1 Introduction

This paper explores the relationship between trade in IT Services and organizational forms in an international context. First the distribution of IT Administration Rights are described in a microeconomic approach of incomplete contracts in section 2. Then in sections 3 and 4 these result are used in a General Equilibrium model with two countries, three sectors and two organizational forms which is based on a model from ANTRAS (2003). The model stress the accompanying character of IT Services and shows that IT services are traded in both directions even when there are no differences in factor intensities or technology. Finally worldwide trade in IT services is split into offshoring within a multinational company and international outsourcing.

2 IT Administration Rights

MIOZZO & MILES (2002) and OECD (2004) emphasize the relationship between IT service companies and multinational enterprises: For many service industries the initial stimulus of their internationalization was the rapid growth and global spread of multinationals in manufacturing sectors. Offering B2B services the IT service companies follow the internationalization pace of their customers. In this section, the link between the organizational structures of companies, IT-administrations rights and the basic choice between two IT system architectures is described. It is proved that the choice of the IT architectures coincides with the choice of the organizational structure of the company.

The model presented in this section is based on the property rights approach from GROSSMAN & HART (1986) and is similar to the idea of BRYNJOLFSSON (1994). The model supports the result of WILLIAMSON (1985) that transaction costs of any economic activity are determined by the asset specificity associated with that activity (ANG & STRAUB (2002)).

Grossman and Hart analyze the distribution of property rights between two companies with incomplete contracts. They also prove that a uniform distribution of the property rights, i.e. both companies remain independent, can lead to economically efficient results. With this model they offer an alternative explanation to the transaction costs approach à la Coase.

Analogously to property rights, IT-administrations rights are considered here. These determine the access policy of the IT systems S_F and S_J from final good producer F and intermediate good producer J. The administration rights include, for instance:

- the control of access including all internal and external safety measures and administration of users, i.e. assignment of users to roles which encompass certain access rights.

- all system changes or expansions and changes in the data model and

- the possibility to access all relevant company data which is stored electronically, i.e. customer's lists, prices, etc.

IT systems are a mirror-image of the enterprise production processes. Therefore controlling the IT-administrations rights also allows the observation and control of the company's workflow. Thus the IT-administrations-rights are an essential subset of the property rights. The following model shows that the choice of the IT system and the distribution of the property and IT-administration rights take place simultaneously.

It is the common objective of intermediate good producer J and final good producer F to increase total productivity through better coordination of the operational processes between both companies. This concerns, for example, order processing, production, logistics, etc. This coordination is carried out by information technology. In the model two possible IT architectures can be chosen to organize the data interchange between the companies:

1. **Separated systems** which use standardized interfaces for data interchange. This means that the 'point of transfer'[1] is standardized and documented openly as well as the exchange format itself being in common use.

2. **Integrated system**. When integrating the systems proprietary (software) solutions are used.

The administration rights which are at the disposal of the companies in these both cases are termed A^F or A^J. The following cases are conceivable:

- $A^F = \{S_F, S_J\}$, $A^J = 0$ The final good producer has the administration rights for both systems or the integrated system respectively.

- $A^J = \{S_F, S_J\}$, $A^F = 0$ The intermediate good producer has the administration rights for both systems or the integrated system respectively.

- $A^F = \{S_F\}\,, A^J = \{S_J\}$ Every company keeps the IT administration rights about its system, but interfaces interchanging data.

Intermediate goods producer J and final goods producers F have to invest for their IT systems amounts of K_F and K_J respectively. The cost function for producing the intermediate product is termed C and depends on the investment volume of the intermediate goods producer in its IT system with

$$C = C(K_J) \;\; with \;\; C' < 0 \;\; and \;\; C" > 0 \tag{1}$$

After having purchased the intermediate goods from the intermediate goods producer J the final goods producer F sells it to its customers. Expenses for finishing, marketing and logistic are deducted. This generates a turnover R which depends on the investment volume of the final goods producer F in its IT system:

$$R = R(K_F) \;\; with \;\; R' > 0 \;\; and \;\; R" < 0 \tag{2}$$

[1] An example is the data interchange via an ODBC (Open DataBase Connectivity) interface.

If both producers could agree on a complete contract, both companies would distribute the IT-administration rights ex ante as well as bindingly negotiate the investment volumes K_F and K_J and the split of profits. In this case they would jointly maximize the profit function $R(K_F) - C(K_J) - K_F - K_J$.

However, de facto this way is not possible. GROSSMAN & HART (1986) point out that in a contract between two companies all eventualities can never be regulated. In this sense the contracts are incomplete. The company which prevails in the case of a conflict has of the residual rights at its disposal, i.e. the rights which could not be described by the negotiated contract completely.

Residual rights also exist in the area of the administration rights. If, for instance, an interface solution is agreed between two companies, the actual investment volumes of a company in its entire IT system remain unobservable although this is crucial for the quality, consistency, safety and availability of data.

Therefore it is assumed that both companies negotiate an incomplete contract which only determines the distribution of the IT administration rights ex ante, because neither the investment volume in the IT systems nor the split of profits can be negotiated bindingly.

The business transactions between the companies may follow this time line:

- period 0: The type of the IT system architecture and the distribution of the IT administration rights are determined.
- period 1: Both companies choose simultaneously and independently of each other their investment volumes K_F and K_J.
- period 2: The companies observe mutually the actual size of their IT investment volumes and decide whether they want to trade the intermediate goods between each other. At the end of the period the companies negotiate about the split of the profit.

The split of profits follows a Nash-bargaining solution. For the negotiating position of the parties the value of their outside options V are crucial. These describe the alternative revenues which can be expected if the intended deal does not work out.

By assumption hold $R(K_F) - C(K_J) > V^F(K_F, A^F) + V^J(K_J, A^J)$ with $V^F(K_F, A^F)$ for the outside option of the final good producer whose value depends on the actual investment volume in the IT system and the received administrations rights. $V^J(K_J, A^J)$ accordingly. The assumption means that the intermediate is actually traded between both companies. For a stable solution it is assumed that by increasing the investment volume by one unit the marginal revenues will see a stronger rise in response. The marginal cost falls more strongly than the value of the outside options increases: $R'(K_F) > V_1^F(K_F, A^F)$ and $|C'(K_J)| > V_1^J(K_J, A^J)$ with V_1 for the first derivative of V with respect to the first operand K.

The value of the outside option depends on the distribution of the administrations rights and IT architecture chosen between both companies for data interchanging, e.g. the interface solution or integration of the systems. It holds

- with an integrated system:

$$V^n \{K_n, A(S_F, S_J)\} > V^F \{K_F, A(S_F)\} = V^J \{K_J, A(S_J)\} = 0 \quad (3)$$

with n = (F, J). As soon as an integrated system is built up, the individual investments of the companies are sunk in the entire system. Hence, if a company owns only the administration rights for its 'subsystem', the value of its outside option is zero.

- with standardized interfaces:

$$V^n \{K_n, A(S_F, S_J)\} = V^F \{K_F, A(S_F)\} = V^J \{K_J, A(S_J)\} > 0 \quad (4)$$

with n = (F, J). With the interface solution a separation of the partners is possible anytime without impairing the integrity of the systems, i.e. the IT systems remain functioning. The investments in the IT system do not become sunk costs. Hence, presuming symmetrical investment behaviour the single value of the outside options of each company administrating its own IT system meets the value of the outside option of one company having received the administration rights for both IT systems.

Nash-bargaining solution determines the actual profit from the relationship between the both companies. Taking into account the value of outside options for both companies[2] this leads to

$$U_F = \frac{1}{2}\left\{R(K_F) - C(K_J) - V^F(K_F, A^F) - V^J(K_J, A^J)\right\} + V^F(K_F, A^F) \quad (5)$$

for the final goods producer

$$U_J = \frac{1}{2}\left\{R(K_F) - C(K_J) - V^F(K_F, A^F) - V^J(K_J, A^J)\right\} + V^J(K_F, A^F) \quad (6)$$

and for the intermediate goods producer.

Assuming that the 'access profit' in the brackets is shared equally. Assuming further that the IT investment costs are completely written off in the considered period, both companies choose their optimum investment volumes K_F^* and K_J^* in such a way that the profit function is maximized after amortizations $(U_F - K_F) \Rightarrow$ max and $(U_J - K_J) \Rightarrow$ max respectively. For the final goods producer results

$$K_F^* : \frac{1}{2}\left\{R'(K_F^*) + V_1^F(K_F^*, A^F)\right\} = 1 \quad (7)$$

and for the intermediate goods producer

$$K_J^* : \frac{1}{2}\left\{-C'(K_J^*) + V_1^J(K_J^*, A^J)\right\} = 1 \quad (8)$$

[2]Please note that A^F can have the value of $A(S_F, S_J)$ or $A(S_F)$ depending on the solution choosen. J respectively.

Incomplete contracts and the split of profits à la Nash lead to distortions compared to the solution with complete contracts. With complete and binding contracts the joint optimization calculation would have yielded $R'(K_F) = 1$ and $-C'(K_J) = 1$. However, a hold-up problem arises with the Nash-bargaining solution: the optimum investment volume of the intermediate goods producer decreases because now only 50 percent of the marginal costs are relevant for its profit maximization. For the final goods producer accordingly. Hence, underinvestment occurs, except the borderline case when the value of the outside option exactly meets the value of the original investment.

Following the arguments of incomplete contracts both companies try to hold the magnitude of the distortions as low as possible from the beginning. The negotiating positions, the value of the outside options at the end of period 2 are anticipated and the administration rights are distributed accordingly already in period 0.

In other words: the theory of incomplete contracts leads to a solution which is economically efficient with respect to the constellations possible.[3] The interdependent relationship between administration rights, property rights and the IT architecture chosen becomes apparent, leading to the following results:

1. When establishing an integrated IT system, only one of the partners should receive all administration rights. Proof: If both companies disposed of partial administration rights, the propensity to invest of one company could be increased by redistributing the administration rights, without affecting the other. For example $V^J = 0$ and $V^F > 0$ with $A^F = A(S_F, S_J)$ could be a result [4].

2. With a system which is based on standardized interfaces both companies should hold the administration rights for their sub-system. Proof: If a company received all administration rights then transferring administration to the other company would increase its propensity to invest without decreasing the investment readiness of the dispensing company.

3. Deviations from these solutions lead to disadvantageous economic side effects. If, for instance, the final good producer compelled a supplier to use not standardized, but proprietary interfaces, it improves its short-term negotiating power. But on the other hand this strategy causes the intermediate goods producer to lower its investment volume, which negatively affect the operational profit of the final good producer. The final goods producer has to solve a trade-off here: Improving the negotiating position or promoting a cost-efficient production of the intermediate good.

The distribution of administration rights and the choice of the IT system architecture coincide. From this follows that:

[3] Theoretically only this 'anticipated ex-post-2nd-best-solution' allows to incorporate incomplete contracts in general equilibrium models.

[4] This does not contradict the modus operandi that in reality a system administrator assign limited rights for parts of the system to others.

- When changing the organizational structure of a (multinational) company existing IT systems have to be taken into consideration. For instance, a merger of two companies can fail (i.e. the additional costs exceed the additional returns generated) if the IT systems cannot be integrated due to technical reasons.

- Which type of information and communication technology is spreading faster also depends on the cooperation between companies and thus on basic economic factors. A standardized interface solution is likely to occur with trading strategies, but a proprietary IT solution is more plausible the closer companies integrate. In a spot market the relationship between the trading partners is short-term and often anonymous. Homogenous goods are traded. Following the approach of the IT-administrations rights the companies keep their administrations rights completely because the costs of changing the trading partner have to be small. Therefore trading in spot markets relies on standardized interfaces (with or without data intermediaries). The value of the outside options are positive for both trading partners. But when the companies integrate or exclusively cooperate along the value chain, it is crucial due to the property rights view to protect the knowledge needed specifically for the products. 'Exit costs' then are higher the more integrated the IT systems are. Hence there is an incentive to favour proprietary IT solutions. Individual ERP- and CRM-systems[5] are more favoured by vertically integrated companies due to the Administrations Rights approach.

Alternative Formulation An alternative formulation of the IT Administration Rights Approach takes into account the IT service companies. Assuming a competitive market with free entry, company J has to pay market price P_{IT} to service provider Z for IT services. Two types of IT Administration rights are considered: $A(S_J)$ encompass the right of the intermediate producer to have access to databases, e.g. to make data entries etc. $A(S_Z)$ describes the right of the IT service provider to change source code of the software etc.

Company Z has two possibilities to spend gross earnings which are defined as revenues minus operating expenses: for dividends or as investments H in human-capital. In the long run equilibrium the free market condition assures that no 'dividend-orientated' company will survive in the market, because investments are necessary to stay in the market. But in the short run contracts are incomplete and the split of 'gross-earnings' cannot be observed by company J.

Company J is interested in investments of H because this lead to a 'better' IT System in terms of reliability, velocity and diminishes the amount spent for the internal IT department by D(H) with $D'(H) > 0$ and $D''(H) < 0$. A better IT system, provided by the IT service company, reduces the work time needed for data entries at J.

Hence the values of the outside options are:

[5] EPR: enterprise resource planning; CRM: customer relationship management

- with a proprietary solution / integrated system:

$$V^J\{H_Z, A(S_J, S_Z)\} > V^J\{A(S_J)\} = V^Z\{H_Z, A(S_Z)\} = 0 \qquad (9)$$

  As soon as a proprietary solution is built up, the investments of the IT Service company are sunk. Hence the value V_Z of its outside option is zero. The outside option $V^J\{A(S_J)\}$ of the intermediate producer also amounts zero, because it relies on know-how of the IT service company.

- with standardized interfaces:

$$V^J\{H_Z, A(S_J, S_Z)\} = \max\left\{V^J\{A(S_J)\}, V^Z\{H_Z, A(S_Z)\} > 0\right\} \qquad (10)$$

  Both companies can have outside options with positive values. The investments are not sunk for the IT service provider. On the other hand, the source code, databases etc. can be used further on due to standardized interfaces by the intermediate producer J. The administration rights are concentrated, the joint value cannot be higher than the maximum of the particular administrations rights.

The savings of J due to improvements of the IT system works like an extra profit which is split between J and Z by factor χ. Values of D, V^J and V^Z are assumed so that service contract between J and Z work out. Then the Nash-bargaining solution leads to:

$$U_Z = \chi\left\{D(H) - V^J(A^J) - V^Z(H_Z, A^Z)\right\} + V^Z(H_Z, A^Z) \qquad (11)$$

Assuming further that the investment costs in human capital are completely written off in the considered period, the IT service provider chooses its optimum investment volume H_Z^* in such a way that the profit function is maximized after amortizations ($U_Z - H_Z$). For the IT service company results:

$$H_Z^* : \chi D'(H) + (1-\chi)V_1^Z(H_Z^*, A^Z) = 1 \qquad (12)$$

The maximization of J is not shown here, because it has no direct influence on H due to the incompleteness of the contract. Equation 12 shows the underinvestment-problem (hold-up): Factor χ diminishes the relevant marginal return $D'(H)$. This is outweighed by a preferable high value of $V_1^Z(H_Z^*, A^Z)$, which can be achieved by an appropriate distribution of the IT Administration Rights. In the case of a system with standardized interfaces this means that the IT service provider remain independent. Compared to the joint solution $V_1^J\{H_Z, A(S_J, S_Z)\}$ the independency raises the value of the outside option.

On the other hand with a proprietary system the best way is to integrate the service provider Z into the IT department of J to create an positive value of the outside option $V^J\{H_Z, A(S_J, S_Z)\}$ of the merged company. The result leads to Lemma 2, which is introduced below.

Criticism of this approach This approach, which relates organizational issues with information technology is simplified by the choice between only two architectures. In reality neither solution shall be observed in pure form, but nevertheless this theoretical approach gives important hints into economic trends in the real world. However this approach can also be criticized from a model-theoretical view:

- Companies have more than one trading partner. Hence, several ways of interaction and data interchange exist in reality.
- The results may change considering more than one period.
- The input factor 'trust' is not taken into consideration. Confidence between trading partners is a crucial precondition in order to raise total productivity. This may be true especially considering more than one period. LEAMER & STORPER (2001) point out, that trust comes from relationships, in the internet age particularly. Aspects such as trust and reliability may prevent changing the IT service provider even if standardized interfaces are implemented.
- Investments in IT have a double function in the presented model. They reduce the marginal cost or increase the marginal revenues, at the same time they are necessary to build up the interfaces or to integrate the systems.
- The organizational consequences of choosing an IT architecture are not addressed. KLING & LAMB (2000) point out the importance of socio-technical support when an IT system is implemented. They describe one case where 'divisions fought cooperation with the new system, attacking its design, technical adequacy, and feasibility. This process dragged on for years, costing numerous hours of effort and meetings. Divisional accountants even attempted to sabotage the system ..'.

Summary However, this criticism does not change the main result, which is that the choice of organizational structures and the type of the IT systems architecture coincide. The first example of incomplete contracts shows that final and intermediate producers distribute their IT Administrations Rights according to their organizational structure. Integrated companies also integrate their IT systems. So IT Administrations Rights become a subset of the more general property rights. The second example of incomplete contracts shows that the distribution of Administrations rights between goods producing and IT service companies also follows the requirement either to build up an integrated system or to leave the IT systems separated. To sum up, the relationship between the IT Service company and intermediate producer follows the organizational structure between intermediate and final goods producer. Table 1 summarize the possible combinations:

In the following model with IT-services in macroeconomic general equilibrium model two conclusions are used particularily:

	(Multinational) Company, e.g. holding	Final and intermediate producer separated
Property Rights	Concentrated	Separated
Technology	Integrated IT system; Software: Proprietary solutions	Interface solution; Software: Standard solutions
Network	Intranet	Internet
IT Administration rights	Concentrated	Separated
IT Services	Department of holding	Independent service company

Table 1: Property Rights and Administration Rights

- **LEMMA 1**: The Distribution of IT Administration Rights is a mirror of the distribution of the Property Rights.
- **LEMMA 2**: The organizational structure between intermediate goods producer and IT service company is on par with the organizational structure between the final and intermediate good producer.

3 A General equilibrium approach

3.1 General Equilibrium Models and Property Rights

In this section a general equilibrium model is described which allows the factor endowments to be linked to IT systems architecture.

According to the theory of COASE (1937) the distribution of property rights doesn't matter as long as they are distributed consistently. Hence, this topic has for a long time been ignored in economic literature in contrast to management literature. Newer work points out the interdependence between organizational structures and trading patterns and considers the choice of the organizational structure of a company as endogenous in general equilibrium (GE) models. In these models incomplete contracts or incentive systems for managers are integrated to overcome the conclusions of Coase that the distribution of property rights is irrelevant from a macroeconomic point of view. Examples for GE-models are the model from ANTRAS et al. (2005) in which communication costs determine the quantity and quality of international outsourcing. Similar is the approach of ANTRAS (2003) which is described in this chapter in more detail. Other authors model search costs more explicitly (e.g. GROSSMAN & HELPMAN (2005), RAUCH & TRINDADE (2003), GROSSMAN & HELPMAN (2002)). A comprehensive overview about the GE-models with endogenous determination of the organizational structure is given by SPENCER (2005).

3.2 Structure of the model

The model consists of 2 countries, 2 factors, 2 industries with 3 sectors (production stages IT-Services, intermediate and final goods production) and 2 organizational forms.

The key assumptions of the model are:

- Countries A and B only differ in their endowments of capital and labour.
- Trade of intermediates is possible, No trading costs occur. Factors are internationally immobile. Also final goods are not tradable, so that final goods producers produce their varieties in all J countries. Cost of assembling the final product is zero.
- Each variety y(i) of the final goods requires a special and distinct intermediate input $x_y(i)$, $z_y(i)$ for varieties i respectively.
- Each final good producer decides whether to obtain the intermediate from a vertically integrated supplier or from a stand-alone supplier.
- Investments in capital and labour are chosen simultaneously and not cooperatively by the final good producer and its supplier. They cannot contract on them because no outside party can verify the amounts. The investments are useless outside the relationship. Only the allocation of the residual rights and a lump-sum transfer $T_k(i)$ is contractible ex ante.
- Incomplete Contracts; Bargaining leaves the final goods producer with a fraction ϕ, $1/2 < \phi < 1$ of the ex post gains from trade.
- IT-Services are used to organize the relationship between final goods and intermediate goods producers. They are necessary for each variant; IT Services are produced with capital-labour intensity of the world endowment. Total costs for IT services are proportional to the number of variants of the final good. The IT Administration Rights approach presented in section 2 holds: the relationship between the IT Service Company and intermediate producer follows the organizational structure between intermediate and final goods producer.
- Two industries Y and Z. Industry Y is more capital-intensive than industry Z.
- Free market entry: zero-profit condition in General Equilibrium.
- Factor price equalization (FPE) holds, e.g. country specific and world relative factor endowments are 'not too different'. Equilibrium prices and aggregate allocations are those of an integrated economy.
- Consumers have identical preferences and have a love for variety. They consider the varieties in each industry Y and Z as differentiated. They allocate a constant share μ, $0 < \mu < 1$ of their spending to sector y, and

$1-\mu$ to sector Z. Decisions are not time-dependent, no discount of future revenues.

- Products are produced with the same technology.

For a list of variables see appendix ??.

3.3 The basic setup - Integrated Economy

First the integrated world economy is described. At the end of the section the wage- interest-rate ratio is determined which is valid in both countries due to factor price equalization.

3.3.1 Demand

The preferences of the representative consumer are identical in both countries:

$$U = \left(\int_0^{n_y} y(i)^{\alpha} di\right)^{\mu/\alpha} \left(\int_0^{n_z} z(i)^{\alpha} di\right)^{\frac{1-\mu}{\alpha}} \tag{13}$$

with elasticity of substition between any two varieties in a given sector

$$\frac{1}{1-\alpha} > 1$$

and

$$0 < \mu < 1$$

for a constant share μ which is spend for sector Y by the customers. The number of varieties n_y produced in industry Y and number of varieties n_z produced in industry Z are determined endogenously.

Due to the unit elasticity the demand for two sectors Y and Z, can be calculated separately. First following ANTRAS (2003) the solution for an integrated economy is described, so that country specific indexes are omitted.

With nominal total expenditure

$$E = \int_0^{n_y} (p_y(i)y(i))di + \int_0^{n_z} (p_z(i)z(i))di \tag{14}$$

leads to a demand function for a variant i of industry Y products:

$$y(i) = \mu E \frac{p_Y(i)^{-\frac{1}{1-\alpha}}}{\int_0^{n_y} p_y(i)^{\frac{\alpha}{\alpha-1}} di} \tag{15}$$

with $p_Y(i)$ as the price for the variant and $P_Y = \int_0^{n_y} p_y(i)^{\frac{\alpha}{\alpha-1}}$ as a price index. The calculus is listed in appendix A in detail.

Rearranging and splitting the price index in two sub indices lead to:

$$y(i) = A_Y p_Y(i)^{-\frac{1}{1-\alpha}} \tag{16}$$

with

$$A_Y = \frac{\mu E}{\int_0^{n_{Y,I}} p_{Y,I}(j)^{-\frac{\alpha}{1-\alpha}} dj + \int_0^{n_{Y,S}} p_{Y,S}(j)^{-\frac{\alpha}{1-\alpha}} dj} \tag{17}$$

$p_{Y,V}$ for the price index for final products of integrated companies and $p_{Y,O}$ for price index for final products with separated intermediate producers.

In general equilibrium E also amounts

$$E = rK^* + wL^* \tag{18}$$

with K^* and L^* as factor supply. The factors cannot be traded internationally, but labour and capital are homogenous and flexible within a country, so that demand for labour and capital always equals supply in general equilibrium.

3.3.2 Production

Three sectors exist in the integrated economy: final good producers, intermediate good producers and IT services. The variable cost function for producing the intermediates for varieties of industry k, $k \in \{Y, Z\}$ depends on a Cobb-Douglas production function:

$$X_k(i) = \left(\frac{K_{x,k}(i)}{\beta_k}\right)^{\beta_k} \left(\frac{L_{x,k}(i)}{1-\beta_k}\right)^{1-\beta_k} \tag{19}$$

with $K_{x,k}(i)$ and $L_{x,k}(i)$ for the amount of capital and labour used for production of variety i in industries Y or Z respectively.

Each final product needs one specific intermediate. For managing the production chain IT Services are used. The Administration Rights are distributed according to the result presented in section 2:

- When final good and intermediate goods producers are integrated, the Administration Rights should be centralized. An IT service department is integrated into the headquarter of the integrated company.
- While the companies of the production chain are separated legally, the IT Service company remains independent as well.

Despite section 2, here the volume of investment in IT Services does not depend on the overall revenue or cost functions, but on the number of variants produced. For each pair of final and intermediate goods IT Services are necessary, which are produced with a fix amount of capital K_0 and labour L_0, which corresponds to the factor endowment of the integrated economy:

$$K_0 = \zeta K^* \tag{20}$$

$$L_0 = \zeta L^* \tag{21}$$

with $0 < \zeta < 1$. The IT service costs for producing a variant of the final good are

$$D = rK_0 + wL_0 = r\zeta K * + w\zeta L* \tag{22}$$

Free entry into the IT service sector is assumed so that profits for IT service companies are zero and D can be integrated into the profit function of the intermediate goods producer directly. It is assumed that the intermediate supplier have to cover the costs of all IT Services. With regard to these assumptions, it is emphasized in section 4 that international trade in IT services occurs without differences in production functions or factor input.

The production function of a variant of the final product of sector Y yields[6]

$$y(i) = x(i) \tag{23}$$

with total cost function for producing a variant of the final product is

$$C_Y(i) = r(K_Y(i) + K_0) + w(L_Y(i) + L_0) + T - T \tag{24}$$

with (rK + wL) for capital and labour employed in equation 19, $(rK_0 + wL_0)$ for capital and labour used for the IT services, and T the lump sum transfer, paid by the intermediate producer (-T) to the final good producer (+T) at the beginning of their relationship. For sector Z respectively.

3.4 Organization

3.4.1 Timing

NASH-Bargaing

The contracts between final and intermediate goods producers are incomplete according to GROSSMAN & HART (1986). The contract between IT service companies and the goods producers follows the organizational structure of the main-contract as described in section 2. Two organizational forms between the producers can occur: Either integration or separation. The decision on the relationship between the two companies depends on the anticipated result of a Nash bargaining process. In detail the timing of events in the negotiations between final and intermediate goods producers are:

- t_0: Choice of organizational structure: integration or separation; Simultaneous decisions are made on the ownership of K (and if K is lent to the supplier by the final goods producer) and the volume of ex-ante transfer T, which is paid from the supplier to the final goods producer to buy into the relationship.
- t_1: The contracts with the IT service company and the ex-ante investments in capital and labour are carried out.
- t_2: The intermediates X are produced.

[6] Alternatively a production function such as $y(i) = \chi(K_0, L_0)x(i)$ with a efficiency parameter $\chi > 1$ could be assumed. When χ would depend on capital and labour invested in IT Services the model would loose mathematical tractability without gaining further insight.

- t_3: The producers bargain over the surplus after having sold the final products, the Nash bargaining process takes place. Volumes of ex-ante investment and the quality of the intermediates are observable for both companies. The values of the outside options are shown in table 2.

- t_4: The final goods are produced and sold.

First the parties are remunerated according to their outside options then, the residual revenues are bargained over. The outside options are 0 for the intermediate goods producer either by integration and separation because the intermediates are specific for the final products. For the final goods producer the outside option is 0 in the case of separation because it has no possibility to change to another intermediate producer by assumptions made above. In the case of integration it is assumed that the final goods producer holds only a fraction $0 < \delta < 1$ of the residual right to use the x(i) for selling final products y(i). The amount of $\delta y(i)$ can be sold for a higher price which is $p_y(i) = A_y^{1-\alpha}(\delta y(i))^{-(1-\alpha)}$ according to 16.

The potential revenues from the sale of a final product of sector Y are

$$R_Y(i)^* = p_y(i)y(i) \tag{25}$$

Rearranging 16 leads to

$$p_y(i) = \left(\frac{y(i)}{A_Y}\right)^{\alpha-1}$$

Including this, 25 and 19 results in

$$R_Y(i)^* = A_Y^{1-\alpha}y^\alpha = A_Y^{1-\alpha}\left(\frac{K_{x,Y}(i)}{\beta_Y}\right)^{\alpha\beta_Y}\left(\frac{L_{x,Y}(i)}{1-\beta_Y}\right)^{\alpha(1-\beta_Y)} \tag{26}$$

By assumption the bargaining process in t_3 ends up with a share of $1/2 < \phi < 1$ from the residual revenues which are taken the final goods producers. If the negotiating process has been successful in the case of separation the revenues for the final goods producers amount ϕ of potential revenues R_Y^*, and $1-\phi$ for the intermediate goods producer respectively. In the case of integration the final goods producer first gets a amount of $(\delta y)(A_y^{1-\alpha}(\delta y(i))^{-(1-\alpha)})$ which equals a share δ^α of potential revenues R_Y^*. The remaining $(1-\delta^\alpha)R_Y^*$ is shared according to ϕ. Table 2 summarizes the revenue sharing:

The table shows that the supplier has weaker bargaining power in the case of integration and a relatively stronger position in the case of separation.

Anticipating the Nash Bargaining process the companies decide on their investment volumes in t_1. The investment volumes depend on the organizational structure which is forecasted by t_1.

3.4.2 Optimal Output

According to table 2 the final goods producers maximise profit

$$\overline{\phi}R_Y(i) - rK_{x,Y,I}(i) \Rightarrow MAX! \tag{27}$$

Profit share	Final Goods Producer	Intermediate Goods Producer
Incomplete Contracts: Integration	$\delta^{\alpha} R_Y^* + \phi (1 - \delta^{\alpha}) R_Y^*$ $= \bar{\phi}\ R_Y^*$	$0 + (1 - \phi)(1 - \delta^{\alpha}) R_Y^*$ $= (1-\bar{\phi}) R_Y^*$
Incomplete Contracts: Separation	$0 + \phi R_Y^*$	$0 + (1 - \phi) R_Y^*$
Complete Contracts	$\phi (R_Y^* - rK)$	$(1-\phi)(R_Y^* - wL)$

Table 2: Value of Outside-Options (first number) and share of ex-post gains from trade (second-number) in the case of a successful Nash-Bargaining process

with

$$\overline{\phi} = \delta^{\alpha} + \phi(1 - \delta^{\alpha}) > \phi$$

by choosing the investment volume of $K_{x,Y,I}(i)$.

Simultaneously the integrated supplier maximise its profit function

$$(1 - \overline{\phi})R_Y(i) - wL_{x,Y,I}(i) - D \Rightarrow MAX! \tag{28}$$

Analogously in the case of separation the companies maximize

$$\phi R_Y(i) - rK_{x,Y,S}(i) - D \Rightarrow MAX! \tag{29}$$

and

$$\phi R_Y(i) - wL_{x,Y,S}(i) - D \Rightarrow MAX! \tag{30}$$

by choosing the investment volumes of $K_{x,Y,S}(i)$ and $L_{x,Y,S}(i)$ respectively.

Optimization By inserting variable ψ_l with $l \in I, S$ and $\psi_I = \overline{\phi}$ and $\psi_S = \phi$ the maximization procedure can be calculated for both cases, integration and separation, simultaneously. The summands with D vanish with differentiation. For details of the calculation see appendix B.

Maximising 27 and 28 and solving the two resulting response-functions for $L_{x,Y,l}(i)$ and $K_{x,Y,l}(i)$ show the known factor-input-relationship of Cobb-Douglas production functions

$$\frac{\psi_l}{1 - \psi_l} \frac{w}{r} \frac{L_{Y,l}}{1 - \beta_Y} = \frac{K_{Y,l}}{\beta_Y} \tag{31}$$

Please note that 31 does not show the total factor-input-ratio of the sector because the costs for IT Services are not in the first derivatives of the profit functions. Solving the maximization problem the equilibrium ex-ante investments yield

$$K_{x,Y,l}(i) = \beta_Y A_Y \left({\psi_l}^{1-\alpha(1-\beta_Y)} (1 - \psi_l)^{\alpha(1-\beta_Y)} r^{\alpha(1-\beta_Y)-1} w^{-\alpha(1-\beta_Y)} \alpha \right)^{\frac{1}{1-\alpha}} \tag{32}$$

and

$$L_{x,Y,l}(i) = A_Y(1-\beta_Y)\left(\alpha\psi_l^{\alpha\beta_Y}(1-\psi_l)^{1-\alpha\beta_Y}w^{\alpha\beta_Y-1}r^{-\alpha\beta_Y}\right)^{\frac{1}{1-\alpha}} \tag{33}$$

IT service costs rK_0 and rL_0 are sufficiently small by assumption, so that positive yields are realized.

32 and 33 into 23 and 19 gives optimal output and prices:

$$y_l = A_Y\left({\psi_l}^{1-\alpha(1-\beta_Y)}(1-\psi_l)^{\alpha(1-\beta_Y)}r^{\alpha(1-\beta_Y)-1}w^{-\alpha(1-\beta_Y)}\alpha\right)^{\frac{\beta_Y}{1-\alpha}} \times$$
$$\left(\alpha\psi_l^{\alpha\beta_Y}(1-\psi_l)^{1-\alpha\beta_Y}w^{\alpha\beta_Y-1}r^{-\alpha\beta_Y}\right)^{\frac{1-\beta_Y}{1-\alpha}}$$

Rearranging leads to:

$$y_l = A_Y\left(\alpha r^{-\beta_Y}w^{\beta_Y-1}\psi_l^{\beta_Y}(1-\psi_l)^{1-\beta_Y}\right)^{\frac{1}{1-\alpha}} \tag{34}$$

Solving 16 for p_Y and inserting in 34 lead to:

$$p_{Y,l} = \frac{1}{\alpha r^{-\beta_Y}w^{\beta_Y-1}\psi_{lY}^{\beta}(1-\psi_l)^{1-\beta_Y}} = \frac{r_Y^{\beta}w^{1-\beta_Y}}{\alpha\psi_l^{\beta_Y}(1-\psi_l)^{1-\beta_Y}} \tag{35}$$

Marginal costs for producing an additional unit of a y-variant are $r_Y^{\beta}w^{1-\beta_Y}$. The standard result of models with monopolistic competition is that the price is $1/\alpha$ above marginal costs. Equation 35 shows that the price is $\psi_l^{\beta_Y}(1-\psi_l)^{1-\beta_Y}$ times higher than in a scenario with complete contracts: The incomplete contracts lead to distortions. The lower β_Y the more important is labour and the higher the mark-up.

The relation between ex-ante equilibrium revenues and factor costs is constant. For the final goods producer it is

$$\frac{p_{Y,l}y_l}{rK_{Y,l}} = \frac{A\left(\alpha r^{-\beta_Y}w^{\beta_Y-1}\psi_l^{\beta_Y}(1-\psi_l)^{1-\beta_Y}\right)^{\frac{\alpha}{1-\alpha}}}{r\beta_Y A_Y\left({\psi_l}^{1-\alpha(1-\beta_Y)}(1-\psi_l)^{\alpha(1-\beta_Y)}r^{\alpha(1-\beta_Y)-1}w^{-\alpha(1-\beta_Y)}\alpha\right)^{\frac{1}{1-\alpha}}}$$

$$\frac{p_{Y,l}\,y_l}{rK_{Y,l}} = \frac{1}{\alpha\beta_Y\psi} \tag{36}$$

Similarly the result for the supplier is

$$\frac{p_{Y,l}\,y_l}{wL_{Y,l}} = \frac{1}{\alpha(1-\beta_Y)(1-\psi)} \tag{37}$$

Profit Functions Now the expected profit of the supplier can be calculated. Due to competition between the suppliers the expected profit equals the Lump-Sum transfer T which is used in t_0 to buy into the relationship so that total profits of the supplier are zero in general equilibrium. Undoing the simplifying notification with $\psi_I = \overline{\phi}$ and $\psi_S = \phi$ the lump sum transfer in the case of integration yields according to 28

$$T_{Y,I} = (1-\overline{\phi})R_Y - wL_{x,Y} - D$$

$$T_{Y,I} = (1-\overline{\phi})p_{Y,l}y_l - wL_{Y,l} - D$$

Using 37 and 16 leads to

$$T_{Y,I} = (1-\overline{\phi})(1-\alpha(1-\beta))A_Y p_{Y,l}^{\frac{-\alpha}{1-\alpha}} - D \tag{38}$$

Similarly the lump sum transfer in the case of separation is determined:

$$T_{Y,S} = (1-\phi)R_Y - wL_{x,Y} - D$$

$$T_{Y,S} = (1-\phi)(1-\alpha(1-\beta))A_Y p_{Y,l}^{\frac{-\alpha}{1-\alpha}} - D \tag{39}$$

Using 27 and 29 now the ex-ante profit function of the final goods producer can be calculated. For the case of integration:

$$\Pi_{F,Y,I} = \overline{\phi}p_{Y,I}y_I - rK_{Y,I} + T_{Y,I} - D$$

And for the case of separation:

$$\Pi_{F,Y,S} = \phi p_{Y,S}y_S - rK_{Y,S} + T_{Y,S} - 0,5D$$

After rearranging using 16 and 36 this leads for the case of **integration** to:

$$\Pi_{F,Y,I} = (\overline{\phi} - \overline{\phi}\alpha\beta + (1-\overline{\phi})(1-\alpha+\alpha\beta))A_Y p_{Y,I}^{\frac{-\alpha}{1-\alpha}} - D$$

$$\Pi_{F,Y,I} = (1-\alpha+\alpha\beta-2\alpha\beta\overline{\phi}+\alpha\overline{\phi})A_Y p_{Y,I}^{\frac{-\alpha}{1-\alpha}} - D \tag{40}$$

with

$$p_{Y,I} = \frac{r^\beta w^{1-\beta}}{\alpha\overline{\phi}^\beta(1-\overline{\phi})^{1-\beta}}$$

and for the case of **separation** to the profit function of the final goods producer of

$$\Pi_{F,Y,S} = (\phi - \phi\alpha\beta + (1-\phi)(1-\alpha+\alpha\beta))A_Y p_{Y,S}^{\frac{-\alpha}{1-\alpha}} - D$$

$$\Pi_{F,Y,S} = (1-\alpha+\alpha\beta-2\alpha\beta\phi+\alpha\phi)A_Y p_{Y,S}^{\frac{-\alpha}{1-\alpha}} - D \tag{41}$$

with

$$p_{Y,S} = \frac{r^\beta w^{1-\beta}}{\alpha\phi^\beta(1-\phi)^{1-\beta}}$$

.

Equations 40 and 41 show that on a more aggregate level it makes no difference in financial terms who finances the IT Service costs in the first instance. The share of the IT Service costs paid by the supplier are carried forward.

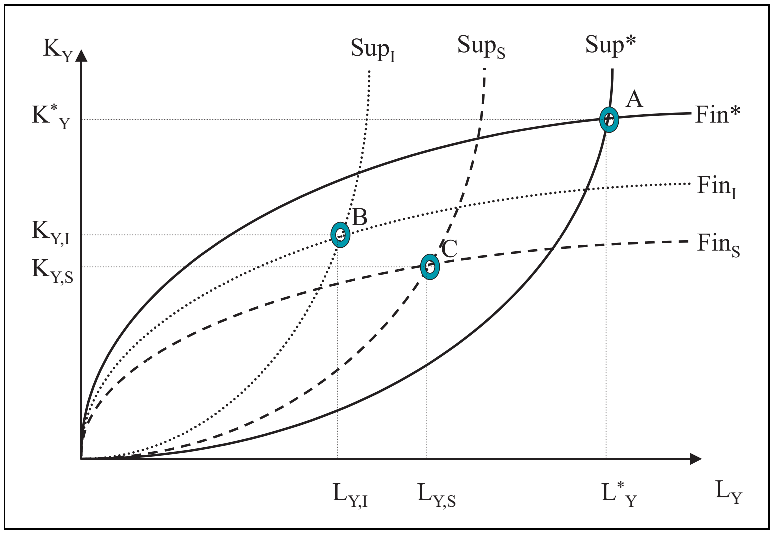

Figure 1: Complete vs. Incomplete Contracts with $\overline{\phi} > \phi > 1/2$; Source:ANTRAS (2003)

3.4.3 Comparison with Complete Contracts

In the case of complete contracts intermediate and final goods producers share the total profit $p_y(i)y(i)-rK_Y(i)-wL_Y(i)-D$ according to the negotiated shares ϕ and $(1-\phi)$. Figure 2 also shows the differences. The two companies optimize their profits by choosing K (final product producer) and L (intermediate product producer), assuming that the fixed costs for IT-Service are small enough so that profit remains positive. Optimization (see appendix C for details) leads to the factor demands of

$$L_Y^c = A_Y(1-\beta)\left(\alpha w^{\alpha\beta-1}r^{-\alpha\beta}\right)^{\frac{1}{1-\alpha}} \tag{42}$$

and

$$K_Y^c = \beta A_Y\left(r^{\alpha(1-\beta)-1}w^{-\alpha(1-\beta)}\alpha\right)^{\frac{1}{1-\alpha}} \tag{43}$$

Comparing 42 with 33 ánd 43 with 32 shows for $0 < \psi < 1$ that $K_Y^c > max\left\{K_{Y,I}, K_{Y,S}\right\}$ and $L_Y^c > max\left\{L_{Y,I}, L_{Y,S}\right\}$. This formally proves the hold-up-problem, that in the case of incomplete contracts investments are lower than in the case of complete contracts. In the case of complete contracts companies can be sure that they are fully rewarded for their investments. This is not the case with incomplete contracts therefore their investments in capital and labour are lower depending on their negotiating power. In figure 1 the point A showing the case of complete contracts is in the upper corner of the K-L-diagram.

The curves Sup and Fin represent the reaction functions of the supplier and the final goods producer in the scenarios of complete contracts (*), Integration (I) or Separation (S). The curves are a result of the optimization process described before without taking into account the costs for IT services. The investments are more capital-intensive in the case of integration (point B), and more labour-intensive in the case of separation (point C). This directly follows from table 2 because the intermediate goods producer has a relatively stronger bargaining position in the case of separation.

Formally, the relative distance between the curves Fin_I, Fin_S remains constant, curves Sup_I, Sup_S respectively. For example the ratio between the demand of capital from an integrated final goods producer and a separated final goods producer is according to 32 yields

$$\frac{K_{Y,I}}{K_{Y,S}} = \frac{\beta_Y A_Y \left(\overline{\phi}_l^{\,1-\alpha(1-\beta)}(1-\overline{\phi}_l)^{\alpha(1-\beta_Y)} r^{\alpha(1-\beta_Y)-1} w^{-\alpha(1-\beta_Y)} \alpha\right)^{\frac{1}{1-\alpha}}}{\beta_Y A_Y \left(\phi_l^{\,1-\alpha(1-\beta)}(1-\phi_l)^{\alpha(1-\beta_Y)} r^{\alpha(1-\beta_Y)-1} w^{-\alpha(1-\beta_Y)} \alpha\right)^{\frac{1}{1-\alpha}}}$$

which reduces to

$$\frac{K_{Y,I}}{K_{Y,S}} = \left[\frac{\overline{\phi}}{\phi}\,\frac{1-\phi}{1-\overline{\phi}}\right]^{\frac{1-\alpha(1-\beta_Y)}{1-\alpha}} > 1$$

for the case of $\overline{\phi} > \phi > 1/2$. According to its reaction function the final goods producer in an integrated company always chooses a higher investment in capital due to a stronger negotiating position. The proves that the other relationships shown in figure 1 can be done accordingly: a supplier will choose a higher investment in labour in the case of separation. In other words: the supplier would choose a higher capital-labour-ratio in the case of integration, which leads to industry specific investment behaviour described. Section 3.6 will show this in the general equilibrium.

3.5 Ownership Structures

The profit situation of a final goods producer also depends on the organizational structure, as the comparison between 40 and 41 shows. Therefore the final goods producer will integrate its supplier, when

$$\Pi_{F,Y,I} > \Pi_{F,Y,S}$$

Subtracting the costs for IT services on both sides leads to the condition that

$$\theta = \frac{\Pi_{F,Y,I} - D}{\Pi_{F,Y,S} - D} > 1 \tag{44}$$

Using the relationship $\overline{\phi} = \delta^\alpha + \phi(1-\delta^\alpha)$ and 40 and 41 the parameter θ can be expressed as a function of the models parameters:

$$\theta = \frac{1-\alpha+\alpha\beta-(2\alpha\beta-\alpha)(\delta^\alpha+\phi(1-\delta^\alpha))}{1-\alpha+\alpha\beta-(2\alpha\beta-\alpha)\phi} \times \left(\frac{\phi^\beta(1-\phi)^{1-\beta}}{[\delta^\alpha+\phi(1-\delta^\alpha)]^\beta(1-(\delta^\alpha+\phi(1-\delta^\alpha)))^{1-\beta}}\right)^{\frac{-\alpha}{1-\alpha}} \tag{45}$$

Rearranging with $1-(\delta^\alpha+\phi(1-\delta^\alpha)) = (1-\delta^\alpha)(1-\phi)$ leads to:

$$\theta = \left(1 + \frac{\alpha(2\beta-1)\delta^\alpha(\phi-1)}{1-\alpha+\alpha\beta-(2\alpha\beta-\alpha)\phi}\right)\left(\frac{\phi^\beta(1-\delta^\alpha)^\beta}{[\delta^\alpha+\phi(1-\delta^\alpha)]^\beta(1-\delta^\alpha)}\right)^{\frac{-\alpha}{1-\alpha}}$$

$$\theta = \left(1 + \frac{\alpha(2\beta - 1)\delta^{\alpha}(\phi - 1)}{1 - \alpha + \alpha\beta - (2\alpha\beta - \alpha)\phi}\right)\left(1 + \frac{\delta^{\alpha}}{\phi(1 - \delta^{\alpha})}\right)^{\frac{\alpha\beta}{1-\alpha}}(1 - \delta^{\alpha})^{\frac{\alpha}{1-\alpha}} \quad (46)$$

The organizational structure between final and intermediate goods producers depend on the fundamental parameters of the model. For $\theta > 1$ all suppliers will be integrated, for $\theta < 1$ they will remain independent.

For further analysis the elasticity β_Y is focussed upon. The derivate yields

$$\frac{\partial\theta}{\partial\beta} > 0$$

for all $0 < \beta < 1$. For details see appendix D. The attractiveness of integration increases with the capital intensity of the intermediate production, because an underinvestment in a capital-intensive sector harms more than capital underinvestment in a labour-intensive one.

Further it is assumed, that there is a knife-edge case $\widehat{\beta}$ for which $\theta = 1$. [7]

- pervasive integration: $\beta > \widehat{\beta}$
- mixed integration (knife-edge case): $\beta = \widehat{\beta}$
- pervasive outsourcing (separation): $\beta < \widehat{\beta}$

To rebuild an economy with diversified organizational structures it is further assumed that one industry is more capital-intensive the other more labour-intensive than a reference industry with elasticity $\widehat{\beta}$:

$$\beta_Z < \widehat{\beta} < \beta_Y \quad (47)$$

which means that industry Y is relatively more capital-intensive and the final and intermediate goods producers tend to integrate.

3.6 General Equilibrium

With this information the model for the closed economy can be described completely by calculation the number of companies, sector specific output, the demand for labour and capital and the wage-interest-rate ratio. Each of these sector specific variables vary with the organizational structure chosen. The knife-edge case with $\beta = \widehat{\beta}$ is not considered further.

In a general equilibrium total expenditure equals factor revenues $E = rK^* + wL^*$ (see 18). The aim now is to calculate the sector-specific factor demands and the output in general equilibrium, which strongly depends on the number of companies n.

[7] The existence of such a $\widehat{\beta}$ can be proved formally. Given the derivative $\frac{\partial\theta}{\partial\beta} > 0$ for all $0 < \beta < 1$ it can be shown, that there exist a β_1 for which $\theta < 1$ and a β_2 for which $\theta > 1$. See ANTRAS (2003)

Integration First the number of companies in the integrated sector Y is calculated. In equilibrium the free entry to the markets implies that profit as defined in 40 becomes zero. According to standard results in models with monopolistic competition the contribution-margins are used to cover fix costs. So 40 becomes to

$$A_Y p_{Y,I}^{\frac{-\alpha}{1-\alpha}} = \frac{D}{1-\alpha+\alpha\beta_Y-2\alpha\beta_Y\overline{\phi}+\alpha\overline{\phi}} \tag{48}$$

On the other hand the overall demand for variants of the sector determine the factor $Ap_{Y,I}$.

The firms of one sector behave symmetrically, so all companies integrate ($n_{Y,S} = 0$) and charge identical prices p_Y. With this information 17 change to

$$A_Y = \frac{\mu E}{n_{Y,I} p_{Y,I}^{\frac{-\alpha}{1-\alpha}}}$$

Inserting $A_Y p_{Y,I}^{\frac{-\alpha}{1-\alpha}}$ into 48 leads to the number of integrated firms in sector y:

$$n_Y = \frac{1-\alpha+\alpha\beta_Y-2\alpha\beta_Y\overline{\phi}+\alpha\overline{\phi}}{D}\mu E = \frac{\mu}{\zeta}(1-\alpha+\alpha\beta_Y-2\alpha\beta_Y\overline{\phi}+\alpha\overline{\phi}) \tag{49}$$

The number of companies in industry Y is independent of the endowment with labour and capital: mathematically demand side effects of a rise of capital or labour (higher expenditures) μE are offsetted by higher fix costs D so that the number of variants remains constant.

With 34 and $\psi = \overline{\phi}$, the optimal output of a variant is defined. This can be rearranged to

$$y_I = \frac{\alpha D}{1-\alpha+\alpha\beta_Y-2\alpha\beta_Y\overline{\phi}+\alpha\overline{\phi}} \frac{(1-\overline{\phi})^{1-\beta_Y}\overline{\phi}_Y^{\beta}}{w^{1-\beta_Y} r_Y^{\beta}} \tag{50}$$

Finally w and r have to be determined. The wage w is the equilibrium price on the labour market, so that labour demand equals L^d supply L^* with

$$L^d = L_Y^d + L_Z^d \tag{51}$$

Total labour demand from industry Y is given by n-times the labour demand induced by the production process of a variant:

$$L_Y^d = n_Y(L_{x,Y,I} + L_0) \tag{52}$$

Using 21, 33 and 49 leads to:

$$L_Y^d = \frac{\mu}{\zeta}(1-\alpha+\alpha\beta_Y-2\alpha\beta_Y\overline{\phi}+\alpha\overline{\phi}) \times$$
$$\left[A_Y(1-\beta_Y)\left(\alpha\overline{\phi}^{\alpha\beta_Y}(1-\overline{\phi})^{1-\alpha\beta_Y} w^{\alpha\beta_Y-1} r^{-\alpha\beta_Y}\right)^{\frac{1}{1-\alpha}} + \zeta L^*\right]$$

Inserting 48 and 35 for A this leads after rearranging to

$$L_Y^d = \mu(rK^* + wL^*)\frac{\alpha(1-\beta_Y)(1-\overline{\phi})}{w} + \mu L^*(1-\alpha+\alpha\beta_Y - 2\alpha\beta_Y\overline{\phi} + \alpha\overline{\phi}) \quad (53)$$

or

$$L_Y^d = \mu\left[rK^*\frac{\alpha(1-\beta_Y)(1-\overline{\phi})}{w} + L^*(1-\alpha\beta_Y\overline{\phi})\right] \quad (54)$$

The first summand shows the effects of a rising endowment with capital: due to a constant number of variants the output of one variant rises causing a higher demand of labour with dependence on elasticity of substitution, production technology and negotiation position of capital owners, which is off-setted by a rise of the wage w. The second summand shows that a rising endowment with labour has the effect that w has to fall but this effect is dampened by $\alpha\beta\overline{\phi}$. If ϕ and hence $\overline{\phi}$ are relatively small the distribution of the profits favours the intermediate department of the integrated company (see table 2) so that they are interested in investing more in labour. The greater ϕ the worse the underinvestment in labour compared to a world with complete contracts.

The solution for capital is analogue. The demand for capital is

$$K_Y^d = K_Y^d + K_Z^d \quad (55)$$

with

$$K_Y^d = n_Y(K_{x,Y,I} + K_0) \quad (56)$$

Inserting 32, 48 and 35 in 56 gives:

$$K_Y^d = \frac{\mu}{\zeta}\left[\alpha\beta_Y D\frac{\overline{\phi}}{r} + \zeta K^*(1-\alpha+\alpha\beta_Y - 2\alpha\beta_Y\overline{\phi} + \alpha\overline{\phi})\right]$$

$$K_Y^d = \mu(rK^* + wL^*)\alpha\beta_Y\frac{\overline{\phi}}{r} + \mu K^*(1-\alpha+\alpha\beta_Y - 2\alpha\beta_Y\overline{\phi} + \alpha\overline{\phi}) \quad (57)$$

Rearranging further leads to:

$$K_Y^d = \mu\left[\alpha\beta_Y\overline{\phi}\frac{w}{r}L^* + K^*(1-\alpha(1-\overline{\phi}) + \alpha\beta_Y(1-\overline{\phi}))\right] \quad (58)$$

The higher ϕ, the higher are $\overline{\phi}$ and the demand for capital. In the second summand $0 < \alpha\beta_Y < \alpha < 1$: When $\overline{\phi}$ rises the diminishing effect of $\alpha\beta_Y\phi$ is outweighed by $\alpha\phi$.

Separation For sector Z, which is characterized by the separation of final, intermediate goods producers and IT service companies, the arguments are similar to the last paragraph: 17 for sector Z reads

$$A_Z = \frac{(1-\mu)E}{\int_0^{n_{Z,I}} p_{Z,I}(j)^{-\frac{\alpha}{1-\alpha}}dj + \int_0^{n_{Z,S}} p_{Z,S}(j)^{-\frac{\alpha}{1-\alpha}}dj} \quad (59)$$

With $n_{Y,I} = 0$ and profit function 41 changed for sector Z and setting zero the optimal number of final products suppliers in sector yields:

$$n_Z = (1 - \alpha + \alpha\beta_Z - 2\alpha\beta_Z\phi + \alpha\phi)\frac{(1-\mu)}{\zeta} \tag{60}$$

Accordingly the values for parameter A, variant output z_S, labour and capital demand of sector Z are

$$A_Z p_{Z,S}^{\frac{-\alpha}{1-\alpha}} = \frac{D}{1 - \alpha + \alpha\beta_Z - 2\alpha\beta_Z\phi + \alpha\phi} \tag{61}$$

$$z_S = \frac{\alpha D}{1 - \alpha + \alpha\beta_Z - 2\alpha\beta_Z\phi + \alpha\phi}\frac{(1-\phi)^{1-\beta_Z}\phi_Z^{\beta}}{w^{1-\beta_Z}r_Z^{\beta}} \tag{62}$$

$$L_Z^d = (1-\mu)(rK^* + wL^*)\frac{\alpha(1-\beta_Z)(1-\phi)}{w} + (1-\mu)L^*(1-\alpha+\alpha\beta_Z-2\alpha\beta_Z\phi+\alpha\phi) \tag{63}$$

or

$$L_Z^d = (1-\mu)\left[rK^*\frac{\alpha(1-\beta_Z)(1-\phi)}{w} + L^*(1-\alpha\beta_Z\phi)\right] \tag{64}$$

$$K_Z^d = (1-\mu)(rK^* + wL^*)\alpha\beta_Z\frac{\phi}{r} + (1-\mu)K^*(1-\alpha+\alpha\beta_Z-2\alpha\beta_Z\phi+\alpha\phi) \tag{65}$$

or

$$K_Z^d = (1-\mu)\left[\alpha\beta_Z\phi\frac{w}{r}L^* + K^*(1-\alpha(1-\phi)+\alpha\beta_Z(1-\phi))\right] \tag{66}$$

Comparing the equations for industries Y and Z shows that the differences between the sectors are the factor intensities $\beta_Z < \beta_Y$ and the different negotiation position, as characterized by the difference between ϕ and $\overline{\phi}$. Nevertheless, also in the case of separation a high ϕ favours capital holders, a small ϕ labour.

Now the wage-interest-ratio can be calculated: In equilibrium the factor prices adjust so that labour demand equals labour supply. Inserting 54 and 64 in 51 yields[8]:

$$\frac{w}{r} = \frac{K^*[(1-\beta_Y)(1-\overline{\phi}) + (1-\beta_Z)(1-\phi)]}{L^*[\beta_Y\overline{\phi} + \beta_Z\phi]} \tag{67}$$

This equation has a striking implication for the distribution of income: if the negotiation power of the final goods producer against their supplier rises (higher values of ϕ and $\overline{\phi}$) the wage-interest-rate ratio falls. Interpreting the assumptions for real world the equations imply that in a case of capital-intensive holdings, as final goods producers and labour-intensive SMEs as suppliers best policy for labour unions would be to support the negotiating power of SME.

Finally the distribution of income can be calculated directly:

$$\frac{L^*w}{K^*r} = \frac{(1-\beta_Y)(1-\overline{\phi}) + (1-\beta_Z)(1-\phi)}{\beta_Y\overline{\phi} + \beta_Z\phi} \tag{68}$$

[8]Alternatively one factor can be choosen as numeraire for the system, so that w and r could be calculated unambiguously.

4 2-Country-Model

4.1 Factor Price Equalization

The aim of the model is to describe the exchange pattern of International IT Services accompanying multinational companies. Therefore the integrated world presented in the previous section is split into 2 countries: A and B. To stress the effects of international trade some further assumptions are made: preferences and production technologies are identical in both countries, but endowments in capital and labour differ. These are the standard assumptions of Heckscher-Ohlin type models (see FEENSTRA (2004) for a recent overview) but here the final products as well as the input factors are assumed to be nontradable. Only intermediate products and associated IT services are tradable, either inhouse (integrated companies) or between companies (outsourcing solution). Following the arguments of HELPMAN & KRUGMAN (1985) it is assumed that factor price equalization holds, e.g. that the capital-labour-ration between the two countries does not differ 'to much' and so factor price equalization is caused by trade in intermediate goods.

Due to the fact that the optimal output of an intermediate is also determined by the costs of IT services and the mark-up parameter of the model (monopolistic competition), which are identical in both countries, the pivotal parameter for trade is the number n of variants produced. The next step therefore is to determine the equilibrium number of variants of industries Y and Z produced in countries A and B.

The number of variants of each country sum up to number of variants in integrated world economy:

$$n_Y^* = n_Y^A + n_Y^B \tag{69}$$

$$n_Z^* = n_Z^A + n_Z^B \tag{70}$$

Having determined overall demand for labour and capital the country specific demand for both factors depends on the share of variants produced in the country. Adding up 65 and 57 by using the country specific weights n_Y^A/n_Y^* and n_Z^A/n_Z^* gives the demand for capital and labour of country A:

$$K^A = \frac{n_Y^A}{n_Y^*}\left[\mu(rK^* + wL^*)\alpha\beta_Y\frac{\overline{\phi}}{r} + \mu K^*(1-\alpha+\alpha\beta_Y - 2\alpha\beta_Y\overline{\phi} + \alpha\overline{\phi})\right]$$
$$+\frac{n_Z^A}{n_Z^*}\left[(1-\mu)(rK^* + wL^*)\alpha\beta_Z\frac{\phi}{r} + (1-\mu)K^*(1-\alpha+\alpha\beta_Z - 2\alpha\beta_Z\phi + \alpha\phi)\right] \tag{71}$$

From 53 and 63

$$L^A = \frac{n_Y^A}{n_Y^*}\left[\mu(rK^* + wL^*)\frac{\alpha(1-\beta_Y)(1-\overline{\phi})}{w} + \mu L^*(1-\alpha+\alpha\beta_Y - 2\alpha\beta_Y\overline{\phi} + \alpha\overline{\phi})\right]$$
$$+\frac{n_Z^A}{n_Z^*}\left[(1-\mu)(rK^* + wL^*)\frac{\alpha(1-\beta_Z)(1-\phi)}{w} + (1-\mu)L^*(1-\alpha+\alpha\beta_Z - 2\alpha\beta_Z\phi + \alpha\phi)\right] \tag{72}$$

Solving this system for $\frac{n_Y^A}{n_Y^*}$ and $\frac{n_Z^A}{n_Z^*}$ yields:

$$\frac{n_Y^A}{n_Y^*} = \frac{\left(\frac{L^A}{L^*}\left[\xi\alpha\beta_Z\phi + \epsilon_Z\right] - \frac{K^A}{K^*}\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z\right]\right)}{\mu\left[DEN1 - DEN2\right]} \tag{73}$$

$$\frac{n_Z^A}{n_Z^*} = \frac{\frac{1}{(1-\mu)}\left(\frac{L^A}{L^*}\left[\xi\alpha\beta_Y\overline{\phi} + \epsilon_Y\right] - \frac{K^A}{K^*}\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi}) + \epsilon_Y\right]\right)}{DEN2 - DEN1} \tag{74}$$

with

$$\begin{aligned}
\xi &= (1 + \frac{wL^*}{rK^*}) \\
\frac{\xi}{\xi-1} &= (1 + \frac{rK^*}{wL^*}) \\
\epsilon_Z &= 1 - \alpha + \alpha\beta_Z - 2\alpha\beta_Z\phi + \alpha\phi \\
\epsilon_Y &= 1 - \alpha + \alpha\beta_Y - 2\alpha\beta_Y\overline{\phi} + \alpha\overline{\phi} \\
DEN1 &= \left(\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi}) + \epsilon_Y\right)\left[\xi\alpha\beta_Z\phi + \epsilon_Z\right] \\
DEN2 &= \left[\xi\alpha\beta_Y\overline{\phi} + \epsilon_Y\right]\left(\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z\right)
\end{aligned}$$

For details of the calculation please see appendix E.

Figure 2 shows the factor price equalization region of the two-country model. World endowment with capital and labour is represented by the total size of the box. Point E represents the division of the factors to country A, as measured from origin O^A, and country B with origin O^B. With factor price equalization the slope of the line EC represents with wage-interest-rate ratio. The lines of the parallelogram O^AYO^BZ show the factor intensities producing goods in industry Y (line O^AY) and Z (line O^AZ). In these lines the necessary factor inputs for IT services are already incorporated. The factor intensity of the IT Service sector itself is represented by line O^AO^B. Variants of industry Y are produced capital-intensive manner, variants of industry Z are produced more labour intensive fashion.

Shifting the lines of the parallelogram through point E leads to points F and G, which represent the number of variants produced by countries A and B. In an equilibrium country A produces $n_Y^A = \left|O^AF\right|$ variants of sector Y and $n_Z^A = |YG|$ variant of sector Z measured in units of labour and capital employed[9]. Analogously country B produces $n_Y^B = |FY|$ variants of sector Y and $n_Z^B = \left|O^BG\right|$ variants of sector Z.

[9]The basic concept of constructing the parallelogram is using the unit value isoquants (see HELPMAN & KRUGMAN (1985)). So a constant length of one side of the parallelogram could represent a higher output when the price for the product lowers, e.g. production becomes cheaper.

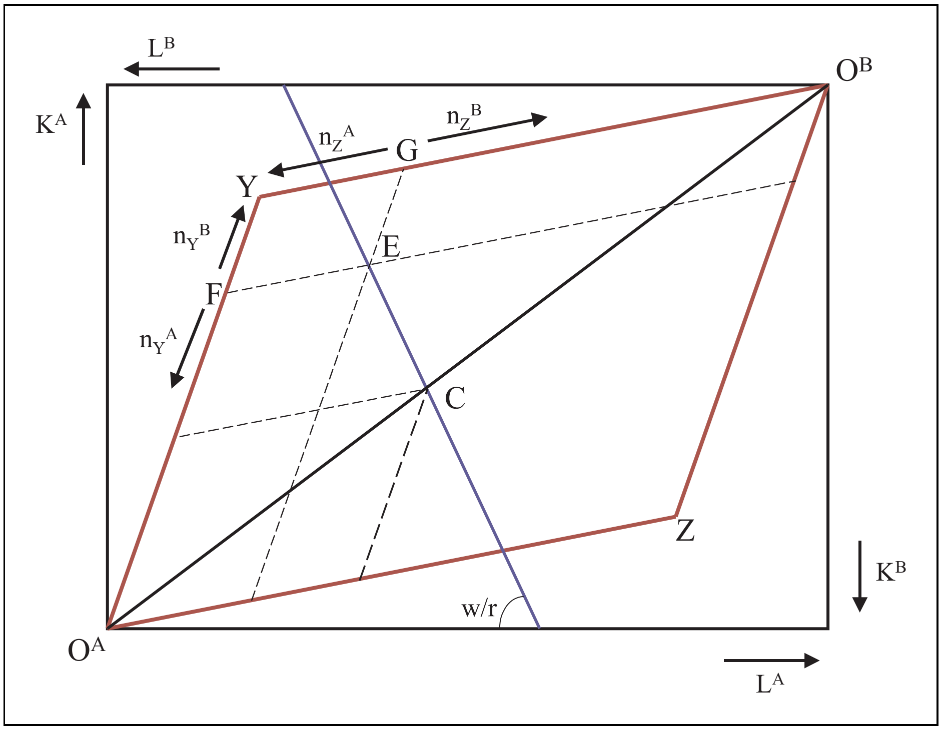

Figure 2: Factor Price Equalization Region; Source: ANTRAS (2003)

Factor price equalization here is not driven by trade in factors or final products, but by trade in intermediates. All factor allocations inside the parallelogram O^AYO^BZ, such as E allow for factor price equalization so that both countries produce intermediates for both industries. If E was on the outer line of O^AYO^BZ there would be factor price equalization but one country would fully specialize in intermediates of the industry.

To assume that factor price equalization holds it is necessary that $n_Y^j > 0$ and $n_Z^j > 0$ for both countries $\{A, B\}$. In the following country A is considered. To explore the conditions $\frac{n_Y^A}{n_Y^*} > 0$ *and* $\frac{n_Z^A}{n_Z^*} > 0$ the symmetry of the above equations (the denominator of 73 equals the denominator of 74 times (-1) and the factor μ) is used. Excluding the case that the denominator becomes zero, in the following the case with an negative denominator of 73 and a positive denominator of 74 is considered here. The other case is omitted because it is contradictory to basic assumptions of the model (see next footnote).

$$\frac{\xi\alpha\beta_Y\overline{\phi} + \epsilon_Y}{\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi}) + \epsilon_Y} > \frac{\xi\alpha\beta_Z\phi + \epsilon_Z}{\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z} \tag{75}$$

Equation 75 holds when for the left hand side

$$\xi\alpha\beta_Y\overline{\phi} + \epsilon_Y > \frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi}) + \epsilon_Y$$

and the right hand side:

$$\xi\alpha\beta_Z\phi + \epsilon_Z < \frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z$$

Using 75 for $\xi - 1$ this can be transformed to:

$$\frac{\beta_Y \overline{\phi}}{(1-\beta_Y)(1-\overline{\phi})} > \frac{rK^*}{wL^*}$$

and

$$\frac{rK^*}{wL^*} > \frac{\beta_Z \phi}{(1-\beta_Z)(1-\phi)}$$

Putting both inequalities together leads to the condition:

$$\frac{\beta_Y \overline{\phi}}{(1-\beta_Y)(1-\overline{\phi})} > \frac{rK^*}{wL^*}\left[= \frac{\beta_Z\phi + \beta_Y\overline{\phi}}{(1-\beta_Z)(1-\phi)+(1-\beta_Y)(1-\overline{\phi})}\right] > \frac{\beta_Z \phi}{(1-\beta_Z)(1-\phi)} \tag{76}$$

The wage-interest-rate-relationship 67 of the integrated world economy, which is valid for country A if factor price equalization occurs is shown in the brackets.

Additionally to the assumption made earlier, $\overline{\phi} > \phi > 1/2$ it has to assumed here, that the capital intensity of the capital intense sector β_Y and the labour intensity of the labour intensive sector $(1-\beta_Z)$ must be sufficiently large enough for a solution. Economically the relative labour intensity of the labour intensive sector $(1-\beta_Z)/\beta_Z$ must be large enough to outweigh the worse relative negotiation power $\phi/(1-\phi)$ of the suppliers so that 76 holds [10].

Furthermore, because 75 holds, the conditions for $\frac{n_Z^A}{n_Z^*} > 0$ *and* $\frac{n_Y^A}{n_Y^*} > 0$ are determined by the numerators of 73 and 74:

$$\frac{L^A}{L^*}\left[\xi\alpha\beta_Z\phi + \epsilon_Z\right] < \frac{K^A}{K^*}\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi)+\epsilon_Z\right] \tag{77}$$

AND

$$\frac{L^A}{L^*}\left[\xi\alpha\beta_Y\overline{\phi} + \epsilon_Y\right] > \frac{K^A}{K^*}\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi})+\epsilon_Y\right] \tag{78}$$

Rearranging this leads to the condition:

$$\frac{\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi})+\epsilon_Y}{\xi\alpha\beta_Y\overline{\phi}+\epsilon_Y} < \frac{K^*}{L^*}\frac{L^A}{K^A} < \frac{\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi)+\epsilon_Z}{\xi\alpha\beta_Z\phi+\epsilon_Z} \tag{79}$$

This determines the upper and lower limits of the relative factor endowment K^A/L^A which leads to factor price equalization.
To further explore the characteristic of this condition I introduce

$$\Omega_Y = \frac{L^A_{high}}{K^A_{low}}\frac{K^*}{L^*} \tag{80}$$

[10] The case of an negative denominator of 73 and a positive denominator of 74 would lead to

$$\frac{\beta_Y \overline{\phi}}{(1-\beta_Y)(1-\overline{\phi})} < \frac{rK^*}{wL^*} = \frac{\beta_Z\phi + \beta_Y\overline{\phi}}{(1-\beta_Z)(1-\phi)+(1-\beta_Y)(1-\overline{\phi})} < \frac{\beta_Z \phi}{(1-\beta_Z)(1-\phi)}$$

. This contradicts to the basic assumptions of $\beta_Y > \beta_Z$ and $\overline{\phi} > \phi > 1/2$ and is therefore not discussed further.

$$\Omega_Z = \frac{L^A_{low}}{K^A_{high}} \frac{K^*}{L^*} \tag{81}$$

According to 79 the actual capital-labour-endowment of country A determined by Ω^A must lie between

$$\Omega_Z < \Omega^A < \Omega_Y$$

so that factor price equalization holds. Therefore the factor endowment of country A lies in the factor price equalization region of figure 2. Economically this explains that the capital-labour-ratio must not differ 'to much' from the endowment ratio of the world economy. L^A_{high}/K^A_{low} describes the highest possible labour-capital ratio so that intermediates for the capital intensive good Y are still produced. Ω_Y indicates the highest possible labour-capital ratio relative to world endowment, and Ω_Z describes the lowest possible relative labour-capital ratio so that intermediates of the labour intensive good are produced. $\Omega_Y > 1$ and $\Omega_Z < 1$ is assumed so that deviations from the worldwide endowment ration L^*/K^* are possible.

Rearranging 81 and plugging K^A_{low}/K^* into 77 leads to a 'border solution' for sector Y:

$$[\xi\alpha\beta_Z\phi + \epsilon_Z] = \frac{1}{\Omega_Y}\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z\right]$$

$$\xi\alpha\beta_Z\phi = \frac{1}{\Omega_Y}\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + (\frac{1}{\Omega_Y} - 1)\epsilon_Z$$

Dividing by α and ξ and using 75 for $\xi - 1$ this lead to

$$\Omega_Y\beta_Z\phi = \frac{rK^*}{wL^*}(1-\beta_Z)(1-\phi) + (1-\Omega_Y)\frac{\epsilon_Z}{\alpha\xi} \tag{82}$$

For sector Z the result is similar. With 81 solving for L^A_{low}/L^* and plugging into 78:

$$\Omega_Z(\xi-1)\beta_Y\overline{\phi} + (\Omega_Z - 1)\frac{\epsilon_Y(\xi-1)}{\xi\alpha} = (1-\beta_Y)(1-\overline{\phi})$$

Using 75 for $\xi - 1$

$$\Omega_Z\frac{wL^*}{rK^*}\beta_Y\overline{\phi} + (\Omega_Z - 1)\frac{\epsilon_Y(\xi-1)}{\xi\alpha} = (1-\beta_Y)(1-\overline{\phi}) \tag{83}$$

To produce variants of sector Z in equilibrium, the factor endowment ratio of country A must differ from the world endowment ratio less than factor Ω_Z which equals the relative negotiating power of the integrated final goods producer $\overline{\phi}/(1-\overline{\phi})$ weighted by relative capital intensity of the Y-sector $\beta_Y/(1-\beta_Y)$ and factor income ratios (first summand) after been corrected for an effect which is related to the use of factors by IT Services (second summand). The typical opportunity costs argument of Heckscher-Ohlin-type models comes through: the high weighted *capital absorbing power* $\beta_Y\overline{\phi}$ of sector Y producers allows for production of sector Z products also when country A is relatively rich of capital. In this case the line O^AY in the parallelogram of figure 2 would be steep, so that the probability grows that the factor endowment point E lies within the factor price

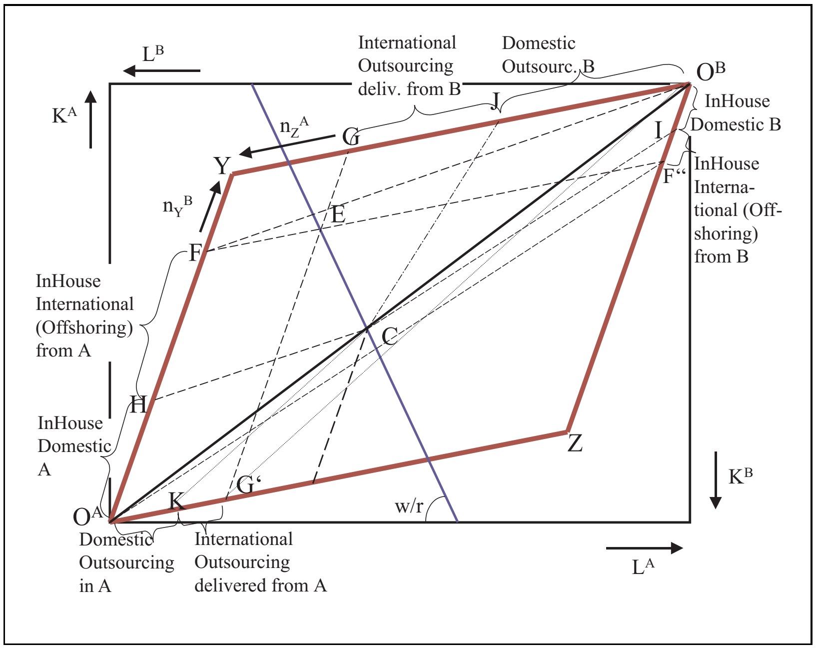

Figure 3: Trade in Intermediates

equalization region and both goods are produced. If this was not the case, the capital intensive country would specialize in the capital intensive intermediates only and not produce the labour intensive variants. For sector Y (see 82) these arguments hold vice versa.

4.2 Trade in Intermediates

Figure 3 shows the volumes of international and domestic outsourcing and offshoring (in-house) of trade in intermediates. The EU's definition is used here, which is shown in table 3.

For example the line $\left|O^A Y\right|$ shows the total production of variants of sector Y of which $\left|O^A F\right|$ are produced in country A. Due to monopolistic competition (love of variety) consumers in both countries like to consume final products based on country's A intermediates. Please note that the final products cannot be traded themselves by assumption, meaning that the according final goods producers are located in each country.

The distribution of the variants equals the distribution of total expenditure represented by $\left|O^A C\right|$ in relation to $\left|CO^B\right|$. Basic geometry ($|HC|$ is parallel to $\left|O^B F\right|$) leads to point H. $\left|O^A H\right|$ represents the share of variants which are used by domestically[11].

[11]This interpretation changes the meaning of the lines of the parallelogramm. Not variants are added anymore, but they shows total volume of the sector and a part of the line the share does not represent a smaller number of variants but an share of total volume (including all different variants).

		Ownership of activities	
		Internal to the firm	**External to the firm**
Location of activities	**Home**	*Domestic in-house production* (firm produces its products domestically without any outside contracts)	*Domestic outsourcing* (firm uses inputs supplied by another domestically-based company)
	Overseas	*Offshoring* (firm uses inputs supplied by its foreign-based affiliates)	*International outsourcing* (firm uses inputs supplied by an unaffiliated foreign-based company)

Table 3: EU Definition of Outsourcing and Offshoring; Source: EU (2005)

Accordingly, the other points in figure 3 are constructed. $\left|O^A K\right|$ represents the intermediates which are used domestically and $|KG'|$ the intermediates which are offered to final goods producers in other countries. Outsourcing to A is shown by $|GJ|$, due to country's A final goods producers importing intermediates and IT Services in this volume from country B.

4.3 Trade in IT Services

Incorporating the IT Administrations Rights Approach the organizational relationship between IT Service companies and intermediate suppliers follows the organizational structure between intermediate and final goods producers. Therefore in the capital-intensive sector Y integrated IT service departments are employed whereas in the labour-intensive sector Z independent IT service companies prevail.

Regarding the intermediates it was assumed that all variants are consumed in both countries according to their share of worldwide expenditures. Accordingly the IT Services departments and companies have to build up IT systems to organize the supply chain between intermediate producers and final goods producers or sales departments of the integrated producer in both countries. It is assumed that the distribution of IT Services employed domestically and abroad follows the distribution of variants produced.

The total factor demand for IT services is also incorporated in the lines of the FPE-Parallelogram in figure **??**. Please note that trade between country A and B is balanced regarding the sum of intermediate trade and IT services, but trade in services has not been balanced. More specifically the pattern of trade in IT Services in shown in figure 4.

The x-axis represents the total number of variants produced in the world economy and also shows the number of variants produced in Y and Z-industries worldwide. The diagonal represents all factor demanded by capital and labour used for IT-Services and is 'a fraction' of the diagonal presented in figure **??**. In the left hand part the lines $\left|O^A Y\right|$ and $\left|Y O^B\right|$ from figure **??** are copied. In figure

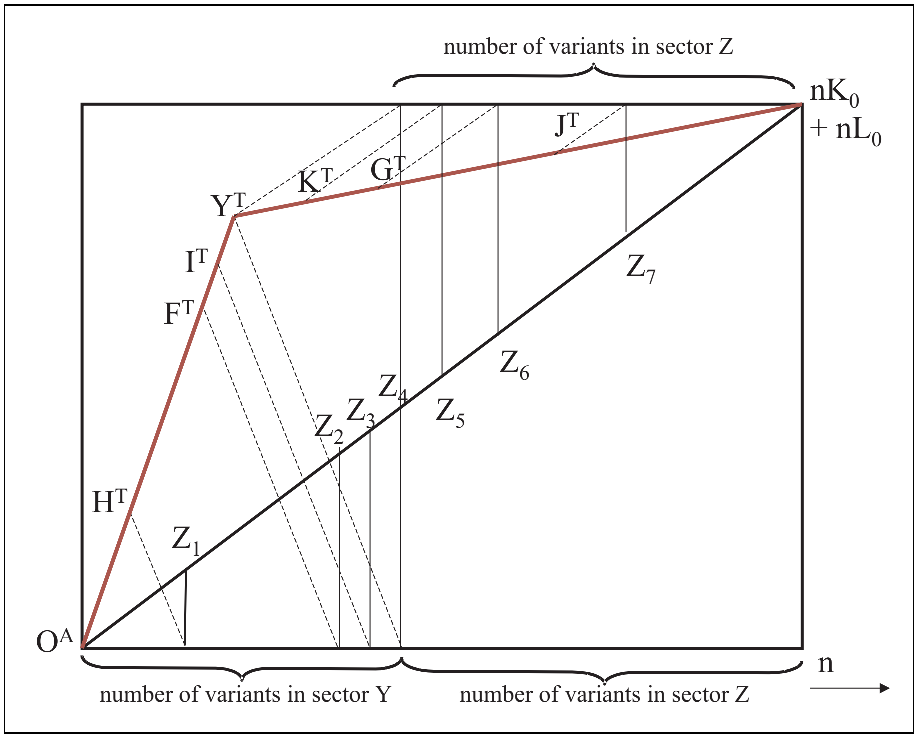

Figure 4: Trade in IT Services

4 they have no direct economic interpretation, but they are used to determine the relative allocation of the IT services.

Using again graphical analysis, the dots on the diagonal represent the shares of total IT Services. Sector Z is split analogously. Figure 4 shows the deployment of IT services in this framework:

- $|0Z_1|$: Domestic in-house production. IT Services of integrated companies for domestic use only.
- $|Z_1Z_2|$: Offshoring from the perspective of country B. In-house exports of IT Services from country A to country B, e.g. IT departments of integrated (multinational) companies are employed abroad.
- $|Z_2Z_3|$: Offshoring. In-house exports of IT Services from country B to country A.
- $|Z_3Z_4|$: Domestic in-house production. IT departments employed domestically in country B.
- $|Z_4C_5|$: Domestic Outsourcing. IT Service companies employed in country A.
- $|Z_5C_6|$: International Outsourcing. Export of IT Services from country A to country B.
- $|Z_6C_7|$: International Outsourcing. Export of IT Services from country B to country A.

- $\left|Z_7 O^B\right|$: Domestic Outsourcing. IT Service companies employed domestically in country B.

In this model the trade of IT Services does not directly depend on differences in factor costs (or productivity or factor endowments) but on the concept of accompanying domestic suppliers. Furthermore it can be proved that a change in ζ representing the costs of IT services has no effect on the factor price equalization region: In this model a lowering of ζ would lead to lower IT service costs per variant, a higher number of variants n and a lower production volume, but without changing the wage-interest-rate-ratio described by equation 67.

Doing this exercise for both countries and industries Y and Z shows that country A prefers to export in-house IT Services to country B. Summarizing:

- It is proved that international trade in IT Services occurs even if there are no differences in costs or factor intensities in the IT Services sectors. Accompanying companies internationally is a key driver of the internationalisation of IT services.

- Imports and exports of IT Services are rising simultaneously. Trading volume in IT Services is largest between countries of a similar size.

- Exports inhouse and imports inhouse behave in a reciprocal manner.

These results also describe different forces which influence the market structure in the IT sector. Since outsourcing of non-ICT intermediates is favoured in labour intensive industries, final and intermediate goods producers keep their own IT systems (they do not integrate) and IT has to provide standardized interfaces. But in capital intensive industries, vertically integrated companies are preferred and IT has to support the proprietary systems as proved with the Administration Right Approach of section 2.

The perception that in a capital-intensive industry all IT service companies are also integrated is strong. It is also plausible that formally independent IT service companies are employed, but the integrated companies holds all Administration Rights. Therefore internationalization of a capital intensive industry implies that (domestic) IT service companies also have to internationalize - a pattern which has favoured the international expansion of SAP for example. In labour rich industries however local IT service companies are employed, which is favoured by open and standardized interfaces. In both countries an insourcing business might be a valuable field of business specialization as well, but dominated in volume by the labour rich country.

Not covered by the model is the pure outsourcing of IT Services, e.g. the case that a domestic company outsources IT without exporting or importing any of its goods. This would be cost driven outsourcing for example. Neither it is covered, that IT itself could be an intermediate. From this point of view it would directly follow from the model of ANTRAS (2003) that outsourcing solutions are favoured by labour rich industries, whereas the integration of IT service providers may mainly occur in capital rich industries.

5 Summary

Based on ANTRAS (2003) in this paper a general macroeconomic equilibrium model is described, which considers the choice of a company's structure as endogenous, leading to implications for the internationalization of IT services. The endowment of a country with labour and capital determines the decisions of final goods and intermediates producers to integrate or to remain independent, with the consequence that IT Services companies with customers in capital intensive industries are pushed to globalize their business as well.

A Calculation of the demand function for y(i)

The preferences of a representative consumer are:

$$U = \left(\int_0^{n_y} y(i)^\alpha di\right)^{\mu/\alpha} \left(\int_0^{n_z} z(i)^\alpha di\right)^{\frac{1-\mu}{\alpha}} \tag{84}$$

with elasticity of substitution between any two varieties in a given sector

$$\frac{1}{1-\alpha} > 1$$

and

$$0 < \mu < 1$$

With

$$E = \int_0^{n_y} (p_y(i)y(i))di + \int_0^{n_z} (p_z(i)z(i))di \tag{85}$$

with

$$E_Y = \mu E = \int_0^{n_y} (p_y(i)y(i))di \tag{86}$$

for spending for products in sector Y and for sector Z respectively. By assumption, in equilibrium spending for sector Y and use of products of sector Y both have a price-adjusted share of μ of total spending or use respectively. Mathematically this is a result of the Cobb-Douglas type demand function[12]

$$L = \left(\int_0^{n_y} y(i)^\alpha di\right)^{\mu/\alpha} \left(\int_0^{n_z} z(i)^\alpha di\right)^{\frac{1-\mu}{\alpha}} \\ -\lambda\left(E - \int_0^{n_y} (p_y(i)y(i))di + \int_0^{n_z} (p_z(i)z(i))di\right) \tag{87}$$

Calculating the derivates and setting them zero leads to [13]

$$\frac{\partial L}{\partial y(i)} = \alpha\frac{\mu}{\alpha}y(i)^{\alpha-1}\left(\int_0^{n_y} y(i)^\alpha di\right)^{\mu/\alpha-1}\left(\int_0^{n_z} z(i)^\alpha di\right)^{\frac{1-\mu}{\alpha}} n_y - \lambda p_y(i)n_y = 0 \tag{88}$$

$$\frac{\partial L}{\partial z(i)} = \alpha\frac{1-\mu}{\alpha}z(i)^{\alpha-1}\left(\int_0^{n_y} y(i)^\alpha di\right)^{\mu/\alpha}\left(\int_0^{n_z} z(i)^\alpha di\right)^{\frac{1-\mu}{\alpha}-1} n_z - \lambda p_z(i)n_z = 0 \tag{89}$$

and

$$\frac{\partial L}{\partial \lambda} = \int (p_y(i)y(i))di + \int (p_z(i)z(i))di - E =!0 \tag{90}$$

[12]Proof: Optimization of $U = Y^/ muZ^{1-\mu}$ with budget restriction $E = p_Y Y p_Z Z$ leads to $\frac{p_Z \mu Z}{p_Y(1-\mu)Y} = 1$ with can be rearranged with the budget restriction to $Y = \frac{\mu E}{p_Y}$ and $Z = \frac{(1-\mu)E}{p_Z}$. Thus the demand for Y only depends on share μ of total spending E and the exogenous price for this product. Demand of Z and price of Z do not influence the demand for Y, what is a standard result of a Cobb-Douglas type demand function with constant elasticities.

[13]Please note, that y(i) does not describe a functional dependence, but i acts as an index from mathematical point of view.

The optimatization procedere is showed for Y in the following. Rearranging 88 gives:

$$y(i) = \frac{1}{\mu}^{\frac{1}{1-\alpha}} \left(\int_0^{n_y} y(i)^\alpha di\right)^{\frac{\alpha-\mu}{\alpha}\frac{1}{\alpha-1}} \left(\int_0^{n_z} z(i)^\alpha di\right)^{\frac{1-\mu}{\alpha}\frac{1}{\alpha-1}} \lambda^{\frac{1}{\alpha-1}} p_y(i)^{\frac{1}{\alpha-1}} \tag{91}$$

Inserting this equation into 90 for all y(i) leads to:

$$E = \int_0^{n_y} p_y(i) \left(\frac{1}{\mu}^{\frac{1}{1-\alpha}} \left(\int_0^{n_y} y(i)^\alpha di\right)^{\frac{\alpha-\mu}{\alpha}\frac{1}{\alpha-1}} \left(\int_0^{n_z} z(i)^\alpha di\right)^{\frac{1-\mu}{\alpha}\frac{1}{\alpha-1}} \lambda^{\frac{1}{\alpha-1}} p_y(i)^{\frac{1}{\alpha-1}}\right) di + \int_0^{n_z} (p_z(i)z(i))$$

Multiplying the $p_y(i)$ and rearranging this equation results in:

$$\frac{E - \int_0^{n_z}(p_z(i)z(i))di}{\int_0^{n_y} p_y(i)^{\frac{\alpha}{\alpha-1}} di} = \frac{1}{\mu}^{\frac{1}{1-\alpha}} \lambda^{\frac{1}{\alpha-1}} \left(\int_0^{n_y} y(i)^\alpha di\right)^{\frac{\alpha-\mu}{\alpha}\frac{1}{\alpha-1}} \left(\int_0^{n_z} z(i)^\alpha di\right)^{\frac{1-\mu}{\alpha}\frac{1}{\alpha-1}}$$

Introducing the right side into 91 amounts to:

$$y(i) = \frac{E - \int_0^{n_z}(p_z(i)z(i))di}{\int_0^{n_y} p_y(i)^{\frac{\alpha}{\alpha-1}} di} p_y(i)^{\frac{1}{\alpha-1}} \tag{92}$$

Using 86 this leads to:

$$y(i) = \frac{\mu E}{\int_0^{n_y} p_y(i)^{\frac{\alpha}{\alpha-1}} di} p_y(i)^{\frac{1}{\alpha-1}} \tag{93}$$

B Incomplete Contracts

Optimal investment volumes are calculated from equations 27 and 28.

According to 26 $R_Y(i)$ is replaced and indices are omitted here to simplify the notification.

The task is to maximise

$$\psi A^{1-\alpha} \left(\frac{K}{\beta}\right)^{\alpha\beta} \left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)} - rK - rK_0 \Rightarrow MAX! \tag{94}$$

by choosing K and

$$(1-\psi) A^{1-\alpha} \left(\frac{K}{\beta}\right)^{\alpha\beta} \left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)} - wL - wL_0 \Rightarrow MAX! \tag{95}$$

by choosing L simultanously. By assumption interest rate r, wage w and investment for IT services K_0 and L_0 are sufficiently small, so that profit is positive for the investment volumes calculated.

Setting the first derivate of 94 and 95 to zero lead to

$$\frac{\partial}{\partial K} = \psi A^{1-\alpha} \alpha\beta \frac{1}{\beta} \left(\frac{K}{\beta}\right)^{\alpha\beta-1} \left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)} - r = 0 \tag{96}$$

and

$$\frac{\partial}{\partial L} = (1-\psi)A^{1-\alpha}\left(\frac{K}{\beta}\right)^{\alpha\beta}\frac{\alpha(1-\beta)}{1-\beta}\left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)-1} - w = 0 \tag{97}$$

In order to be maximised, the second derivates should be < 0, which is fulfilled for all K, L by:

$$\frac{\partial^2}{(\partial K)^2} = \psi A^{1-\alpha}\frac{\alpha(\alpha\beta-1)}{\beta}\left(\frac{K}{\beta}\right)^{\alpha\beta-2}\left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)} < 0 \tag{98}$$

with

$$\alpha\beta < 1$$

and

$$\frac{\partial^2}{(\partial L)^2} = (1-\psi)A^{1-\alpha}\left(\frac{K}{\beta}\right)^{\alpha\beta}\frac{\alpha(\alpha(1-\beta)-1)}{1-\beta}\left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)-2} - w < 0 \tag{99}$$

with

$$\alpha < \alpha\beta + 1$$

Equations 96 and 97 are two reactions functions, which show the optimal investment of K (L) in dependence on the investment volume of L (K) of the integrated supplier (final goods producer respectively). To find an equilibrium the intersection of the two functions is calculated.

Equation 96 can also be expressed as:

$$\left(\frac{K}{\beta}\right)^{-\alpha\beta} = \frac{\psi A^{1-\alpha}\frac{\alpha}{r}\left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)}}{\frac{K}{\beta}} \tag{100}$$

or

$$\frac{K}{\beta} = \left(\frac{\psi\alpha}{r}\right)^{\frac{1}{1-\alpha\beta}} A^{\frac{1-\alpha}{1-\alpha\beta}}\left(\frac{L}{1-\beta}\right)^{\frac{\alpha(1-\beta)}{1-\alpha\beta}} \tag{101}$$

Equation 97 can be transformed to:

$$\left(\frac{K}{\beta}\right)^{-\alpha\beta} = (1-\psi)A^{1-\alpha}\frac{\alpha}{w}\left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)-1} \tag{102}$$

or

$$\frac{L}{1-\beta} = \frac{(1-\psi)\alpha}{w}^{\frac{1}{1-\alpha(1-\beta)}} A^{\frac{1-\alpha}{1-\alpha(1-\beta)}}\left(\frac{K}{\beta}\right)^{\frac{\alpha\beta}{1-\alpha(1-\beta)}} \tag{103}$$

Equalizing the right sides of equation 102 and equation 100 and simplifying leads to:

$$\frac{\psi}{1-\psi}\frac{w}{r}\frac{L}{1-\beta} = \frac{K}{\beta} \tag{104}$$

Introducing equation 101 in 104 then result in:

$$\frac{\psi}{1-\psi}\frac{w}{r}\frac{L}{1-\beta} = \psi^{\frac{1}{1-\alpha\beta}} A^{\frac{1-\alpha}{1-\alpha\beta}}\left(\frac{\alpha}{r}\right)^{\frac{1}{1-\alpha\beta}}\left(\frac{L}{1-\beta}\right)^{\frac{\alpha(1-\beta)}{1-\alpha\beta}}$$

Rearranging leads to:

$$\psi^{1-\frac{1}{1-\alpha\beta}} \frac{1}{1-\psi} \frac{w}{r} A^{\frac{\alpha-1}{1-\alpha\beta}} \left(\frac{\alpha}{r}\right)^{\frac{-1}{1-\alpha\beta}} = \left(\frac{L}{1-\beta}\right)^{\frac{\alpha(1-\beta)}{1-\alpha\beta}-1} = \left(\frac{L}{1-\beta}\right)^{\frac{\alpha-1}{1-\alpha\beta}}$$

Simplifying result in:

$$L = A(1-\beta)\psi^{\frac{-\alpha\beta}{\alpha-1}} (1-\psi)^{\frac{\alpha\beta-1}{\alpha-1}} w^{\frac{1-\alpha\beta}{\alpha-1}} r^{\frac{\alpha\beta}{\alpha-1}} \alpha^{\frac{-1}{\alpha-1}} \tag{105}$$

$$L = A(1-\beta) \left(\alpha\psi^{\alpha\beta}(1-\psi)^{1-\alpha\beta} w^{\alpha\beta-1} r^{-\alpha\beta}\right)^{\frac{1}{1-\alpha}} \tag{106}$$

Solving for K equation 103 is put into 104 leading to:

$$\frac{\psi}{1-\psi} \frac{w}{r} \left(\frac{(1-\psi)\alpha}{w}\right)^{\frac{1}{1-\alpha(1-\beta)}} A^{\frac{1-\alpha}{1-\alpha(1-\beta)}} \left(\frac{K}{\beta}\right)^{\frac{\alpha\beta}{1-\alpha(1-\beta)}} = \frac{K}{\beta}$$

Finally rearranging and simplifying leads to:

$$K = \beta A\psi^{\frac{1-\alpha(1-\beta)}{1-\alpha}} (1-\psi)^{\frac{\alpha(1-\beta)}{1-\alpha}} r^{\frac{\alpha(1-\beta)-1}{1-\alpha}} w^{\frac{-\alpha(1-\beta)}{1-\alpha}} \alpha^{\frac{1}{1-\alpha}} \tag{107}$$

$$K = \beta A \left(\psi^{1-\alpha(1-\beta)}(1-\psi)^{\alpha(1-\beta)} r^{\alpha(1-\beta)-1} w^{-\alpha(1-\beta)} \alpha\right)^{\frac{1}{1-\alpha}} \tag{108}$$

C Complete Contracts

The task is to maximise

$$\phi \left[A^{1-\alpha} \left(\frac{K}{\beta}\right)^{\alpha\beta} \left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)} - rK - wL - rK_0 - wL_0\right] \Rightarrow MAX!$$

by choosing K and

$$(1-\phi) \left[A^{1-\alpha} \left(\frac{K}{\beta}\right)^{\alpha\beta} \left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)} - rK - wL - rK_0 - wL_0\right] \Rightarrow MAX!$$

by choosing L simultaneously. Because a constant $\phi > 0$ does not influence the optimization result, the task reduces to

$$A^{1-\alpha} \left(\frac{K}{\beta}\right)^{\alpha\beta} \left(\frac{L}{1-\beta}\right)^{\alpha(1-\beta)} - rK - wL - rK_0 - wL_0 \Rightarrow MAX! \tag{109}$$

Following the calculations of section B this leads to

$$\frac{w}{r} \frac{L}{1-\beta} = \frac{K}{\beta} \tag{110}$$

The factor demands in the case of complete contracts are:

$$L = A(1-\beta) \left(\alpha w^{\alpha\beta-1} r^{-\alpha\beta}\right)^{\frac{1}{1-\alpha}} \tag{111}$$

and

$$K = \beta A \left(r^{\alpha(1-\beta)-1} w^{-\alpha(1-\beta)} \alpha\right)^{\frac{1}{1-\alpha}} \tag{112}$$

D Calculation of first derivate of θ with regard to β

The task is to calculate the first derivative of 46 and to prove that it is ¿ 0.

$$\theta = \left(1 + \frac{\alpha(1-2\beta)\delta^{\alpha}(1-\phi)}{1-\alpha+\alpha\beta-(2\alpha\beta-\alpha)\phi}\right)\left(1+\frac{\delta^{\alpha}}{\phi(1-\delta^{\alpha}}\right)^{\frac{\alpha\beta}{1-\alpha}}(1-\delta^{\alpha})^{\frac{\alpha}{1-\alpha}} > 0 \quad (113)$$

with regard to β.
To simplify notification I define the functions

$$f(\beta) = \left(1 + \frac{\alpha(1-2\beta)\delta^{\alpha}(1-\phi)}{1-\alpha+\alpha\beta-(2\alpha\beta-\alpha)\phi}\right) \quad (114)$$

$$g(\beta) = \left(1+\frac{\delta^{\alpha}}{\phi(1-\delta^{\alpha})}\right)^{\frac{\alpha\beta}{1-\alpha}}(1-\delta^{\alpha})^{\frac{\alpha}{1-\alpha}} \quad (115)$$

$$h(\beta) = \alpha(1-2\beta)\delta^{\alpha}(1-\phi) \quad (116)$$

$$i(\beta) = 1-\alpha+\alpha\beta-(2\alpha\beta-\alpha)\phi \quad (117)$$

$$B = \frac{\delta^{\alpha}}{\phi(1-\delta^{\alpha})} \quad (118)$$

Applying the product rule, the first derivative of 113 is given by

$$\frac{\partial\theta}{\partial\beta} = \theta' = f'g + g'f = (h'[i]^{-1} - hi'[i]^{-2})g + g'f \quad (119)$$

with

$$h' = -2\alpha(1-\phi)\delta^{\alpha} \quad (120)$$

$$i' = \alpha - 2\alpha\beta \quad (121)$$

$$g' = (1+B)^{\frac{\alpha\beta}{1-\alpha}}\frac{\alpha}{1-\alpha}ln(1+B)(1-\delta^{\alpha})^{\frac{\alpha}{1-\alpha}} \quad (122)$$

The first summand of the derivative $\frac{\partial\theta}{\partial\beta}$ is

$$f'g = \frac{h'i - i'h}{i^2} = \frac{a(1-\phi)\delta^{\alpha}\left[-2-2\alpha-2\alpha\beta-2\alpha\phi+4\alpha\phi\beta\right]-\left[\alpha-2\alpha\phi-2\alpha\beta+4\alpha\beta\phi\right]}{i^2} \quad (123)$$

This reduces to

$$f'g = \frac{(1-\phi)\delta^{\alpha}(-2\alpha+\alpha^2)}{i^2} \quad (124)$$

so that

$$\frac{\partial\theta}{\partial\beta} = \left[\frac{(1-\phi)\delta^{\alpha}(-2\alpha-\alpha^2)}{i^2} + \left[1+\frac{h}{i}\right]\frac{\alpha}{1-\alpha}ln1+B\right](1+B)^{\frac{\alpha\beta}{1-\alpha}}(1-\delta^{\alpha})^{\frac{\alpha}{1-\alpha}} > 0 \quad (125)$$

Dividing by the constant factors $(1+B)^{\frac{\alpha\beta}{1-\alpha}}(1-\delta^{\alpha})^{\frac{\alpha}{1-\alpha}} > 0$ and subcontracting the first summand gives:

$$\left[1+\frac{h}{i}\right]\frac{\alpha}{1-\alpha}ln(1+B) > \frac{(1-\phi)\delta^{\alpha}(2\alpha-\alpha^2)}{i^2} \tag{126}$$

or

$$ln(1+B) + \frac{hiln(1+B)}{i^2} > \frac{(1-\phi)\delta^{\alpha}(2-\alpha)(1-\alpha)}{i^2} \tag{127}$$

This relationship is surely satisfied when

$$hiln(1+B) > (1-\phi)\delta^{\alpha}(2-\alpha)(1-\alpha) \tag{128}$$

Defining

$$\Omega(\beta) = h(\beta)i(\beta) \tag{129}$$

leads to

$$\Omega(\beta)ln\left(1+\frac{\delta^{\alpha}}{\phi(1-\delta^{\alpha})}\right) > (1-\phi)\delta^{\alpha}(2-\alpha)(1-\alpha) \tag{130}$$

with

$$\Omega(\beta) = (1-\alpha(1-\overline{\phi})+\alpha\beta(1-2\overline{\phi}))(1-\alpha(1-\phi)+\alpha\beta(1-2\phi)) \tag{131}$$

using the calculations for 46, esp. the definition $\overline{\phi} = \delta^{\alpha}+\phi(1-\delta^{\alpha})$.

E Number of variants produced in a country

$$K^A = \frac{n_Y^A}{n_Y^*}\left[\mu(rK^*+wL^*)\alpha\beta_Y\frac{\overline{\phi}}{r}+\mu K^*(1-\alpha+\alpha\beta_Y-2\alpha\beta_Y\overline{\phi}+\alpha\overline{\phi})\right]$$
$$+\frac{n_Z^A}{n_Z^*}\left[(1-\mu)(rK^*+wL^*)\alpha\beta_Z\frac{\phi}{r}+(1-\mu)K^*(1-\alpha+\alpha\beta_Z-2\alpha\beta_Z\phi+\alpha\phi)\right] \tag{132}$$

From 53 and 63

$$L^A = \frac{n_Y^A}{n_Y^*}\left[\mu(rK^*+wL^*)\frac{\alpha(1-\beta_Y)(1-\overline{\phi})}{w}+\mu L^*(1-\alpha+\alpha\beta_Y-2\alpha\beta_Y\overline{\phi}+\alpha\overline{\phi})\right]$$
$$+\frac{n_Z^A}{n_Z^*}\left[(1-\mu)(rK^*+wL^*)\frac{\alpha(1-\beta_Z)(1-\phi)}{w}+(1-\mu)L^*(1-\alpha+\alpha\beta_Z-2\alpha\beta_Z\phi+\alpha\phi)\right]$$

Defining

$$\epsilon_Z = 1-\alpha+\alpha\beta_Z-2\alpha\beta_Z\phi+\alpha\phi \tag{133}$$
$$\epsilon_Y = 1-\alpha+\alpha\beta_Y-2\alpha\beta_Y\overline{\phi}+\alpha\overline{\phi} \tag{134}$$

and

$$\xi = (1+\frac{wL^*}{rK^*}) \tag{135}$$

$$\frac{\xi}{\xi-1} = (1+\frac{rK^*}{wL^*}) \tag{136}$$

and dividing through K^* and L^* respectively leads to:

$$\frac{K^A}{K^*} = \frac{n_Y^A}{n_Y^*}\left[\mu\xi\alpha\beta_Y\overline{\phi}+\mu\epsilon_Y\right] + \frac{n_Z^A}{n_Z^*}\left[(1-\mu)\xi\alpha\beta_Z\phi+(1-\mu)\epsilon_Z\right] \tag{137}$$

$$\frac{L^A}{L^*} = \frac{n_Y^A}{n_Y^*}\left[\mu\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi})+\mu\epsilon_Y\right] + \frac{n_Z^A}{n_Z^*}\left[(1-\mu)\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi)+(1-\mu)\epsilon_Z\right] \tag{138}$$

Solving 137 for n_Y^A/n_Y^*:

$$\frac{n_Y^A}{n_Y^*} = \frac{\frac{K^A}{K^*} - \frac{n_Z^A}{n_Z^*}\left[(1-\mu)\xi\alpha\beta_Z\phi+(1-\mu)\epsilon_Z\right]}{\left[\mu\xi\alpha\beta_Y\overline{\phi}+\mu\epsilon_Y\right]} \tag{139}$$

Plugging into L^A/L^*:

$$\frac{L^A}{L^*} = \frac{K^A}{K^*}\frac{\left[\mu\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi})+\mu\epsilon_Y\right]}{\left[\mu\xi\alpha\beta_Y\overline{\phi}+\mu\epsilon_Y\right]} + \frac{n_Z^A}{n_Z^*}\left(\frac{-\left[(1-\mu)\xi\alpha\beta_Z\phi+(1-\mu)\epsilon_Z\right]\left[\mu\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi})+\mu\epsilon_Y\right]}{\left[\mu\xi\alpha\beta_Y\overline{\phi}+\mu\epsilon_Y\right]}\right) + \frac{n_Z^A}{n_Z^*}\left((1-\mu)\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi)+(1-\mu)\epsilon_Z\right) \tag{140}$$

and multiplying with $\left[\mu\xi\alpha\beta_Y\overline{\phi}+\mu\epsilon_Y\right]$ leads to

$$\frac{L^A}{L^*}\left[\mu\xi\alpha\beta_Y\overline{\phi}+\mu\epsilon_Y\right] - \frac{K^A}{K^*}\left[\mu\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi})+\mu\epsilon_Y\right] = -\frac{n_Z^A}{n_Z^*}\left[(1-\mu)\xi\alpha\beta_Z\phi+(1-\mu)\epsilon_Z\right]\left[\mu\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi})+\mu\epsilon_Y\right] + \frac{n_Z^A}{n_Z^*}\left((1-\mu)\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi)+(1-\mu)\epsilon_Z\right)\left[\mu\xi\alpha\beta_Y\overline{\phi}+\mu\epsilon_Y\right] \tag{141}$$

$$\frac{n_Z^A}{n_Z^*} = \frac{\frac{1}{(1-\mu)}\left(\frac{L^A}{L^*}\left[\xi\alpha\beta_Y\overline{\phi}+\epsilon_Y\right] - \frac{K^A}{K^*}\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi})+\epsilon_Y\right]\right)}{DEN2-DEN1} \tag{142}$$

with

$$DEN1 = \left(\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi}) + \epsilon_Y\right)[\xi\alpha\beta_Z\phi + \epsilon_Z]$$

$$DEN2 = \left[\xi\alpha\beta_Y\overline{\phi} + \epsilon_Y\right]\left(\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z\right)$$

Solving 137 for n_Z^A/n_Z^*:

$$\frac{n_Z^A}{n_Z^*} = \frac{\frac{K^A}{K^*} - \frac{n_Y^A}{n_Y^*}\left[\mu\xi\alpha\beta_Y\overline{\phi} + \mu\epsilon_Y\right]}{(1-\mu)\xi\alpha\beta_Z\phi + (1-\mu)\epsilon_Z} \tag{143}$$

Plugging into L^A/L^*:

$$\begin{aligned}\frac{L^A}{L^*} &= \frac{n_Y^A}{n_Y^*}\left[\mu\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi}) + \mu\epsilon_Y\right] \\ &-\frac{n_Y^A}{n_Y^*}\frac{\left[\mu\xi\alpha\beta_Y\overline{\phi} + \mu\epsilon_Y\right]((1-\mu)\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + (1-\mu)\epsilon_Z)}{(1-\mu)\xi\alpha\beta_Z\phi + (1-\mu)\epsilon_Z} \\ &+\frac{K^A}{K^*}\frac{(1-\mu)\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + (1-\mu)\epsilon_Z}{(1-\mu)\xi\alpha\beta_Z\phi + (1-\mu)\epsilon_Z}\end{aligned} \tag{144}$$

Rearranging

$$\begin{aligned}\frac{L^A}{L^*} &= \frac{n_Y^A}{n_Y^*}\mu\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi}) + \epsilon_Y\right] \\ &-\frac{n_Y^A}{n_Y^*}\frac{\mu\left[\xi\alpha\beta_Y\overline{\phi} + \epsilon_Y\right](\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z)}{\xi\alpha\beta_Z\phi + \epsilon_Z} \\ &+\frac{K^A}{K^*}\frac{\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z}{\xi\alpha\beta_Z\phi + \epsilon_Z}\end{aligned} \tag{145}$$

and multiplying with $[\xi\alpha\beta_Z\phi + \epsilon_Z]$ and rearranging leads to

$$\begin{aligned}&\frac{L^A}{L^*}[\xi\alpha\beta_Z\phi + \epsilon_Z] - \frac{K^A}{K^*}\left(\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z\right) \\ &= \frac{n_Y^A}{n_Y^*}\mu\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Y)(1-\overline{\phi}) + \epsilon_Y\right][\xi\alpha\beta_Z\phi + \epsilon_Z] \\ &-\frac{n_Y^A}{n_Y^*}\left(\mu\left[\xi\alpha\beta_Y\overline{\phi} + \epsilon_Y\right]\left(\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z\right)\right)\end{aligned} \tag{146}$$

The solution for n_Y^A/n_Y^* yields:

$$\frac{n_Y^A}{n_Y^*} = \frac{\left(\frac{L^A}{L^*}[\xi\alpha\beta_Z\phi + \epsilon_Z] - \frac{K^A}{K^*}\left[\frac{\xi}{\xi-1}\alpha(1-\beta_Z)(1-\phi) + \epsilon_Z\right]\right)}{\mu[DEN1 - DEN2]} \tag{147}$$

The results for $\frac{n_Y^A}{n_Y^*}$ and $\frac{n_Z^A}{n_Z^*}$ are symmetrical: The first summand in the denominator equals the second summand of the denominator in the other equation.

References

ANG, S., D. STRAUB (2002), Costs, Transaction-Specific Investments and Vendor Dominance of the Marketplace: The Economics of IS Outsourcing. In R. Hirschheim, A. Heinzl, J. Dibbern (eds.), *Information Systems Outsourcing: Enduring Themes, Emergent Patterns and Future Directions*, Berlin, Heidelberg, New York: Springer Verlag, 47–76.

ANTRAS, P. (2003), Firms, Contracts, and Trade Structure. *National Bureau of Economic Research Working Paper*, Vol. 9740.

ANTRAS, P., L. GARICANO, E. ROSSI-HANSBERG (2005), Offshoring in a knowledge-economy. *National Bureau of Economic Research Working Paper*, Vol. 11094.

BRYNJOLFSSON, E. (1994), An Incomplete Contracts Theory of Information, Technology and Organization. URL `http://ccs.mit.edu/papers/CCSWP126/CCSWP126.html`.

COASE, R. H. (1937), The nature of the Firm. *Economica*, 4: 386–405.

EU (2005), The EU Economy 2005 Review: Rising International Economic Integration.

FEENSTRA, R. C. (2004), *Advanced International Trade*. Princeton and Oxford: Princeton University Press.

GROSSMAN, G. M., E. HELPMAN (2002), Outsourcing in a global economy. *NBER Working Paper*, 8728.

GROSSMAN, G. M., E. HELPMAN (2005), Outsourcing in a global economy. *Review of Economic Studies*, 72 (1): 135–160.

GROSSMAN, S. J., O. D. HART (1986), The Costs and Benefits of Ownership - A Theory of Vertical and Lateral Integration. *Journal of Political Economy*, 94(4): 691–719.

HELPMAN, E., P. R. KRUGMAN (1985), *Market Structure and Foreign Trade*. Cambridge: MIT Press.

KLING, R., R. LAMB (2000), IT and Organizational Change in Digital Economies: A Sociotechnical Approch. In E. Brynjolfsson, B. Kahin (eds.), *Understanding the Digital Economy*, Cambridge, Massachusetts: MIT Press, 295–324.

LEAMER, E. E., M. STORPER (2001), The Economic Geography of the Internet Age. *NBER Working Paper*, 8450.

MIOZZO, M., I. MILES (2002), The relation between the internationalization of services and the process of innovation: a research agenda. In M. Miozzo, I. Miles (eds.), *Internationalization, Technology and Services*, Cheltenham, UK: Edward Elgar, 15–32.

OECD (2004), Information technology outlook 2004. URL `http://www1.oecd.org/publications/e-book/9304021E.PDF`.

RAUCH, J. E., V. TRINDADE (2003), Information and Globalization: Wage Co-Movements, Labor Demand Elasticity, and Conventional Trade Liberalization. *American Economic Review*, 93: 775–791.

SPENCER, B. J. (2005), International Outsourcing and Incomplete Contracts. *NBER Working Paper*, Vol. 11418, URL `http://papers.nber.org/papers/w11418.pdf`.

WILLIAMSON, O. E. (1985), *The economic institutions of capitalism*. New York: Free Press.