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The Labour Market Effects of Outsourcing Parts and Components: A Simple Model with Cournot Competition

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The paper analyses a partial equilibrium outsourcing model with Cournot competition in intermediate good production. Final production is located in Western Europe, whereas the intermediate good can be manufactured by a Western (outsourcing) or Eastern European supplier (offshore outsourcing). The paper asks the question how changes in production costs, in particular wages, affect labour input in the two regions in the presence of Cournot competition. The main results are: higher production costs in one region reduce intermediate good production in both regions leading to a substitution effect between high- and low-skilled labour intensive inputs rather than between Eastern and Western low-skilled labour intensive inputs. The sensitivity of outsourcing activities to production cost changes is highest when the interregional cost differential is smallest.

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1 Introduction

The outsourcing phenomenon has been a frequently discussed topic in the United States since the late 20th century. The debate on the influence of globalisation versus technical progress on the increasing income differential between high-skilled and low-skilled labour is still going on. Outsourcing, or more precisely offshore outsourcing across borders, has also been intensively discussed in the context of the European Union Eastern enlargement. The question of main interest is how outsourcing activities that attempt to exploit lower production costs in Central and Eastern European countries affect employment in Western European countries (Real wages in the East average around one-fifth of the respective wage levels in the former EU-15).[1] This is the so-called vertical outsourcing in the spirit of FEENSTRA and

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1 According to World Bank purchasing power parity estimates, BOERI and BRÜCKER (2000).

HANSON (1996).[2] This issue is especially important for the debate on unions' bargaining and minimum wages.

SINN (2005) describes Germany as a Bazaar Economy importing and exporting large amounts of goods but adding a low production value. Indeed, the value added divided by the output value in the German industry declined from 40.2 % to 34 % between 1970 and 2003 (SINN 2005). For example, the German Porsche Cayenne is actually to a large extent produced in Bratislava. Additionally, the European automotive industry can be characterised by the following developments (MEISSNER and JÜRGENS 2007): There are not only few automobile final producers, but also an agglomeration tendency towards oligopolies of "mega suppliers" exploiting scale effects and being powerful enough to bargain with the big final producers. In particular, in many cases there are only a few suppliers of a certain module that is used in final assembly. Furthermore, price pressure forces the suppliers to cut costs and to offer their intermediate components at the common price given by the rivals' performance and the existing technologies.

Referring to this development within the European automotive industry, this paper examines an easily tractable microeconomic partial equilibrium model. However, the model can also be applied to other industries with similar structures. The model assumes one final producer and two suppliers of intermediate components who are forced into Cournot competition, since the final producer would neither accept buying the components at a price higher than the common price, nor would he accept relying on one supplier only. This would make the final producer totally dependent on the single supplier. Instead there are two suppliers with oligopolistic power. We assume that one of them has moved intermediate production towards Eastern Europe, that is into a low-wage region. The other supplier keeps production in the Western European region that has higher wages, but also a better

2 Outsourcing means removing part of the production process from the own company and buying it from an external company instead. The outsourced part can be a product or a service, but not raw material (KIRKEGAARD 2005). Offshore outsourcing in the current discussion is a certain type of outsourcing, namely outsourcing to a foreign country. FDI is distinguished from outsourcing and pure portfolio investment by the ownership criterion: The investor has a certain degree of influence on the foreign investment receiving country (by holding a company share of at least 10%). The OLI paradigm by DUNNING (1981) distinguishes three motives for FDI: ownership advantage, location advantage and internalisation advantage. In that respect the expression multinational firm is closely related to FDI (for instance MARKUSEN and MASKUS 2001). There are two types of FDI: vertical and horizontal. Vertical FDI is similar to offshore outsourcing, since part of the production process is done by the affiliate and the resulting intermediate good is transferred back. An important factor driving vertical FDI is the benefit from lower production costs abroad. Horizontal FDI and horizontal multinationals have little in common with offshore outsourcing, since the main purpose is direct access to a foreign market instead of exporting to that market. According to the definition by KIRKEGAARD (2005), offshoring in general encompasses offshore outsourcing as well as vertical FDI and refers to imports of intermediate goods across borders.

productivity level. The paper deals with the question in what ways and how sensitively the labour inputs of the suppliers react when production costs, in particular wages, change. Wages change exogenously according to unions' bargaining and policies such as minimum wages. When the supplier, who is affected by the production cost change, adjusts his output quantity, the rival will react immediately adjusting his output quantity as well, both aiming to maximise profits. The question is whether this leads to a one to one substitution of unskilled labour between the East and the West. It turns out that the sensitivity of outsourcing activities to production cost changes is highest when the interregional cost differential is smallest. Moreover, it is shown that higher production costs in one region reduce intermediate good production in both regions leading to a substitution effect between high- and low-skilled labour intensive inputs rather than between Eastern and Western low-skilled labour intensive inputs.

The paper is organised as follows: Section 2 summarises the related theoretical and empirical literature on international outsourcing. Section 3 describes the model structure, section 4 introduces Cournot competition of intermediate goods suppliers, section 5 derives the allocation of intermediate good production and the elasticity of relative interregional production, and section 6 analyses the resulting allocation of production factors focussing on labour. Section 7 introduces transport costs, and section 8 provides graphical representations. Section 9 discusses implications and caveats, and section 10 concludes.

2 A Brief Review of the Outsourcing Literature

Offshore Outsourcing has first been investigated theoretically and empirically in the case of the United States. Later on, a mainly empirical literature strand has examined the labour market effects of offshore outsourcing in the context of the European Union Eastern enlargement. Not surprisingly, a variety of theoretical models has been set up in order to better understand the determinants and effects of outsourcing activities.

Concerning the United States, FEENSTRA and HANSON (1996a and 1996b) show that rising imports, reflecting the outsourcing of production activities, contributed to the decline of relative employment and wages of unskilled workers during the 1980s. When firms outsource low-skilled labour intensive activities to low-wage countries and import the produced intermediate goods, this will shift employment towards skilled labour within industries.

BHAGWATI, PANAGARIYA and SRINIVASAN (2004) refer to US outsourcing at the beginning of the 21st century as another phenomenon: Trade in services at arm's length that does not require geographical proximity of the buyer and the seller. This view emphasises the role of information and communication technology opening the possibility of outsourcing call centres, software programming and data analysis to Asia connected via fast internet data transfer.

Turning to the European Union, MARIN et al. (2002) indicate that the most dynamic and innovative segments of the German industry invest in Eastern Europe and that exploiting low Eastern wages is one motive for outsourcing activities. MARIN (2006) finds empirically that falling trade costs, lower levels of corruption and improvements in the contracting environment in Eastern Europe influence the level of intra-firm imports from the East to Austria and Germany indicating more outsourcing to the East. MARIN (2004) goes one step further, stating that German and Austrian firms carry out outsourcing activities towards the East in order to take advantage of the abundant high-skilled labour there. She finds high educational levels among employees and more workers engaged in R&D and engineering in Eastern affiliates compared to firms in Germany and Austria. BRACONIER and EKHOLM (2001) find opposite results. MARIN (2004) shows small job losses in the West due to outsourcing, because outsourcing helps Western firms to stay competitive in accordance with KONINGS and MURPHY (2001). In contrast to these studies, BECKER et al. (2005) find a more substantial replacement of Western jobs by jobs in Eastern affiliates. KIRKEGAARD (2005) identifies European companies supplying or receiving outsourced or offshored goods and services and consumers of the resulting final commodities as winners. On the other hand companies being unable to adapt to the outsourcing boom and workers laid off due to outsourcing are potential losers.

In summary, the empirical outcomes point to some negative redistribution and employment effects for low-skilled employees. However, there is no reason for an outsourcing hysteria concerning production and jobs moving to low wage countries rapidly, considering that outsourcing improves efficiency and competitiveness and therefore reduces commodity prices under competitive markets, making consumers of these products better off.

Various models have been recently developed due to the public awareness of outsourcing and its consequences. There are models with a continuum of (intermediate) goods or production stages in the tradition of FEENSTRA and HANSON (1996a) and GROSSMAN and HELPMAN (2002 and 2003), models

extending the classic Heckscher-Ohlin theory, models based on standard production functions combined in multiple stages, and there are models based on outsourcing cost considerations. Within the group of models with a continuum of (intermediate) goods, WANG (2006) develops a model of choosing between vertical integration and outsourcing depending on cost differentials, transport costs and costs of searching for intermediate good trade. KOHLER (2004) models the reaction of a multi-stage industry with outsourcing to changes of the final good price and fragmentation costs. MITRA and RANJAN (2005) extend the outsourcing and FDI literature to dynamic behaviour with externalities and firm heterogeneity. According to their results, temporary shocks can have permanent effects, and most productive firms move abroad first. A key issue in the research of GROSSMAN and HELPMAN (2005) is the view of outsourcing as an activity that requires a costly search for a partner (in the home country or in a foreign country). GROSSMAN and ROSSI-HANSBERG (2006a) propose a new conceptual framework of the global production process focussing on tradeable tasks. They show that in contrast to neoclassical trade theories (under certain conditions), all domestic parties can share the gains from improved offshoring opportunities (For a comprehensive theoretical treatment of offshoring see GROSSMAN and ROSSI-HANSBERG 2006b.). A reformulation of the four basic theorems of the Heckscher-Ohlin theory allowing for offshoring (fragmentation) is provided by BALDWIN and ROBERT-NICOUD (2007). MARKUSEN (2005) applies modules from the existing trade theory to numerical analyses. Besides other results, his simulations suggest welfare gains for the South and the global economy, while the outsourcing Northern country may lose if it is large. MUNCH and SKAKSEN (2005) combine CES and Cobb-Douglas functions in a multi-stage setup. They point out that outsourcing to abroad worsens the wages for unskilled workers, whereas this effect cannot be expected from outsourcing within a country. Furthermore, SENSES (2006) illustrates how the wage elasticity of low-skilled labour demand increases in heavily outsourcing industries and how a decline in the share of unskilled labour at home lowers the elasticity on the other hand. BANDYOPADHYAY and WALL (2005a) derive the optimal amount of outsourcing for a given immigration level, while the model by BANDYOPADHYAY and WALL (2005b) includes an oligopolistic export sector and a competitive import-competing sector and shows that an outsourcing tax can be justified under a minimum wage but not under flexible wages. Among the models applying cost function representations, EGGER and EGGER (2004a) include multinational firms' competition in quantities and price-cost margins. EGGER and EGGER (2007) analyse the trade-off between transport costs and lower production costs induced by outsourcing in a multi-stage decision chain on mar-

ket entry and price setting in a spatial world. BARTEL, LACH and SICHERMAN (2005) show how technological progress lowers firms' adjustment costs of outsourcing.

Summing up, a large variety of models has been developed to examine different aspects related to outsourcing, such as labour market effects, transport costs versus lower production costs, searching for an outsourcing partner, the relationship of outsourcing and migration and the role of technological progress. Accordingly, outsourcing is a phenomenon with many facets, some of them investigated and understood, others not yet understood – leaving room for further research in different directions.

This paper deals with a facet of high public interest, not sufficiently covered theoretically: The reaction of (offshore) outsourcing in the spirit of FEENSTRA and HANSON (1996a and 1996b) to changes in production costs in the presence of Cournot competition of suppliers of parts and components.

3 The Model Structure

The partial equilibrium model consists of final good Y production located in the Western European country, and intermediate good X production located in the Western and the Eastern country. The model can be interpreted referring to the European automotive industry as motivated in the introduction. Y is produced with a Cobb-Douglas technology using the inputs H and X:

$$(1) \quad Y = H^{\alpha} \left(X_W + X_E\right)^{1-\alpha}; \quad 0.5 < \alpha < 1$$

The final good Y can be an automobile produced in Germany via a complex process with a sophisticated technology.[3] The final good producer takes demand, for example for his car type, as given by the market (the final good market form is not of importance for the considerations in this paper). H is a high-skilled labour and high-technology intensive input, which is available in the Western area only and cannot be outsourced. This is a conservative assumption contrasting with MARIN (2004) finding outsourcing of high-skilled labour towards Eastern Europe, but not crucial for the interpretation of the outcomes. For simplicity the production factor H encompasses

3 The model could also describe any other suitable industry, where outsourcing of intermediate goods production occurs, and where a small number of intermediate goods producers compete.

all processes involving highly educated employees such as design, engineering and management, the necessary high technology capital and firm specific knowledge.

The intermediate good X production process includes all activities demanding low-skilled labour like manual work plus usual capital input. X represents for instance interior automotive parts like dashboards and seats. X can be manufactured in Western (X_W) and Eastern Europe (X_E). Low-skilled labour is supplied in both regions. That means, there is no offshore outsourcing with the purpose of getting access to well educated workers in the East as described by MARIN (2004), nor service outsourcing according to BHAGWATI, PANAGARIYA and SRINIVASAN (2004), but it is offshore outsourcing in the spirit of FEENSTRA and HANSON (1996a and 1996b). Intermediate good production can be moved to the East when production costs or wages are cheaper in the East; afterwards the manufactured intermediates are imported into the West. X_W and X_E are homogeneous goods and perfect substitutes so that they can be summed up to $X = X_W + X_E$. The assumption $\alpha > 0.5$ implies a higher income share for the high-skilled labour and high-technology intensive input located in the West (under perfect competition). This means that the share of the production process which is mobile via outsourcing is less than half of the whole production in terms of revenues. The intuition is that the main part of production is not outsourced but kept within the company in contrast to the example by SINN (2005).[4] $\alpha > 0.5$ is plausible, because H encompasses high-skilled labour as well as high tech capital. The Cobb-Douglas function implies the possibility of replacing part of input X, produced with a high amount of low-skilled labour and a standard technology by input H, produced by high-skilled workers and modern technologies, and vice versa. The Y producer minimises production costs C for a given output Y:

$$(2) \qquad \begin{aligned} &Min.\ C = w_H H + p_W X_W + p_E X_E \\ &s.t.\ \ Y = H^{\alpha} \left(X_W + X_E\right)^{1-\alpha} \end{aligned}$$

w_H is the price of high-skilled labour intensive input H, p_W and p_E are the prices of X, manufactured in the Western or Eastern region. The final good Y producer is a price taker; he sets the input factor amounts according to the factor prices wH, p_W and p_E.

4 The Bazaar Economy hypothesis has been rejected by other authors, for instance HORN and BEHNCKE (2004).

The intermediate good is manufactured by independent rivalling firms located in Western or Eastern Europe, respectively. We call the former case outsourcing, the latter case offshore outsourcing. Intermediate good X production is represented by using Cobb-Douglas functions with the inputs capital K and low-skilled labour L with constant returns to scale:

$$(3) \quad X_i = A_i K_i^{\beta_i} L_i^{1-\beta_i}; \quad 0 < \beta_i < 1; \quad i = [W; E]$$

The production processes in the West and in the East differ in technologies A_i and in the real wages w_i. Capital is not mobile across borders. Furthermore, differences in the returns to capital investment r_i and in the elasticities of production β_i and $1-\beta_i$ are possible. Cost minimizing X manufacturing leads to the following marginal costs c_i (VARIAN 2001):

$$(4) \quad c_i = \beta_i^{-\beta_i} (1-\beta_i)^{\beta_i - 1} A_i^{-1} r_i^{\beta_i} w_i^{1-\beta_i}$$

Marginal costs c_i are assumed constant and equal to the cost per unit of output. Marginal costs are derived from the exogenous parameters technology A_i, real wage w_i, real return rate on investment r_i and the Cobb-Douglas function exponents β_i and $1-\beta_i$. If the returns on investment and the exponents are similar in the East and West, a cost advantage can be achieved via a more efficient technology or a lower wage level. X producers maximise their profits and have oligopolistic (monopolistic) power reflected in the price for X depending on the quantity of X, where $X = X_W + X_E$:

$$(5) \quad Max. \pi_i = p_i(X) \cdot X_i - c_i \cdot X_i$$

Without any market power of X producers prices would be equal to marginal costs. In general, a productivity gap between the East and the West exists, and hence, under perfect competition intermediate good production would take place in the area with lower marginal costs only.

In the case of Bertrand competition (price competition), intermediate good manufacturing occurs only in the cheaper region, too. Now the cheaper producer can increase the price for X and reduce the production quantity of X. But if he increases the price for X more than to the marginal costs of the rival X producer, he will lose all the demand for his product. Cournot competition (competition in quantities) is the interesting case referring to the current tendencies in the European automotive industry as well as analytically.

4 Cournot Competition

Production of automotive components containing numerous distinct parts, for example seats or dashboards, requires low-skilled manufacturing. Nevertheless, specific knowledge and a sufficient firm size are necessary to produce automobile parts in large amounts according to the final producer's needs and fulfilling the quality requirements. The intermediate good and the final good company agree to a long term contract, so that other suppliers can hardly enter the market. For that reason it is plausible to suppose a small number of companies being able to provide the specific components needed in final production, in this model in particular two suppliers. Under the assumption of pure Cournot competition, the Eastern and Western company offer the intermediate good X at the same price $p_X = p_W = p_E$. The firms optimise their supply of X taking into account the rival's reaction and the demand function for X given by the Western final good Y producer. The conditional factor demand functions can be derived from (2) in the standard way:

$$(6) \quad X(Y, w_H, p_x) = \left(\frac{\alpha p_x}{(1-\alpha) w_H} \right)^{-\alpha} Y$$

Total demand for X falls with the price p_X and increases with w_H, the price of the skilled labour intensive good H. Similarly, the input quantity of H is expressed:

$$(7) \quad H(Y, w_H, p_x) = \left(\frac{\alpha p_x}{(1-\alpha) w_H} \right)^{1-\alpha} Y$$

A change in the exogenous quantity Y leads to proportional shifts of the input factors X and H (the absolute value of Y is not important when dealing with relative values between the East and the West, since Y drops out). Solving (6) for p_X yields the inverse factor demand function for X:

$$(8) \quad p_X = \frac{1-\alpha}{\alpha} w_H X^{\frac{-1}{\alpha}} Y^{\frac{1}{\alpha}}$$

Obviously, the intermediate good suppliers face a non-linear and downward-sloping inverse factor demand function with respect to the total production of X. Since $\alpha < 1$, expanding the supply of total X leads to a more than proportional fall in the price p_X. Hence, a monopolist would choose the output as small as possible, but in the oligopoly the situation is different. For every given positive quantity of one supplier there is an optimal output of the rival, which results in an equilibrium with positive quantities. In mar-

ket equilibrium, supply equals demand for X at the price p_X, so that we can insert (8) into (5) recalling that the final producer is a price taker:

$$(9) \quad Max.\ \pi_i = \frac{1-\alpha}{\alpha} w_H X^{\frac{-1}{\alpha}} Y^{\frac{1}{\alpha}} \cdot X_i - c_i \cdot X_i$$

The oligopolists maximise their profits Π_i by choosing their production quantities X_i and taking into account the total amount X that includes their own and their rival's quantity. This results in the following first order conditions for profit maximisation representing the oligopolists' reaction functions with $i = [W; E]$:

$$(10) \quad \frac{d\pi_i}{dX_i} = \frac{1-\alpha}{\alpha} w_H Y^{\frac{1}{\alpha}} \left(-\frac{1}{\alpha} X^{\frac{-1}{\alpha}-1} \cdot X_i + X^{\frac{-1}{\alpha}} \right) - c_i = 0$$

The appendix[5] (a) shows that the second order condition for a profit maximum is fulfilled. Dividing the first order conditions for the East and the West yields the intermediate good output ratio (appendix b):

$$(11) \quad V_{WE} \equiv \frac{X_W}{X_E} = \frac{(1-\alpha)c_{WE} + \alpha}{(1-\alpha) + \alpha\, c_{WE}}$$

V_{WE}, a key variable in this model, is the ratio of production in the West relative to the East. c_{WE} means c_W / c_E, that is marginal production costs in the West divided by marginal costs in the East, in other words the relative Western marginal costs.

5 Allocation of Intermediate Good Production

This section examines how the allocation of intermediate good production to Eastern and Western Europe reacts to changes in the production cost differential between those regions. For this purpose the elasticity of relative interregional production is defined. The first derivative of expression (11) with respect to marginal costs in the West relative to the East shows the reaction of relative X production V_{WE} to changes in relative marginal costs c_{WE} (more detailed in the appendix (b)).

5 The mathematical appendix is available upon request. Internet: http://www.ifw-kiel.de/research/the-environment-and-natural-resources/view?set_language=en.

$$(12)\quad \frac{dV_{WE}}{dc_{WE}} = \frac{1-2\alpha}{[(1-\alpha)+\alpha c_{WE}]^2} < 0$$

α is larger than 0.5 per plausible assumption, and hence the term above is negative. That means, increasing marginal production costs in the West relative to the East lower the relative Western production V_{WE} as expected. Facing higher production costs in the West, the oligopolist reduces the profit maximising output X_W, so that the relative Western X output falls. Now the following elasticity ε can be derived from (11) and (12) in order to analyse the sensitivity of relative X production to changes in relative production costs c_{WE}:

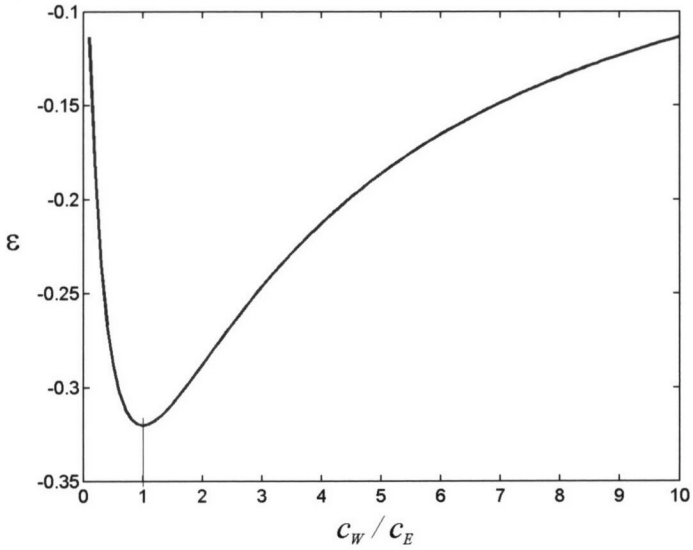
$$(13)\quad \varepsilon = \frac{dV_{WE}}{dc_{WE}} \cdot \frac{c_{WE}}{V_{WE}} = \frac{1-2\alpha}{[(1-\alpha)+\alpha c_{WE}]^2} \cdot \frac{c_{WE}}{\frac{(1-\alpha)c_{WE}+\alpha}{(1-\alpha)+\alpha c_{WE}}} < 0$$

This elasticity of relative interregional production is a measure for the sensitivity of offshore outsourcing to interregional production cost changes. When it is high, cost deviations at home lead to a large relative production shift to abroad. Term (13) and the graphical representation in Figure 1 show that the elasticity of relative intermediate good production is a function of relative production costs (Note that the graph is symmetric, that is the branch left of the minimum is the inverse of the branch on the right hand side of the minimum, so that the results are independent of looking at c_W / c_E or at c_E / c_W.). The elasticity curve is steep near its extremum, while it is flatter when relative production costs deviate more from 1. We now analyse the first derivative of the denominator of equation (13) in order to find an extremum of ε:

$$(14)\quad \frac{d}{dc_{WE}}\left[(1-\alpha)^2 + \alpha^2 + \alpha(1-\alpha)\frac{1}{c_{WE}} + \alpha(1-\alpha)c_{WE}\right] = 0 \Rightarrow c_{WE} = 1$$

It can be shown that ε has a minimum lower than zero for $c_{WE} = 1$ (appendix b). For c_{WE} towards infinity or towards minus infinity, the elasticity approaches zero (Figure 1).

Figure 1:



With the definition of V_{WE} according to (11) in the middle bracket and some algebra (see appendix c), X_E and X_W can be expressed as:

$$(15)\quad X_E = \left(\alpha' \frac{w_H}{c_W + c_E}\right)^{\alpha} \frac{1}{1+V_{WE}};\quad X_W = \left(\alpha' \frac{w_H}{c_W + c_E}\right)^{\alpha} \frac{1}{1+\frac{1}{V_{WE}}}\ Y;$$

$$\text{where}\quad \alpha' = \frac{(1-\alpha)\left(2-\frac{1}{\alpha}\right)}{\alpha}$$

We write α' for simplicity. $1 / (1 + V_{WE})$ is the Eastern European share of X production, and $1 / (1 + 1/V_{WE})$ is the Western share of total X production. The Eastern supply of X increases proportionally with the exogenous final output Y. The higher the sum of marginal costs in the West and the East compared to the price for high-skilled labour w_H, the lower the input of X_E and also the input of X_W in final production.

Equation (10) represents a Nash equilibrium, because both oligopolists maximise their profits taking the rival's behaviour into account, and the firm that deviates from this optimal production will suffer a lower profit. Adding the Eastern and the Western output derived from (10) leads to total supply of X:

$$(16)\quad X = X_W + X_E = \left(\alpha' \frac{w_H}{c_W + c_E}\right)^{\alpha} Y$$

The equilibrium price p_X, which is identical for X_W and X_E per assumption, becomes obvious by comparison of the above term with expression (6). It follows:

$$(17)\quad p_X = \frac{c_W + c_E}{2 - \frac{1}{\alpha}}$$

The equilibrium price of X is a linear function of the sum of the marginal costs in the regions. The input of X as a production factor in final production decreases when p_X rises. Consequently, higher costs in one region not only reduce the output in this region, but also total supply of the intermediate good X by increasing p_X. Hence it is not immediately clear whether higher production costs in the East increases or decreases absolute X production in the West. This depends on whether the production shift from East to West is lower or higher than the negative effect of the total X production decline. The magnitude of p_X movements due to marginal cost changes is determined by the coefficient $1/(2-1/\alpha)$. For α approaching 1, p_X is approximately the sum of marginal costs. This would imply a very high exponent in the Cobb-Douglas function for H and a very low exponent for the input X. The magnitude becomes higher and higher when α falls towards 0.5, keeping in mind that 0.5 is a lower bound for α in this model.

The profits of the intermediate good suppliers can easily be expressed with the help of the price p_X:

$$(18)\quad \pi_i = p_x \cdot X_i - c_i \cdot X_i$$

As the simulation will show, profits decrease with increasing costs as expected. But not only do the profits of the producer facing rising costs fall, the other supplier's profits also slightly fall together with a small output reduction.

6 Allocation of Production Factors

This section describes the profit maximising allocation of production factors depending on production costs. We concentrate on labour inputs, while absolute and relative capital inputs can be derived in an analogue way. The analytic relationships are then used to carry out simulations in section 7.

At first we look at the input of high-skilled labour intensive input H by plugging p_X into (7):

$$(19)\quad H(Y, w_H, c_W, c_E) = \left(\frac{1}{\alpha'}\frac{c_W + c_E}{w_H}\right)^{1-\alpha} Y$$

It follows for the ratio of H to X:

$$(20)\quad \frac{H}{X} = \frac{\frac{p_X}{1-\alpha}}{\frac{w_H}{\alpha}} = \frac{1}{\alpha'}\frac{c_W + c_E}{w_H} = \frac{c_W + c_E}{1-\alpha}\frac{\alpha}{w_H}\frac{1}{2-\frac{1}{\alpha}}$$

This cost minimising ratio of high-skilled labour intensive input H to the low-skilled manufactured input X is the standard microeconomic outcome, but with p_X expressed as shown before. A rising sum of marginal costs in X manufacturing shifts the input intensity in final production from X to H. In contrast to the standard microeconomic relationship the impact of α is unclear, as α also affects p_X via the factor $1/(2-1/\alpha)$.

We continue by writing the standard conditional factor demands for low-skilled labour L_i derived from the production function (3) with $i = [W; E]$ in order to produce the amounts X_i at minimal costs (VARIAN 2001). Note that capital and labour are specific for each region, they are immobile between the regions, so that there is no factor price equalisation, which implies a short- or medium-run point of view.

$$(21)\quad L_i(X_i, r_i, w_i) = \frac{1}{A_i}\left(\frac{(1-\beta_i)r_i}{\beta_i w_i}\right)^{\beta_i} X_i$$

The ratio of labour inputs is expressed using the definition of V_{WE} according to (11):

$$(22)\quad \frac{L_W}{L_E} = V_{WE}\frac{A_E}{A_W}\frac{\left(\frac{\beta_E w_E}{(1-\beta_E)r_E}\right)^{\beta_E}}{\left(\frac{\beta_W w_W}{(1-\beta_W)r_W}\right)^{\beta_W}};$$

$$\text{where}\quad V_{WE} = f\left(\frac{\bar{c}_W}{\bar{c}_E}\right) = f\left(\frac{\bar{A}_E}{\bar{A}_W}; \frac{\bar{w}_W}{\bar{w}_E}; \frac{\bar{r}_W}{\bar{r}_E}\right)$$

The minus signs indicate that VWE is a falling function of A_E/A_W, w_W/w_E and r_W/r_E. The labour input in the West compared to the East is therefore

determined by the relative productivity, the relative Western return rate on investment and the relative Western wage level. Within a region it depends on the price of capital relative to the price of labour as usual. When $\beta = \beta_W = \beta_E$, the relation simplifies to:

$$(23)\quad \frac{L_W}{L_E} = V_{WE}\frac{A_E}{A_W}\left(\frac{\frac{w_E}{r_E}}{\frac{w_W}{r_W}}\right)^{\beta} = V_{WE}\frac{A_E}{A_W}\left(\frac{w_E}{w_W}\frac{r_W}{r_E}\right)^{\beta}$$

A higher relative Western wage clearly lowers the labour input in the West in comparison to the East (directly in 22 and indirectly via V_{WE}), but the impacts of changes in r_W/r_E and A_W/A_E *per se* are not clear. On the one hand, a higher Western return rate on capital shifts production towards more labour input in the West; on the other hand, a higher return rate increases overall production costs, which drives production and thus labour and capital inputs from the West to the East. The result of a productivity improvement in the West is ambiguous, too: It lowers production costs extending Western X production, but at the same time a given output Y can be produced with less labour and capital inputs.

To conclude, the analysis has shown that the wage for high-skilled workers w_H compared to the sum of marginal production costs in the East and West determines the ratio of H to X in final good production, while the marginal cost ratio c_W/c_E determines the distribution of X production to the West and to the East.

7 Transport Costs

Manufacturing the intermediate good X in the Eastern region and importing it for final production into the Western region creates transportation costs for X. Referring to the classic approach by SAMUELSON (1954), transport costs C_T are represented by a quantity melting like ice. For that purpose an additional factor $(1-C_T)$ is introduced in (3) and for simplicity combined with the productivity coefficient A_E:

$$(24)\quad X_E = A_E' K_E^{\beta_E} L_E^{1-\beta_E};$$

$$\text{where}\quad A_E' = (1-C_T)A_E;\quad 0 \le C_T < 1$$

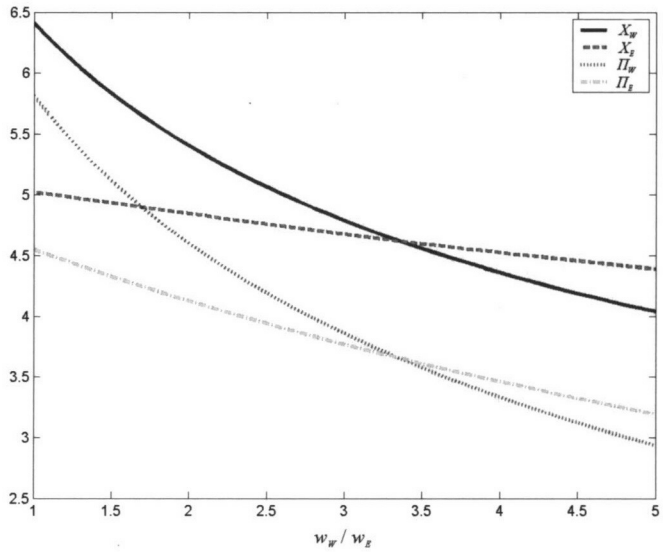
It is immediately obvious that transport costs lower the Eastern productivity, or in other words, increase Eastern marginal production costs and hence shift production from the East to the West. Transport costs will be included in the simulations in the next section.

8 Graphical Representations

The following graphs visualise the effects of a change in relative production costs in form of a rising Western wage level. The simulations are based on the equations derived in sections 5, 6 and 7 and the analogue expressions for capital inputs.

Figure 2 illustrates the change in absolute amounts of X production in the East and the West and the corresponding profits Π_W and Π_E (according to equations 15 and 18) when the Western wage rises relative to the Eastern wage, while the Eastern wage is fixed.[6]

Figure 2:



6 The profits are divided by 10 to scale them down in the figure.

The following assumptions on parameter values have been made for the functions of the model:[7] For any given relative wage the graphs show the inputs necessary to produce one unit of final output Y. The Cobb-Douglas exponent for the high-skilled labour intensive input α equals 0.66 and the one for the X input 0.34. The price of H is set 15 times higher than the payment for Eastern low-skilled workers ($w_E = 1$). Accordingly, there is a much higher income share for high-skilled workers such as managers, engineers and designers creating H than for low-skilled workers manufacturing X in the East. In the graph, the Western wage (w_W) rises exogenously from 1 up to 5 relative to the Eastern wage. For example, the labour cost ratio between Germany and the Czech Republic amounts to about 5 and might decrease in the future. Returns on capital in the East and West are set equal to one, since the graph focuses on wage differentials. The exponents β_i related to capital inputs in intermediate good production are assumed to be 0.34 in both regions. The exponents $1-\beta_i$ for labour inputs consequently lead to higher income shares for low-skilledworkers than for capital owners in every region. The Western X producer has an advantage in total factor productivity; for simplicity A_E is set to 1 and A_W to 2. The intuition is access to better production technologies in the West. Finally, transport costs C_T are included amounting to 10% of the transferred good X, causing a further cost disadvantage for the East.

Consequently, for equal wages ($w_W / w_E = 1$, left hand side of Figures 2 and 4) the manufactured quantity of X in the West is higher than in the East because of the higher Western productivity level and the transport costs of importing X_E from the East to the West. As expected, rising the Western wage while holding the Eastern wage constant reduces Western X production strongly. Surprisingly, Eastern X production slightly decreases at the same time, resulting in an even larger decrease in total X supply. The reason is that higher Western production costs increase p_X (the common price for Eastern and Western good X) proportionally as shown in equation (17). When the price for the intermediate good X increases, the final good producer replaces X by H leading to a (substantial) decline in the demand for X. Hence, total X, which is the sum of X_W and X_E, also falls. Corresponding to the quantities, Western profits decrease strongly with rising labour costs, and Eastern profits fall slightly.

7 For a comparison of relative wages, productivity and labour costs between Germany and Austria and Eastern European regions see MARIN (2004).

Figure 3:

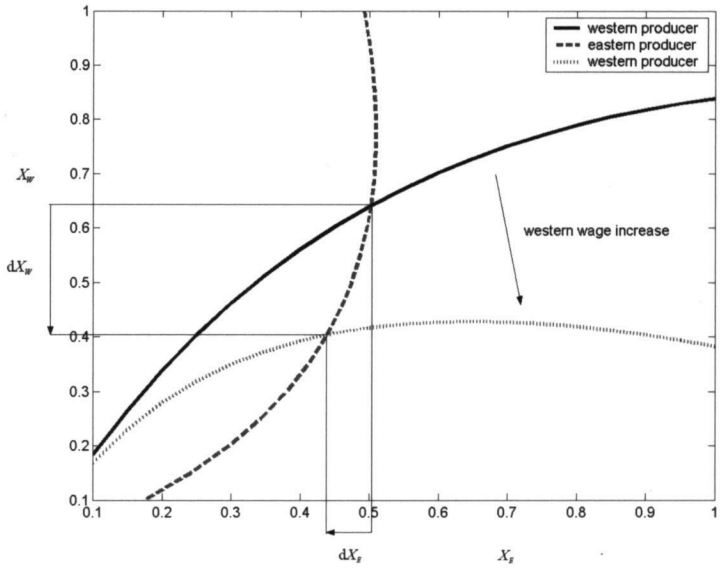


Figure 3 points out the mechanisms on the X supply side. The curves are the graphical representations of the reaction functions in (15) of the Western and the Eastern firm, each representing profit maximising output as a function of the rival's output.

The parameter values are set as before. The curves are again asymmetric because the Eastern oligopolist faces transport costs and an inferior technology. Obviously, the reaction curves are upward sloping, so that one firm reacts to a higher quantity of the other firm with another output expansion. In certain regions of the curves and for certain parameter values it is also possible to find downward sloping or approximately vertical or horizontal reaction curves. Then the firm reacts to the rival's output expansion with an output reduction or is not affected at all. But the typical case in this model framework is that of upward sloping reaction curves, causing the important result of an output reduction in both regions for a cost increase in one region. This means the intermediate good production factor is replaced by the high-tech production factor. Is a zero-zero solution without intermediate good production feasible? The quantities X_W and X_E are endogenous and will never become jointly zero, nor will one quantity become zero. This means the model cannot represent the non-production case and the mo-

nopoly case. Even when a very large inter-regional cost differential exists, there will be a marginally small rest of production in the high-cost region.

As shown in Figure 3, a Western wage raised from 1 to 5 relative to the Eastern wage shifts the Western reaction curve downwards, lowering Western output strongly (dX_W) and decreasing Eastern output slightly (dX_E).

Figure 4:

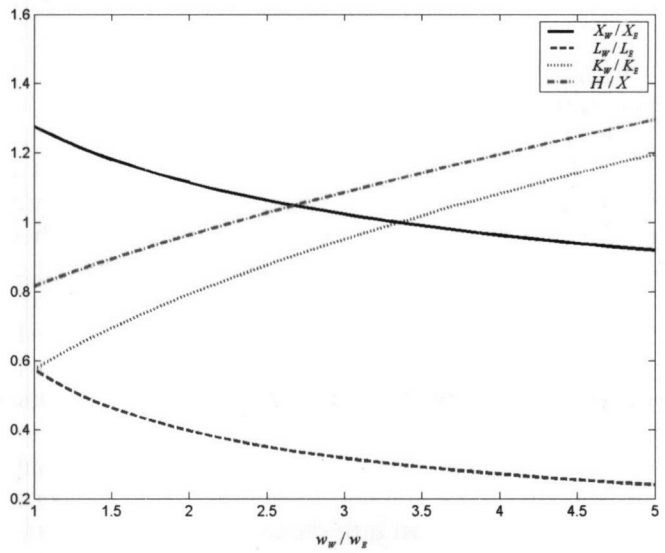


Figure 4 plots the relative factor distribution, that is Western in relation to Eastern X production, Western compared to Eastern low-skilled labour and capital inputs as well as the ratio of the Western high-skilled labour intensive factor H to low-skilled labour intensive X being produced in the West and the East (equations 11, 21 and similarly for capital inputs). Again the Western wage is exogenously increased relative to the fixed Eastern wage.

All parameter values are the same as before and the results are in accordance with those of Figure 2. For the case of identical wages (left hand side), the output of X in the West is higher than in the East ($X_{WE} > 1$) because of the Western technological advantage and the Eastern transport costs disadvantage. Nevertheless, low-skilled labour input is lower in the West than in the East, and capital input is lower in the West, too. This follows from the fixed final good Y output limiting the demand for factors H and X and from

the Western productivity advantage reducing the required input quantities to produce a certain output quantity.

Obviously all curves in figures 2 and 4 have a sharper (rising or falling) slope when labour costs are similar (left hand side) in accordance with the higher elasticity of relative production for equal marginal costs derived in chapter 5 (equation 13). This is caused by the strictly convex inverse factor demand function (8) which is steeply falling for low prices in combination with the reaction functions (15).[8]

9 Interpretation and Caveats

The model analysis has the following implications: It reveals that the elasticity of interregional outsourcing activities as a reaction to interregional cost changes depends on the original gap in production costs between the regions. When intermediate good production occurs in two regions with similar production costs, any cost change in one region will have strong reallocation effects. Hence, a higher wage agreement for the Western intermediate good firm or a higher wage level after bargaining with unions would lower, for example, the Western intermediate good production relative to the Eastern one a lot in terms of relative changes. In the same way higher additional labour costs (taxes and insurance) have a strong negative influence on Western production and labour input. Given a situation of a large East-West production cost differential and completed offshore outsourcing activities, additional cost changes will have little effect on outsourcing, thus contradicting outsourcing fears.

Moreover, higher marginal costs in one region not only reduce intermediate good output in this region, but also in the other region due to a rising common intermediate good price, which reduces demand for the intermediate good. Thus, the cost increase reduces intermediate good production in both regions. Of course the output decline is higher in the region where the cost increase occurs. In order to keep final output constant, low-skilled labour intensive intermediate good input is substituted by the high-skilled labour (and advanced technology rich) input located in the West. Consequently, any rise in intermediate good production costs benefits Western high-skilled workers. The outcome for low-skilled workers in the region with rising costs depends on whether the cost increase includes higher wages. In case of higher wages the entire group of low-skilled workers in that region can still lose because the production decline eliminates jobs due

to higher costs. If the wage increase overcompensates the reduced labour input, the workers can all be better off after redistribution. However, this is unlikely the case. We saw that a cost increase in one region also slightly reduces intermediate production in the other region. Therefore, *ceteris paribus* capital owners and workers involved in intermediate production in the other region also lose to some extent. We conclude that there is no direct competition between low-skilled workers in the East versus the West, but mainly between Western high-skilled on the one hand and both Eastern and Western low-skilled workers on the other hand in terms of absolute input quantities. Of course, referring to relative quantities, any cost increase in one region lowers the relative production share of this region compared with the other region. According to the graphical interpretation for a specific parameterisation, an advantage via a higher productivity leads to a higher intermediate good output with relatively lower factor input quantities.

When applying and interpreting the model, several caveats should be considered: The paper is a typical partial equilibrium analysis. It abstracts from trade and terms of trade effects. Therefore, it is not possible to carry out a general welfare analysis.

The model concentrates on the supply side, assuming a constant demand for Y. The analysed changes in factor prices or production technologies do not affect the price for Y, either. But since the development of consumer tastes and technological change during the allocation process are unknown, it seems reasonable to set these variables exogenous and constant.

An oligopoly in intermediate good production is a sensible assumption for certain sectors of the economy, but of course not for all sectors. The automobile industry has been chosen as an example. However, the oligopoly assumption would also be sensible in final good production, which has been neglected here in order to keep the model analytically tractable. Furthermore, a typical automobile producer has to some extent market power concerning the purchase of parts and components. This model is in favour of the intermediate good suppliers concerning market power.

Furthermore, the findings are based on convex decreasing inverse factor demand functions derived from Cobb-Douglas technologies. Thus, the intermediate good producers tend to keep their output low for the purpose of holding the price high. The results probably also hold when assuming CES production functions. However, the substitution effect between high-skilled and low-skilled labour will be stronger when the elasticity of substi-

tution of the CES function is higher. On the other hand, a higher elasticity of substitution between labour and capital in intermediate production will probably make the outsourcing behaviour less sensitive to labour cost changes, because capital can more easily substitute for labour within intermediate in one region.

The exponent of the high-skilled labour intensive input in the Cobb-Douglas function is assumed to be larger than one half, so that the exponent of the low-skilled labour intensive input is smaller than one half. This necessary assumption seems sensible, since it implies a higher income share for the combination of high-skilled labour and high technology capital found in the Western region than for the low-skilled labour intensive input that is outsourced. It indicates in a way that production is mainly located in the Western region.

When a very large inter-regional cost differential exists, there will still be a marginally small rest of production in the high cost region. In that sense, the Cournot competition assumption is not realistic for very large cost differentials. On the other hand, a large cost differential points to a big difference in per capita incomes and the levels of development. Hence, poor infrastructure, unsecured property rights, corruption and other disadvantages and risks dominate the outsourcing decision of investors rather than pure production costs. These factors prevent higher outsourcing into the low cost country even when a large cost differential exists. Moreover, the results show the strongest elasticity of outsourcing activities to production cost changes when the interregional cost difference is smallest, that is when the countries are similar. In reality there is a sluggishness of production movements due to the home bias and costs of planning and organising the outsourcing activity. This sluggishness opposes the offshore outsourcing incentive, and the outsourcing costs create a threshold, that is a minimum cost differential necessary to cause any offshore outsourcing.

Do the results of the simulations hold for all parameter values? Actually, it is possible to find certain parameter values that yield the classic outcome: One oligopolist reduces output due to higher production costs and the other firm reacts with an output expansion. Another possibility is a reaction function that is locally vertical or horizontal. Then the first firm can change output without affecting the second firm. Nevertheless, these are special cases, while the normal behaviour for most parameter values within this model framework is as explained before.

Finally, a precondition for the analysis is a situation of completed adjustment of factor allocation according to efficiency or profit maximisation, respectively. When applying the model to the current situation of the European Union we need to take into account that dynamic adjustment processes are still in progress. Consequently, adjustment processes towards the equilibrium offset the outcomes resulting from the model. The model does not assume factor price equalisation. This means, it has a medium-run point of view, or there are persistent barriers to trade or factor movements.

10 Conclusions

This paper deals with the question how and how sensitively outsourcing from a high-technology area with high production costs like Western Europe to a low-technology and low-cost area like Eastern Europe reacts to changes in production costs. It refers to current tendencies in the (European) automotive industry: Concentrations of firms in final production as well as in production of parts and components, increasing market power of the suppliers, but at the same time price or cost pressure, and offshore outsourcing to Eastern European countries with lower wage levels.

The model presented here is a two stage model based on Cobb-Douglas technologies and Cournot competition in intermediate goods as perfect substitutes. Final good production takes place in Western Europe, while the intermediate activity can be located in Western Europe (outsourcing) or Eastern Europe (offshore outsourcing).

It is shown how relative production costs, determined by technology levels, wages and returns on investment, influence the allocation of production and of labour input between the two regions. The first key result is that intermediate good production falls in region A relative to B when production costs in A rise relative to B. But intermediate good output in B does also slightly fall in absolute terms as a result of the Cournot competition. Graphical simulations illustrate the findings. Thus, there is a substitution effect between high-skilled and low-skilled labour rather than between low-skilled labour in the East and in the West.

The second key result is that the sensitivity of outsourcing behaviour to production cost changes is higher the smaller the cost difference between the regions is. Consequently, the effect of changes in wage agreements or labour taxes depends on the original cost gap. Given a situation of a large East-

West production cost differential and completed outsourcing activities, additional cost changes will have little effect on outsourcing behaviour. This contradicts the fear of production rapidly moving towards the East once Western wages or labour taxes change slightly. Moreover, the simulation example shows that a superior technology in one region leads to a higher relative output and lower relative factor inputs in that region compared to the other region.

Currently, labour costs differ strongly between Eastern European countries. According to this simplified model and ignoring other factors driving outsourcing decisions, the sensitivity of Western outsourcing activities to production cost changes in countries like Czech Republic and Hungary is higher than in Romania and Bulgaria, since the wage levels of the former countries are closer to the Western wage level than those of the latter countries. When the Eastern production cost level converges to the Western level, the outsourcing sensitivity will increase. However, the analytical model does not capture outsourcing determinants like infrastructure and the legal framework predicting the most offshore outsourcing into countries with the lowest labour costs.

The model serves as an easily tractable analytical tool and can be implemented in a more detailed general equilibrium model. Particularly, the final good demand side and international trade can be implemented. Income effects for high- and low-skilled workers and capital owners in the two regions can then be investigated in a more detailed way, and a general welfare analysis can be done.

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