wood*, 1995).

- Incentives for employers to hire more low-skilled workers, especially in non-traded services are mentioned by *Wood* (1995).

- Immigration policy in favor of high-skilled immigrants (*Srinivasan*, 1995). It was observed that certain low-skilled jobs in the non-tradable sector seem to be performed disproportionately by immigrants.

- Subsidies particularly on the education of the children of the low-skilled workers.

- Taxes on wages of the high-skilled labor (or on the production of skill-intensive goods) in order to finance the subsidies for the low-skilled labor are also discussed (*Wood*, 1995, *Deardorff*, 1998b). Note a progressive tax system works in this direction since the high-skilled workers usually earn the higher incomes.

From a trade theory perspective our results suggest that policies towards higher wage flexibility and inter-sectoral mobility of workers could have some moderating effects on employment losses, especially for the low-skilled workers. Finally, public policy should support structural change that gets an additional impetus from outsourcing. Of course, the optimal policy will vary from country to country, and no specific policy will be the correct one for all countries (*Wood - Ridao-Cano*, 1999). Theory does not provide us with a clear-cut solution which policies will handle the problem best (*Deardorff*, 1999). Nevertheless, policy makers are requested to prevent low-skilled workers from too severe welfare losses in the adjustment process.

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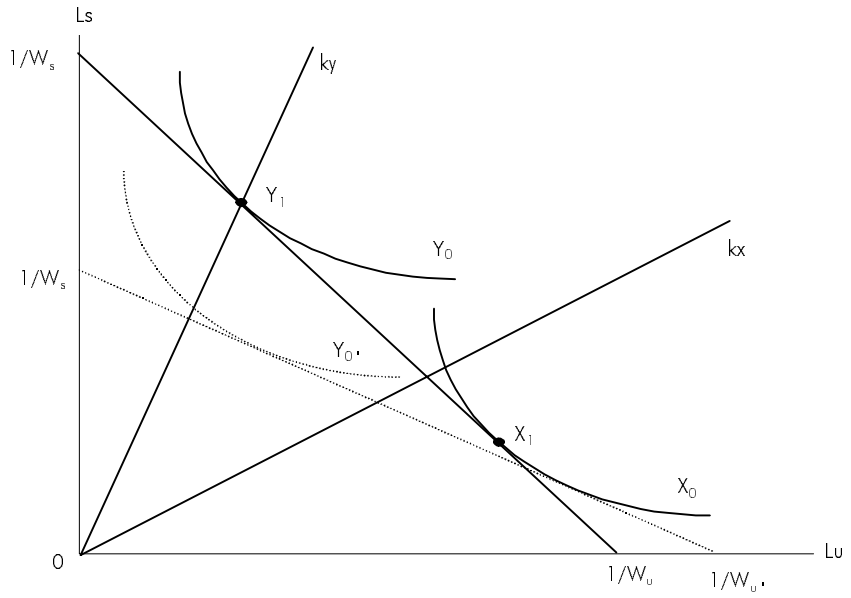
Figure 10: Lerner-Pearce Diagram



8 Appendix

8.1 The Lerner-Pearce diagram

The relationship between goods prices and factor prices in a Heckscher-Ohlin model are pictured in the Lerner-Pearce diagram. L_s and L_u describe the amount of high-skilled and low-skilled labor input, respectively, w_s and w_u are wages of high-skilled and low-skilled. The Lerner-Pearce diagram also shows two unit-value or "equal value" isoquants (X_o and Y_o), which give the inputs required to produce the same value (e.g. 100 USD) of the outputs X and Y at world prices. Thus each might represent 100 USD worth of the respective good. The isoquants are tangent at points X_1 and Y_1 to a common unit-value iso-cost line so that both points represent cost minimizing production points. In other words, in order for both goods to be produced in a country, the relative factor prices must equal the slope of the cost line that is tangent to both isoquants because only then costs are equal to revenue in both sectors. Furthermore, since the intercept of the cost line on the low-skilled labor input axis is $1/w_u$, while the intercept on the high-skilled labor input axis is $1/w_s$, changes in factor rewards can be easily read off the diagram. In addition, the factor intensity of the sectors is given by the two expansion paths kx and ky, respectively, which together also define the "cone of diversification". Note that a country will produce both goods

only if its endowment point lies within this cone of diversification.

A higher relative price of one good will shift its unit-value isoquant inwards, as will any technological change if there is no change in the relative price of the good, since both imply that less inputs are needed to produce the same value of output. Thus, any improvement in the technology for producing the skill-intensive good or an increase in its price, will produce an inward shift of the Y-unit-value isoquant (Y_0 to Y_o') and raise the high-skilled wage rate and decrease the low-skilled wages - regardless of the factor bias of that change (the iso-cost line becomes flatter). And similarly any technological advance or relative price increase in the low-skilled labor-intensive sector will shift factor prices the other way.

8.2 Fragmentation in an international oligopoly

To analyze the simple simultaneous two-stage game where firms decide about fragmentation of production in the first stage and compete in quantities in the second stage the following notation is used (capital letters indicate the foreign country): $c^I = w_H a + w_L b$, $C^I = W_H A + W_L B$, $c^F = w_H a + \overline{c}$, $C^F = W_H A + \overline{c}$, $\overline{c} = \overline{w}_L \overline{b}$.

Symmetric Case: Here $c^I = C^I$ and $c^F = C^F$. The superscript F denotes the fragemented production structure, I the integrated one. From the second stage of the game profit functions for firm 1 are given by (and similarly for firm 2):

$$\begin{aligned} \pi^{II} &= \frac{1}{9}\left(A - 2c^I + C^I\right) \\ \pi^{FI} &= \frac{1}{9}\left(A - 2c^F + C^I\right) - f \\ \pi^{IF} &= \frac{1}{9}\left(A - 2c^I + C^F\right) \\ \pi^{FF} &= \frac{1}{9}\left(A - 2c^F + C^F\right) - f \end{aligned} \tag{25}$$

The fragmented production structure of both firms forms a Nash equilibrium if the following condition holds:

$$\pi^{FF} > \pi^{IF} \text{ and } \Pi^{FF} > \Pi^{FI} \tag{26}$$

On the other hand none of the firms chooses fragmentation if

$$\pi^{II} > \pi^{FI} \text{ and } \Pi^{II} > \Pi^{IF} \tag{27}$$

The corresponding for conditions read:

$$\frac{4}{9}\left(c^I - c^F\right)\left(A - c^F - c^I + C^F\right) - f = \frac{4}{9}\left(w_L b - \overline{w}_L \overline{b}\right)\left(A - w_H a - w_L b\right) - f \tag{28}$$

and

$$\frac{4}{9}\left(c^F - c^I\right)\left(A - c^F - c^I + C^I\right) - f = \frac{4}{9}\left(\overline{w}_L \overline{b} - w_L b\right)\left(A - w_H a - \overline{w}_L \overline{b}\right) - f \tag{29}$$

respectively. Figure 11 below normalizes $c^I = C^I = 1$ and assumes $A = 4$. It highlights the trade-off between savings in variable costs in case of fragmentation ($\gamma = 1 - \overline{c}$) and fixed plant set-up for production of fragment 2 aborad (f) in determining the equilibrium structure of production. The II-line for condition (28) is given by

$$\gamma^* = \frac{3}{2}\left[\left(\sqrt{1+f}\right) - 1\right] \tag{30}$$

and the FF-line for condition (29) by

$$\gamma^{**} = \frac{3}{4}f \tag{31}$$

Both firms will fragment production if $\gamma > \frac{3}{4}f$ and they will choose not to do so if $\gamma < \frac{3}{2}\left[\left(\sqrt{1+f}\right) - 1\right]$. For intermediate cost reductions $\frac{3}{2}\left[\left(\sqrt{1+f}\right) - 1\right] < \gamma < \frac{3}{4}f$ no symmetric equilibrium exists. But there are asymmetric equilibria where one firm chooses to fragment production but it does not pay for the other to do so. Here, the equilibrium is not unique (and one is mixed) and the equilibrium structure depends on who moves first (and has the first mover advantage). Generally, Figure 11 confirms the trade-off between γ and f: If cost savings are sufficiently large in comparison to the plant fixed set-up costs, both firms will choose the fragmented production structure.

Figure 11: Trade-off between the Cost Savings of Fragmentation and Fixed Plant Set-up Costs, Symmetric Costs

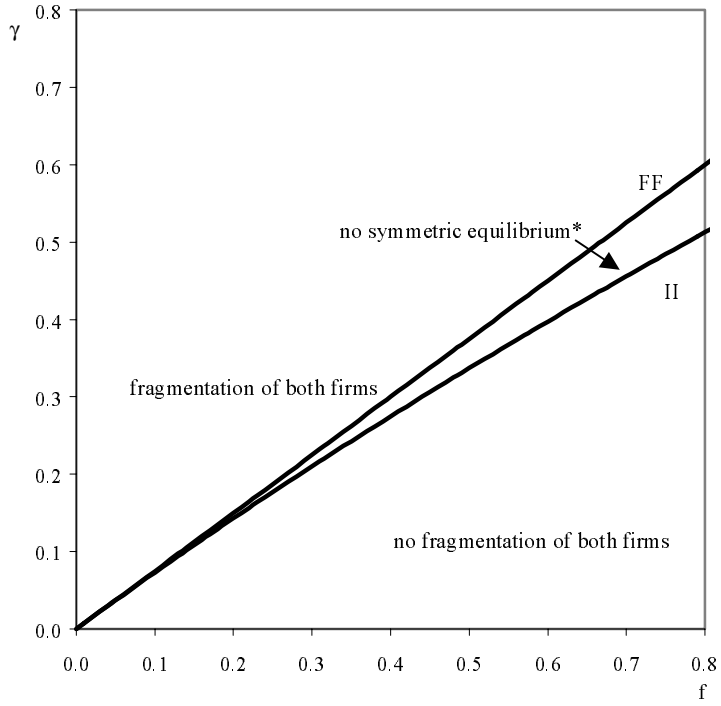


Figure 12: Market size versus cost savings

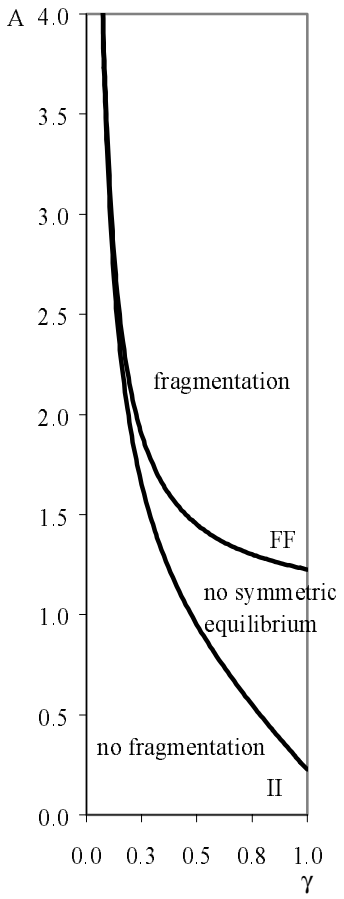
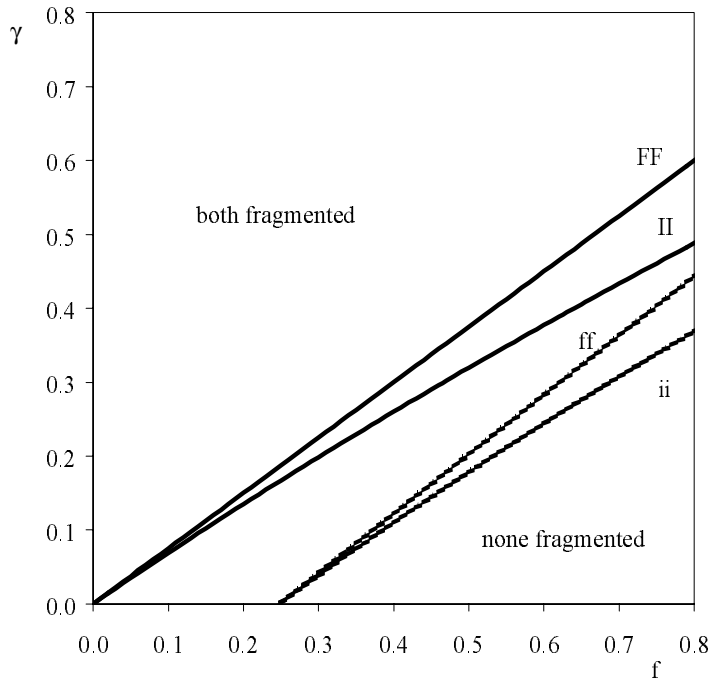


Figure 12 plots the equilibrium conditions for (A, γ) - combinations assuming f is fixed at 0.5. For given fixed costs and fixing the rate of cost savings, Figure 12 illustrates that fragmentation becomes more likely, the greater the market is. That means, if markets grow faster relative to the cost savings potential and the fixed plant set-up costs, a fragmented production structure becomes more likely.

If one firm has a cost disadvantage (assume firm 1), there exist parameter combinations, where the high cost firm 1 chooses a fragmented production structure, but firm 2 doesn't. In Figure 13, $A = 4$, $c^I = 1.5$ and $C^I = 1$ is assumed. The area in the (γ, f)-plane where this occurs is given for points below FF , but above II. Here, unique asymmetric equilibria arise generically.

Figure 13: Trade-off between the Cost Savings of Fragmentation and Fixed Plant Set-up Costs, Asymmetric Costs



8.3 Measuring international outsourcing by imports of intermediates

In our calculations of imported intermediates we rely on the Austrian I-O table for 1990 and preliminary I-O data constructed from the usual make and absorption matrices for 1995, that were just made available to us by Statistics Austria. While the 1990 table disaggregates intermediate input flows in domestic products and imports, this information was not available for 1995. Thus for each missing year as well as for 1995 the intermediate import matrix was calculated by the following formula:

$$\frac{MI_{ij}}{I_{ij}} \frac{I_{ij}}{\sum_j I_{ij}} \sum_j I_{ij} \tag{32}$$

The first term describes the share matrix of each type of intermediate import j of each industry i (MI_{ij}) in total intermediate purchases of type j of industry i (I_{ij}). This matrix is known for 1990 and was extrapolated by yearly growth rates of import quotas (share of total imports in gross production) for each good, derived from yearly national account figures. The underlying assumption is that the development of the imported intermediate share of each good is the same across sectors.

The second term gives the share of purchases of each type of input j in total intermediates sourced by industry i. This information is given by the respective I-O data for 1990 and 1995 and interpolated for the other years.

Finally, data for the last term (total intermediate purchases of each industry i) is derived from national account figures.

8.4 Estimating the impact of fragmentation on total factor productivity

Following *Feenstra - Hanson* (1997, 1999) and others we assume that outputs and inputs of manufacturing industries are related by a translog production function (skipping the time and industry index):

$$\ln f(z) = A_0 + (\alpha + \mathbf{A})' \ln z + \frac{1}{2} \ln z' \gamma \ln z \tag{33}$$

where $z = (x, y)$ is a vector of primary inputs x and intermediate inputs y. The scalar A_0 captures neutral technical progress and the vector $\alpha + \mathbf{A}_i$, $\sum_{i=1}^{N+M} A_i = 0$, represents non-neutral technical change. Additionally, $\sum_{i=1}^{N+M} \alpha_i = 1$ and the rows and columns of γ sum to zero if the production function is linearly homogeneous which is assumed

through out. The discrete change in output, input and technology, the latter stemming inter alia from outsourcing, is given by

$$\Delta \ln f(z) = \left[\Delta A_0 + \Delta \mathbf{A}' \frac{1}{2}(\ln z_{-1} + \ln z)\right] + \left[\alpha + (\mathbf{A}_{-1} + \mathbf{A})\frac{1}{2}\right]' \Delta \ln z + \Delta \frac{1}{2} \ln z' \gamma \ln z \tag{34}$$

and provides a decomposition in:

- technological change (e.g. induced by outsourcing) evaluated at average levels of the inputs;
- change in inputs evaluated at average technology parameters;
- change in the quadratic input terms.

The change of total factor productivity is given by the first component of equation (34):

$$\Delta TFP = \Delta A_0 + \Delta \mathbf{A}' \frac{1}{2}(\ln z_{-1} + \ln z) \tag{35}$$

and using the first order condition for cost minimization it can be shown that the change in TFP can be represented by the Tornqvist index which subtracts the growth of inputs weighted by observed cost shares from total output growth.

$$\Delta TFP = \Delta \ln Y - \frac{1}{2}(s + s_{-1})' \Delta \ln z \tag{36}$$

We follow *Feenstra - Hanson* (1997, 1999) and postulate that ΔA_0 and ΔA are functions of outsourcing, exogenous technological change and other determinants (τ) i.e.:

$$A_i = B\tau_i + u_i \tag{37}$$

$$A_{j0} = \beta\tau_i + v_i \tag{38}$$

implying

$$\Delta TFP_i = \beta \Delta \tau_i + \frac{1}{2} \Delta \tau_i^{'} B^{'} \left(\ln z_{i,-1} + \ln z_i \right) + \varepsilon_i \tag{39}$$

We can then isolate the impact of outsourcing on ΔTFP from the effect of different variables measuring technological progress (denoted by k):

$$\Delta TFP_{ik} = \beta_k \Delta \tau_{ik} + \frac{1}{2} \Delta \tau_{ik} \sum_{j=1}^{M+N} b_{jk} \left(\ln z_{ijk,-1} + \ln z_{ijk} \right) \tag{40}$$

In the empirical exercise this specification cannot be estimated since the interaction effects (second part of equation (40)) are highly collinear. Rather we classify industries as skill-intensive if the median high-skilled-to-low-skilled ratio is higher than that of total manufacturing and as capital-intensive if the median of the real stock of capital-to-total employment ratio is above the median of total manufacturing. These two dummies are interacted with the outsourcing measure and introduced instead of the second term in equation (40).

8.5 Measuring the effects of outsourcing on wage inequality - mandated factor price changes.

In accordance to *Feenstra - Hanson* (1997, 1999) we adopt a modification of the conventional mandated factor price regression and use a two-stage approach:

1) In a first step the total changes in productivity and price changes, corrected for inter-industry wage differentials are decomposed into different structural components, specifically, into an outsourcing component and an R&D component denoted by vector τ:

Changes in TFP are decomposed according to:

$$\Delta TFP_{it} = \beta' \Delta \tau_{it} + \frac{1}{2} \Delta \tau_{it}' B' (\ln z_{i,t-1} + \ln z_{it}) + \eta_{it} \tag{41}$$

which is the same as equation (39).

Changes in value added prices and industry-specific wage changes are decomposed according to:

$$\Delta \ln p_{it}^{V} - e_{it} = \delta' \Delta \tau_{it} + \lambda \Delta TFP_{it} + \varrho_{it} \tag{42}$$

where λ is the pass-through coefficient, measuring how much of the productivity change is passed through to industry value added prices, δ is a vector of coefficients measuring the direct impact of outsourcing on industry prices. e_{it} is defined as: $e_{it} = \frac{1}{2}(v_{i,t-1} + v_{ti})'(\Delta \ln w_{ti} - \Delta \ln \omega_t)$ where v_{ti} is the vector of cost shares of primary inputs, $\Delta \ln w_{ti}$ are industry specific factor price changes and $\Delta \ln \omega_t$ the average factor price change across industries. This term corrects for the fact that factor prices are not the same for all industries as it is assumed in trade theory.

Both equations combined give:

$$\Delta \ln p_{it}^{V} + \Delta TFP_{it} - e_{it} = \gamma' \Delta \tau_{it} + \frac{1}{2} \Delta \tau_{it}' A' (\ln z_{i,t-1} + \ln z_{it}) + \varepsilon_{it} \tag{43}$$

where

$$\gamma = [\beta(1+\lambda) + \delta]\,;\ A^{'} = B^{'}(1+\lambda); \varepsilon_{it} = \eta_{it}(1+\lambda) + \varrho_{it} \tag{44}$$

The regression again includes an interaction term of the structural variable τ and the primary factor quantities (z), whereby A is the matrix of coefficients measuring this interaction and should give evidence on the magnitude of non-neutral changes in technology due the factor bias of outsourcing to the East and other structural variables. Again, these interaction effects turn out to be highly collinear in our regression analysis and are dropped. As before, we define dummies for skill-intensive industries ($D_{high-skill}$) and capital-intensive industries ($D_{capital}$) and interact these two dummies with our outsourcing measure for Austrian sourcing from the East. We then arrive at the following specification for our first stage regression:

$$\begin{aligned} \Delta \ln p_{it}^{V} + \Delta TFP_{it} + e_{it} = \gamma_o + \gamma_1 O_{it} + \gamma_2 O_{it} D_{high-skill} \\ + \gamma_3 O_{it} D_{capital} + \gamma_4 \mathbf{X}_{it} + \mu_i + \nu_t + \varepsilon_{it} \end{aligned} \tag{45}$$

The variable matrix $\mathbf{X}$ comprises the R&D-to-output ratio as well as overall export and import openness with respect to Eastern countries as additional control variables. μ_i and v_t are industry and time specific fixed effects. Subscript i refers to industry and t to time (years) and Δ indicates first differences.

2) As a second step, the decomposed price and productivity changes are regressed on factor cost shares to estimate the changes in primary factor prices attributable to (mandated by) outsourcing alone. The second stage regressions for each structural variable k are:

$$\Delta \ln p_{itk}^{VA} + \Delta TFP_{itk} - \Delta e_{itk} = \frac{1}{2}(v_{i,t-1} + v_{it})'\omega_k \tag{46}$$

v denote factor cost shares of primary factors and the coefficients ω_k obtained are the change in primary factor prices that are explained by determinant k, that is, outsourcing to the East and other possible determinants.

For our regressions we use the following specification:

$$\Delta \ln p_{it}^{V,O} + \Delta TFP_{it}^{O} - \Delta e_{it}^{O} = \omega' cs + \varphi_i + \psi_t + \xi_{it} \tag{47}$$

where $p^{V,O}$, TFP^{O} and e^{O} are the changes in value added prices, total factor productivity and industry-specific wage differences due to outsourcing, cs denotes cost shares of primary factors. Finally, the coefficients ω obtained from these regressions are the changes in primary factor prices that are explained (mandated) by outsourcing to the East.

8.6 Variables and data sources

Table 17 and Table 18

Table 17: List of Variables and their Definition

Variable	Symbol	Definition
Relative skill-specific employment	H/L	High-skilled employment in heads divided by low-skilled employment in heads
Relative skill-specific wages	w_H/w_L	Wage per high-skilled worker divided by wage per low-skilled worker
Export openness	XOP	Exports as percent of gross production
Import openness	MROP	Imports minus outsourcing to Eastern countries as percent of gross production
Capital output ratio	KY	Real capital stocks divided by real gross production
Degree of organisation of trade unions	ORG	Union members' share in industry (i) in overall industry members divided by employment share of industry (i)
Median firm size	MSIZE	Median size of firms in industry (i)
Price cost margin	PCM	Value added minus wage costs as percent of gross production
Total factor productivity	TFP	Tornqvist index: growth of inputs weighted by observed cost shares minus total output growth
Outsourcing to Eastern countries	O	Austrian imports of manufactured intermediates from Eastern countries as percent of gross production
Dummy variable for skill-intensive industries	$D_{high\ skill}$	value = 1 if the median high-skilled-to-low-skilled ratio is higher than that of total manufacturing
Dummy variable for capital-intensive industries	$D_{capital\ intesive}$	value = 1 if the median real stock of capital-to-total employment ratio is that of total manufacturing
Value added industry price	p^V	
Change in inter-industry wage differentials	e	Cost share weighted difference between industry-specific factor price changes and the average factor price change across industries
Cost shares of primary factors	cs	Wage costs for low-skilled and high-skilled labor, as well as total capital rents, respectively, divided by total costs

Table 18: Data Sources

Variable	Source
Real value added	Statistics Austria, Österreichs Volkseinkommen 1998
Nominal value added	Statistics Austria, Österreichs Volkseinkommen 1998
Nominal gross production	Statistics Austria, Österreichs Volkseinkommen 1998
Real gross production	Statistics Austria, Österreichs Volkseinkommen 1998
Total employment	Statistics Austria, Österreichs Volkseinkommen 1998
Exports	Statistics Austria and reclassified to NACE 2-digit industry level by WIFO
Imports	Statistics Austria and reclassified to NACE 2-digit industry level by WIFO
Real stock of capital	Own calculations using the nominal stock of capital and the user costs of capital
Nominal stock of capital	Statistics Austria; we are indebted in K. Schwarz who kindly provided the unpublished figures
User costs of capital	Prime rate (WIFO) plus depreciation rate (15%) plus change in investment prices (investment deflator from the capital stock series, Statistics Austria)
Intra-firm imports	Austrian National Bank; we are grateful to R. Dell'mour for providing the detailed databasis
Intra-firm exports	See intra-firm imports
Employment in foreign affiliates	See intra-firm imports
R&D intensity	Chamber of Commerce, reclassified to NACE 2-digit indiustry level, values for 1997 from Statistics Austria, interpolated in between.
High-skilled workers and employees	"Lohnerhebung", Austrian Chamber of Commerce; blue colour workers of the categories "Besonders qualifizierte Arbeiter", and "Qualifizierte Arbeiter" and white colour workers of group IV to VI, reclassified to NACE 2-digit industry level
Low-skilled workers and employees	"Lohnerhebung", Austrian Chamber of Commerce; blue colour workers and white colour workers of the remaining categories, reclassified to NACE 2-digit industry level
Manufactured intermediate imports	Statistics Austria, Austrian Input-Output table 1990 and (preliminary) 1995, interpolation and extrapolation
Degree of organisation of trade unions	Austrian Tade Union Federation
Median firm size	WIFO Investment Survey

DIE INTERNATIONALE FRAGMENTIERUNG DER WERTSCHÖPFUNGSKETTE- KURZFASSUNG

Seit der Ostöffnung zu Beginn der neunziger Jahre kam es zu einer starken Ausweitung der Handelsbeziehungen zwischen den westlichen Industrieländern und den Ländern Mittel- und Osteuropas, aber auch zu einem sprunghaften Anstieg der Direktinvestitionen. Die Dynamik dieses Prozesses war besonders von der Ausschöpfung relativ großer Spezialisierungspotentiale (basierend auf großen Lohndifferentialen) zwischen West und Ost nach dem Fall des Eisernen Vorhangs geprägt. Tragende Bedeutung kam dabei der internationalen Aufspaltung der Wertschöpfungskette zu, die neue Möglichkeiten der internationalen Arbeitsteilung öffnet: Unternehmen gehen mehr und mehr dazu über, ihren Produktionsprozess grenzüberschreitend zu organisieren und die einzelnen Produktionssegmente entsprechend den komparativen Vorteilen der einzelnen Produktionsstandorte aufzuteilen. Diese internationale Fragmentierung der Wertschöpfungskette kann entweder durch vermehrten Handel von Zwischenprodukten mit anderen ausländischen Unternehmen ("arm's length trade") oder innerhalb des eigenen Unternehmens (durch Direktinvestitionen) bewerkstelligt werden. Unabhängig davon welche Organisationsform gewählt wird, wird diese Diskussion unter dem Schlagwort "Outsourcing" geführt.

Das Outsourcing einzelner - vor allem arbeitsintensiver - Produktionsschritte wurde insbesondere durch die Ausweitung und Vertiefung des europäischen Integrationsprozesses im Rahmen der Europa-Abkommen begünstigt, welche die Erweiterung der EU in näherer Zukunft in Aussicht stellten. Darüber hinaus haben die Formulierung paneuropäischer Ursprungsregeln sowie die allgemeine Reduktion von Informations- und Netzwerkkosten den Handel mit Zwischenprodukten erleichtert und die internationale Fragmentierung der Produktion begünstigt.

Die vorliegende Studie beleuchtet die Auswirkungen des Outsourcing und zeigt die Herausforderungen für die österreichische Wirtschaftspolitik aus Sicht der neueren Theorie auf. Im empirischen Teil werden neben der Beschreibung der wichtigsten Tendenzen seit Beginn der neunziger Jahre erste Einschätzungen der Auswirkungen auf die österreichische Sachgüterer-zeugung vorgelegt.

Aus Sicht der Außenwirtschaftstheorie ergeben sich folgende qualitativen Aussagen zum Phänomen Outsourcing:

- In einer Welt perfekter Güter- und Faktormärkte (dem langfristig orientierten ökonomischen Referenzmodell ohne Ungleichgewichte) erhöht die internationale Fragmentierung der Wert-schöpfungskette

aufgrund der Effizienzgewinne die Wohlfahrt in beiden involvierten Ländern (Sender- und Empfängerland).

- Outsourcing ist langfristig mit einem Strukturwandel in der Industrie verbunden. Je reibungsloser die Reallokation der Produktionsfaktoren in jene Industrien bzw. Produktions-segmente, in denen ein komparativer Vorteil gegenüber dem Ausland besteht, desto stärker wird der allgemeine positive Wohlfahrtseffekt ausfallen.

- Die Verteilungswirkungen des Outsourcing gehen mit großer Wahrscheinlichkeit zulasten der weniger qualifizierten Arbeitskräfte. Die relativen Gewinne der besser Qualifizierten sind jedoch groß genug, dass sie die weniger Qualifizierten entschädigen könnten.

Diese Studie versucht eine erste Abschätzung dieser Wirkungen auf Grundlage österreichischer Daten der Sachgütererzeugung. Aus deskriptiver Sicht sind als wichtigste stilisierte Fakten hervorzuheben:

- Mit einem durchschnittlichen jährlichen Wachstum von 10,7% entwickelte sich das Outsourcing (gemessen als Anteil am Bruttoproduktionswert) der österreichischen Industrie in die Oststaaten zwischen 1990 und 1998 noch dynamischer als die gesamte Import- oder Exporttätigkeit aus und in diese Staaten.

- Die zunehmende Öffnung gegenüber den Oststaaten ging dabei vor allem zulasten von österreichischen Zwischenprodukten und Vorleistungsimporten aus anderen Ländern. Die Fragmentierung der Produktion per se ist mit durchschnittlich 1,7% pro Jahr im Vergleichs-zeitraum kaum gestiegen.

- Insgesamt blieb die Struktur der fragmentierenden Industrien zwischen 1990 und 1998 relativ stabil. Jene Branchen mit hohen Outsourcingaktivitäten am Beginn der Untersuchungsperiode waren auch am Ende die Aktivsten. Die Branchenstruktur der Outsourcingaktivitäten in den Oststaaten hat sich allerdings stark gewandelt und näherte sich der Struktur des Outsourcing mit der übrigen Welt an.

Diese ersten Ergebnisse führten zu einer eingehenderen Analyse der Daten mittels panel-ökonometrischen Methoden. Im Zentrum des Interesses standen dabei die Wirkungen auf Produktivität, qualifikationsspezifische Beschäftigung und Löhne in der österreichischen Industrie zwischen 1990 und 1998. Als wichtigste Ergebnisse sind zu nennen:

- Outsourcing in die Oststaaten erhöht das Wachstum der totalen Faktorproduktivität und damit die Wettbewerbsfähigkeit österreichischer Industrieunternehmen signifikant (dies gilt insbesondere für Branchen, die besonders kapital- bzw. humankapitalintensiv sind).

- Outsourcing in die Oststaaten verschiebt die relative Beschäftigung in der Industrie zugunsten der besser qualifizierten Arbeitskräfte.

- In perfekten Faktormärkten wäre der Lohnunterschied zwischen besser und schlechter qualifizierten Industriebeschäftigten, der dem Outsourcing in die Oststaaten zugerechnet werden kann, größer. Aufgrund der vorhandenen Rigiditäten auf den Faktormärkten beobachten wir jedoch beides: (relativ geringe) Lohn- und (ausgeprägtere) Beschäftigungseffekte zulasten der weniger Qualifizierten.

Die weitere Annäherung zwischen den mittel- und osteuropäischen Ländern und den Mitgliedsländern der EU könnte zu einer noch stärkeren Ausprägung dieser Entwicklung führen: Hohe relative Wohlfahrtszuwächse der besser Qualifizierten gegenüber den schlechter Qualifizierten gemessen in Löhnen und v. a. Beschäftigung. Die ökonomische Theorie schlägt einige Möglichkeiten vor, um den Übergangsprozess am Arbeitsmarkt so zu gestalten, dass starke Belastungen für die weniger qualifizierten Arbeitnehmer abgefedert werden. Es besteht jedoch Konsens, dass Handelsrestriktionen und protektionistische Maßnahmen zur Milderung der Verteilungswirkungen eine inadäquate wirtschaftspolitische Reaktion darstellen würden. Genauso werden Subventionen (sofern diese überhaupt noch möglich sind), die die bisherige Beschäftigungs- und Lohnstruktur konservieren und den strukturellen Wandel verlangsamen, als falsche Reaktionen betrachtet.

Folgende wirtschaftspolitische Maßnahmen, welche Distorsionen im Zuge des Anpassungsprozess so gering als möglich halten, werden in der umfangreichen Literatur zu diesem Thema diskutiert:

- Bildungs- und ausbildungspolitische Initiativen zur Verbesserung der Qualifikationen der Arbeitskräfte und zur Erhöhung des Ausbildungsstandards werden am häufigsten genannt.

- Die Deregulierung von Dienstleistungssektoren (wie z. B. persönliche Dienste) könnte den Verlust von Arbeitsplätzen der weniger Qualifizierten in der Industrie kompensieren.

- Maßnahmen zur Erhöhung des Lebensstandards jener Gruppe, die zu den Verlierern des Outsourcing (Globalisierung) gerechnet werden (Steuererleichterungen, Lohnzuschüsse, Verbesserung des Angebots öffentlicher Güter; ein progressiveres Steuersystem wirkt etwa in diese Richtung).

- Anreizsysteme für Unternehmen, in der Übergangsphase auch weniger qualifizierte Personen einzustellen und sich an den Umschulungs- und Weiterbildungskosten (Requalifizierung) zu beteiligen.

- Stärkere Ausrichtung der Migrationspolitik auf den Zuzug höher qualifizierter Arbeitskräfte.

- Förderung der Ausbildung der Kinder von weniger qualifizierten Personen.

Angesichts der dynamischen Entwicklung des Outsourcing sollten möglichst frühzeitig wirtschaftspolitische Initiativen gesetzt werden, um einerseits die kurzfristigen Wohlfahrtsverluste so gering als möglich zu halten und andererseits den strukturellen Wandel im Rahmen der zunehmenden internationalen Arbeitsteilung zu unterstützen. Obwohl nicht alle vorgeschlagenen für die spezifische österreichische Situation geeignet sind, bietet der Katalog doch eine sinnvolle Basis einer informierten Diskussion. Die adäquate wirtschaftspolitische Reaktion wird jedenfalls von Land zu Land verschieden sein.

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