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Real and Monetary Issues of International Economic Integration

Edited by

Gerhard Rübel

Duncker & Humblot · Berlin

GERHARD RÜBEL (ed.)

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Preface

From April 15th-17th 1999, the 1st Passau Workshop on "International Economics" was held under the auspices of the Economics Department of the University of Passau. Two reasons induced my associates and me to set up this meeting. On the one hand, increasing globalization is bringing issues associated with international economics to the fore in academia, too. On the other hand, in contrast to this observation contributions on international topics given at economics conferences have decreased over the last few years.

In late summer of 1998 we issued the first call for papers. Invitations went out to all of our relevant colleagues in the German-speaking countries, but also explicitly to young economists, i.e. tenure-track post docs, Ph.D. students and members of research institutes. The response was extraordinarily positive, so that on three days more than thirty presentations were held and discussed. In view of this success, the Passau Workshop "International Economics" will be continued.

This edited book contains 10 contributions chosen from those given at the workshop, dealing with real and monetary aspects of international integration.

How falling transportation costs can lead to "The Emergence of Multinational Enterprises" is shown by *Jörn Kleinert*. In his paper a general equilibrium model of bi-directional intra-industry FDI between industrialized countries is used to show that decreasing transport costs first lead to increased FDI activities and only later to decreased FDI. Additionally, his analyses reveals that FDI is more likely in industries with differentiated products, with higher scale economies on company relative to plant level, with smaller inputs of intermediate goods and with more differentiated intermediate goods.

Michael Koop tries to combine the different aspects of international economic activity into one general equilibrium model and to derive a comprehensive theory of globalization. His model explains various types of trade, FDI, and MNEs. Simulation techniques are applied to assess the influence of country asymmetries and transportation costs on production patterns, trade, and investment flows.

If MNEs transfer capital from industrialized countries to developing countries and relocate intermediate production processes, does this development lower demand for labor in the capital exporting country? *Carsten Eckel* explores the impact of international production strategies of MNEs on labor de-

mand in the home country and finds that under certain conditions demand for labor in the capital exporting country can even increase.

Harald Proff analyses the intra- and inter-regional similarities and differences between developing countries in the main integration areas AFTA, SADC and MERCOSUR to evaluate the question of whether regional integration will lead to marked inequality in these regions. His results give rich insights into how heterogeneous some of these groups are with respect to various economic and social parameters.

The impact of a devaluation on a large open economy with imperfect competition in the home and the foreign market is analyzed by *Thomas Büttner*. He shows that the impact is weaker than that on a small economy, that an exchange rate shock has real long run effects, and that incomplete exchange rate pass-through persists after wage adjustments. Therefore, his model offers an explanation for pricing to market in the long run.

Christof Fischer sets out to explore the determinants of the long run natural real exchange rate in a medium-sized economy dependent on raw material imports. He finds that these are eventually the same determinants as for such a country's capital stock and net foreign debt. Shocks of fundamentals are introduced to examine their impact on the medium and long run equilibrium values.

In a joint paper, *Gregor Kolck* and *Dirk Rübesamen* address the issue of a "Tobin Tax and Exchange Rate Volatility". They introduce a Tobin tax into a Dornbusch-overshooting model and investigate whether the positive correlation between volatility and trading volumes allow a conclusion on the stabilizing effects of a Tobin tax.

Michael Carlberg addresses the issues of how to treat the European Monetary Union in macroeconomic analyses. He models the monetary union as an open economy with perfect capital mobility that consists of two identical countries, say Germany and France, and analyzes both fiscal and monetary policies. His results show that in such a setting only policy mix can boost income effectively.

In her paper "Coordinating Monetary Policy between Ins and Outs" *Sylvia Staudinger* investigates two possible target regimes to coordinate the policy between the European Monetary Union and non-participating countries. Under which conditions should both central banks target inflation or should only the ECB target inflation and the outside central bank should target the nominal exchange rate? This question is analyzed in a Mundell-Flemming framework by determining the outcomes of the main macroeconomic variables.

Christiane Nickel looks at the future of the EMU and examines how fit EU candidates are for the monetary union. Her study is based on the theory of optimum currency areas and by empirically assessing an OCA index she finds that "first wave" candidates for the EU appear to be as ready for the EMU as some non-EMU EU members.

Gerhard Rübel

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Part I: International Trade and Factor Movements

The Emergence of Multinational Enterprises

Simulation Results

Jörn Kleinert

I. Introduction

Multinational enterprises (MNE) stand at the centre of the new wave of globalisation. They are a dominant part in each of the different aspects of globalisation. First, the turnover of foreign affiliates in 1995 was at US$ 7 trillion, exceeding world trade in that year (The Economist, 1998). Second, 40% of world trade takes place within MNEs (Panic, 1997). Third, a high percentage of world wide R&D activities is carried out by MNEs. The global payments of fees and royalties for technology quadrupled from 1983 to 1995. In 1995, 80% of these payments flew between parent companies and their foreign affiliates (UNCTAD, 1997). Forth, world wide foreign direct investment (FDI) set a new record in 1996. It increased to US$ 347 billion (UNCTAD, 1997).

FDI is increasingly intra-OECD investment. According to de la Mothe (1996), in 1991 70% of world wide FDI stock is cross industrial country investment, compared to 51% in 1967. A high and increasing share of these FDI is intra industry cross investment (Cantwell and Sanna Randaccio, 1992). Factor price arbitrage does not seem to be the crucial reason behind this development. A large share of FDI is probably better explained by proximity-concentration theories. That is supported by the more than 90% of the output of US affiliates in Europe and Japan which are sold within the region (de la Mothe, 1996).

Despite their importance, MNE are still not well understood in theory. The OLI (Ownership, Location, Internalisation) paradigm (Dunning 1977, 1988) is dominant in the management literature on MNE. It has proved to be a useful way of organising almost all known factors which cause FDI, but it lacks rigorous theoretical formulation. Literature on the theory of MNE is rather new. It started with Markusen (1984) and Helpman (1984). More recent studies include Brainard (1993), Markusen and Venables (1995) and Koop (1997). Markusen and Venables (1995) and Koop (1997) analyse trade, investment and MNE in a general equilibrium framework using simulation techniques. "The key idea is that in each of the two countries a homogenous

good which is produced with economies of scale at the plant and at the firm level can be produced by exporters and/or multinational firms" (Koop, 1997: 5)

This paper keeps to the tradition of Brainard (1993) in that, a homogenous and a differentiated goods sector are modelled. That makes the results directly comparable to the findings of new trade theory. The differentiated goods sector is made up of companies producing final goods and companies producing intermediate goods. These companies engage in monopolistic competition within their groups. Since intermediate goods are often very specific to a production process or final goods, it is assumed that final product firms exclusively use intermediate goods from their home country. The final good producer produces in a multi-stage process that includes fixed inputs at the corporate level (R&D, marketing) and at the plant level. The variable costs incurred in production include the costs for the input of intermediate goods and factor costs of skilled and unskilled labour. Final goods producing companies choose between exports and production abroad to serve the foreign market. Export saves on additional fixed costs at the plant level, while production abroad saves on transport costs.

Only economies with identical relative factor endowments are examined to exclude effects which result from factor price differentials, since these are not the driving force behind developed countries' cross FDI. The paper goes beyond Brainard (1993) in (i) that it allows for differences in absolute factor endowments of both countries, which make numerical simulations necessary but gives richer insight in the complexity of the investment decision; (ii) the introduction of an intermediate goods sector; (iii) that conditions of competition are changed by letting transport costs decrease throughout the simulations.

It is the central aim of this paper to present a model of bi-directional intra industry FDI which is able to reproduce these basic stylised facts of FDI development in past decades.

In models of FDI so far, FDI increases if transport costs increase. But this theoretical prediction is at odd with the facts. In the last decades transport and communication costs fell and FDI increased. Moreover, existing models are hardly able to explain the time pattern of FDI with investment first by US companies, later by companies from other industrial countries and recently also from industrialising countries. In addition to political factors, globalisation is driven by falling transport and communication costs. The simulations in this paper mimic reality by letting transport costs decrease. Transport costs affect the profitability of a company's FDI. Through variation of different model parameters simulations identify determinants of a company's investment decision.

The major results can be summarised as follows: At moderate transport cost levels production abroad is more profitable than exports, at high and low levels exports are more profitable. If economies differ in size, the companies in the larger country invest abroad first. For companies in the smaller country investment only becomes profitable, if transport costs are falling further. It may also be the case that it is never profitable for those firms although they produce with the same technology as the companies in the larger country.

The profitability of FDI differs between industries. It is more profitable to invest abroad for a highly differentiated industry than for industries producing less differentiated goods. Further, the emergence of MNE is accelerated by a higher share of fixed costs at the company level relative to the plant level and slowed down by an increasing amount of intermediate goods used in production.

II. The Model

Consider two countries, G and K, each with two sectors of production. One sector, agriculture, produces a homogenous product Q_A with constant returns to scale under perfect competition. The other sector, manufacturing, produces a variety of final goods and a variety of intermediate goods under imperfect competition. The aggregate amount of output of the final goods in the manufacturing sector is Q_M. Each firm produces only a single variety i; output is denoted q_i. The final goods producer, which can serve the foreign market through exports or production abroad, uses intermediate goods, which are also produced in the manufacturing sector. The aggregate amount of output of the intermediate goods Z is used as input exclusively by the final goods producer headquartered in the same country. An individual intermediate firm's output is denoted z_i . The structure of the production side of the economy is shown in Figure 1.

It is assumed that every individual is either endowed with one unit of unskilled labour L or one unit of skilled labour H. Labour is perfectly mobile within national economies. However, there is no cross-border mobility of labour. The labour market equilibria give wage levels for unskilled and skilled labour w_j, v_j in country j. Full employment is assumed.

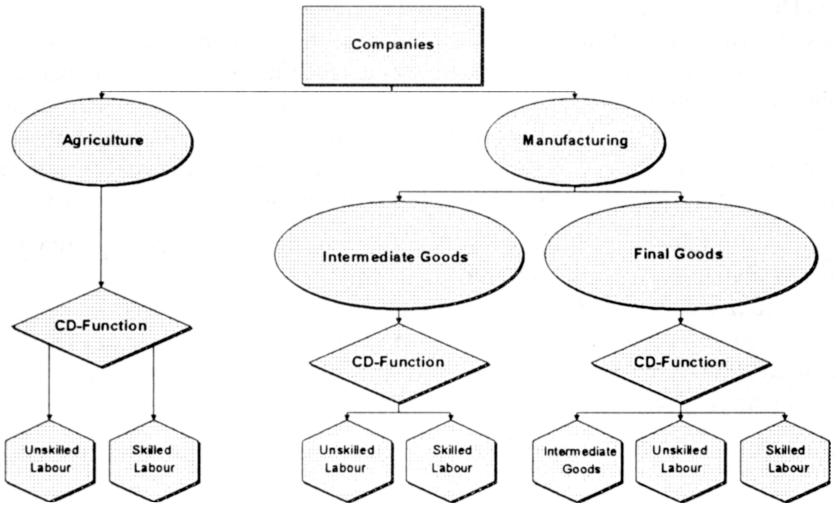


Figure 1: The Structure of the Production Side of the Economy

1. Consumption

N_j inhabitants live in each country j. They have identical preferences. Their utility function is increasing in the agricultural product and the aggregate manufacturing product.

$$U_j = Q_{A,j}^{1-\mu} Q_{M,j}^{\mu} \qquad \mu \in (0,1)\,;\, j = G,K \tag{1}$$

μ gives the income share spent on manufacturing goods. The aggregate Q_M is a CES-function with λ different products.

$$Q_{M,j} = \left[\sum_{i=1}^{\lambda} q_{i,j}^{\rho} \right]^{1/\rho} \qquad \rho \in (0,1)\,;\, j = G,K \tag{2}$$

ρ defines the degree of differentiation of the manufacturing goods. The products are poor substitutes for each other if ρ is small, leaving the companies with more market power. If ρ increases, it is easier for consumers to substitute one good for the other, therefore market power decreases.

Equation (2) implies that consumers love variety. If they are indifferent to two products, they prefer a mix of half a unit of each good. The CES-function (2) implies a constant elasticity of substitution σ, with $\sigma = 1/(1-\rho)$, between any two varieties of the manufacturing products.

Individuals maximise their utility (1) subject to budget constraints

$$Y_j = p_{A,j}Q_{A,j} + \sum_{i=1}^{\lambda} q_{i,j}p_{i,j} \qquad j = G,K \tag{3}$$

to obtain the optimum quantities of agricultural and manufacturing goods.

$$Q_{A,j} = (1-\mu)Y_j / p_{A,j} \qquad j = G,K \tag{4}$$

$$Q_{M,j} = \mu Y_j / p_{M,j} \qquad j = G,K \tag{5}$$

$p_{A,j}$ is the price of agricultural goods, $p_{M,j}$ is the price-index of the varieties of manufacturing goods. It depends on the price of every individual product. Since agriculture stands for the perfectly competitive sector of economy and the agricultural good can be traded without costs, the price of the agricultural product will be the same in both economies and set to 1. The agricultural good Q_A will therefore be used as numeraire throughout this paper.

2. Production

The agricultural good is assumed to be produced under constant returns.

$$Q_{A,j} = L_{A,j}^{\theta_1} H_{A,j}^{1-\theta_1} \tag{6}$$

Since agriculture is a perfect competition sector wages w_j and salaries v_j are paid according to the marginal products of the production factors unskilled and skilled labour, respectively.

$$\frac{\partial Q_{A,j}}{\partial L_{A,j}} = w_j \text{ and } \frac{\partial Q_{A,j}}{\partial H_{A,j}} = v_j \,. \tag{7}$$

Perfect mobility of workers across sectors, assures that wages and salaries are identical in every sector of the economy.

For a Cobb-Douglas technology the production function can be transformed into a cost function. For the remainder of this paper, technology is described by the cost function. Production costs in agriculture are given by

$$C_{A,j} = \left(\frac{w_j}{\theta_1}\right)^{\theta_1} \left(\frac{v_j}{1-\theta_1}\right)^{1-\theta_1} Q_{A,j} \qquad j = K,G; \theta_1 \in (0,1) \tag{8}$$

In the manufacturing sector, companies are engaged in monopolistic competition. Consumers view the differentiated products as imperfect substitutes. Each company produces a single variety. Hence, the number of differentiated goods equals the number of firms in the two countries.

There are two groups of firms in the manufacturing sector, intermediate goods producers and final goods producers. The final goods producers use a bundle of intermediate goods as input in their production. Since intermediate goods are often very specific to a production process or final good, the production of this final good in a foreign market depends on the supply of intermediate goods from the home market. It is assumed that MNEs exclusively use intermediates produced in their home market irrespective of whether production of the final good occurs at home or in the foreign country.[1]

The intermediate goods are not perfect substitutes for each other. The bundle of intermediate goods used by any firm in the manufacturing sector contains all varieties of intermediate goods.

$$Z_j = \left[\sum_{i=1}^{s_j} z_i^{\varepsilon} \right]^{-\frac{1}{\varepsilon}} \qquad j = G,K; \varepsilon \in (0,1) \tag{9}$$

Aggregation is again assumed to be a CES function. The intermediate goods' degree of differentiation depends on ε. s_j is the number of intermediate goods produced in country j.

The price-index pz_j for intermediate goods can be calculated from (9).

$$pz_j = \left[s_j pZ_{,i,j}^{-\phi} \right]^{-\frac{1}{\phi}} \qquad j = G,K \tag{10}$$

where $\phi = \varepsilon/(1-\varepsilon)$. s_j is the number of varieties of the intermediate goods in the bundle Z_j, $p_{Z,i,j}$ is the price of any of these varieties.

The production costs of an intermediate good variety follow the cost function

$$C_{i,j}^{Z} = \left(\frac{w_j}{\theta_2}\right)^{\theta_2} \left(\frac{v_j}{1-\theta_2}\right)^{1-\theta_2} f_{Z,j} + \left(\frac{w_j}{\theta_3}\right)^{\theta_3} \left(\frac{v_j}{1-\theta_3}\right)^{1-\theta_3} z_{i,j} \tag{11}$$

[1] This seems to be a very strict assumption, but it is not, because only specific intermediate goods are modelled. Other, more easily substitutable intermediates, can be dealt with like unskilled or skilled labour. For the sake of simplicity, these are excluded.

The first term of the right hand side gives the fixed costs. $f_{Z,j}$ is the level of fixed inputs determined by the production technology. The second term describes the marginal costs $c_{Z,j}$ multiplied by the output $z_{i,j}$. Because all producers of intermediate goods face the same factor costs and use the same technology, their marginal costs and their fixed costs are identical.

The amount spent on intermediate goods of country j by the final goods producer is denoted I_j. From the composition of the aggregate intermediate good (9), the demand of any of the varieties can be derived.[2]

$$z_{i,j} = \frac{pZ,i,j^{-(1+\phi)}}{pz_j^{-\phi}} I_j \qquad j = G,K \tag{12}$$

In an equilibrium, demand for the intermediate good equals its production. The output of an intermediate goods producer decreases, therefore, in its own price $p_{Z,i,j}$, and increases in the price-index of intermediate goods pz_j and the demand for intermediate goods from the final goods producer I_j.

Maximising the profit function of an intermediate goods producer

$$\Pi_{i,j}^{Z} = \left[pZ,i,j - cZ,j\right] z_i(pZ,i,j) - C_{ZF,j} \qquad j = G,K \tag{13}$$

yields the optimal price of his intermediate good

$$pZ,i,j = cZ,j \,/\, \varepsilon \qquad j = G,K \tag{14}$$

The producers of intermediate goods set their prices $1/\varepsilon$ over their marginal costs $c_{Z,j}$. These prices are identical, because their marginal costs are identical as well as the outputs z_j.

The number of intermediate goods firms s_j is determined by the zero-profit-condition.

$$\Pi_j^{Z} = (1-\varepsilon) p_{Z,j} z_j - C_{ZF,j} = 0 \tag{15}$$

Since there is free market entry and exit in both countries in this model, new companies will enter profitable markets until profits fall to nil. New entrants influence the profit of existing firms by increasing competition: the price index (11) decreases as a result. In equilibrium, the zero-profit condition holds.

[2] For a derivation of the price index and the demand for any variety see *Kleinert* (1998).

Equation (10) gives the price-index for a home based plant of a final good producer. The price-index of affiliates in the foreign country pz_j^M must take the transport costs $(\tau_M D)$ into account.

$$pz_j^M = \left[s_j \left(p_{Z,j} e^{\tau_M D} \right)^{-\phi} \right]^{-\frac{1}{\phi}} \qquad j = G,K \tag{16}$$

Transport costs are modelled according to Samuelson's 'iceberg' form: a part of the value of every product must be paid for transportation. This value increases with the distance D between the two markets (which is set to 1 for the remainder of this paper). To buy one unit of an imported intermediate good, $e^{\tau_M} (> 1)$ units have to be paid by the producer of the final good in the foreign country, $\left(e^{\tau_M} - 1\right)$ units being transport costs.

There are two possible types of final goods producers in every country: (i) national firms producing in their home market and serving the foreign country through exports and (ii) MNE producing domestically and abroad. For the sake of simplicity, exports of the MNE affiliates to the home country are excluded.

The final goods producers manufacture their products in a multi-stage process. In the first stage, headquarter services are produced in each firm. The headquarter services have the character of public goods within the company. In the second stage, actual production takes place at the plant. Therefore, headquarter services and intermediate goods are used as inputs in the second stage.

In the first stage, a headquarter-service is produced with unskilled and skilled labour. The cost function of any final good producer is given by

$$C_{Hq,i,j} = \left(\frac{w_j}{\theta_4} \right)^{\theta_4} \left(\frac{v_j}{1-\theta_4} \right)^{1-\theta_4} r_j \qquad j = G,K; \theta_4 \in (0,1) \tag{17}$$

r_j is the level of headquarter-services produced by the companies in country j. In the second stage, at the plant level, the companies produce with fixed and variable input factors. The cost function of the fixed inputs $C_{PF,i,j}$ is

$$C_{PF,i,j} = \left(\frac{w_j}{\theta_2} \right)^{\theta_2} \left(\frac{v_j}{1-\theta_2} \right)^{1-\theta_2} f_j \qquad j = G,K; \theta_2 \in (0,1) \tag{18}$$

f_j is the level of fixed input necessary for the production of final good. r_j and f_j are given by the production technology; therefore, exogenous to the company.

The costs of variable inputs $C^N_{PV,i,j}$ of a plant of a national company in j are determined by

$$C^N_{PV,i,j} = \left(\frac{w_j}{\theta_5}\right)^{\theta_5}\left(\frac{v_j}{\theta_6}\right)^{\theta_6}\left(\frac{pz_j}{1-\theta_5-\theta_6}\right)^{1-\theta_5-\theta_6} q^N_{i,j} \tag{19}$$

$$j = G,K \text{ and } \theta_5,\theta_6 \in (0,1)$$

Variable costs $C^N_{PV,i,j}$, increase in the factor prices of unskilled and skilled labour w_j, v_j, the price-index of the intermediate goods pz_j and the output $q^N_{i,j}$.

Different plants of MNEs have different variable costs $C^M_{PV,i,j,h}$ in each country because of different wages ($w_j \neq w_h, v_j \neq v_h$) and different prices of the intermediate goods $\left(pz^M_j \neq pz_j\right)$ in both markets. A multinational company's variable costs of production in the home-country j, $C^M_{PV,i,j,j}$, are

$$C^M_{PV,i,j,j} = \left(\frac{w_j}{\theta_5}\right)^{\theta_5}\left(\frac{v_j}{\theta_6}\right)^{\theta_6}\left(\frac{pz_j}{1-\theta_5-\theta_6}\right)^{1-\theta_5-\theta_6} q^M_{i,j,j} \tag{20}$$

The variable costs of production in h of an MNE headquartered in j $C^M_{PV,i,j,h}$ are

$$C^M_{PV,i,j,h} = \left(\frac{w_h}{\theta_5}\right)^{\theta_5}\left(\frac{v_h}{\theta_6}\right)^{\theta_6}\left(\frac{pz^M_j}{1-\theta_5-\theta_6}\right)^{1-\theta_5-\theta_6} q^M_{i,j,h} \tag{21}$$

$$j = G,K; h = G,K \text{ and } \theta_5,\theta_6 \in (0,1); j \neq h$$

An MNE's variable costs abroad depend on the wage rates of unskilled and skilled labour w_h, v_h in the foreign country h, the elasticities of production θ_5, θ_6

(technology used) and the costs of the intermediate goods pz_j^M (including transport costs from the home country). The output $q_{i,j}^k$ $(k = N,M;\ j = G,K)$ differs between domestic suppliers and MNE in the same country as well as between MNE affiliates in the MNE's home country and the affiliates in the foreign country.

In equilibrium, companies produce the amount of goods they can sell for the optimal price. Using the utility function (1) and the composition of the aggregated manufacturing good (2), equation (22) gives the demand for one single product $q_{i,j}^N$ for a national firm, which serves the foreign market through exports:

$$q_{i,j} = \frac{p_{i,j}{}^{-(1+\gamma)}}{pM_{,j}{}^{-\gamma}}\mu Y_j + \frac{p_{i,j}{}^{-(1+\gamma)}e^{-(1+\gamma)\tau_M}}{pM_{,h}{}^{-\gamma}}\mu Y_h \tag{22}$$

$$j = G,K; h = G,K \text{ and } h \neq j; \gamma = \rho/1-\rho$$

The optimal quantity of a good i produced in j depends on: its price $p_{i,j}$, the price-indices $p_{M,j}$, $p_{M,h}$ in both final goods markets and the transport costs τ_M. The lower the price of good i relative to the price-index in both countries, the higher the optimal output. High transport costs decrease the optimal output by increasing the sales price in the foreign market. Consumers in the importing country h must pay the transport costs and react therefore by partially substituting imported goods for goods produced in their country h.

An MNE headquartered in j produces in both countries. It supplies goods which are produced within each country. The output from the domestic plant

$$q_{i,j,j}^M = \frac{p_{i,j,j}^{M\ -(1+\gamma)}}{pM_{,j}{}^{-\gamma}}\mu Y_j \qquad j = G,K \tag{23}$$

equals the demand in the home country, since re-export is excluded.

The price of an MNEs goods in the foreign market h are lower than prices for imported goods, since consumers do not have to pay transport costs.

$$q_{i,j,h}^M = \frac{p_{i,j,h}^{M\ -(1+\gamma)}}{pM_{,h}{}^{-\gamma}}\mu Y_h \qquad j = G,K; h = G,K \tag{24}$$

$q^M_{i,j,h}$ is the output in h of an MNE i with Headquarters in j. It increases in the price-index and the market size μY_h of h and decreases in its own price.

The quantity of the intermediate goods-bundle used by a single final goods producer can be calculated from the variable cost functions (19) – (21) by taking the partial derivative with respect to the price-index pz_j (Shephards lemma).

(25)
$$qz^N_{i,j} = \frac{\partial C_{PV,i,j}}{\partial pz_j}$$
$$= (1-\theta_5-\theta_6)\left(\frac{w_j}{\theta_5}\right)^{\theta_5}\left(\frac{v_j}{\theta_6}\right)^{\theta_6}\left(\frac{1-\theta_5-\theta_6}{pz_j}\right)^{\theta_5+\theta_6} q^N_{i,j}$$

(26)
$$qz^M_{i,j} = \frac{\partial C^M_{PV,i,j,j}}{\partial pz_j} + \frac{\partial C^M_{PV,i,j,h}}{\partial pz^M_j} = qz^M_{i,j,j} + qz^M_{i,j,h}$$
$$= (1-\theta_5-\theta_6)\left(\frac{w_j}{\theta_5}\right)^{\theta_5}\left(\frac{v_j}{\theta_6}\right)^{\theta_6}\left(\frac{1-\theta_5-\theta_6}{pz_j}\right)^{\theta_5+\theta_6} q^M_{i,j,j}$$
$$+ (1-\theta_5-\theta_6)\left(\frac{w_h}{\theta_5}\right)^{\theta_5}\left(\frac{v_h}{\theta_6}\right)^{\theta_6}\left(\frac{1-\theta_5-\theta_6}{pz^M_j}\right)^{\theta_5+\theta_6} q^M_{i,j,h}$$

In equilibrium the aggregate demand for intermediate goods $\left(\sum_{i=1}^{m_j} qz^M_{i,j} + \sum_{i=1}^{n_j} qz_{i,j}\right)$ equals the aggregate supply $\left(Z_j\right)$. The total costs for intermediate goods $\left(\sum_{i=1}^{m_j} pZ_{,j} qz^M_{i,j} + \sum_{i=1}^{n_j} pZ_{,j} qz_{i,j}\right)$ equal the demand I_j.

The final goods producers set their prices to maximise their profits.

(27)
$$\Pi^N_{i,j} = \left[p^N_{i,j} - c^N_{PV,i,j}\right] q_i\left(p^N_{i,j}\right) - C_{Hq,i,j} - C_{PF,i,j} \qquad j = G,K$$

(28)
$$\Pi^M_{i,j} = \left[p^M_{i,j} - c^M_{PV,i,j}\right] q^M_{i,j}\left(p^M_{i,j}\right) + \left[p^M_{i,h} - C^M_{PV,i,h}\right] q^M_{i,h}\left(p^M_{i,h}\right)$$
$$- C_{Hq,i,j} - C_{PF,i,j} - C_{PF,i,h}$$

The solution to this maximisation-problem is always a fixed mark-up factor over marginal costs $c^k_{PV,i,j}$.

$$p^k_{i,j} = c^k_{PV,j} / \rho \qquad j = G,K; k = N,M \tag{29}$$

The price of a single final good depends only on the good's marginal costs $c^k_{PV,j}$ and ρ, the parameter of differentiation. Marginal costs can easily be obtained from the variable costs (17) – (21). Since all companies use the same technology, the marginal costs differ only if factor prices differ. But factor prices can not differ within one country, because there is inter-sectoral mobility, hence $p_{j,j} = p_{i,j,j}$.

In each country j there are four different potential supplier of final manufacturing goods. (i) National firms of country j producing for their home market. (ii) Foreign firms serving country j through exports. (iii) MNEs with their headquarters in country j producing at their plant in j and (iv) MNEs with the headquarter in country h producing at their affiliate in country j.

Prices set by companies located in G and K differ as result of different marginal costs caused by different factor costs. Prices set by national and multinational enterprises also differ in the foreign market but not at home. There are therefore up to three different prices $p^k_{j,h}$ ($j = G,K; h = G,K; j \neq h$ and k=N, M) in each country h: price of goods produced by j based firms (nationals and multinationals), imported goods and goods produced by an h-headquartered MNE's plant in j. The price of a national firm's good in the foreign market $p^N_{j,h}$ equals the home-market price multiplied by the transportation costs $p^N_{j,h} = p^N_{j,j} e^{\tau_M}$.

From the utility functions (1) and (2) the price index for each market can be calculated.

$$pM,j = \frac{\mu Y_j}{QM,j} = \left[\sum_{i=1}^{\lambda} p_i^{-\gamma} \right]^{-\frac{1}{\gamma}} \qquad j = G,K. \tag{30}$$

Using the different product prices of the different companies, the price index can be written as

(31)
$$p_{M,j} = \frac{\mu Y_j}{Q_{M,j}}$$

$$= \left[\sum_{i=1}^{n_j} \left(p_{j,j}^{N}\right)^{-\gamma} + \sum_{i=1}^{n_h} \left(p_{h,j}^{N}\right)^{-\gamma} + \sum_{i=1}^{m_j} \left(p_{j,j}^{M}\right)^{-\gamma} + \sum_{i=1}^{m_h} \left(p_{h,j}^{M}\right)^{-\gamma} \right]^{-\frac{1}{\gamma}}$$

$$j = G,K;\ h = G,K;\ j \neq h$$

n_j is the number of national companies, located in j, n_h the number of nationals located in h, m_j and m_h are the numbers of multinationals headquartered in j and h, respectively. n_j, n_h, m_j and m_h add up to λ.

Since there is free market entry and exit, in equilibrium the zero-profit condition holds for national and multinational companies.

(32)
$$\Pi_j^N = (1-\rho) p_j^N q_j^N - C_{Hq,j} - C_{PF,j} = 0$$
$$j = G,K; h = G,K; j \neq h$$

(33)
$$\Pi_j^M = (1-\rho)\left(p_{j,j}^M q_{j,j}^M + p_{j,h}^M q_{j,h}^M\right) - C_{Hq,j} - C_{PF,j} - C_{PF,h} = 0\,.$$

The zero-profit-conditions (32) and (33) are sufficient to determine the number of national firms n_j and multinational firms m_j.[3]

3. Investment Decision

All final goods producers can decide whether to serve the foreign market through exports or to become an MNE and to produce abroad. If there are no restrictions to FDI, a company will invest in the foreign market if it is profitable to do so. The price of the good drops in the foreign market, when an exporting company becomes an MNE, since there are only transport costs on the intermediate good but not on the final good. The quantity sold rises as do variable profits. A national final goods producer decides to invest in a foreign country if the gains in variable profits are at least as high as the additional fixed costs at the plant level.

[3] In general, there is no simple solution to the number of companies in both countries. But there are some special cases where an expression for the number of companies can be derived (see *Brainard*, 1993).

(34) $$C_{PF,h} \leq (1-\rho)\left(p_{j,j}^{M} q_{j,j}^{M} + p_{j,h}^{M} q_{j,h}^{M} - p_{j}^{N} q_{j}^{N}\right)$$

$$j = G,K; H = G,K \quad j \neq h$$

The lower the fixed costs at the plant level $C_{PF,h}$, the sooner a national firm will decide to build a plant abroad. Not clear is the influence of the transport costs. The last term of the right hand side increases with lower transport costs, because q_j^N increases. But the second term from the right increases as well. The net effect depends on the parameters. The influence of ρ is also ambiguous. The first factor on the right hand side of equation (34) will increase, as product differentiation increases (falling ρ). That accelerates investment. But $\Delta q = q_{j,j}^{M} + q_{j,h}^{M} - q_j^N$ is influenced by ρ, as well. A smaller ρ implies a smaller Δq, and therefore a smaller increase in variable profits. Therefore, the influence of ρ on the investment decision depends on the specific value of the parameters.

One company's investment in the foreign market intensifies competition for all companies in this market. It produces the same effect as the entry of a new firm, the price index decreases.

MNEs are free to divest in the foreign country and serve consumers there instead through exports. Fixed costs at the plant-level are sunk-costs, but if the revenue of a MNE is smaller than the revenue of a national company,

(35) $$p_{j,j}^{M} q_{j,j}^{M} + p_{j,h}^{M} q_{j,h}^{M} < p_j^N q_j^N$$

$$j = G,K; h = G,K; j \neq h$$

it is profitable for a company to divest. Factor prices for labour and skilled labour must be much cheaper in country j compared to country h to make up for the additional transport costs.

4. Factor Demand

Factor demand is derived by Shepards Lemma. The cost functions (8), (11) and (17) through (21) are differentiated with respect to the factor price. The derivation of the labour demand is shown in Kleinert (1998).

5. Market Equilibrium

Full employment of all resources is assumed in both economies. For a given endowment of unskilled labour, L_j, the labour market condition is

$$L_j = L_{A,j} + n_j\left(L_{Hq,j} + L_{PF,j} + L^N_{PV,j} + L^N_{t,j}\right) + s_j\left(L_{Z,j} + L^Z_{tz,j}\right) + m_j\left(L_{Hq,j} + L_{PF,j} + L^M_{PV,j,j}\right) + m_h\left(L_{PF,j} + L^M_{PV,h,j}\right) \tag{36}$$

Then, the market clearing condition for skilled labour is

$$H_j = H_{A,j} + n_j\left(H_{Hq,j} + H_{PF,j} + H^N_{PV,j} + H^N_{t,j}\right) + s_j\left(H_{Z,j} + H^Z_{tz,j}\right) + m_j\left(H_{Hq,j} + H_{PF,j} + H^M_{PV,j,j}\right) + m_h\left(H_{PF,j} + H^M_{PV,h,j}\right) \tag{37}$$

Wages and salaries are set as to clear factor markets in each country. The wage level determines the size of the agricultural sector because this is a perfectly competitive industry.

$$p_{A,j} = c_{A,j} \qquad j = G,K \tag{38}$$

The income Y_j in j is given by the sum of the income of each individual.

$$Y_j = w_j L_j + v_j H_j \qquad j = G,K \tag{39}$$

The demand functions (4) and (5), the income equation (39) and the budget constraint (3) ensure that goods markets clear. The factor market clearance is given by (36) and (37). The value of the marginal products of unskilled and skilled labour (7) determines the wages in each economy. The pricing rule (29) and the equations (22) to (24), (32) and (33), define the output of the national and multinational firms and their number in each country. The number of intermediate goods firms and their output levels are given by (14), (12) and (15). The pricing rule (38) sets the agricultural goods output in each economy and therefore the level of inter-industry trade. The costless one-way trade of the homogenous good leads to price equality of this good in both economies.

There is always intra-industry trade in final products, because the final goods are not perfect substitutes for one another. The quantities $q^N_{j,h}$ sold fall with rising transport costs, they are very small for almost prohibitive transport costs.

$$Ex^M_j = n_j p^N_{j,h} q^N_{j,h} \qquad j = G,K; h = G,K; j \neq h \tag{40}$$

Trade in (headquarter) services depends on the existence of MNE. It equals

$$Ex_j^S = m_j C_{Hq,j} \frac{q_{j,h}^M}{q_{j,j}^M + q_{j,h}^M} \qquad j = G,K \tag{41}$$

Since this is a static model, in equilibrium trade must be balanced.

$$Ex_j^A + Ex_j^M + Ex_j^S = Ex_h^M + Ex_h^S \qquad j = G,K; h = G,K; j \neq h \tag{42}$$

Ex^A can be positive or negative, depending on whether j is an exporter or an importer of the agricultural good. Ex^M must be positive for both economies. Ex^S can be nil or positive for both countries depending on the existence of MNEs.

III. Simulation Results

To analyse the determinants on bi-directional intra-industry foreign direct investment in industrialised countries the model described in section II is simulated for different scenarios. Since the influence of relative factor endowment differences is not the focus of this paper, a constant unskilled-skilled labour endowment ratio of 3:1 across countries is assumed.

To make the changes in profitability of FDI visible a trigger curve of investment is derived form the investment decision (34).

$$\Phi = (1-\rho)\left(p_{j,j}^M q_{j,j}^M + p_{j,h}^M q_{j,h}^M - p_j^N q_j^N\right) - C_{PF,h} \tag{43}$$

The first two terms describe the change in variable profits resulting from investment, the last term describes fixed costs. Φ is positive if profits are increased by FDI. The company invests abroad if Φ is greater than 0, since companies are assumed to maximise profit. Φ shows the incentive for a company from j to invest in the foreign country h.

Φ in (43) is derived using a price index with national companies only. Hence, the trigger curve (43) is only valid before the investment of any company has occurred. One company's FDI changes the price index (30), the optimal output conditions (22) through (26) and, therefore, the investment decision (34) and the trigger curve (43).

The focus of this paper is the point where investment abroad becomes profitable. That is the point where the trigger curve crosses the zero line. It is

examined how this point is influenced by the variation of the different parameters. If the value of the trigger curve is positive and at least one company decides to invest in the foreign market the trigger curve (43) is not valid any more, because its derivation used a price index with only national companies. The consequences of one company's investment in the foreign market is beyond the scope of this paper. Here, the determinants of initial investment are considered. To separate the different influences, equilibria with only national companies are employed.

The following simulations begin at very high transport cost levels. There is no inter-industry trade, since the two countries have the same relative factor endowments. Due to high transport costs, there is almost no trade in differentiated final goods. The countries are autarkic. Factor prices are identical in both countries. There is no incentive to invest in the foreign country, because high transport costs leads to high intermediate goods prices.

Scenario 1: The Influence of Transport Costs

Transport costs fall in this scenario. As a result, intra-industry trade rises between the two countries. Transport costs prevent price equalisation. Hence factor prices differ in both countries and inter-industry trade arises. Falling transport costs raise profit from FDI because home-supplied intermediate goods become cheaper abroad.[4]

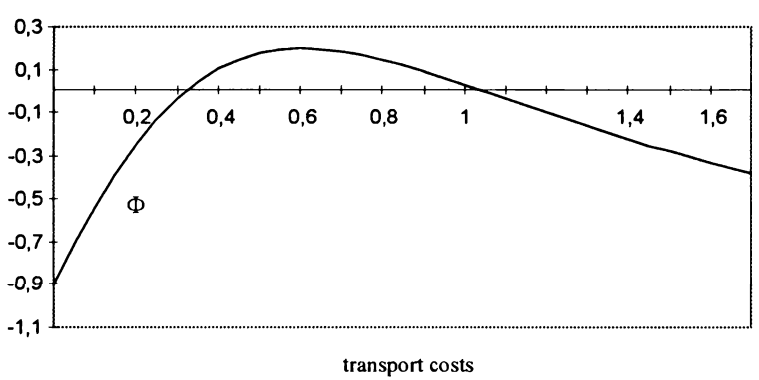


Figure 2: The Influence of Transport Costs

[4] In order to understand falling transport costs as a characteristic of economic development, Figure 3.1 to 3.5 have to be read from right to left.

Figure 2 shows the trigger curve for equilibria with two identical countries 1 and 2.[5] It is profitable for companies in both countries to invest in the foreign market if the transport costs are not too high, but not too low, either. In the case of high transport costs intermediate goods from the home country are very expensive and production abroad, therefore, is not profitable. If transport costs are very low, the company does not save enough on transport costs which would make up for the additional fixed costs for the second plant. Hence it is not profitable to invest.

Scenario 2: The Influence of Transport Costs when Countries Differ in Size

To allow for differences in absolute, but not in relative factor endowments, the size of country 2 is reduced to two third of the size of country 1. This changes the investment decision for both countries. Now, Φ differs between the two economies.

$$\Phi_1 = (1-\rho)\left(p_{1,1}^M q_{1,1}^M + p_{1,2}^M q_{1,2}^M - p_1^N q_1^N\right) - C_{PF,2} \tag{44}$$

$$\Phi_2 = (1-\rho)\left(p_{2,2}^M q_{2,2}^M + p_{2,1}^M q_{2,1}^M - p_2^N q_2^N\right) - C_{PF,1} \tag{45}$$

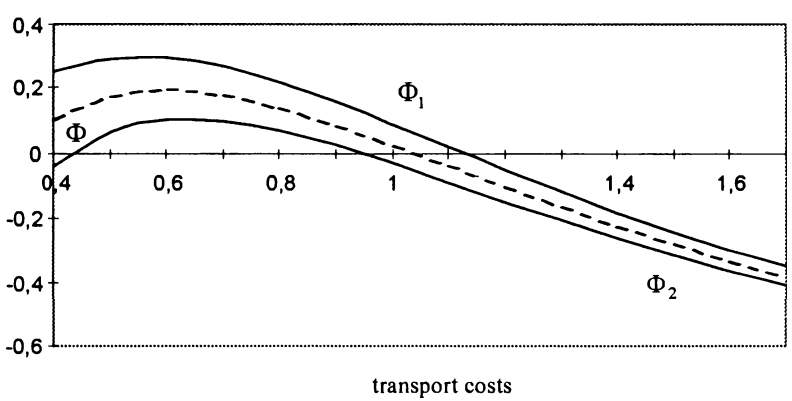


Figure 3: The Influence of Transport Costs when Countries Differ in Size

[5] The parameters which are used to derive the trigger curves in scenario 1 to 5 are given in the Appendix.

Figure 3 shows the new trigger-curves ϕ_1 and ϕ_2 in comparison to the trigger curve Φ of 3.1. All trigger curves increase with falling transport costs until transport costs fall below a certain point ($\tau_M \approx 0.6$) and decrease thereafter.

ϕ_1, the larger country's trigger curve lies above Φ. FDI is profitable at a higher level of transport costs for companies based in the larger country 1 ($\tau_M = 1.1$), compared to those in the smaller country 2 ($\tau_M = 0.94$), because they enjoy a cost advantage that stems from higher economies of scale in their larger home market. The actually valid part of these trigger curves is only the part of the right of the point where the trigger curve of the larger country 1 crosses the zero line. At this point, country 1's companies investment in the smaller country 2 becomes profitable. MNE emerge since profit maximisation is assumed. That changes the price index (30) and, therefore, the trigger curves (43), (44) and (45). The rest of the trigger curve stays valid only if the companies of country 1 do not invest.

Scenario 3: The Influence of Transport Costs on Various Industries in Economies of Different Size

If industries are characterised by different degrees of product differentiation ρ, the trigger curve differs by industry. The degree of differentiation determines the economies of scale enjoyed by the companies. Figure 4 shows trigger curves for the larger and the smaller country for different parameters ρ.

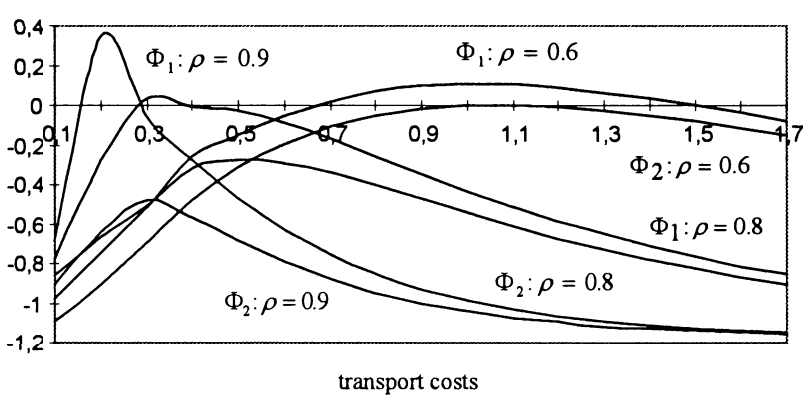


Figure 4: The Influence of Transport Costs on Various Industries of Economies of Different Size

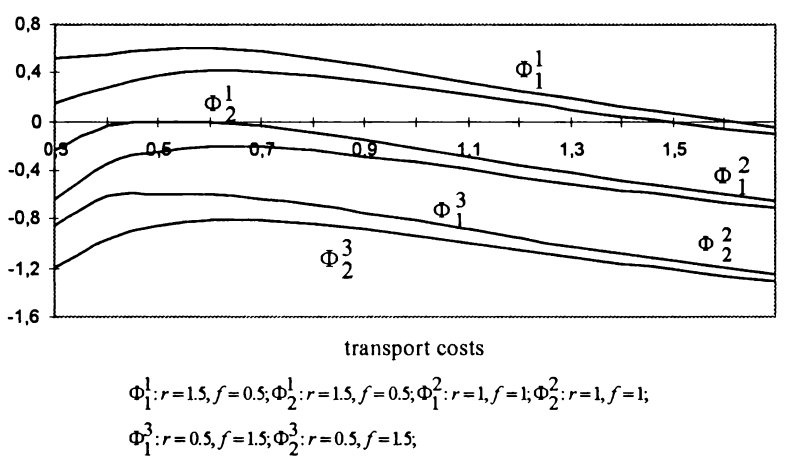
The point where the trigger curve Φ crosses the τ_M -axis differs from industry to industry. FDI is profitable at higher levels of transport costs for

industries that are characterised by higher product differentiation (lower ρ) because this translates to greater economies of scale. To make FDI of an industry with very low economies of scale profitable, transport costs have to fall to a very low level. It is not profitable for a company in a less differentiated sector ($\rho = 0.8$ and $\rho = 0.9$) from the smaller country to invest in the larger country at any transportation costs level.

Scenario 4: The Influence of Transport Costs when Fixed Costs Vary

In this scenario the ratio of fixed costs at the company level to plant level is varied while the absolute level of fixed costs is kept constant. High (total) fixed costs are a barrier to entry, because of the zero-profit-function (32), but in the trigger curve function (43) only the plant fixed costs are included. Equation (32) does not change but the trigger function shifts outward with a higher share of fixed costs at the company level. Company level services are public goods within the company. The profitability of an investment increases with the level of services which can be used at no additional costs by the second plant.

The total fixed costs in all three cases shown in Figure 5 are identical. The variation in the distribution of plant and company fixed costs strongly effects the profitability to invest in a foreign country. Increasing returns resulting from high fixed costs at the plant level favour exports since the concentration advantage of production is large compared to transport costs.



$\Phi_1^1: r = 1.5, f = 0.5; \Phi_2^1: r = 1.5, f = 0.5; \Phi_1^2: r = 1, f = 1; \Phi_2^2: r = 1, f = 1;$

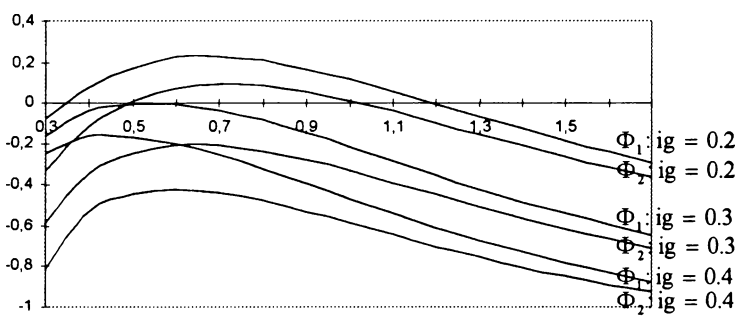
$\Phi_1^3: r = 0.5, f = 1.5; \Phi_2^3: r = 0.5, f = 1.5;$

Figure 5: The Influence of Transport Costs when Fixed Costs Vary

High fixed costs at the company level favour foreign direct investment since the exploitation of the headquarter-service is not restricted to one production site. The ability to split the production process is an important requirement for investment abroad.

Scenario 5: The Influence of Transport Costs on Various Industries with Different Cost Share Spent on Intermediate Goods

The complexity of the production process influences the decision between investment and export, too. The amount of intermediate goods used in the production of the final good characterises the complexity of the production process in this model. The cost share spent on intermediate goods (ig = 1-θ_5 - θ_6) varies in Figure 6.



transport costs

(ig = 0.2: $\theta_4 = 0.55; \theta_5 = 0.25$, ig = 0.3: $\theta_4 = 0.5; \theta_5 = 0.2$ and ig = 0.4: $\theta_4 = 0.4; \theta_5 = 0.2$)

Figure 6: The Influence of Transport Costs on Industries with Different Cost Shares Sent on Mediate Goods

ig stands for the intermediate goods cost share of a company's variable costs. The higher the cost share of intermediate goods the less likely is an investment in the foreign market. As in the scenarios above, there is an advantage for companies from the larger country.

IV. Conclusion

Determinants of FDI and the emergence of MNEs have been analysed in a general equilibrium framework that was solved by simulations. The profitability of investment in the foreign market and, therefore, the possible

emergence of multinational companies increases with decreasing transport costs up to a certain point and decreases thereafter. However, it depends on several factors, whether the investment in a foreign country actually is profitable.

Firstly, the profitability is influenced by the size of its home market relative to that of the foreign market. Companies in the larger country invest at higher transport costs than countries headquartered in the smaller country. That matches the history of FDI after World War II. US companies took the initiative in the internationalisation process in most industries, followed with a time lag by European, Japanese and Canadian companies.

Secondly, product differentiation influences the investment decision. Companies which produce highly differentiated goods are more likely to become multinational. It can be observed, that FDI and multinational companies are dominant in few industries such as chemicals, pharmaceuticals, electronics and motor vehicles, which are industries with imperfect competition and differentiated goods.

Thirdly, product differentiation is necessary but not sufficient. The ability to split the fixed costs from the production process is important for the emergence of multinational corporations. In this model, all fixed costs that can be separated from production process are headquarter-fixed costs. If these are high compared to the fixed costs at the plant level, investment in the foreign market is more likely. The relatively moderate FDI in machinery in spite of highly differentiated goods in this industry is due to its high content of tacit knowledge. Fixed costs that can not be separated from production process (fixed costs at the plant level) are high compared to fixed costs at the corporate level. In other industries, high fixed costs at the plant level relative to transport costs result in a high concentration advantage. That seems to be the case in the shipbuilding industry, as a very extreme case, since the transport costs of the final product are close to zero. In the steel industry, transport costs are high, but are outweighed by the high concentration advantage resulting from high fixed costs at the plant level.

Finally, companies with complex production processes (high proportion of intermediate goods) tend to stay national longer.

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VI. Appendix

Parameters for the Derivation of the Trigger Curve in the Scenarios 1 to 5

Scenario 1	$\mu=0.6; \rho=0.75; \varepsilon=0.85; \theta_1=0.7; \theta_2=0.5; \theta_3=0.6; \theta_4=0.3;$ $\theta_5=0.5; \theta_6=0.2; L_1=L_2=150; H_1=H_2=50; \eta=r_2=1.25;$ $f_1=f_2=0.75; fz_1=fz_2=0.3$
Scenario 2	$\mu=0.6; \rho=0.75; \varepsilon=0.85; \theta_1=0.7; \theta_2=0.5; \theta_3=0.6; \theta_4=0.3;$ $\theta_5=0.5; \theta_6=0.2; L_1=150; L_2=105; H_1=50; H_2=35; \eta=r_2=1.25;$ $f_1=f_2=0.75; fz_1=fz_2=0.3$

(continuation)

(continuation)

Scenario 3	$\mu = 0.6, \varepsilon = 0.85, \theta_1 = 0.7, \theta_2 = 0.5, \theta_3 = 0.6, \theta_4 = 0.3, \theta_5 = 0.5, \theta_6 = 0.2,$ $L_1 = 150, L_2 = 105, H_1 = 50, H_2 = 35, r_1 = r_2 = 1, f_1 = f_2 = 1,$ $fz_1 = fz_2 = 0.3$
Scenario 4	$\mu = 0.6, \rho = 0.75, \varepsilon = 0.85, \theta_1 = 0.7, \theta_2 = 0.5, \theta_3 = 0.6, \theta_4 = 0.3, \theta_5 = 0.5,$ $\theta_6 = 0.2, L_1 = 150, L_2 = 105, H_1 = 50, H_2 = 35, fz_1 = fz_2 = 0.3$
Scenario 5	$\mu = 0.6, \varepsilon = 0.85, \theta_1 = 0.7, \theta_2 = 0.5, \theta_3 = 0.6, \theta_4 = 0.3,$ $L_1 = 150, L_2 = 105, H_1 = 50, H_2 = 35, r_1 = r_2 = 1, f_1 = f_2 = 1,$ $fz_1 = fz_2 = 0.3$ ig=0.2: $\theta_5 = 0.55; \theta_6 = 0.25$, ig=0.3: $\theta_5 = 0.5; \theta_6 = 0.2$ ig=0.4: $\theta_5 = 0.4; \theta_6 = 0.2$

Market Structures in International Trade

The Role of Partial Capital Mobility

Michael J. Koop

I. Introduction

The internationalization of economic activities has increased considerably over the last ten years. While trade was the main form of internationalization for most of the post-war era this changed in the early eighties. Although trade volumes are still growing faster than world output, other forms of international economic exchange are expanding even more rapidly. For instance, foreign direct investment (FDI) has been growing at a rate of more than 10 percent annually for most of the past 15 years (IMF 1996). The expansion of trade and investment is accompanied by a change in their respective structures. Two-way intraindustry trade is now dominating traditional Heckscher-Ohlin trade, and arm's length trade between unrelated firms has been partly replaced by trade related to multinational enterprises (MNE). One third of world trade is intrafirm trade within one MNE (UNCTAD 1995) and another third is trade of MNEs with unrelated third parties. Moreover, sales of MNE foreign affiliates now exceed MNE exports (WTO 1996). Another striking feature of the internationalization process is that trade and investment have developed along similar geographical lines, with intraindustry trade and two-way investment flows between industrialized countries accounting for the lion's share of world trade and FDI. Only recently, has FDI in developing countries and emerging market economies picked up.

A comprehensive theory of international economic activity must focus on the international allocation of production in a system of value-added activities across national borders. It has to integrate inter- and intraindustry trade in goods and services, capital flows downstream as well as cross-hauling of FDI between industrialized countries. Moreover, it has to account for the existence of vertically and horizontally integrated MNEs with significant intrafirm trade as well as foreign affiliate sales. Combining such diverse phenomena in one model makes economic analysis technically complex and economists have traditionally resorted to analyzing them individually or a few at a time. This paper aims at providing a comprehensive theory of globalization. It builds on the most recent advances in the direction of a unified theory of international economics brought forth in a series of papers by Markusen and Venables

(1995, 1996), Konan et al. (1996), Markusen (1997), and Koop (1997). For instance, Konan et al. analyze inter- and intraindustry trade as well as trade in services in a general equilibrium simulation model with factor proportions differences and the proximity-concentration tradeoff. This framework allows them to investigate the emergence and influence of different types of multinational enterprises.

This paper extends the analysis by explicitly introducing capital flows and a somewhat more complex production function which includes an intermediate input. By applying the Markusen-Venables simulation techniques, the paper aims at explaining the patterns of various forms of trade and investment, specifically taking country asymmetries into account. The key idea is that in each of two countries a homogeneous good which is produced with economies of scale at the plant and at the firm level can be produced by exporters and/or multinational firms. Exporters produce all components of the good in their home country and then export a part of the output incurring some transport costs. Multinational firms, on the other hand, produce all of the intermediate inputs abroad. Final assembly is split up in the way that plants in each country produce the goods to be sold in the respective market. In order for this to be possible, part of the intermediate inputs produced abroad is shipped back to the multinationals' home country. The rationale for the emergence of multinationals and therefore FDI is twofold. First, multinationals are able to exploit factor price differences (vertical direct investment). Secondly, contrary to exporters they do not incur transport costs (horizontal direct investment). However, they have to weigh this advantage against the additional fixed costs of operating a second plant abroad.

The remainder of the paper is organized as follows: Section II outlines the basic structure of the model, Section III identifies the major assumptions for the simulations and presents the simulation results. The first part of the section deals with the allocation of the various production stages, while the second part analyzes trade and investment flows. Section IV summarizes and concludes.

II. The Model

The model consists of two countries (i), the domestic country d and the foreign country f, with stocks of the two factors of production capital (K_i) and labor (L_i). Whereas capital is internationally mobile (within a firm), labor cannot migrate. Both factors are mobile across sectors within the same country. There are two homogeneous goods, Y and X. Good Y which will be used as the numeraire throughout the paper is produced in both countries according to the following CES technology:

(1) $$Y_i = (L^{\rho}_{iy} + K^{\rho}_{iy})^{1/\rho} \qquad i = d, f$$

where ρ stands for the elasticity of substitution. K_{iy} and L_{iy} denote the amounts of capital and labor used in country i for the production of good Y.

In both countries, good X can be produced by exporters and by multinational firms. Good X is produced with increasing returns to scale due to fixed cost at the firm (R&D) as well as at the plant level (T). Research and development is carried out at the firm level. The results are public goods throughout the firm. In order to implement the results of R&D activities (e.g. in sophisticated equipment or through training workers) the firm incurs additional fixed costs (denoted T) at each plant. These fixed costs are specific to each plant and lead to increasing returns to scale at the plant level. The intermediate input which is used in the X sector is produced with constant returns to scale. Each exporter (E) produces good X according to the following cost function:

(2) $$w_i L_{Ei} + r_i K_{Ei} = w_i\,[FL_{Ei} + PL_{Ei} + (c_{IL} + c_{FL})\,X_{Eii} + (c_{IL} + c_{FL} + \tau)\,X_{Eij}] + r_i\,[FK_{Ei} + PK_{Ei} + (c_{IK} + c_{FK})\,(X_{Eii} + X_{Eij})] \qquad i, j = d, f; \quad i \neq j$$

where w_i denotes the wage rate in country i and r_i the rate of interest. L_{Ei} stands for total labor demand of one exporter of country i whereas K_{Ei} is the exporter's total demand for capital. Since an exporter only produces in the home country, the respective factor demand is restricted to domestic suppliers. FL_{Ei} (PL_{Ei}) denote total labor demand of a country i exporter for firm-specific (plant-specific) fixed costs. Likewise FK_{Ei} and PK_{Ei} denote an exporter's demand for capital for firm-specific and plant-specific fixed costs. The parameters c_{IL} and c_{FL} stand for marginal labor requirements for the production of the intermediate input and final production. Likewise, c_{IK} and c_{FK} denote marginal capital requirements for the intermediate input and for final production. The parameter τ denotes fixed transport costs measured in units of domestic labor which are independent of the direction of trade. Transport costs may, however, differ due to differences in labor costs.

Contrary to good X, good Y and the intermediate input I can be transported at no cost. Therefore the X-specific transport costs may be interpreted as a refinement activity necessary to appeal to foreign consumers or to obey foreign regulation such as labelling provisions. Finally, X_{Eii} is the quantity of ouput produced by an exporter of country i to be sold in the home market whereas X_{Eij} denotes the same exporter's output for sales in the foreign market, i.e. exports.

A multinational enterprise (for simplicity denoted by M in the equations) serves both markets by producing the final output in the respective country. It produces firm-specific fixed costs in the home country and incurs plant-

specific fixed costs in both countries. By transferring its technologies (R&D) to a foreign affiliate, the multinational firm engages in international trade in services. Because this transfer is carried out within the firm it constitutes intrafirm trade. Production of the intermediate input is completely carried out in the foreign country. Part of the intermediate inputs is then shipped back to M's home country where it is used for final production. Because there are no independent suppliers of the intermediate input, trade in intermediate inputs is a strictly internal transaction, constituting the model's second type of intrafirm trade. Contrary to Konan et al. (1996), intrafirm trade consists of trade in services and intermediate inputs but not in final goods. From an empirical point of view, multinationals engage in both types of intrafirm trade. However, the larger share of trade between foreign subsidiaries and the parent company is in intermediate inputs whereas intrafirm trade in final products is often carried out between different subsidiaries of the same MNE. Since the model only involves two countries it seems appropriate to model intrafirm trade as trade in R&D and intermediate inputs.

A multinational firm fulfills the capital requirements of its foreign affiliate for plant-specific fixed costs as well as for intermediate and final production by deploying part of its domestic capital stock in the foreign country. This constitutes the FDI part of the model. It is a restricted form of capital mobility as it allows firms in the X sector to invest abroad. This specification differs markedly from that in Markusen, Venables (1995) and Konan et al. (1996) who also claim to analyze foreign direct investment (which the latter call skilled labor). However, the capital transfer is of an indirect nature as it is the capital content of headquarter services exported which constitutes foreign direct investment, i.e. FDI is done via an inverse embodiment effect. Instead of technology embodied in capital exports it is capital embodied in the export of technology.

It is assumed that the minimum rate of return on capital deployed abroad has at least be equal to the company's domestic return on investment. Total production costs of a multinational enterprise of country i are:

$$
\begin{aligned}
(3) \qquad & w_i L_{Mii} + w_j L_{Mij} + r_i K_{Mii} = w_i \left[FL_{Mii} + PL_{Mii} + c_{FL} X_{Mii}\right] + \\
& r_i \left[FK_{Mii} + PK_{Mii} + PK_{Mij} + c_{IK} (X_{Mii} + X_{Mij}) + c_{FK} (X_{Mii} + X_{Mij})\right] + \\
& w_j \left[PL_{Mij} + c_{IL} (X_{Mii} + X_{Mij}) + c_{FL} X_{mij}\right] \qquad i, j = d, f; i \neq j
\end{aligned}
$$

where L_{Mii} stands for a multinational's total demand for domestic labor and L_{Mij} for its labor demand abroad. The firm's demand for capital K_{Mii} is strictly limited to domestic sources. FL_{Mii} (PL_{Mii}) are again labor requirements for firm-specific fixed costs (domestic plant-specific fixed costs). Contrary to exporters, however, multinationals also engage in production in the foreign country. FK_{Mii} (PK_{Mii}, PK_{Mij}) denote the demand for capital for firm-specific and (domestic and foreign) plant-specific fixed costs. Since all capital re-

quirements are fulfilled through the parent company in the domestic country, PK_{Mij} dwells on the domestic capital stock as well. PL_{Mij} constitutes the labor requirements for the plant-specific fixed costs abroad. The parameters c_{IL} and c_{FL} (c_{IK} and c_{LK}) again denote per unit requirements of labor (capital) for intermediate and final production. Finally, X_{Mii} and X_{Mij} are the quantities of X produced and sold by an MNE of country i in countries i and j, respectively.

This specification of multinational firms differs significantly from the one presented in Konan et al. (1996) where two different kinds of multinationals were included. One the hand, vertically integrated multinational firms exist with headquarters and plants in different countries. On the other hand, horizontally integrated firms produce the final output in both countries. While this is analytically appealing it is not consistent with empirical evidence. Firms operating in a global environment do not position themselves as vertically or horizontally integrated entities. They rather pursue vertical and horizontal integration simultaneously, the relative importance of the two strategies depending on market sizes and factor price differences. Therefore this paper will continue to analyze both types of integration while at the same time abandoning the formal distinction between the different types of multinational firms.

The production technologies of exporters and MNEs are essentially the same. While the technologies used in the production of R&D and T, the intermediate input I, and the final production stage are identical, two differences occur. First, exporters have to add some additional labor input to the final output X if it is to be exported. Secondly, MNEs incur the additional fixed costs of a second plant abroad. The small differences in technologies give rise to three structural differences between the two types of firms. First, the capital intensity of the production of good X is somewhat higher for MNEs than for exporters. Secondly, exporters operate with somewhat higher variable cost but somewhat lower fixed cost. Thirdly, since exporters only incur the fixed costs of one plant they can charge lower markups than MNEs. Since optimal markups equal market shares it follows that the output of individual exporters is always smaller than that of individual MNEs.

Despite the fact that the number of firms producing good X is finite and may be small, factor markets in both countries are assumed to be fully competitive, i.e. neither exporters nor MNEs can exert monopsonistic powers. The labor market in country i clears if the domestic labor supply (L_i) equals total labor demand generated by exporters of country i and multinational firms from both countries:

$$L_i = L_{iy} + e_i LE_i + m_i L_{Mii} + m_j L_{Mji} \tag{4}$$

where e_i is an endogenous variable denoting the number of exporters in country i. Accordingly, $e_i L_{Ei}$ equals total labor demand of exporters in country i.

Likewise, m_i (m_j) is the number of multinationals of country i (j) so that $m_i L_{Mii}$ ($m_j L_{Mji}$) equal total labor demand of country i (country j) multinationals in country i.

The national capital markets clear if the domestic capital supply (K_i) equals total capital demand of domestic exporters and domestic multinational firms:

$$K_i = K_{iy} + e_i K_{Ei} + m_i K_{Mii}. \tag{5}$$

In order to endogenize the number of firms in the oligopolistic market (e_i, m_i) there is free entry and exit. The approach followed is the static entry concept (Friedman 1983) in which positive profits immediately induce new firms to enter and negative profits immediately trigger the exit of some firms. This implies that capital is perfectly mobile across sectors and that structural change occurs instantaneously and at no cost. With free entry and exit, no profits are made in the oligopolistic sector. Therefore income in country i (I_i) consists of the sum of factor rewards for domestic capital and labor:

$$I_i = w_i L_i + r_i K_i. \tag{6}$$

Income can be spent on the two goods. With p_i representing the relative price of good X in terms of the numeraire, the budget constraint is:

$$I_i = p_i X_i + Y_i \tag{7}$$

with X_i representing total supply of good X in country i:

$$X_i = e_i X_{Eii} + e_j X_{Eji} + m_i X_{Mii} + m_j X_{Mji}. \tag{8}$$

It is assumed that consumers in both countries have identical homothetic preferences. Therefore the distribution of income and property rights can be ignored. In other words, it does not matter who owns the multinational firms, an issue with otherwise important implications. Moreover, consumers have no preferences as to whether good X is produced in the home or in the foreign country or whether it is supplied by an exporter or a multinational firm. The utility function of country i is assumed to be of the Cobb-Douglas type:

$$U_i = X^{\alpha}_i Y^{1-\alpha}_i. \tag{9}$$

Maximizing (9) subject to the household budget constraint (7) results in the following demand functions for the two goods:

$$X_i = \alpha I_i / p_i \qquad Y_i = (1 - \alpha) I_i. \tag{10}$$

Exporters and MNEs maximize their profits subject to the contraints that production quantities and profits be nonnegative. Their behavior is strictly noncooperative. Strategic alliances, licencing agreements and other forms of joint profit maximization are ruled out. When making its output decisions each firm conjectures that the output quantities chosen by all other firms in both markets are independent of its own production, i.e. there is Cournot competition. The ensuing equilibrium is the standard single-period Cournot-Nash equilibrium. In order to maximize profits firms set marginal revenues to be not higher than marginal costs. In other words, if marginal costs exceed marginal revenues the company will not exist in equilibrium. The pricing equations are given in complementary slackness form:

(11) $$p_i(1 - z_{Eii}) - [w_i(c_{IL} + c_{FL}) + r_i(c_{IK} + c_{FK})] \leq 0; \qquad X_{Eii} \geq 0;$$

$$\{p_i(1 - z_{Eii}) - [w_i(c_{IL} + c_{FL}) + r_i(c_{IK} + c_{FK})]\}X_{Eii} = 0$$

(12) $$p_j(1 - z_{Eij}) - [w_i(c_{IL} + c_{FL} + \tau) + r_i(c_{IK} + c_{FK})] \leq 0; \qquad X_{Eij} \geq 0;$$

$$\{p_j(1 - z_{Eij}) - [w_i(c_{IL} + c_{FL} + \tau) + r_i(c_{IK} + c_{FK})]\}X_{Eij} = 0$$

(13) $$p_i(1 - z_{Mii}) - [w_i c_{FL} + w_j c_{IL} + r_i(c_{IK} + c_{FK})] \leq 0; \qquad X_{Mii} \geq 0;$$

$$\{p_i(1 - z_{Mii}) - [w_i c_{FL} + w_j c_{IL} + r_i(c_{IK} + c_{FK})]\}X_{Mii} = 0$$

(14) $$p_j(1 - z_{Mij}) - [w_j(c_{IL} + c_{FL}) + r_i(c_{IK} + c_{FK})] \leq 0; \qquad X_{Mij} \geq 0;$$

$$\{p_j(1 - z_{Mij}) - [w_j(c_{IL} + c_{FL}) + r_i(c_{IK} + c_{FK})]\} = 0$$

The parameters z_{Eii} (z_{Eij}) and z_{Mii} (z_{Mij}) denote markups which companies charge in order to recover their fixed cost. The markups are defined as the relative difference between price and marginal costs, i.e. they are applied on a gross basis. In a Cournot model with homogeneous products, the optimal markups can be approximated by dividing a firm's market share by the Marshallian price elasticity of demand in the respective market. In this model, the price elasticity of demand equals one. Therefore the optimal markups are equal to a firm's market share in the two markets:

(15) $$z_{Eii} = p_i X_{Eii} / \alpha I_i \qquad z_{Eij} = p_j X_{Eij} / \alpha I_j$$

$$z_{Mii} = p_i X_{Mii} / \alpha I_i \qquad z_{Mij} = p_j X_{Mij} / \alpha I_j \qquad i, j = d,f$$

Given that there are no barriers to free entry and exit in the oligopolistic sector, companies must make zero profits, i.e. total markup revenues must be equal to total fixed costs. Since the number of firms present in equilibrium is

endogenous it might turn out that in some situations the zero profit condition cannot be fulfilled by one or more firm types. In this case e_i or m_i are equal to zero, meaning that good X is not produced by the respective firm type. In other words, the set of possible solutions is not by assumption restricted to interior solutions but may very well contain corner solutions. Accordingly, the zero profit conditions for the firm types are given in comparative slackness form with the associated variables in parentheses:

$$p_d X_{Edd} z_{Edd} + p_f X_{Edf} z_{Edf} \leq w_d (FL_{Ed} + PL_{Ed}) + r_d (FK_{Ed} + PK_{Ed}) \qquad (e_d) \tag{16}$$

$$p_f X_{Eff} z_{Eff} + p_d X_{Efd} z_{Efd} \leq w_f (FL_{Ef} + PL_{Ef}) + r_f (FK_{Ef} + PK_{Ef}) \qquad (e_f) \tag{17}$$

$$p_d X_{Mdd} z_{Mdd} + p_f X_{Mdf} z_{Mdf} \leq w_d (FL_{Mdd} + PL_{Mdd}) + w_f PL_{Mdf} + r_d (FK_{Mdd} + PK_{Mdd} + PK_{Mdf}) \qquad (m_d) \tag{18}$$

$$p_f X_{Mff} z_{Mff} + p_d X_{Mfd} z_{Mfd} \leq w_f (FL_{Mff} + PL_{Mff}) + w_d PL_{Mfd} + r_f (FK_{Mff} + PK_{Mff} + PK_{Mfd}) \qquad (m_f) \tag{19}$$

In equilibrium, exporters from both countries and therefore intraindustry trade in identical products can exist. When transport costs are zero exporters from both countries basically operate in an integrated goods market although factor markets remain separated. Even with positive transport costs intraindustry trade in identical products is profitable as exporters engage in reciprocal dumping, i.e. they undercut the price in the other country as they only have to cover their marginal costs which are below prices due to fixed costs (Brander, Krugman 1983). For all levels of transport costs it is assumed that there are no resale activities. Therefore a product sold at a lower price in the foreign market cannot profitably be re-imported to the country of origin.

The model can be summarized as follows. Production (cost) functions of the two goods and the (up to four) different types of firms are given in equations (1) through (3). Factor market clearance is ensured through equations (4) and (5). Together with the utility function (9), the income equations (6) and (7) determine demand functions (10) and assure that goods markets clear. Inequalities (11) - (14) and (16) - (19) associated with the four types of companies determine production levels and thereby trade and investment flows. Thus, the model consists of 36 equations of which the 12 determining output levels and number of firms are inequalities. Although marginal costs are constant which normally allows to solve one-period oligopoly problems for each market separately (Brander 1981), the equations need to be solved simultaneously because the markets are interrelated. This is due to the endogeneity of the number and type of firms which determine supply conditions in the two markets simultaneously. In order to analyze the effects of different factor endowments and transport costs, the comparative statics analysis would have to be performed on

a set of 12 simultaneous inequalities. Since this proved to be technically intractable, simulation techniques were applied.

III. Simulation Results

When calibrating the model, it had to be decided whether the parameters should represent real world data or simply a fictitious world. A number of reasons made the latter option the more convincing one. Only if the complete set of parameter values were available would the application of a CGE model make sense. This prerequisite, however, was not fulfilled. The major bottleneck turned out to be the unavailability of empirical firm-level data such as firm-specific and plant-specific fixed costs as well as markups. Although some studies estimate markups, even the results of the most detailed study were insufficient to be implemented in a CGE study. Other shortcomings of the required data set would have included missing or inconsistent data on multinational enterprises such as sales and number of employees abroad, intrafirm trade and investment abroad. All this made it impossible to construct a data set that represents a consistent benchmark equilibrium. Therefore this paper will examine the theoretical aspects of the problem only.

In the simulations good X is the capital-intensive good whereas Y is the labor-intensive one[1]. Good Y was chosen as the numeraire because it is always produced in at least one country whereas production of good X by one company type is not always part of the equilibrium solution. In the benchmark equilibrium with identical countries, total capital intensity of good X is approximately twice that of good Y. However, firms can split up the production of good X into three different stages: the production of fixed costs (R&D, T), the intermediate input (I) and final assembly (F). Each step requires capital and labor to be used, albeit in different proportions. The assumptions on relative factor endowments (in the benchmark scenario) and capital intensities with respect to the various production stages are as follows:

$$(K^{R\&D}_i / L^{R\&D}_i) = (K^T_i / L^T_i) > (K^F_i / L^F_i) > (K / L) > (K^Y_i / L^Y_i) > (K^I_i / L^I_i)$$

The part of the production process in which domestically produced output is converted into exports is of the Leontief-type, assuming that one unit of exports always requires a constant amount of domestic labor to be exported. The simulations presented in this chapter were carried out with the transport cost parameter (τ) taking on the value 0.08. For simplicity, this scenario will be

[1] The model was simulated using the GAMS subsystem for solving general equilibrium models (MPSGE).

called the 8 percent transport cost case, although the use of percent may be somewhat misleading.

As the model aims at specifying the role of factor endowment asymmetries in determining production levels as well as trade and investment flows, most simulation results will be presented in terms of the Edgeworth box. The factor endowment boxes measure the two countries' endowment shares, starting for the domestic country d in the lower left-hand corner with both 10 percent of the world's capital stock and labor endowment. Vertical movement up increases the domestic country's capital share by 5 percentage points at a time. Horizontal movement to the right increases its share in labor endowment, likewise by 5 percentage points at a time. Foreign endowment shares are measured starting from the upper right-hand corner. Along the diagonal, the two countries are identical with respect to relative but differ with respect to absolute factor endowments. Above the diagonal, the domestic country is relatively capital-abundant and the foreign country is relatively labor-abundant.

Besides relative and absolute factor endowments, real income is the third major determinant of the simulation equilibria. Real income matters because it determines demand in the two markets and thereby market size. The wage-rental ratio of the benchmark equilibrium is equal to one. The model is parameterized such that world labor endowment exceeds the world supply of capital (by a factor of 2.5). Therefore the equal-income line runs from the point where one country owns 95 percent of the world capital stock and roughly 30 percent of the world labor supply through the point of identical factor endowments down to the point where the same country owns only 5 percent of the world capital stock and about 70 percent of the labor supply. At all points to the left of the equal-income line, country d is considered the „small" country whereas to the right it is the „big" country.

The utility functions are of the Cobb-Douglas type with expenditure shares of 0.5 for both products, an elasticity of substitution of one, and a price elasticity of demand of one as well. All elasticities of substitution in the production function were chosen to be one, except for transport costs. Markups for exporters are 20 percent for the home market and roughly 13 percent for the foreign market, reflecting the exporters home-market bias.

1. Allocation of Production and Market Structure

Figure 1 shows which types of firms are active in equilibrium. The most interesting part of the figure is the core where the two countries have similar income levels and similar relative factor endowments. In this area, where factor proportions differences are small and proximity advantages roughly balance concentration advantages, exporters and MNEs from both countries exist. By containing intraindustry trade in final goods, intermediate inputs and

services as well as multinational enterprises and two-way FDI, the equilibria appear to be a fair image of economic exchange between industrial countries. Evidently, factor price differences vanish and multinational enterprises exist purely as the horizontal type. In addition, since no country is sufficiently bigger than the other, neither firm type can exploit economies of scale to an extent that allows it to outcompete other firm types. The competitiveness of firm types is mainly determined on the basis of the tradeoff between transport cost and additional fixed cost.

Moving away from the central region, one of the two MNE types loses competitiveness and exits the market. Redistributing factors along the equal-income line, these MNEs come from the labor-abundant country. Although goods and factor prices are still equalized across countries they are unable to compete because initial relative factor endowments are sufficiently different to make exporters and MNEs of the capital-abundant and exporters of the labor-abundant country competitive. Redistributing factors along the diagonal of identical relative factor endowments, the MNEs of the big country exit the market as the smaller country's market does not generate sufficient markup revenues to recover the additional fixed costs of a second plant abroad.

K\L	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90
.90																	
.85		$m_d > 0$							$e_d > 0$								
.80							$e_d > 0$		$m_d > 0$			$e_d > 0$					
.75							$e_f > 0$										
.70							$m_d > 0$			e_d							
.65																	
.60		$e_f > 0$						$e_d > 0$						$e_d > 0$			
.55		$m_d > 0$						$e_f > 0$		**				$m_f > 0$			
.50																	
.45									$m_d > 0$								
.40								*	$m_f > 0$								
.35																	
.30								e_f		$e_d > 0$							
.25										$e_f > 0$							
.20										$m_f > 0$							
.15			$e_f > 0$				$e_f > 0$							$m_f > 0$			
.10							$m_f > 0$										

* $e_d > 0$, $e_f > 0$, $m_d > 0$; ** $e_d > 0$, $e_f > 0$, $m_f > 0$.

Figure 1a: Active Type of Firms ($\tau = 0.08$)

Starting in the lower part of Figure 1, the left-hand corner of the diagram where the home country possesses only ten percent of the world's resources but has the same relative endowment as the foreign country, only foreign exporters produce good X. Obviously, with identical relative endowments there are no vertically integrated MNEs. Because the domestic country's market is too small it is also not profitable for horizontally integrated MNEs to operate a second plant in the domestic country. Due to the large foreign market foreign exporters exploit economies of scale and outcompete domestic exporters. Increasing the domestic country's share in the world capital stock and also increasing its labor supply makes the country relatively capital-abundant and raises domestic income. The country's wage-rental ratio exceeds that of the foreign country. This makes domestic MNEs competitive which deploy some of the relatively cheap domestic capital in the foreign country to take advantage of the relatively cheap foreign labor. Moving the capital endowment axis up further, domestic multinationals outcompete the foreign exporters owing to substantial factor price differences but also because they are able to exploit significant economies of scale.

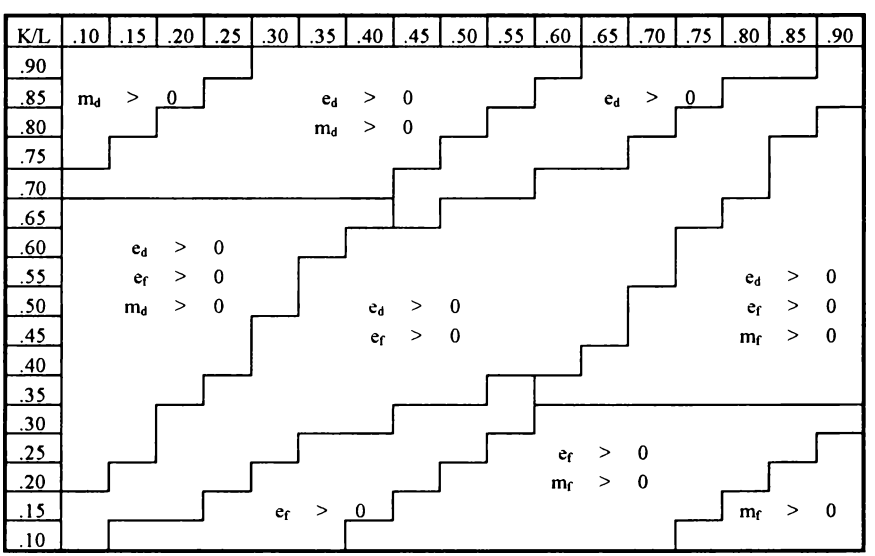

Figure 1b: Active Type of Firms ($\tau = 0$)

Moving to the right and increasing the domestic share in the world's labor supply beyond 50 percent raises domestic income and lowers the domestic wage-rental ratio at the same time. Because exporters' production is marginally more labor-intensive (due to positive transport costs and lower fixed costs)

some domestic exporters enter the market. Which of the firm types is dominant in this region of the diagram in terms of accumulated market shares is indeterminate as the number of firms of each type can vary according to factor distribution. Close to the diagonal, the domestic country gets so big that the foreign country's market is too small to generate sufficient markup revenues for a second MNE plant abroad and domestic exporters supplant all other firm types.

Lowering transport costs to zero (Figure 1b) changes the simulation results, particularly in the center. Since the proximity advantage (saving on positive transport costs) is the very reason for the existence of horizontal MNEs zero transport costs make MNEs disappear even when market sizes are very similar. Exporters continue to penetrate foreign markets by reciprocal dumping. However, since markets are no longer segmented goods prices are equalized and domestic and foreign firms are of equal size and charge equal markups. For factor distributions which did not result in factor price equalization when transport costs were positive, lowering transport costs allows exporters to become competitive earlier. Generally, the role of vertically integrated multinational firms is diminished while horizontal MNEs disappear entirely.

Figures 1a and 1b can also be used for determining where R&D is carried out and where the final assembly of good X takes place. In the overwhelming number of cases final production of X is carried out in both countries. With 8 percent transport cost, merely the small area underneath (above) the diagonal in the left (right) part of Figure 1a where foreign (domestic) exporters outcompete all other firm types, X is only produced in the capital-abundant foreign (domestic) country (except for the two corners where relative endowments are identical). Lowering transport costs does not give rise to substantial change. The only difference occurs in the area where the production of X was geographically concentrated in the 8 percent scenario. Without transport cost, this area increases somewhat because exporters displace multinational firms in some cases.

With respect to the location of R&D activities three different areas are discernible when transport cost are 8 percent. If a country's share in the world capital stock is below 25 percent it (almost) never produces R&D, independent of its income. The only exception to this is when the country is tiny but capital-abundant. In this situation, a small number of fairly big domestic MNEs engages in R&D. This might reflect the cases of Sweden and the Netherlands which are small, capital-abundant and home to a number of big MNEs. For capital shares in the range of 25-75 percent, both countries produce R&D although the share of R&D in GDP is higher for the capital-abundant country. If a country's share in the world's capital stock exceeds 75 percent, this country is almost always the sole producer of R&D, more or less independent of its share in the world's labor supply. Setting transport cost equal to zero does not

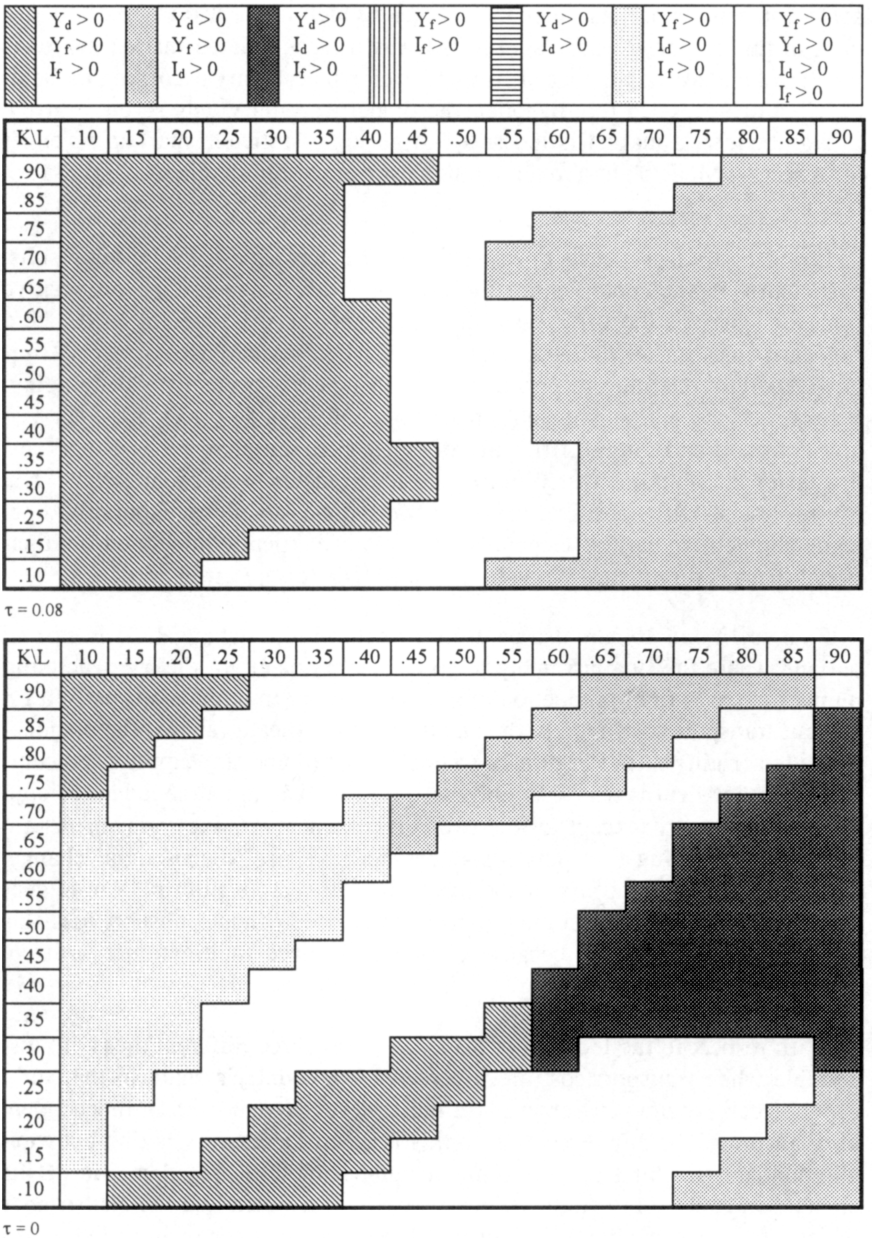

Figure 2: Production of Good Y and Intermediate Input I

change the results significantly. In particular, the concentration of R&D in the very capital-abundant country is basically unaffected by transport cost.

Figure 2 briefly highlights where the labor-intensive activities, i.e. production of good Y and intermediate input I, are carried out. With 8 percent transport cost, both countries always produce some amount of good Y. The intermediate input I is solely produced in one country when this country owns at least 65 percent of the world labor supply. With the exception of some very extreme distributions of the world capital stock this is true independent of the size of that country's capital stock. Only if the world's labor supply is divided up fairly evenly do both countries engage in the production of I.

Lowering transport cost and thereby reducing the factor price equalizing activities of multinational enterprises leads to a more diversified pattern of specialization. The three parallelograms stretching from the south-west to the north-east indicate an enlarged area where both countries engage in both labor-intensive productions. For very uneven relative factor endowments in the upper left-hand corner and the lower right-hand corner both countries continue to produce the final output Y but the production of I is concentrated in the labor-abundant country. Fairly even distributions of the capital stock combined with unequal shares in total labor supply forces the capital-abundant country to discontinue production of Y and to engage its labor force mainly in the production of the (even more labor-intensive) intermediate input. This somewhat unexpected result occurs because domestic exporters are the dominant firm type which uses up most of the country's relatively scarce labor supply. The remaining labor is employed by domestic MNEs for producing fixed costs and the final output. Only when the country's labor supply rises sufficiently, is the production of Y taken up again.

Combining these findings allows the discussion of structural change within one economy. Despite frequent changes in market structures, the general result is that structural change is a fairly smooth process rather than one characterized by abrupt changes in the production patterns. For positive transport cost, the moderately capital-intensive final assembly of X and the moderately labor-intensive production of Y are carried out in both countries for most factor endowment distributions. Changes in a country's specialization pattern mainly occur with respect to the heavily capital-intensive production of fixed costs (R&D, T) and the heavily labor-intensive production of the intermediate input. For example, a labor-abundant developing country with 5 percent of the world's capital stock and 20 percent of the world's labor supply (which may be called the Korean case) initially does not have a R&D sector of its own and produces only a small quantity of good X. The main part of its production consists of the two labor-intensive goods. When the country starts accumulating capital (faster than the developed country) its capital-labor ratio and relative size increase. As a consequence it discontinues the production of the most labor-intensive good I and extends the production of Y adjusting the

overall factor intensity of its production to its new relative factor endowment. Since foreign MNEs exit the market the production of X is discontinued in the developing country. When the country accumulates more capital, some domestic MNEs emerge and the country starts producing capital-intensive R&D. Continuing capital accumulation, the country increases production of R&D and X further and lowers its production of Y, eventually turning from an exporter of Y to an importer. In short, structural change mostly appears to be a rather smooth undertaking for both countries. In the process of (relative) capital accumulation, they gradually reduce the most labor-intensive activities for more capital-intensive ones. They do not close down big industries at once and replace them with others.

The simulation results with respect to the geographical allocation of production can be condensed into 3 hypotheses:

- *Concentration of production*: The most capital-intensive production of R&D is concentrated in the (very) capital-abundant country, (almost) independent of transport cost and the country's labor endowment. If the world capital stock is divided fairly evenly among the two countries, both engage in R&D. On the contrary, the most labor-intensive production of the intermediate input is concentrated in the labor-abundant country independent of the country's capital endowment. Final production of the moderately labor-intensive good Y is always and that of the moderately capital-intensive good X is (almost) always carried out in both countries unless one country is big and slightly capital-abundant.
- *Specialization of countries*: Even with big absolute and/or relative factor endowment differences, countries seldom fully specialize. Only when a country is small and slightly labor-abundant will it fully specialize in the labor-intensive good Y. Except for similar absolute and relative factor endowments the degree of specialization increases with transport cost. Structural change in the wake of capital accumulation mostly is a gradual process of replacing labor-intensive production with more capital-intensive production.
- *Existence of multinational enterprises*: MNEs become more important (a) the more uneven relative factor endowments become, (b) the more similar income and relative endowments become, and (c) the higher transport costs are.

2. International Trade and Foreign Direct Investment

Since there are numerous international transactions involved in most equilibria a short summary in terms of the balance of payments is in order. Commodity trade consists of three goods, namely X, Y, and the intermediate

input I. While the intermediate input and good X can simultaneously be imported and exported by one country, good Y can only flow in one direction. Commodity trade of each country need not balance as there are transactions covered in a country's service account. First, the export of capital generates capital income that is repatriated by the parent companies. Secondly, the transfer of technology by a country's multinational firms to their foreign subsidiaries is remunerated in terms of markup revenues which are equally repatriated by the parent companies. In summary, only a country's current account must be balanced. The transfer of capital in a one-period model is somewhat blurred. It is assumed that the rate of depreciation is zero and that the capital stock is returned to the home country at the end of the period. Therefore the capital accounts of both countries are necessarily balanced.

Figure 3 presents the simulation results for trade in good X and foreign direct investment flows. In the 8 percent transport cost scenario, the most interesting part, again, is the center of the figure where absolute and relative endowments differ only slightly (Point A). In this area, intraindustry trade as well as cross-hauling of foreign direct investment occurs. As multinational firms exist in both countries there is also intraindustry intrafirm trade in intermediate inputs and R&D. Evidently, with similar relative and absolute factor endowments factor proportions considerations play no role. With factor prices equalized multinationals survive because they do not have to pay transport costs, whereas exporters save the costs of operating a second plant abroad. Proximity and concentration advantages just balance so that neither firm type has a significant competitive advantage.

In the region above the center (point B), intraindustry trade continues to exist and the capital-abundant country becomes the net exporter of the increasing returns to scale product. In contrast to this, two-way capital flows cease to exist and capital only flows from the capital-abundant to the labor-abundant one. Capital flows in the opposite direction dry up because the retrenched supply of capital in the foreign country makes foreign MNEs uncompetitive and forces them to exit the market. In the extreme upper left-hand corner (Point C), vertical multinational enterprises prevail, taking advantage of substantial factor price differences. Capital is so scarce in the foreign country that the domestic country switches from the indirect export of capital services embodied in the exported goods to the direct export of capital by means of FDI. Thus the capital-abundant country continues to export capital whereas trade in the final product X comes to a halt. Below that area (Point D), the biggest section of the figure is made up of equilibria with one way-trade and one-way FDI, with good X and capital flowing in opposite directions. Finally, close to the diagonal (Point E) there is a narrow band where the exporters of the capital-abundant country displace all other firm types so that there is only one-way trade in X but no capital flows.

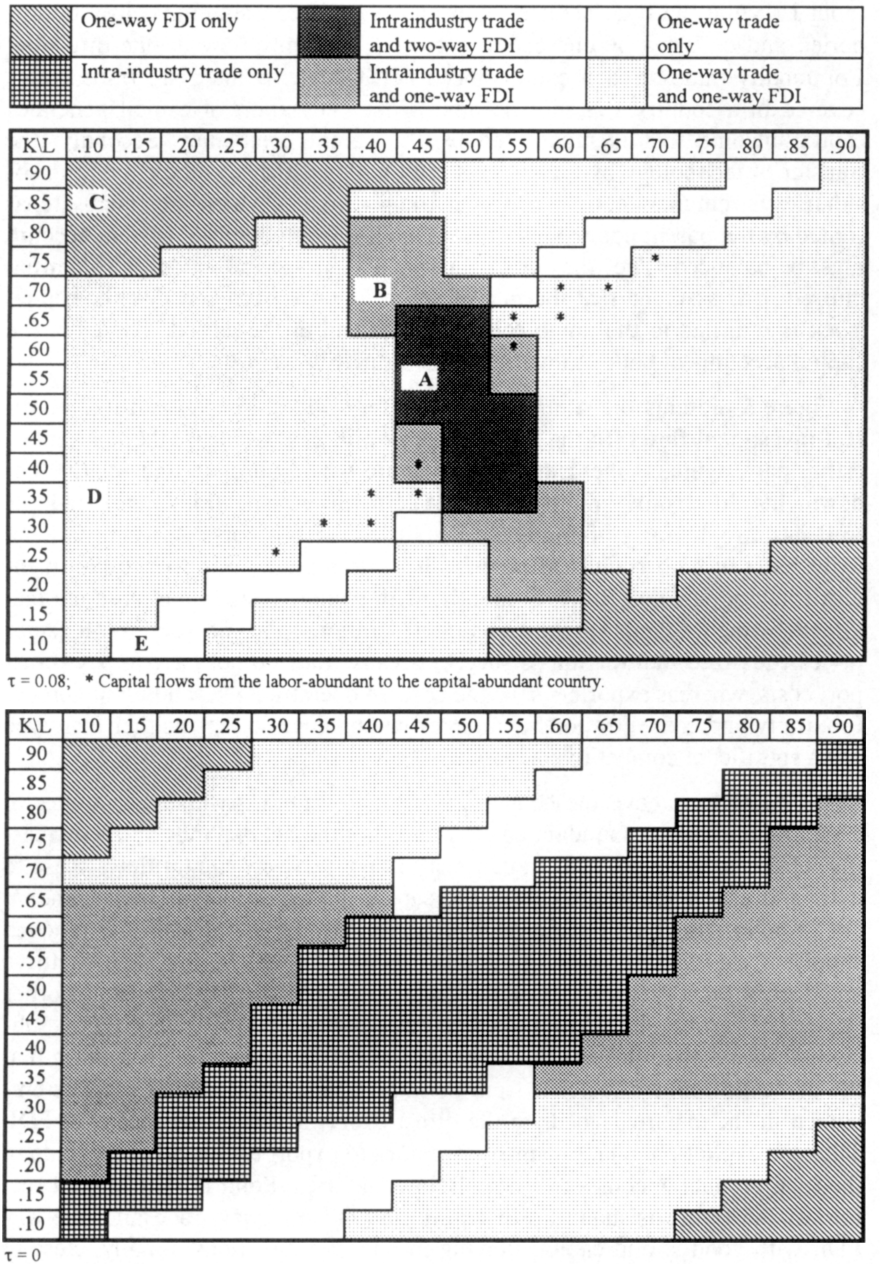

Figure 3: Trade in X and Foreign Direct Investment

Lowering transport cost mostly has the expected effects. For the whole area surrounding the diagonal, including the core region, extended intraindustry trade replaces multinational enterprises and thereby capital flows. This resembles the integrated world economy parallelogram in Helpman, Krugman (1985). As before, extremely dissimilar relative factor endowments favor multinational firms and one-way capital flows completely displace trade in X. When a country is capital-abundant but not too large intraindustry trade continues to exist but due to factor price differentials multinational firms of that country become competitive and some capital flows abroad. When the country is capital-abundant and fairly big the exporters of the labor-abundant country exit the market and the capital-abundant country exports capital as well as the final product X. Finally, with one country being very big and slightly capital-abundant capital flows dry up completely and only one-way trade prevails.

With respect to FDI, one would expect that capital flows from the capital-abundant to the labor-abundant country. This hypothesis is generally corroborated for the scenario without transport cost. However, the simulation results indicate that there are exceptions from that rule for the positive transport cost scenario. The first one is the cross-hauling of FDI between almost identical countries which is based on the advantage of producing close to the market. The second exception is that capital flows upstream when the two countries are similar (but not identical) in relative factor endowments and not too different in size. In this case, the labor-abundant country still has a marginally higher wage-rental ratio because the other country's exporters exert a high demand for their domestic capital. In addition to exporting capital, the labor-abundant country also has substantial exports of the labor-intensive good Y. Therefore the capital-abundant country remains the net exporter of capital services despite its direct capital imports.

Since trade in services (R&D) is bound to an MNE's foreign investment, exporting (importing) capital always implies exporting (importing) services. Therefore a capital-abundant country (almost) always exports services. When relative endowments and income levels are similar and transport cost are positive both countries export services (intraindustry trade in services) but the capital-abundant country remains the net exporter of services. As with capital flows, the only exception is when a country is only somewhat capital-abundant and slightly bigger at the same time. In this case, capital flows upstream and so do services. Since lower transport costs favor exporters and impede MNEs the volume of trade in services decreases with transport costs. With zero transport costs there is also no intraindustry trade in services. Trade in services increases when both relative factor endowments and income levels either converge or diverge. Only when one of the two is similar while the other is very different will trade in services be small.

Figure 4 presents a summary of the direction of trade and investment flows. Without covering the details of all the different production/ trade scenarios, some general results can be derived:

- Intraindustry trade in the oligopolistic market is the dominant trade regime when transport costs are zero. Only when one country is very capital-abundant do its exporters and MNEs outcompete all foreign firm types and intraindustry trade ceases to exist. With positive transport costs intraindustry trade only occurs when countries converge in income levels more or less independent of relative factor endowments. Surprisingly, despite higher transports costs intraindustry trade is more wide spread (in the center region) than with zero transport costs. However, total trade volumes (of X) are smaller.
- The volume of service trade increases with transport costs and when both relative factor endowments and income levels either converge or diverge. When income levels diverge and relative endowments converge trade in services is either small or absent.
- Intrafirm trade in intermediate inputs increases with converging income levels and with rising transport costs. With positive transport costs there is also a local intrafirm trade maximum when relative and absolute factor endowments converge. Here, intraindustry trade in intermediate inputs can occur.
- Higher transport costs always stimulate capital flows and reduce trade volumes. This is true in spite of the fact that the volumes of trade in services and intermediate inputs increase with transport costs. Only when relative endowments are so different that there is no trade in X when transport costs are zero, are trade and investment unaffected by changes in transport costs.
- Capital flows only exist for sufficiently big differences in relative endowments when transport costs are zero. Capital always flows to the labor-abundant country. With higher transport costs, FDI spreads to more factor endowment distributions and the size of capital flows increases. Whereas capital often flows to the labor-abundant country, there are circumstances under which the capital-abundant country directly imports capital from the labor-abundant country. When countries are very similar in terms of relative as well as absolute factor endowments cross-hauling of FDI occurs.

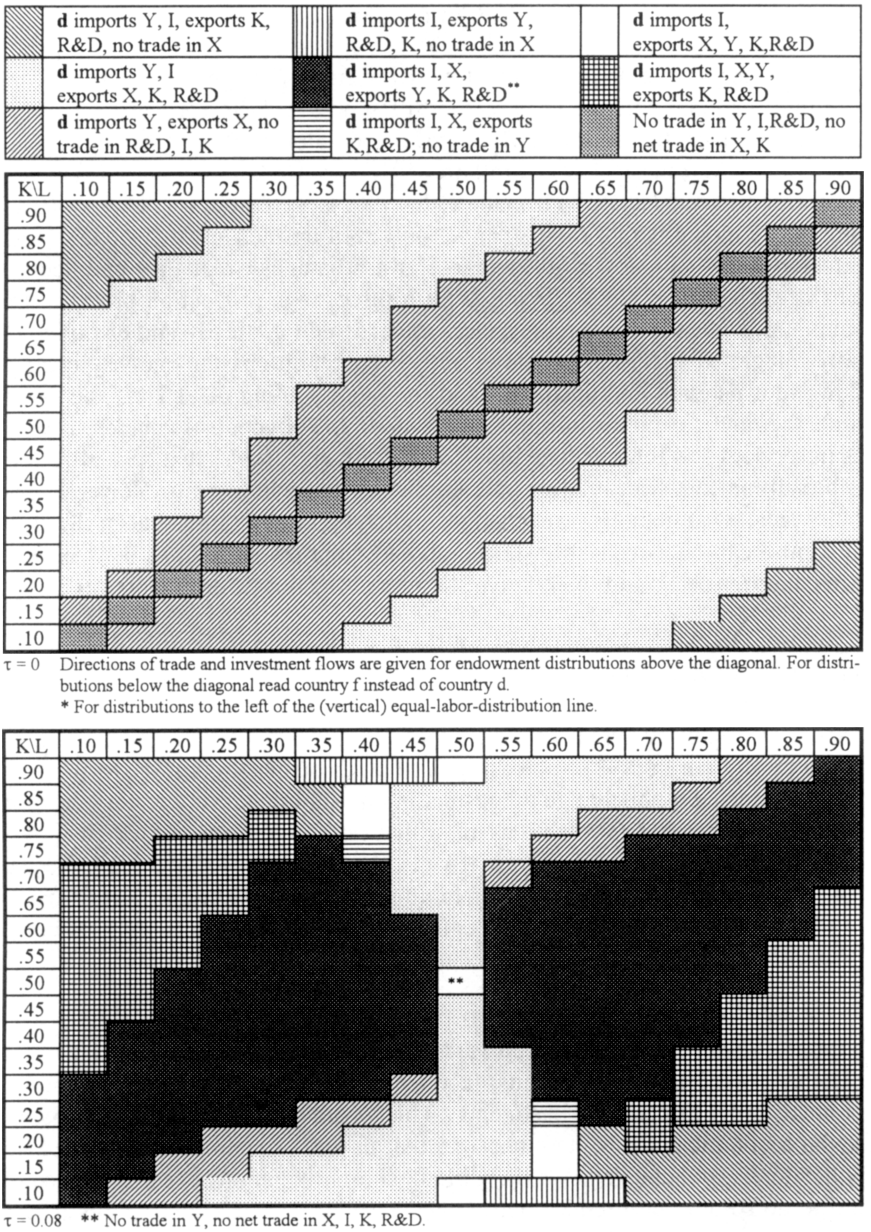

Figure 4: Direction of Trade and Investment Flows

IV. Conclusions

The paper sets up a fairly general model of trade, foreign direct investment, and multinational enterprises based on differences in factor proportions and a proximity-concentration tradeoff. It covers a number of theoretical models (Horstman, Markusen 1992, Brainard 1993) as well as simulation studies (Markusen, Venables 1995, Konan et al. 1996) as special cases. The new feature of the model is that MNEs cannot only split up their product process and transfer their technologies to their foreign affiliates but that they can deploy part of their capital stock abroad. With a three stage production process, the simulations identify the circumstances under which vertically and/or horizontally integrated MNEs exist and establish the conditions for one-way capital flows (downstream and upstream) and the cross-hauling of FDI. At the same time, the model explains intraindustry trade in the oligopolistic market as well as in services and intermediate inputs. Generally, it is found that specialization is broadly in line with relative and absolute factor endowments. However, because factors cannot only be exchanged indirectly through trade but in the case of capital can be directly transferred abroad more complex links between the two countries occur and the relative strength of the two determinants varies.

In order to check the robustness of the results and to make sure that the results bear some generality a large number of respecified versions were simulated. For instance, increasing the share of plant-specific fixed costs in total fixed costs regularly enhanced the competitiveness of exporters which was also found by Brainard (1993). Increasing elasticities of substitution in the production functions did not change the results in any significant way while lowering them sometimes led to situations in which no equilibrium existed. In those cases, the redistribution of factors between the two countries was too large for the low flexibility of the economies to attain a new equilibrium. Experimenting with slightly different technologies for the exporters and multinational firms also did not produce marked changes.

One obvious result of the paper is that at times small changes in the distribution of factor endowments can lead to very different production, trade and FDI patterns. In other situations, factor redistributions of similar magnitude produce only marginal adjustments. This result is important for devising sound economic policies. It emphasizes that in some situations a set of specific policy tools can achieve its goals while in similar situations it may completely fail to do so or even produce detrimental results. The reason simply is that a change in a country's factor endowment can alter the previously existing production and/or trade regime entirely. Therefore the amount of information necessary for finetuning economic policies is tremendous. In the light of these findings, it seems that models which explicitly deal with normative issues of economic policy making are sometimes overly simplistic and might therefore come up with policy advice that cannot be generalized. This is particularly true

if economic policies are themselves dynamic in the sense that they change domestic factor endowments and thereby a country's relative position in the world. In this case, the policies may bring about exactly the type of change that renders them ineffective or even harmful. The paper, however, did not attempt to analyze any specific type of economic policy. As the model provides a fairly general framework future research will address policy issues more directly. Besides fairly obvious candidates such as trade and investment policies, it will be worthwhile to analyze strategic industrial policies and the taxation of capital income in a general equilibrium framework with a distinct international structure.

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International Production and Domestic Labor Demand*

Carsten Eckel

I. Introduction

The dramatic increase in international capital mobility is one of the key characteristics and driving forces of globalization. On average, foreign direct investment flows (FDI) have outgrown both international trade and national outputs and multi-national enterprises (MNEs) are playing an increasing role in the international division of labor. At the same time, many industrialized countries have experienced times of high unemployment: coincidence or causality? Fears are growing in developed countries that as real capital is increasingly transferred to developing countries jobs are being exported with it and, with demand for labor declining, domestic workers are left as the "losers" of globalization.

The employment effects of outflowing FDI in general have received considerable attention in the literature. Most authors try to approach the question from a macroeconomic perspective. Glickman/Woodward (1989) differentiate between a displacement effect and a stimulus effect. If foreign production merely displaces domestic exports or if imports from affiliates displace domestic production, then outward FDI is most likely to decrease demand for domestic labor. On the other hand, if exports of capital goods to affiliates abroad are stimulated by FDI it might increase domestic employment. A similar classification is brought forth by McGuire (1995): The impact of outward FDI on domestic employment depends on the relationship between foreign production and domestic exports and between reimports and domestic production. Additionally, Agarwal (1996) adds that FDI might lead to an expansion of white-collar jobs in the parent company and that capital formation might be affected in the home country by investments abroad with an inconclusive net effect on labor demand at home. However, empirical studies have not been able to show a clear correlation between FDI and employment, neither a positive nor a negative correlation. According to Baldwin (1994), a

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firm conclusion about the net employment effects is difficult because of the sensibility of the results with respect to assumptions made about what would have happened in the absence of FDI, a story statistical data cannot tell.

Additionally, little is known about the causal relationship between FDI and employment, a question that tabulations of data cannot answer. Conventional wisdom tries to derive a causal relationship from the company's motivation to invest abroad. If the investment is efficiency-seeking, i.e. if it is undertaken to save on production costs, then this implies that offshore production facilities are created *instead* of domestic production facilities. In this case, the home country looses job opportunities and demand for labor associated with this particular activity. On the other hand, if the MNE tries to open up markets with the investment, i.e. investments in marketing, distribution, and sales, the goal is not to save on production costs, but to increase global turnover. This, so the argument, is more likely to have a stimulating effect and increase employment. However, MNEs usually do not pursue a single goal only when investing abroad. Their investment decisions are based on a very broad definition of competitiveness, including (but not restricted to) parameters as production costs and access to markets [see Madeuf (1995)].

More recently, attention has shifted towards international production strategies and relocations of intermediate production processes. Technological progress has made it possible for companies to "slice up the value chain" and perform different stages of the production process at different locations [see Tanaka/Vickery (1993), Papaconstantinou (1995), UNCTAD (1993)]. Today, the internationalization includes almost all of a company's activities, from R&D and innovation, finance, through production and distribution, to final sales. This development has made companies even more sensible to international production cost differentials and has increased the scale of their global operations. As Deardorff (1998) showed, Heckscher-Ohlin trade in production fragments enlarges the factor price equalization cone. As more and more developing countries are integrated into the international division of labor, their integration has an ever increasing impact on the economies of the industrialized world. This can also be observed for capital movements. Whereas a few decades ago, most FDI was among developed countries, nowadays the share of low-wage developing countries as recipients of investment flows is growing [see f. ex. UNCTAD (1996)]. Most of the developing countries that have experienced such an inflow of capital from the developed countries have benefited from it through technological spillovers, more employment opportunities and higher growth rates. But does this in return mean that the industrialized countries are losing jobs?

We present a simple neoclassical production type model that allows for an international diversification of intermediate production processes. As the locational decision is determined endogenously, our model provides a microeconomic foundation of possible causal links between international production

strategies and labor demand at home. A comparative-static analysis shows the impact on demand for domestic labor of falling costs for running and integrating a remote production site. Results are presented analytically and graphically for both an inelastic supply of capital and an endogenous capital stock. Finally, we introduce a second sector to compare our results with the theorems of traditional trade models before concluding the paper.

II. The Model

We assume that a homogenous final product X is costlessly assembled from two types of intermediate products, Q and Z, using a linear-homogenous technology. At a point of optimum production, costs per unit of output is a function of input prices only and in equilibrium equals the product price.

$$x(q, z) = p^x \tag{1}$$

Here, x denote costs per unit of output of the final good X, q and z denote prices (costs per unit of output) for Q and Z, respectively, and p^x denotes the product price of X. No specific functional type is assumed for x to keep the analysis open to various ranges of substitutability between the two inputs.

The first derivatives of the cost function x with respect to the input prices (denoted by a subscript) yield the respective input coefficients, so that demand for the two intermediate products is given by

$$x_q X = Q \tag{2}$$

$$x_z X = Z \tag{3}$$

As x is homogenous of degree one in q and z, the first derivatives are homogenous of degree zero, indicating that input coefficients are functions of *relative* input prices only.

Both intermediate goods are produced under constant returns to scale with capital and labor as factors of production. To capture the idea of an internationally diversified production we assume that capital is freely mobile between different locations and that firms can choose to either employ their capital at home and combine it with domestic labor to produce intermediate good Q, or to export it and combine it with foreign labor to produce the offshore-manufactured intermediate good Z. If technology is embedded in capital, and developed countries have more advanced technologies than developing countries, then firms of high-tech industrialized countries have an

incentive to keep their production integrated when opening plants in developing countries even with constant returns to scale.

Production costs per unit of output of either intermediate are given by

$$q = q(r, \ell) \tag{4}$$

$$c^z = c^z\left(r, \ell^*\right) \tag{5}$$

with r denoting the domestic rental rate, ℓ denoting the domestic wage rate and ℓ^* denoting the foreign wage rate. Again, first derivatives denote the respective input coefficients.

Whereas production costs are the relevant costs for the domestically produced intermediate, companies have to carry additional costs for running and controlling remote production of Z (e.g. communication etc.) and subsequent integration of Z into the production of X (e.g. transportation costs, tariffs on Z etc.). All of these factor neutral costs are included in an additional parameter t. Therefore, "total landed costs" for Z are given by

$$z = tc^z\left(r, \ell^*\right) \tag{6}$$

We can now derive demand for domestic labor and capital straight from the respective cost functions. As domestic labor is only used in the production of Q, its demand is given by

$$q_\ell Q = L \tag{7}$$

On the other hand, capital is freely mobile across production of Q and Z. Therefore, its demand is given by

$$q_r Q + c_r^z Z = K \tag{8}$$

Assuming that L and K denote supplies of labor and capital, (7) and (8) represent the respective factor market equilibria. With respect to labor, it is assumed that it is inelastically supplied as it is supposed to be a location-specific factor of production. Capital supply, on the other hand, is supposed to be somewhat elastic with respect to profits. If profits rise, new companies enter and capital flows into the country from other (industrialized) economies with similar technologies.

(9) $$K = K(r)$$

With respect to the elasticity of capital supply we suppose that it can take on any values between zero and positive indefinite.

Finally, we assume that the country analyzed is small. Therefore, both the price of the final product and the foreign wage rate are exogenously given as neither changes in the domestic demand for the final good nor changes in the domestic production structure of X are large enough to have a significant impact on world demand for X and L*. This closes our model and equations (1)-(4) and (6)-(9) unambiguously determine q, z, r, ℓ, X, Q, Z, and K.

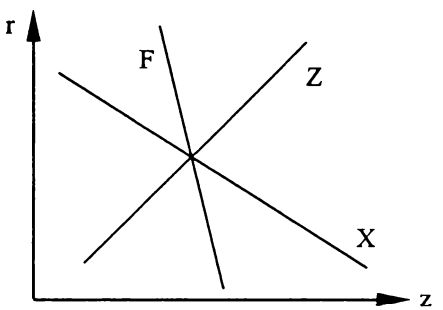

Figure 1

The equilibrium can be shown graphically in an r/z-diagram and is represented by the intersection of the isocost curve of X, given by (1) and (4), the partial cost curve of Z (6), and a curve F for the factor market clearing conditions (7)-(9). Without loss of generality, linearity of all curves is assumed for simplicity.

The X curve has a clearly negative slope as it represents a traditional isocost curve for two substitutional factors of production. Its slope is determined by input intensities of K and Z. Both the domestic wage rate and the product price of X are level parameters. The X curve is shifted to the right if the product price increases or if the wage rate falls. The Z curve yields total landed costs for the intermediate Z as a function of the rental rate and is, therefore, strictly increasing in r. Its slope is determined by the capital intensity of offshore production. A fall of either the foreign wage rate or the parameter t will shift the curve to the left. Finally, the slope of the F curve depends on the elasticity of capital supply and on the various elasticities of substitution, both between the two intermediates in the production of X as well as between capital and labor. It depicts combinations of r and z at given levels of both the domestic

and the foreign wage rate where factor markets are in equilibrium. In terms of the labor market, points to the right of the curve represent an excess demand for labor, followed by an increase of ℓ, whereas points to the left represent an excess supply of labor, driving down the wage rate. Thus, the intersection of all three curves in figure 1 depicts an equilibrium for given values of t, p^x, ℓ^* and L, showing the equilibrium values of r and z explicitly, with an implicit solution for the domestic wage rate ℓ.

III. Comparative-statics

Total differentiation of (1)-(4) and (6)-(9) and rearranging yields the analytical foundations of the three curves derived above:

$$a^{Kq}a^{Qx}\hat{r} + a^{Lq}a^{Qx}\hat{\ell} + a^{Zx}\hat{z} = \hat{p}^x \tag{10}$$

$$a^{Kz}\hat{r} - \hat{z} = -\hat{t} - a^{L^*z}\hat{\ell}^* \tag{11}$$

$$\left(S_K - \varepsilon_{K,r}\right)\hat{r} + S_L\hat{\ell} + S_Z\hat{z} = -\hat{L} - \lambda_K^z\eta_{KL^*}^z\hat{\ell}^* \tag{12}$$

with
$$S_K = \lambda_K^q\eta_{KK}^q + \lambda_K^z\eta_{KK}^z + \lambda_K^z a^{Kq}\left(\eta_{ZQ}^x - \eta_{QQ}^x\right) - \eta_{LK}^q$$

$$S_L = \lambda_K^q\eta_{KL}^q + \lambda_K^z a^{Lq}\left(\eta_{ZQ}^x - \eta_{QQ}^x\right) - \eta_{LL}^q > 0$$

$$S_Z = \lambda_K^z\left(\eta_{ZZ}^x - \eta_{QZ}^x\right) < 0$$

Here, a hat denotes relative change, a^{ij} denote factor cost shares (e.g. $a^{Kq} = rK^Q/qQ$), λ_K^j denote the international allocation of (high-tech) capital (e.g. $\lambda_K^q = K^Q/K$), $\varepsilon_{K,r}$ denotes the elasticity of capital supply with respect to profits, and η_{ij} stand for the elasticities of factor coefficients with respect to changes in factor prices (e.g. $\eta_{KL}^q = \partial q_r/\partial\ell$). Own price elasticities are negative and cross price elasticities are positive.

Suppose now that as a consequence of globalization and due to technological progress it becomes easier for companies to run and integrate foreign production facilities, so that t decreases ($\hat{t} < 0$). If all other exogenous parameters remain constant ($\hat{p}^x = \hat{\ell}^* = \hat{L} = 0$), and if, to begin with, the supply of capital is exogenously given as well ($\varepsilon_{K,r} = 0$), we can solve for

changes of total landed costs of the offshore-manufactured intermediate, the rental rate, and the domestic wage rate:

$$(13)\quad \frac{\hat{z}}{\hat{t}} = \frac{1}{\Delta} a^{Qx}\left[-a^{Lq}\left(\lambda_K^q \eta_{KK}^q + \lambda_K^z \eta_{KK}^z - \eta_{LK}^q\right) + a^{Kq}\left(\lambda_K^q \eta_{KL}^q - \eta_{LL}^q\right)\right] > 0$$

$$(14)\quad \frac{\hat{r}}{\hat{t}} = \frac{1}{\Delta}\left(a^{Lq} a^{Qx} S_Z - a^{Zx} S_L\right) < 0$$

$$(15)\quad \frac{\hat{\ell}}{\hat{t}} = \frac{1}{\Delta}\left(a^{Zx} S_K - a^{Kq} a^{Qx} S_Z\right) \gtreqless 0$$

with $$\Delta = a^{Qx}\left[a^{Kq}\left(\lambda_K^q \eta_{KL}^q - \eta_{LL}^q\right) - a^{Lq}\left(\lambda_K^q \eta_{KK}^q + \lambda_K^z \eta_{KK}^z - \eta_{LK}^q\right)\right] + a^{Zx} a^{Kz} S_L - a^{Lq} a^{Qx} a^{Kz} S_Z > 0$$

As (13) shows, total landed costs of the offshore-manufactured intermediate fall as t decreases. This is not surprising as t represent costs specific to foreign locations. However, it should be noted that the elasticity of z with respect to t is smaller than one, i.e.

$$0 < \frac{\hat{z}}{\hat{t}} < 1$$

Therefore, the relative reduction of z is smaller than the initial decline of t. This result holds even though we are looking at a small country and traditional theory of tariffs would predict that the elasticity of the price of an imported good with respect to the tariff is equal to one in the small country case (remember that t can also be interpreted as a tariff on reimports). This is due to the fact that production abroad also uses domestic factor inputs, specifically capital, that profit from the increasing demand for these inputs. And, as (14) shows, the rental rate rises as a consequence of a decline of t.

The change of the rental rate (14) indicates that the process as described here is not a zero-sum game. If the reduction of t only brought about a simple substitution of domestic production by foreign production, the overall demand for capital and, thus, r would not change. But the rental rate rises because a decline in t not only brings about a change in the international allocation of production but also lowers overall production costs of the final product. With a perfectly elastic demand for this good on world markets output expands and demand for capital rises.

Finally, as (15) shows, the change of the domestic wage rate is ambiguous and, thus, the impact on demand for labor inconclusive. A decline of t does not have a direct impact on labor demand but triggers adjustment processes that indirectly influence demand for labor. The decline of z makes foreign production more attractive and companies start substituting the two locations in favor of offshore production. The extent of this effect depends on the substitutability of the two locations, i.e. the elasticity of substitution between Q and Z in the final production. On the other hand, the rise of the rental rate brings about adjustments of the production structure of the two intermediate products, and companies substitute away from capital, which has become more expensive, and towards labor. Therefore, demand for labor rises to the extent that capital and labor are substitutional factors of production. The question of whether demand for labor rises or falls is, thus, a question of substitutability between the two locations on one hand and between the two factors of production on the other hand.

Critical values for the two elasticities of substitution can be derived mathematically:

$$\sigma_{QZ} = \frac{a^{Kx}}{a^{Kq}a^{Kz}}\tilde{\sigma}_{KL} \tag{16}$$

$$\text{with} \quad \tilde{\sigma}_{KL} = \lambda_K^q a^{Lq}\sigma_{KL}^q + \lambda_K^z a^{L^*z}\sigma_{KL^*}^z + a^{Kq}\sigma_{KL}^q$$

Here, σ_{QZ} denotes the Allen elasticity of substitution between Q and Z in X and $\tilde{\sigma}_{KL}$ denotes a weighted average Allen elasticity of substitution between capital and labor in both Q and Z. If (16) holds, demand for labor does not change and ℓ remains constant. If the left hand side of (16) exceeds the right hand side, then the labor demand reducing effect overweighs and ℓ falls as a consequence of international production relocations. On the other hand, if the elasticity of substitution between capital and labor is sufficiently large, demand for labor increases in spite of an expansion of offshore production.[1]

If we look at (16) and compare the results for various elasticities between the two locations for any given $\tilde{\sigma}_{KL}$, we can derive some results with respect to the probable motivation of the investment. If σ_{QZ} is low, the two intermediate products are only weak substitutes. This fits the case of market-seeking FDI. If the investment has been undertaken to open up markets, so that it includes mainly aspects of marketing, distribution and sales, these activities

[1] This result is indirectly supported by *Cushman* (1987), who explicitly points to the importance of capital-labor substitution as determinants of FDI flows.

are at best weak substitutes, if not complements, for the actual production process at home. On the other hand, if the two intermediate products are very good substitutes, then σ_{QZ} is high. In the case where the two intermediate goods are identical, and they only differ with respect to the production location, their elasticity of substitution approaches infinity. This describes a typical cost-oriented, efficiency-seeking investment. Location only matters with respect to the production costs. Thus, for the two extreme cases, our results support conventional wisdom: "Purely market-seeking" FDI increases demand for domestic labor, whereas "purely production-driven" investments reduce demand for labor. For everything in between the two extreme cases, we have to look at (16).

A change in ℓ triggers further adjustment processes that can best be described using a graphical analysis. Starting from an equilibrium as shown in figure 1, a fall of t shifts the Z curve to the left. Whether the new product market equilibrium, the intersection between the Z curve and the X curve, is to the left or to the right of the F curve depends on the slope of the X curve relative to the slope of the F curve. As was derived above, points left of F represent an excess supply of labor, whereas the area to the right of F represent an excess demand for labor. As supply remains constant, the question of whether demand for labor falls or increases is a question of whether F is steeper or flatter than X. This is shown in figure 2. A mathematical comparison of the two slopes shows that both slopes are identical if (16) holds.

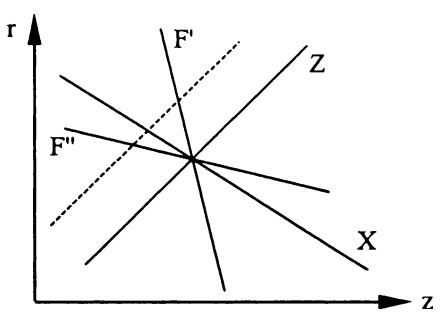

Figure 2

In figure 2, F' represents the case where demand for labor declines and F" shows how demand for labor can increase if t falls. In either case, a change in ℓ brings about shifts of both the X curve and the F curve, as ℓ is a parameter in both (10) and (12). And, as these two equations show, the two curves are always shifted towards each other along the new Z' curve. If F is steeper than X, and ℓ falls, than the F curve is shifted to the left, whereas the F curve is shifted rightward. On the other hand, if F is flatter than X, and ℓ rises, than

both curves are shifted in the other direction, again approaching each other along the Z' curve. These two cases are shown in figures 3a and 3b.

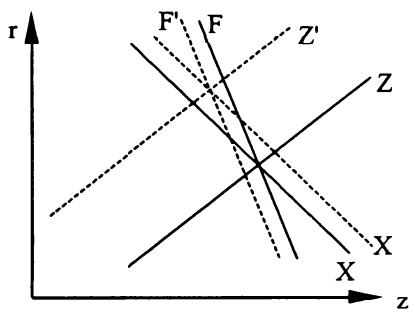

Figure 3a

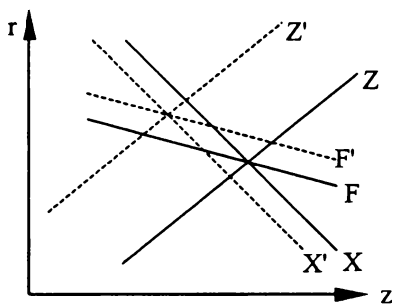

Figure 3b

Let us now come to the role of the elasticity of capital supply ε. A look at (10)-(12) reveals that ε only appears in (12) and is an argument in the slope of the F curve. The slope of F is given by:

$$\frac{\hat{r}}{\hat{z}} = -\frac{S_Z}{\left(S_K - \varepsilon_{K,r}\right)} \tag{17}$$

It follows that

$$\frac{\partial\left(\hat{r}/\hat{z}\right)}{\partial\varepsilon_{K,r}} = \frac{-S_z}{\left(S_K - \varepsilon_{K,r}\right)^2} > 0 \text{ and} \tag{18}$$

$$\lim_{\varepsilon_{K,r}\to\infty} \frac{\hat{r}}{\hat{z}} = 0 \tag{19}$$

(18) reveals that the F curve is the flatter, the higher the elasticity of the capital supply. This means that with a highly elastic supply of capital, the likelihood of a rise in demand for labor increases. The additional effect brought about by capital mobility is one of output expansion and productivity. If the supply of capital rises and new companies enter when profits increase, output of the final product X expands and workers' productivity increases. It is this output expansion that drives up labor demand, so that domestic workers' income rises.

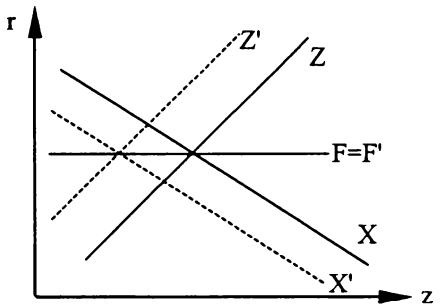

Figure 4

If we let ε go to infinity (capital is perfectly mobile), the F curve is a horizontal line, see (19), and the rental rate is completely determined on world markets. In this case, any marginal change of r is instantaneously offset by supply responses, so that for our small country the rental rate is exogenously determined. In this case, a decline of t always brings about an increase in demand for domestic labor, as output expands. As figure 4 shows, in the new equilibrium, r has remained unchanged and z has fallen by t.

Mathematically, using L'Hôpital's rule where necessary, the following results can be obtained:

(20) $$\lim_{\varepsilon_{K,r}\to\infty} \frac{\hat{r}}{\hat{t}} = 0$$

(21) $$\lim_{\varepsilon_{K,r}\to\infty} \frac{\hat{z}}{\hat{t}} = 1$$

(22) $$\lim_{\varepsilon_{K,r}\to\infty} \frac{\hat{\ell}}{\hat{t}} = \frac{-a^{Zx}}{a^{Lq}a^{Qx}} < 0$$

(20)-(22) support the results of our graphical analysis. With an exogenously determined rental rate, r remains constant, z falls by t, and demand for labor increases, driving up the wage rate, as t declines. This result is completely independent of any values for the various elasticities of substitution. We see that the output effect exceeds the substitution effect.

One other feature of this model should be pointed to. If we allow supply of capital to be at least somewhat elastic with respect to profits, the model gives an endogenous explanation for cross-hauling. As t falls, and companies relo-

cate some of their production facilities abroad, profits rise and attract capital inflows from abroad. We, thus, have simultaneous inflows and outflows of real capital.

IV. A Two Sector Analysis

We have seen that output changes can outweigh effects of substitution. This can also be observed in traditional trade models. With two sectors and two factors of production, the two factor prices are clearly determined by commodity prices. When commodity prices change, e.g. as a consequence of international trade, the economy undergoes a structural change. One sector, whose relative price has risen, expands and the other sector contracts, as factors of production are reallocated between the two sectors. If demand for the two factors varies between the two production techniques, factor prices adjust accordingly, i.e. the factor that is used intensively in the expanding (contracting) sector rises (falls).

It seems a natural objective to extend our analysis to a two sector model to see how our results compare to the results of traditional trade theory. We, therefore, introduce a second sector that produces a different, but also homogenous good Y with a constant returns to scale technology, using the same two factors of production, capital and labor. Furthermore, we suppose that Y, too, is a tradable good and that its commodity price is determined on world markets as well. However, sector Y cannot split up its production process into independent intermediate production processes and, for technological reasons, has to produce all the value added at home. Sector X, on the other hand, remains internationally diversified in its production as described above. We assume that factors are perfectly mobile between the two sectors.

Product market equilibrium for Y is given by

$$c^y(r, \ell) = p^y \tag{23}$$

To simplify things, we substitute (4) and (6) in (1) and obtain a single equation for X:

$$c^x\left(r, \ell, \ell^*, t\right) = p^x \tag{24}$$

As both commodity prices, the foreign wage rate and the globalization parameter t are all given exogenously, (23) and (24) unambiguously determine the two factor prices r and ℓ.

We can now easily solve for changes of r and ℓ triggered by a decline of t by totally differentiating (23) and (24) and applying Cramer's rule. We obtain:

$$\frac{\hat{r}}{\hat{t}} = -\frac{a^{Zx}a^{Ly}}{a^{Ly}a^{Kx} - a^{Ky}a^{Lx}} \tag{25}$$

$$\frac{\hat{\ell}}{\hat{t}} = \frac{a^{Zx}a^{Ky}}{a^{Ly}a^{Kx} - a^{Ky}a^{Lx}} \tag{26}$$

The result looks very similar to the Stolper-Samuelson theorem, and the underlying economic processes are very much alike, too. Whether the rental rate or the wage rate rise or fall depends on which of the two factors is intensively used in the sector pursuing international production strategies. If t falls, and production costs of X decrease, this sector expands. Productive factors are withdrawn from the other sector, so that Y falls. If X and Y differ in factor intensities, then demand for the factor that is used intensively in the production of X (Y) rises (falls) as a consequence of the changing production structure.

Therefore, if X is the capital intensive good, so that $a^{Kx}/a^{Ky} > a^{Lx}/a^{Ly}$, then $\hat{r}/\hat{t} < 0$ and $\hat{\ell}/\hat{t} > 0$. On the other hand, if labor is used intensively in the production of X, i.e. $a^{Kx}/a^{Ky} < a^{Lx}/a^{Ly}$, results reverse: $\hat{r}/\hat{t} > 0$ and $\hat{\ell}/\hat{t} < 0$.

We see that in a two sector world, changes in the production structure between the two sectors outweigh all other effects on factor prices. Demand for the two factors is predominantly determined by relative output levels. If we divide the economy along the line of whether international production strategies are pursued, then costs associated with running and integrating a remote production site or affiliate are specific to only one sector. If these costs fall, the final product of this sector can be produced at lower overall costs, and companies in this sector can increase their market shares at the cost of the other sector. Changes in factor prices are then brought about by different sectoral factor intensities. The important result of (25) and (26) is that whether demand for labor rises or falls depends on *sectoral* factor intensities, and not on factor intensities of either intermediate production process.

V. Conclusion

The model presented discussed the employment effects of outflowing FDI in an environment of an integrated international production network. With two intermediate products, one domestically produced and one offshore-

manufactured, companies increase the volume of their offshore activities as costs for running and integrating foreign affiliates decrease. The results showed that the employment effects of international production strategies depend not only on the elasticity of substitution between the two locations, but that capital-labor substitutions have to be taken into account, too. They also showed that globalization can boost labor productivity in sectors pursuing strategies of global production networks if rising profits lead to capital inflows.

However, the question of whether workers in industrialized countries lose or gain as a consequence of globalization remains ambiguous. Nonetheless, we were able to derive conditions under which workers gain. In a one sector perspective, workers are better off the higher the elasticity of substitution between capital and labor, the lower the elasticity of substitution between the two locations for intermediate production, and the higher the elasticity of (high-tech) capital supply with respect to profits. From a two sector perspective, wage effects of globalization depend on sectoral factor intensities. Workers gain, if the labor intensity in sectors pursuing strategies of international production is higher than in the rest of the economy.

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Economic and Social Convergence or Divergence in and between Developing Regions - a Relevant Debate?*

Harald V. Proff

I. Introduction

Convergence or divergence in and between developing regions in Africa, Asia and Latin America is an important issue in the present convergence debate[1]. This paper analyses the intra- and inter-regional similarities and differences between developing countries in the main integration areas AFTA, SADC and MERCOSUR to evaluate question whether regional integration will lead to marked inequality in these regions and to prove the relevance of comparing aggregated geographical units like „Africa" or „Asia". Convergence is understood as a faster per-capita growth in poor economies than richer ones in accordance with the neo-classical assumption of diminishing returns to capital (cf. *Barro/Sala-i-Martin*, 1992, p.226). The divergence assumption rejects the inverse relationship of per-capita growth and the initial level of output due to the availability of technological progress.

This paper looks for theoretical and empirical evidence for either convergence or divergence in and between developing regions. The literature on this topic can be grouped into two ideal types of comparative research on developing regions (cf. *Lipton* 1998)

(1) cross national multiple regressions with the introduction of SADC or AFTA as dummy variables beside the traditional (growth theory) variables and

* The author is thankful for useful remarks and suggestions on previous versions of this paper at the ESCR Development Economics Study Group Conference, Reading 10th-11th July 1998 and appreciates the comments provided by Professor Körner and Professor Lipton. Remaining errors are my own.

[1] For an overview of this debate cf. for example the controversy on the convergence and divergence of growth rates in the Economic Journal Vol.106, 1996, p. 1016-1069; cf. Durlauf (1996) or Pritchett (1997).

(2) comparative case studies with comparisons of pairs and smaller groups in different regions for a specific field situation to explain differences or similarities.

Both types of comparative research face severe limitations. In economics, it is only necessary to introduce „space" if it has an impact on (the performance of) markets (cf. *Giersch,* 1995, p.8). It is not the location of an economy in the SADC or AFTA "as such" that affects the market performance, so that dummy variables in the first ideal type of comparative research do not possess a high explanatory power. Comparative case studies lack the theoretical grounding of the multiple regression approach and are hardly able to offer any far-reaching conclusion.

In spite of these theoretical problems multinational enterprises are looking for criteria to reduce the complexity of their environment while designing and implementing global strategies for the non-triade markets. The formation of regional integrations between countries provides a popular framework for this kind of complexity reduction (cf. *Proff/Proff,* 1996), so that there is a demand for comparative research (cf. *Durlauf et al,* 1996, p.9) which this paper intends to address.

The plan of the paper is as follows. In Section II the impacts of regional integration among developing countries is analysed to examine convergence and divergence *in* a developing region. Section III provides a discussion of convergence and divergence *between* the developing regions. Section IV then empirically examines the inter-regional homogeneity and heterogeneity of developing regions with the help of multivariate cluster analyses that also examines convergence or divergence in and between developing regions. An outlook and policy recommendations are provided in Section V.

II. Impacts of Regional Integration Among Developing Countries on Convergence and Divergence in Developing Regions

Since the beginning of the nineties there has been an increased trend in the world economy towards regional trade agreements. Of particular importance for development policy are SADC, MERCOSUR and AFTA. In addition to these there are a large number of other regional integration agreements in all parts of the globe in which industrializing countries participate.

Generally regional integration concentrates on the creation of trade. The trade-creation effect is one of the non-monetary effects of regional integration and leads to increased trade between the participating countries, due to the reduction of customs duties. As a result the economies of these countries will be stimulated; hence their economic growth. This positive integration effect, which is based on the most efficient utilisation of the resources available in the participating countries, contrasts with the trade diversion effect. This arises

because competitive products from third countries, which are not party to the regional integration, are replaced by less competitive products from the participating countries, which are cheaper because of the reduction in tariffs. From a purely theoretical point of view, therefore, the whole theory of regional integration belongs to the theory of *second best*. Thus, a movement towards one condition for Pareto optimality by reducing tariffs on imports from one source *may* not be welfare improving unless other conditions are fulfilled, which is not the case when tariffs remain on non-preferred (third-countries) imports (*Lipsey/Lancaster*, 1956/57). This is the reason why generalisations on welfare gains from regional integration are hard to make, thus opening up the field on non-economic motivation for or against regional integration (*Pomfret*, 1986).

The traditional argument indicates that the liberalisation of trade tends to polarise regional development in the more advanced partner countries. Initial regional disparities are thus perpetuated by a cumulative process and industrial growth tends to gravitate towards the economically more advanced countries (cf. *McCarthy*, 1994, p.10).

As Krugman has noted, a full analysis of the costs and benefits of regional trade agreements requires not only a strong theoretical base but also an analysis of the bargaining process in the trade negotiations (*Krugman*, 1991, p.10). A decision tree of a bargaining process in trade negotiation contains 4 steps (cf. Figure 1):

The first decision is centred around the political will towards substantial regional integration. If this hurdle is taken, the question then arises of the overall gains from trade through regional integration. Here acting politicians face a dilemma when consulting economists on a specific integration project. On the one hand there are abstract theoretical models that barely take into consideration the economic context of the integration in question. On the other hand there are econometric models - normally CGE-approaches that depend heavily upon assumptions of elasticity parameters (cf. *Proff, H.V.*, 1994, p.22,86 and 87).

It becomes clear that proponents and opponents selecte the model most helpful for their own political goals. Therefore it seems to be more fruitful to deduce a set of hypotheses from the theory of regional integration to analyse regional integration in a manner which is both theoretically grounded and sensitive to the economic context. The clear disadvantage of this approach is that there is no "exact" figure for GDP growth/decline resulting from regional integration. However, a stable and specific evaluation of sign and size of the economic impact can be made, leading to a clear judgement as to whether overall gains from trade through a regional integration can be expected or not. It is generally expected that regional integration will enhance overall economic welfare due to gains from trade (cf. *Leistner*, 1995 p.30; *Proff, H.V.*, 1994).

The distribution of the gains among the partner countries is the next issue for negotiation. Here lobbyism occurs, as the potential gains may vary among different subgroups of the partner countries. Influential pressure groups try to raise their welfare during the negotiation process (cf. *Becker,* 1983, p. 373-374). Designing an optimal strategy from the theoretical point of view (even if it is *only* second best) does not mean at all that the policy implemented will be optimal due to lobbyist influences (cf. *Oberender/Daumann*, 1995, p.95). Introducing pressure groups in the bargaining process explains the large exclusion lists in regional trade agreements. Exclusion generally improves the chances of reaching an agreement due to a bargain of special treatment of a mighty pressure group for their support of the agreement (cf. *Grossman/ Helpman*, 1995, p.684). In this third step government assessments of (discounted) welfare effects of exclusions and concessions under incomplete information are relevant. Incomplete information generally leads to a long negotiation process because better understanding between the negotiation partners provides a higher degree of security in assessing the partner's reactions (cf. *Bac/Raff*, 1997, p.500).

The analysis of the distribution of the gains from trade is easiest done in a simple trade model. Here the gains from trade can be broken down into two components: the gains from exchange and the gains from specialisation and the terms of trade determine the distribution of the gains from trade (*Kenen*, 1989, p.28; *Salvatore* 1995, p.67). Assuming a persistence of negative terms of trade evolution for developing countries according the Prebisch-Singer thesis and extending this thesis to all unequal economic environments, a bias of the gains from trade towards the more developed countries can be expected.

However, a static indicator - only appropriate to characterize comparative static situations - does not seem to be methodologically adequate to assess a dynamic development process. Another way to analyse the distribution of gains from trade is the more dynamically oriented cumulative causation model. The argumentation is mainly based on core-periphery models, which were developed to explain the economic transactions between the northern hemisphere as the core and the southern hemisphere as the periphery (*Myrdal,* 1957, chap. 3). The mechanism of differences in size between economies and level of development can also be used within a region as well as within a country. These models suggest that within a region the growth inducing trickle-down effects of trade are small compared with the negative *„backwash effects"* for the less developed countries. The economically more developed countries will attract industry because of increasing returns to scale, the better availability of a trained workforce and the existence of necessary industrial services like finance, transport and lawyers (cf. *McCarthy,* 1994, p.9). As a consequence, labour-intensive craft industries in the less developed countries decline due to their inability to compete with cheap imported mass produced goods from economically more developed countries within the region. The consequence of this bias in the potential for exploiting the benefits from

greater specialisation due to regional integration leads to the prediction that countries specialising in land-based activities are likely to grow more slowly than those specialising in manufacturing activities.

Krugman/Venables (1995) deduce a similar cumulative causation process by analysing regional differentiation (core-periphery) driven by the interaction of scale economies and transport costs.

The cumulative causation model leads to two main hypotheses (cf. *Kaldor* 1970): (a) the money wages and their rates of increase are approximately the same in all countries and (b) a region's rate of productivity growth is an increasing function of its rate of growth of output. A look at the AFTA, MERCOSUR or SADC indicates that there is no similar money wage in the respective regions for instances because of restrictions in labour mobility or different economic institutions in the countries. The hypotheses might be true in a very distant future but this is not the problem today or tomorrow. The remaining money wage gap between different countries involved in a regional integration will nevertheless aggravate the problems of (illegal) migration in the short run. The illegal inflow of labour to the more developed countries generates social and political pressure within the countries but also between them. The experiences of the border region between the United States and Mexico, where there is a worldwide unique situation of a 3000 km common border between an industrialized and a developing country, show that even with the extremely resource intensive U.S. border patrol system, the illegal inflow of Mexicans cannot be stopped. This was one main reason why the U.S. wished to establish NAFTA. The integration in North America is leading to strong economic interdependence. The positive economic development of Mexico must therefore be in the interests of the U.S. because the migration of Mexico's poor can only be effectively reduced by improving living conditions in Mexico itself (*Proff, H.V.*, 1993, p. 280).

The second hypotheses is not that easy to reject. Kaldor assumed a high correlation between productivity growth and growth of output. A look at the contribution to growth for the high growth countries in Asia shows a different picture. The sources of GDP growth are (cf. *Durlauf et al,* 1996, p.3):

(1) increases in the accumulation of investment,

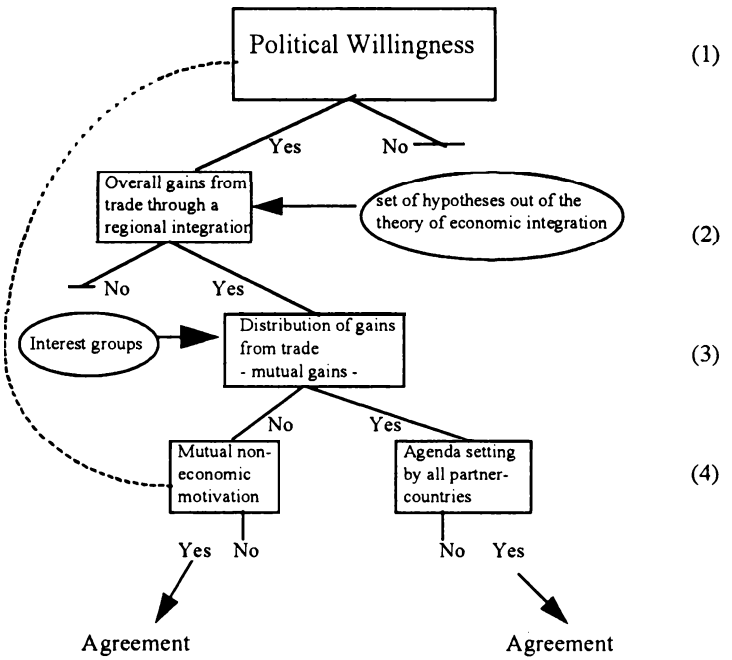
(2) increases in the qualification of the workforce,

(3) reallocation of capital from low-to-high growth producing sectors and

(4) total factor productivity/technological change.

Due to a strongly rising investment rate and labour-force participation rate the „residual" total factor productivity accounts for only 10-15% of growth in high-growth Asian countries (cf. *Behravesh*, 1996, p.11). So, in the case of these developing countries factor accumulation and not productivity progress

is the explanation for growth, with the consequence that the second hypothesis of Kaldor is not relevant either.



Source: Own design.

Figure 1: Bargaining process in trade negotiations for regional integration

Neither the traditional static model explaining the distribution of gains from trade according to the terms of trade nor the cumulative causation model of Myrdal and Kaldor are able to prove a bias in the distribution of gains from trade for regional integration among developing countries. At first sight this result contrasts with results of *Krugman/Venables* (1995). Their model predicts a first stage of growing inequality (in the real wages) due to falling transport costs leading to a core periphery situation. Assuming transportation cost keep falling the lower wage rates in the periphery will offset the agglomeration advantages of the core in a second stage (cf. *Krugman/Venables*, 1995, p.861). This will lead to a reduction of the inequality. Transport costs in many developing countries are extremely high due to the poor infrastructure, with the consequence that an uneven distribution of gains from trade might be expected. However, the impact of regional integration on infrastructure is

certainly positive. Infrastructure needs a critical mass like any public or semi-public good. Infrastructural improvements will reduce transaction costs, which are prohibitively high in many developing countries. Infrastructural improvements are very sensitive to regional integration if a multispeed approach through cooperation among different infrastructure providers is possible (cf. *Odén* 1996, p.34). Looking at the restrictive assumptions of the Krugman and Venables model (e.g. no labour and capital mobility) it also becomes evident that this model is not able to prove an uneven distribution of gains from trade.

If mutual gains can be expected the agenda setting is the last decision to take in a fourth step. Without these mutual gains only a non economic motivation will lead to an agreement.

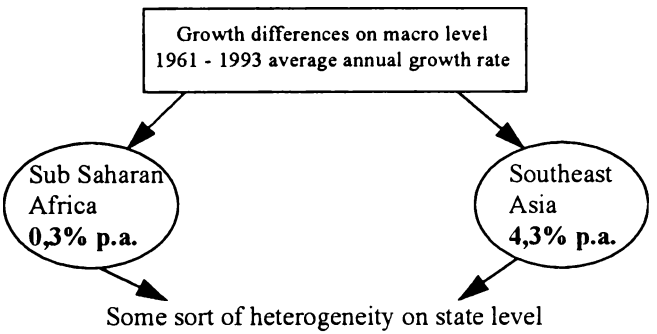
Summing up this consideration of the impact of regional integration on developing countries, mutual gains can be expected and it is evident that neither a clear convergence nor divergence pattern within a developing region exist.

Section III will now discuss the convergence or divergence pattern between the developing regions.

III. Developing Regions in the Growth Controversy - Convergence and Divergence between Developing Regions

The analyses of long run economic growth from either the convergence or the divergence approaches are generally based on a set of some abstract parameters and their interplay. To prove if convergence or divergence between developing regions occur, cross-country studies have been conducted by a large number of authors and institutions. The World Bank's 1993 „East-Asian Miracle" and its 1994 „Adjustment in Africa" studies are prominent examples of this type of research. The main result are presented in Figure 2.

In the 1960's the average level of GDP in the main AFTA countries and Sub-Saharan Africa were similar. Southeast Asia could be characterised as being relatively rich in natural resources but weaker in human resources. This is similar to the situation in many countries in Sub-Saharan Africa both in the 1960's and today. As is well known, the actual performance of the two developing regions differed greatly. Figure 2 shows that Southeast Asia growth rates were 4 percentage points higher per year than in Sub-Saharan Africa over three decades.



	1965-1985	1985-1990
Botswana	6,8%	5,5%
Malaysia	4,6%	3,7%
Thailand	3,9%	7,5%
Brasil	3,8%	-0,2%
Chile	0,0%	4,2%
Mozambique	-2,9%	1,1%

Source: Barro/Sala-i-Martin (1998), p.483-487; *Court et al* (1998), p.4.

Figure 2: Global and state-level growth differences between developing region (in per-capita terms)

The direct comparison between Southeast Asia and Sub-Saharan Africa accentuates the greater ability of the former to expand. But it is important to make two qualifications. First, the 1997 economic crisis in Southeast Asia highlights the need to rethink the Asian lessons and to focus on some of the severe challenges for economic management and not just growth opportunities. Second, it is important to distinguish between the differential situations and performance of countries within Africa. The Figure 2 indicates the wide range in Sub-Saharan rates of GDP-growth. Botswana, for example, has had growth rates that are the fastest in the world grown at over the last three decades. In contrast countries like Mozambique have faced a dramatic decline in economic activities due to the effects of civil wars and have only recently started to recover slightly.

On average there is a clear tendency towards higher economic growth in Southeast Asia than in Sub-Saharan Africa and Latin America even after the financial turmoil in Asia. However „selection biases" of the samples and theoretical problems with the concept absolute and conditional convergence occur in the different studies (cf. *Straubhaar,* 1998, pp.13-15). There is also a considerable heterogeneity in the growth rates inside developing regions so that again no clear convergence or divergence pattern between developing

regions exist. Furthermore this type of research neglects the fact that major objectives of regional integration are to achieve development *and* economic growth (cf. *Madonsela*, 1996, p. 3). Development is not only limited to GDP growth or trade growth. Economic development is understood to mean a structural change in the economy with a parallel increase in the participation of the population in the formal economic system, increasing industrialisation, urbanisation and a change in trade pattern and consumption habits (cf. *Sell*, 1993, p.2). This means that development is not simply a matter of economic principles but also of social issues and institution building.

The next section will now examine inter and intraregional homogeneity and heterogeneity of developing regions. Due to the fact that the consideration of GDP alone was not able to produce a satisfying result the empirical analysis will introduce more variables than only per-capita income.

IV. Inter-Regional Homogeneity and Heterogeneity of Developing Regions

A trend towards convergence or divergence can be supported by testing the hypotheses of an intra-regional heterogeneity and some inter-regional homogeneity of the most important new regional integrations (AFTA, MERCOSUR and SADC) with the help of a cluster analysis of central economic and social indicators for the member countries. The objective of clustering is to minimise the within-group variance and maximise the between-group variance. The cases to be clustered are all 27 member countries of the three new important regional integrations. This approach also examines the convergence or divergence in and between developing regions. There will be two sets of variables for the 27 countries. Section 1. examines the economic variables primarily in the focus of private capital looking for investment opportunities. Section 2. then uses social variables primarily in the focus of development agencies and multilateral donors.

1. Economic Convergence or Divergence in and between Developing Regions

The variables used as criteria for clustering these countries were obtained from the analysis of the business environment for multinational enterprises, namely those determinants of the sales, procurement and investment conditions that are affected by regional integration (cf. *Proff/Proff*, 1996). Multinational enterprises are looking for criteria to reduce the complexity of their environment to decide where to allocate their resources in the process of designing and implementing global strategies for the non-triade markets. Hence there is a demand for comparative research which should be addressed with this cluster analysis.

Relevant determinants of the sales conditions used as variables are: 1. per-capita income in US-$ as a three-year average of the latest existing data for all 27 countries (mainly 1993-1995), 2. annual growth in per-capita income (predominantly 1996-2000), 3. income distribution shown by the latest available Gini-coefficients and 4. tariffs which can be seen by the post-Uruguay Round (WTO) applied rate. In addition relevant determinants of the procurement conditions used as further variables are 5. wages in US-$ which are the latest available for 1991, 6. the state of education shown by an education index and 7. infrastructure operationalised by electricity consumption per capita in 1994. For the investment conditions only one relevant determinant is used as a last variable, namely 8. the investment risk shown by the Institutional Investors Ranking 1995 (for sources and further explanation of the variables see annex).

In a first step of clustering a standardisation through z-transformation was necessary to ensure complementarity between data of different scales (cf., *Backhaus et al,* 1996, p.314), while in a second step the Euclidean distance process of minimum squared error was chosen as a distance measure, for it tends to produce more "spherical" (and, hence, different but usually more interpretable) clusters than other algorithms (cf. *Harrigan* 1985, p.60). In a next step of the clustering process, Singapore was identified as an outlier with the single linkage technique (cf. *Backhaus et al,* 1996, p.315) and was eliminated from the analysis.

Then in the fourth step it came to the choice of a clustering algorithm. Usually the Ward technique is recommended, for it is the only technique that simultaneously finds a very good partition and signalises the right number of clusters and was therefore also chosen in this analysis. According to a comparison of the sum of error squares a five-cluster solution seems to be suitable. Decisive is the elbow-criteria (cf. *Raffée et al,* 1994, pp.385-386 and *Backhaus et al*, 1996, p.307) that chooses the cluster solution which characterises the sharp bend in the curve of the sum of error squares. With the transition from five clusters to a four-cluster solution a significant increase in the sum of error squares can be seen.

Table 1 shows the five cluster-averages for all eight variables.

Table 1: Five cluster-averages for the eight economic variables

Clusters / Variables	1 "emerging markets"	2 "poor SADC"	3 "advanced SADC"	4 "advanced AFTA"	5 "poor AFTA"
Per-capita Income (US-$)	3.067	967	2.495	6.772	493
Annual growth in per-capita income (%)	4,86	3,46	2,65	6,75	6,10
Income distribution (Gini coefficient)	50,31	46,97	52,65	43,65	36,92
Tariffs (%)	31,03	19,40	19,40	15,15	21,18
Wages (US-$)	3.197	1.423	8.685	7.159	1.213
Education Index	0,82	0,60	0,68	0,79	0,67
Electricity consumption per capita (kw/h)	1.319	492	2.707	3.364	144
Institutional Investors Ranking	43,40	25,40	45,20	69,10	23,64

1. **"emerging markets"**
   = comprising all MERCOSUR members, Zimbabwe, Indonesia and Thailand

2. **"poor SADC"**
   = comprising all SADC member countries besides South Africa, Namibia and Zimbabwe

3. **"advanced SADC"**
   = comprising South Africa and Namibia

4. **"advanced AFTA"**
   = comprising Malaysia and Brunei

5. **"poor AFTA"**
   = comprising Viet Nam, the Philippines, Cambodia, Laos and Myanmar.

Source: Own compiliation based on clustering results.

Looking at Table 1 it becomes evident that Malaysia and Brunei forming cluster 4 ("advanced AFTA") are very attractive markets and production locations due to high market potential and growth, low tariffs, a high standard of education and good infrastructure. In spite of high wages they have the highest average Institutional Investors Ranking of all clusters. The "emerging markets"-cluster (1) has a lower institutional investors ranking because especially in the MERCOSUR-countries there is still a high inflation risk. Therefore production bases should be full-fledged with the greatest possible independence of the local environment or should be relinquished. The average per-capita income in this cluster is lower than that in the two low populated "advanced AFTA"-countries Malaysia and Brunei. However, due to high purchasing power in a sufficiently extended upper class market segment as a

consequence of the unequal income distribution (high Gini-coefficient) and a high broad education, cluster 1 can be evaluated as quite attractive for multinational companies. "Advanced SADC" on the other hand has the problem of high wages and political uncertainty but good infrastructure, low tariffs but high purchasing power especially among the white population due to a very unequal income distribution. "Poor SADC" and "poor AFTA", the latter despite high GDP growth rates, have very unfavourable economic conditions. Especially "poor AFTA" with the quite equal income distribution has no effective demand and the lowest Institutional Investors Ranking of all five clusters.

Concerning the 26 countries' relation, an inter-regional homogeneity can reversely be proved because member countries of all three integrations belong to cluster 1. This result can be seen as a support for the *club convergence* hypothesis of countries that are similar in their structural characteristics (cf. *Galor,* 1996, p. 1056). The clustering results also show intra-regional homogeneity only between the MERCOSUR-countries, that all belong to cluster 1, while AFTA- and SADC-members are in both cases split up into three clusters. This confirms the hypothesis of intra-regional heterogeneities. The heterogeneity of AFTA would have been even higher if Singapore, which constitutes its own cluster, had not been eliminated from the analysis.

2. Social Convergence or Divergence in and between Developing Regions

While the economic variables primarily provide information for private investors looking for new investment opportunities in the process of globalisation of business, the public or private development organization and multilateral donors are looking for a different kind of comparative research. Here social variables are central. According to the methodology presented in Section 1. another cluster analysis will be conducted for the 27 member countries. Again 8 key social variables were used looking at the medical and educational infrastructure, urbanization and environmental sensitiveness. The data collection was considerably simplified due to the fact that all social variables could be found in the latest (1998) UNDP Human Development Report.

No outlier was found but Singapore was excluded from the analysis in order to obtain a better comparability with the analysis in Section 1. Again a five cluster solution shows highest statistical explanatory power, although the clustering results are lower than with the economic indicators (87,9% versus 95,5% explained variance). According to the traditional assumption that economic development goes hand in hand with social development a similar clustering result might be expected. Table 2 shows, however, that the five cluster significantly differ from the economic indicator.

Table 2: Five cluster-averages for the eight social variables

Clusters / Variables	1 "Social Achievers"	2 "Ecological blind"	3 "Poor Africans"	4 "Asian in Betweens"	5 "Very poor Performer"
Annual rate of deforestation	0,56	2,75	0,27	1,133	0,99
Adult illiteracy rate (%)	7,96	9,00	23,16	13,13	44,1
Life expectancy at birth	72,42	69,35	56,23	63,1	48,2
Infant mortality (per 1000 live birth)	21,2	25,5	60,5	61,7	122,4
Public expenditure on health (% GDP)	2,86	1,15	3,4	0,83	2,81
Daily supply of calories	2853	2470	2280	2621	2024
Television (per 1000 people)	363	182	47	129	29
Urban Population (% of total)	81,80	45,00	38,7	26,7	29,62

1. **"Social Achievers"**
   = comprising Chile, Argentina, Brazil Uruguay and Brunei.

2. **"Ecological Blinds"**
   = comprising Thailand, Malaysia, Paraguay and Phillippines.

3. **"Poor African Performers"**
   = comprising RSA, Botswana, Namibia, Swaziland Zimbabwe and Lesotho.

4. **"Asian In Betweens"**
   = comprising Indonesia, Vietnam and Myanmar.

5. **"Very Poor Performers"**
   = comprising Laos, Cambodia, Sambia, Mauritius, Tanzania, Angola, Malawi and Mozambique.

Source: Own compiliation based on clustering results.

While the economic indicator show that AFTA and SADC countries are split up in three cluster AFTA is, in the social context, even more differentiated in 4 clusters, while the SADC countries were focused on the two poor performing clusters. This result is easy to interpret for SADC due to the fact that RSA and Namibia have above average economic records but poor social records for the majority of the black population.

The AFTA countries are split up into four clusters which again demonstrate the heterogenity of this region, making it even more useless to speak of "Asia" as a whole from the point of social variables than from the point of economic variables.

From a social point of view Mercosur and SADC reveal a quite homogeneous structure (between the countries in the region not inside each particular country!) on a higher level in Mercosur and a very low level in SADC. While the life expectancy in the „Social Achiever-Cluster" is 72, it is in the „Poor African-Cluster", only 56 and in the „Very Poor Performer-Cluster" only 48.

With the social indicators no clear tendency towards convergence or divergence in and between developing regions can be given. There is a tendency towards converging social variables in Mercosur and SADC while AFTA clearly demonstrate diverging social variables. No support for a club convergence of countries of different regions like in Section 1. can be found with the exception of the „Ecological Blind-Cluster".

It is neither on the basis of theoretical considerations nor of empirical research possible to give a clear answer to the question of whether there is economic and social convergence or divergence in and between developing regions. This raises the concern as to whether the whole convergence/divergence debate is a relevant one. This question will now be addressed in Section V.

V. Outlook and Policy Recommendations

Economics is neither applied mathematics nor „caseology" but the constant search for empirically relevant insights into the mechanisms of markets. Thus (macro)economics is not an interplay of some abstract parameters but an interplay of the behaviour of many economic agents. Their behaviour depends - in parts - on the political and social context, so that an appropriate growth policy will differ according to that context. As it is not fitting to give geographical space „as such" an importance in economics, the same can be said of the stage of a development. Why should these two parameters (space and stage of development) determine the economic growth and thereby lead to convergence or divergence in and between developing regions? The traditional notion in the technical papers dealing with the convergence/divergence debate that a backward economy will accumulate human capital and later knowledge capital more rapidly than a technological advanced country, is a difficult assumption. Why should the technologically advanced country stop investing in human and knowledge capital? These questions indicate that it might be better not to continue focusing *only* on the statistical robustness of the convergence/divergence finding than on the economic interpretability.

Summing up, it became clear that it does not provide too many insights to compare aggregated geographical areas like „Africa“ or „Asia“ *en bloque*. Economic convergence may take place in the form of convergence clubs with members from all developing regions. This increases inter-regional homogeneity, which can be taken as indicative of a transition to multilateralism instead of an aggressive stabilisation of regional trading blocks. Therefore two policy recommendations can be drawn:

(1) The responsibility for a stable economic development in the member countries of the developing regions rests with each individual country; there is no such thing as blaming only external (e.g. geographical) influences.

(2) A „one fits all approach“ for economic growth and development does not exist; even inside a developing region the appropriate growth policy depends on the economic context.

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Annex: The Economic Variables of the Cluster Analysis

The variables of the cluster analysis were operationalised as follows:

I. determinants of the sales conditions:

1. *Per-capita income* in US-$ as a three-year average of the latest existing data sets of all 27 countries to avoid deviations, for example according to exchange rate fluctuations (in most cases 1993-1995, cf. *The World Bank* 1997, pp.214-215 and pp.222-223, *Weltbank* 1996, pp.214-215 and *Weltbank* 1995, pp.188-189) for Swaziland and Brunei only data for 1996 (cf. *United Nations Development Programme* 1997, pp.158-160) was available. Although per-capita income in US-$ tends to underestimate the economic power compared to purchasing power parity, it is more important for multinational companies which usually calculate in US-$.

2. *Annual growth in per-capita income*. Data for some of the AFTA-countries have been taken from the DRI/ McGraw-Hill Asian automotive industry forecast report 1996-2000 (*DRI/ McGraw-Hill* 1996a) and for Argentina and Brazil from the world car industry forecast 1996-2000 (cf. *DRI/ McGraw-Hill* 1996b). Because of a lack of data for the other AFTA- and MERCOSUR-countries, for Brunei, Viet Nam, Cambodia, Laos and Myanmar the average of the other AFTA-countries (6.1% annual growth rate) was taken and for the other MERCOSUR-countries the annual growth rate of Brazil (5.0%), which was recommended by country experts. For SADC-countries growth forecasts for South Africa, Namibia, Botswana have been taken from the *Centre for proactive marketing research* (1996) while for the other SADC-countries only an average growth forecast for sub-Saharan Africa 3.5% was available.

3. *Income distribution* shown by the latest available Gini-coefficients (cf., *The World Bank* 1997, pp.222-223 and *Deininger, Squire* 1996). For countries which are lacking data the average actual Gini-coefficient for the respective region was used (cf., *Deininger, Squire* 1996, p.548).

4. *Tariffs* (post-Uruguay applied rate) taken from the statistics on tariff concessions in the Uruguay Round (cf., *The World Bank* 1996), because these tariffs will be compulsory after 1999. Some data are missing and had to be estimated as average tariff rates, i.e. for Paraguay the average tariffs of Latin America; for Brunei, Cambodia, Lao, Viet Nam and Myanmar the average tariffs of East Asia and Pacific and for all SADC-countries except South Africa the average tariffs of sub-Saharan Africa.

II. determinants of the procurement conditions:

5. *Wages,* which are the last available for 1991 (cf., *International Labour Office* 1996). The wages were taken as an average of different industries (ISIC 2 categories 2-9) and had to be converted in US-$ with the help of *International Monetary Fund* (1997). The lack of wage data was supplemented for the SADC-countries by multiplying the quotient of wages and per capita income for Zimbabwe and Malawi (which are both poor countries) with the per capita income of the countries for which the data are not available. For Brunei this quotient of Singapore (as a city state) was multiplied with its per-capita income and for Viet Nam, Laos and Cambodia this quotient of Myanmar and Indonesia was multiplied by each of the three countries' per capita income.

6. *State of education* operationalised by the education index (cf. *UNDP* 1997, pp. 146-148), as measured by a combination of adult literacy (two-thirds weight) and combined primary, secondary and tertiary enrolment ratios (one-third weight).

7. *Infrastructure* measured by electricity consumption per capita in 1994 (cf. *ditto*, pp.196-197). The unavailable data for Botswana, Namibia, Lesotho, Swaziland and Cambodia were estimated by country experts.

III. determinants of the investment conditions:

8. *Investment risk* shown by the Institutional Investors Ranking 1995 (cf., *o.V.* 1996). Unavailable data for Laos and Cambodia were supplemented by the index for Myanmar and the unavailable data for Brunei were supplemented by the index of Malaysia.

These eight variables have not been weighted to avoid distortion. However, an empirical investigation of the effects of environmental changes for multinational enterprises (cf., *Proff, H.,* 1994) showed the outstanding importance of sales conditions for the assessment of the business environment followed by the procurement conditions. To correspond to the importance of these environmental conditions from the companies' perspective, four variables were chosen concerning the sales conditions, only three variables concerning the procurement conditions and just one variable concerning the investment climate.

Part II: International Finance and Open Economy Macroeconomics

Pricing to Market and Exchange Rate Pass-Through in a Macroeconomic Model of a Large Open Economy with Imperfect Competition

Thomas Büttner

I. Introduction

Since the early 1980s it has been observed that import and export prices tend to show weak reactions to exchange rate shocks. Empirical evidence[1] has shown that they often do not vary proportionally to the exchange rate change as might be expected if one relied on traditional trade models. For the phenomenon that prices vary too little in response to exchange rate changes, Paul R. Krugman established the expression "Pricing to market" in 1987. Pricing to market refers to the fact that firms, which face a change in their relative cost due to an exchange rate change, adjust their profit margins in order to keep prices constant rather than pass the cost shock on to the consumer. Exchange rate pass-through is the degree to which prices are affected by the exchange rate and it is therefore complementary to pricing to market.

A large number of theoretical and mostly partial equilibrium models have been developed in the last decade using imperfect competition to explain pricing to market.[2] The first models focused on different aspects including market structure, product homogeneity and substitutability, the dynamics of demand and supply, and reputation and pricing. Little attention has however been paid to the macroeconomic implications of pricing to market. Nevertheless, it seems obvious that phenomena affecting price reactions to exchange rate changes on a microeconomic level may have important implications on macroeconomic variables. The influence of an exchange rate change on the trade balance is especially susceptible to being dependent on microeconomic price setting, since the values of exports and imports depend on prices. Another deficit of partial equilibrium models is their limited focus

[1] See e.g. *Krugman* (1987), *Dornbusch* (1987), *Knetter* (1989), and *Knetter* (1993) among others.

[2] See e.g. *Krugman* (1987), *Dornbusch* (1987), *Froot/Klemperer* (1989), *Venables* (1990), *Menon* (1996).

on short run effects, since medium and long run adjustment of cost and demand which affect pricing to market behavior can not be explained. It is therefore interesting to examine pricing to market in a macroeconomic model. Among the few authors that have already analyzed the short-term and long-term implications of incomplete exchange rate pass-through in a macroeconomic model with imperfect competition is Huw D. Dixon (1994). Dixon concludes that in a small open economy, with a domestic and a foreign firm competing in the home market, incomplete exchange rate pass-through (and therefore pricing to market) only occurs in the very short run when wages are fixed. In the short run and in the long run, the induced adjustment of the domestic wage leads to further price reactions, which results in a complete exchange rate pass-through. Dixon therefore finds the traditional result of a proportional reaction of prices to exchange rate changes once wages have adjusted.

The macroeconomic model of Huw Dixon relies, like many macroeconomic models, on the assumption of a small country. The possibility that foreign variables may be affected by an appreciation or a depreciation of the domestic currency is disregarded. This assumption facilitates modeling, but restricts the applicability of these models to large economies like the USA. However, the case of a large economy will gain in importance, as economic areas with one single currency (e.g. the European Monetary Union) emerge.

In order to analyze the rarely examined implications of pricing to market and imperfect competition in a large country,[3] a model of a large open economy with imperfect competition will be constructed and the effects of an exogenous exchange rate change will be examined. Although, no explicit model for the foreign economy (which may be interpreted as the rest of the world) will be formulated, reactions of foreign variables are taken into account. It is therefore possible to compare the large country case with the small country case. There are three important results: (i) The effects of a devaluation are less important in a large economy than they are in a small economy; (ii) there are real long run effects of an exchange rate change; and (iii) exchange rate pass-through and pricing to market persist in the medium and in the long run. The last point is of special interest, since in macroeconomic models for small economies, pricing to market was only observed in the (very) short run (See Dixon (1994)). This paper shows that only in the case of a small economy (which can be integrated in the model as a limiting case) complete exchange rate pass-through can be observed in the long run. In the general case, long run exchange rate pass-through is incomplete and depends on the importance of the home economy.

[3] *Fender/Yip* (1994) examine the issue of imperfect competition in an open economy with a two country macroeconomic model.

Section 2 introduces the structure of the model which will be solved for its macroeconomic equilibrium in section 3. In section 4, the effects of a devaluation on the domestic economy are analyzed as functions of the reaction of foreign variables. Section 5 concludes the paper.

II. The Model

The model combines Huw Dixon's (1994) macroeconomic model of an open economy with imperfect competition with Cournot-Nash-type competition of domestic and foreign firms in goods markets.[4] Since the case of a large economy is built upon the structure of Dixon's original model, it may be considered as a generalization or expansion of that model.

We shall assume a home economy with a (representative) domestic market and a foreign economy with a foreign market. The markets are segmented or separated, so that there is no spatial arbitrage. The price in one market may therefore differ from that in the other, and the law of one price does not hold. As a consequence, domestic consumers can only buy in the home market and foreign consumers in the foreign market. There is one representative homogenous good which is sold in both markets and which is produced by domestic firms in the home country and by foreign firms in the foreign country. Production costs occur therefore in the home currency of each firm. Each firm may sell at home and abroad, so that domestic and foreign firms compete in each market. Firms are assumed to act as Cournot-Nash competitors. Since there is only one homogenous good, households can not differentiate between a locally produced good and a good produced abroad.

On the basis of these assumptions, households' behavior, the situation in each market, and the domestic trade balance shall now be derived. In the next section the model is solved for its general equilibrium. The effects of a devaluation are analyzed in section 4 taking reactions of relevant foreign variables as exogenously given. The case of a large economy is then compared with that of a small economy by assuming different values of these exogenous reactions.

1. Households

There is a number of H households with homothetic preferences. Each household supplies up to one unit of labor. Since we shall assume that prefer-

[4] The market structure is based on a partial equilibrium international Cournot-model by *Dornbusch* (1987).

ences are suitable for aggregation, it is possible to deal with one representative household which decides over the total labor supply (up to H units) and which derives utility from the consumption of the representative homogeneous good and from real money balances. The amount of labor L of the representative household reduces its utility. Household preferences take the form:

$$U = c^{-c}(1-c)^{c-1}C^{c}\left(\frac{M}{P}\right)^{1-c} - \theta \cdot L \quad \text{with} \quad 0 < c < 1 \tag{1}$$

U is the household utility, C real consumption of the homogeneous good, M nominal money balances, and P the price level in the economy which is also the price of the homogeneous good, since there is only one good. M/P are real money balances of the household, and c is the marginal propensity to consume as will be shown by maximization. The disutility of labor is represented by the term $\theta \cdot L$, where L is the amount of labor and θ its marginal (and average) disutility.

The household's income Y consists of wages wL and profits Π (2). Its initial nominal money balances are denoted M^0 and the household pays a lump sum tax T levied by the government. Its budget is allocated between nominal consumption PC of the homogeneous good and savings in the form of nominal money balances M. Income and budget constraint are therefore:

$$Y = wL + \Pi \tag{2}$$

$$PC + M \leq Y + M^0 - T = wL + \Pi + M^0 - T \tag{3}$$

Maximizing the utility function (1) over C, M and L with respect to the budget constraint (3) yields:

$$PC = c\left(Y + M^0 - T\right) \tag{4a}$$

$$M = (1-c)\left(Y + M^0 - T\right) \tag{4b}$$

$$\frac{w}{P} = \theta \tag{4c}$$

The parameter c can be identified as the marginal (and average) propensity to consume, since the household uses the proportion $0<c<1$ of its income for consumption of the good and saves $(1-c)$ in the form of nominal money balances. Equation (4c) describes the household's labor supply decision. If the

real wage exceeds θ, the household wishes to supply H units of labor; if it equals θ, it is indifferent between work and leisure; if it is less than θ, the household does not work. Under the assumption of a declining labor demand curve, which intersects the totally elastic labor supply curve at a level of labor below H, the equilibrium real wage equals θ and the actual level of employment is demand determined.

2. International Oligopoly in the Domestic Market

There is an exogenous number of n domestic and n^* foreign firms in the domestic market. The firms produce in their home country and act as Cournot-Nash competitors. The market structure corresponds therefore to the international Cournot Model developed by Rüdiger Dornbusch (1987).

The demand depends on total expenditure E in the domestic market which is determined by private (the household's) expenditure on consumption PC and government expenditure G which is assumed to be fixed in nominal terms.

(5a) $$E = PC + G = c\left(Y + M^0 - T\right) + G = PQ$$

Since total expenditure E must equal the product of price P and demand Q, demand in the domestic market can be determined as

(5b) $$Q = \frac{E}{P} \quad \text{or} \quad P = \frac{E}{Q}.$$

For given expenditure $E=PQ=const.$ (and therefore a given income Y), the demand Q is inversely related to the price P, and the price elasticity of demand η equals negative unity:

(6) $$\eta = \frac{\partial Q}{\partial P}\frac{P}{Q} = -1$$

In equilibrium, the price is determined by substituting total supply Q into the demand function (5), where total supply is the sum of the output of the n domestic and the n^* foreign firms in the market. The output of the domestic firm i is q_i and that of the foreign firm j is q_j^*. An asterisk indicates a variable relating to foreign firms.

(7a) $$Q = \sum_{i=1}^{n} q_i + \sum_{j=1}^{n^*} q_j^*$$

Each domestic firm i and each foreign firm j has an increasing returns technology with labor L_i (respectively L_j^*) as the only input. $\overline{L}$ and $\overline{L}^*$ denote fixed amounts of labor necessary for production:

(8a) $$q_i = L_i - \overline{L} \quad \text{and} \quad q_j^* = L_j^* - \overline{L}^*$$

Since it is assumed that firms produce in their home countries, each firm's labor cost arises in its home currency. Domestic firms pay wages at a nominal level w (in domestic currency) and foreign firms at the level of the foreign nominal wage w^* (in foreign currency) which is determined in the foreign labor market. With e denoting the nominal exchange rate (defined as units of domestic currency per unit of foreign currency), the foreign nominal wage in domestic currency is ew^*.

Solving (8a) for L_i (respectively L_j^*) and multiplying with nominal wage in domestic currency w (ew^*) yields the cost functions K_i (K_j^*) in domestic currency with constant marginal cost w (ew^*).

(8b) $$K_i = wL_i = wq_i + w\overline{L} \quad \text{and} \quad K_j^* = ew^* L_j^* = ew^* q_j^* + ew^* \overline{L}^*$$

Firms choose their output in order to maximize nominal profits. As Cournot-Nash competitors they know market demand (5) and assume that the other firms do not modify their output. It shall also be assumed that a single firm's profit does not have an impact on total income Y and therefore on expenditure E, which implies that firms treat E as given. This assumption is justified, if the domestic market is interpreted as a representative market which is one of many, so that firm's actions have no effect on aggregate variables.[5] A domestic firm's profit Π_i and a foreign firm's profit Π_j^* can be denoted as:

(9) $$\Pi_i = Pq_i - wq_i - w\overline{L} \quad \text{and} \quad \Pi_j^* = Pq_j^* - ew^* q_j^* - ew^* \overline{L}^*$$

[5] See *Dixon* (1994), p.54. See for the same problem in a different setting *Mankiw* (1988), p. 384, note 2.

We shall now consider the domestic firm i first. If profit is to be maximized, marginal revenue must equal marginal cost:

(10a) $$P + \frac{\partial P}{\partial Q} q_i = w$$

with $\frac{\partial P}{\partial q_i} = \frac{\partial P}{\partial Q}\frac{\partial Q}{\partial q_i} = \frac{\partial P}{\partial Q}$, since $\frac{\partial Q}{\partial q_i} = \frac{\partial}{\partial q_i}\left(\sum_{k=1}^{n} q_k + \sum_{l=1}^{n^*} q_l^*\right) = 1$.

Since the output of the other firms is assumed to be constant, total supply Q rises by one unit if firm i increases its output q_i by one unit.

Rewriting (10a) yields the typical relation for the Cournot-case:

(10b) $$P\left(1 + \frac{1}{\eta} \cdot \frac{q_i}{Q}\right) = w$$

with $\eta = \frac{\partial Q}{\partial P}\frac{P}{Q}$.

The expression in brackets is the inverse of the mark-up of price over marginal cost of firm i. It depends on the price elasticity of demand η and on the market share q_i/Q of the firm. Since the elasticity of demand is negative, the expression is smaller than unity and declines when market share increases and when demand becomes less elastic. This corresponds to an increase in the market power of the firm which can therefore gain a higher mark-up over marginal cost.

Equation (10b) also shows that under perfect competition (i.e. the individual firm's market share tends toward zero) the price equals marginal cost. If market share tends towards unity, (10b) reduces to the mark-up equation of a monopolist. As is well known, the cases of perfect competition and a monopoly can therefore be interpreted as limiting cases of the Cournot-oligopoly.

Substituting the price elasticity of demand (6) into (10b) yields:

(10c) $$P\left(1 - \frac{q_i}{Q}\right) = w$$

Solving for q_i/Q yields the market share of firm i as function of its profit margin ($1-w/P$):

(11a) $$\frac{q_i}{Q} = 1 - \frac{w}{P}$$

A foreign firm's market share is derived in the same way with the exception that its marginal cost in domestic currency is denoted as ew^*.

(11b) $$\frac{q_j^*}{Q} = 1 - \frac{ew^*}{P}$$

In the Cournot-equilibrium all firms maximize their profit for the given outputs of their competitors. Since all domestic firms face identical marginal costs, the market share and therefore individual output of these firms must be symmetric, which also applies to foreign firms:

(12) $$q = q_i \text{ for } i=1,2...n \quad \text{and} \quad q_j^* = q^* \text{ for } j=1,...n^*$$

Equation (7a) therefore simplifies to:

(7b) $$Q = nq + n^* q^*$$

Summing all individual market shares (11) to unity under the assumption of symmetry (12) yields after solving for P:

(13a) $$P = \frac{nw + n^* ew^*}{n + n^* - 1}$$

The equilibrium market price P is therefore a function of the number of domestic and foreign firms in the market, of domestic and foreign nominal wage, and of the nominal exchange rate.[6] For given domestic and foreign wages and for a given number of firms, equilibrium price reacts less than proportionally to an exchange rate change since the exchange rate only affects foreign firms' marginal cost.

[6] Equations (11), (12) and (13) imply that for non-negative output of foreign and domestic firms the relative wage must satisfy the condition: $(n-1)/n \leq w/(ew^*) \leq n^*/(n^*-1)$. If the relative wage drops below the inferior border, foreign firm would have to produce negative output to maximize profit, since their marginal cost would exceed the market price. The inferior border is therefore the point of exit for foreign firms. The upper border corresponds to the point of exit for domestic firms.

Rewriting (13a) yields:

$$P = \frac{n+n^*}{n+n^*-1}\bar{w} \quad \text{with} \quad \bar{w} = \frac{n}{n+n^*}w + \frac{n^*}{n+n^*}ew^* \tag{13b}$$

Equation (13b) shows the typical mark-up over marginal cost for a Cournot-oligopoly with $n+n^*$ firms and a unit elastic demand. Marginal cost is represented by the average wage $\bar{w}$ in domestic currency of domestic and foreign firms. For initially equal domestic and foreign marginal costs ($w=ew^*$), equation (13a) directly shows the typical Cournot-result.

3. International Oligopoly in the Foreign Market

The treatment of the foreign market is analogous to that of the domestic market. Variables referring to the foreign market are denoted by an apostrophe. An exogenous number of n' domestic and $n^{*\prime}$ foreign firms is assumed with individual output q' and $q^{*\prime}$ respectively. Q^* is total output, P^* equilibrium price in foreign currency, and E^* (given) expenditure in foreign currency on the consumption of the homogenous good in the foreign market. Market demand can therefore be written as

$$Q^* = \frac{E^*}{P^*} \quad \text{or} \quad P^* = \frac{E^*}{Q^*} \quad \text{since} \quad P^*Q^* = E^* = const. \tag{14}$$

Price elasticity of demand again equals negative unity and total supply Q^* is the sum over the individual output of all domestic and foreign firms in the market.

Since markets are segmented and marginal costs are constant, firms, which may be present in both markets, maximize their profit in each market independently of their behavior in the other market. The profit of a domestic firm in the foreign market can be denoted in domestic currency as

$$\Pi_i' = eP^*q_i' - wq_i' - w\bar{L}\,. \tag{15}$$

Maximizing and rewriting yields for the foreign market:

$$P^*\left(1 - \frac{q_i'}{Q^*}\right) = \frac{w}{e}, \tag{16}$$

(17a) $$\frac{q_i'}{Q^*} = 1 - \frac{w}{eP^*}$$

for a domestic firm in the foreign market, and

(17b) $$\frac{q_j^{*\prime}}{Q^*} = 1 - \frac{w^*}{P^*}$$

for a foreign firm in the foreign market.

Individual market share is again a function of individual profit margins. Equilibrium price is derived using symmetry for all domestic and all foreign firms:

(18a) $$P^* = \frac{n'\frac{w}{e} + n^{*\prime} w^*}{n' + n^{*\prime} - 1}$$

or

(18b) $$P^* = \frac{n' + n^{*\prime}}{n' + n^{*\prime} - 1} \bar{w}^*$$

with $\bar{w}^* = \frac{n'}{n' + n^{*\prime}} \frac{w}{e} + \frac{n^{*\prime}}{n' + n^{*\prime}} w^*$

Again, the price is a function of the number of foreign and domestic firms, the foreign and the domestic nominal wage, and the exchange rate.

4. Trade Balance

Since there is only one homogeneous good and since households can not differentiate between domestic and foreign goods, the levels of imports and exports are not based on consumption decisions for domestic or foreign goods. Imports are determined by the market share of foreign firms in the domestic market and exports by that of domestic firms in the foreign market. The nominal level of imports *IM* can be denoted as the product of total expenditure *E* and foreign market share in the domestic market ($n^* q^*/Q$). Foreign market share can therefore be interpreted as endogenous average/marginal propensity to import $\overline{im}$, since this proportion of expenditure is used for the consumption of foreign goods. In the same way, nominal exports *EX* are domestic market

share in the foreign market multiplied with foreign expenditure in domestic currency eE^*. The domestic market share in the foreign market ($n'q'/Q^*$) can be interpreted as endogenous propensity to export $\overline{ex}$ or as the endogenous propensity of foreign households to consume domestic goods.

(19) $$EX = n'q'eP^* = \overline{ex} \cdot eE^* \quad \text{and} \quad IM = n^* q^* P = \overline{im} \cdot E$$

(20) $$\text{with} \quad \overline{ex} = \frac{n'q'}{Q} = n'\left(1 - \frac{w}{eP^*}\right) \quad \text{and} \quad \overline{im} = \frac{n^* q^*}{Q} = n^*\left(1 - \frac{ew^*}{P}\right)$$

The propensity to import and to export are determined by the equations for the market share (11b) and (17a) multiplied by the number of firms under the assumption of symmetry.

The domestic trade balance is denoted using equations (19):

(21) $$TB = EX - IM = \overline{ex} \cdot eE^* - \overline{im} \cdot E$$

It should be noted that imports are invoiced in domestic currency, while exports are invoiced in foreign currency and converted into domestic currency using the exchange rate. This is remarkable because this form of the trade balance implies that a devaluation has an immediate positive effect, even before quantities and prices (expenditure and market shares respectively) adjust themselves. The trade balance therefore does not show the initial negative reaction after a devaluation known as the J-curve effect, which is compensated by adjustment of quantities and prices if the Marshall-Lerner condition holds.

III. Macroeconomic Equilibrium for a Large Open Economy

The macroeconomic general equilibrium for a given exchange rate e and a given government policy (G, T, M^0) is solved by deriving the equilibrium condition of the labor market and the equilibrium national income.

1. Equilibrium on the Labor Market

In the equilibrium on the labor market, the real wage w/P adjusts itself to the marginal disutility of work θ as discussed in section II Since the price index is also the price of the homogeneous good, the equilibrium price (13a) can be substituted into the labor market equilibrium condition (3c), which yields after solving for w:

(22) $$w = \frac{n^{*}\theta}{n(1-\theta)+n^{*}-1} ew^{*}$$

The equilibrium nominal wage w is therefore a function of exogenous parameters and is proportional to the foreign wage in domestic currency ew^{*}. The equilibrium relative wage w/ew^{*} is fixed by exogenous parameters.[7]

2. Equilibrium National Income

Domestic income can be denoted as the sum of domestic private and public consumption (domestic expenditure), and the exports reduced by the imports (the trade balance):

(23) $$Y = PC + G + EX - IM = E + TB$$

Substituting equations (4a) and (21) into (23) and solving for Y yields:

(24) $$Y = \frac{1-\overline{im}}{1-c\left(1-\overline{im}\right)}\left(c\left(M^{0}-T\right)+G\right)+\frac{\overline{ex}\cdot eE^{*}}{1-c\left(1-\overline{im}\right)}$$

National income is therefore a function of the propensity to consume c, government policy parameters (G, T, M^{0}), foreign expenditure E^{*}, the exchange rate e, and the market shares $\overline{ex}$ and $\overline{im}$. Since the latter are functions of wages, exchange rate, and equilibrium prices and since the equilibrium domestic wage (22) and therefore also equilibrium prices ((13a) and (18a)) are determined by exogenous parameters (n, n^{*}, e, w^{*}, n', $n^{*}{}'$, and θ), equilibrium national income is given by the purely exogenous parameters G, T, M^{0}, c, θ, n, n^{*}, n', $n^{*}{}'$, E^{*}, w^{*} and e.

In the long run, balanced trade is imposed ($TB=0$) and equation (23) simplifies to:

(25) $$Y = E = \frac{1}{1-c}\left(c\left(M^{0}-T\right)+G\right)$$

[7] The condition of non-negative output (note 6) limits the range of possible values of θ to: $(n-1)/n \leq \theta \leq 1$. If this condition does not hold, the relative wage does not satisfy the condition of note 6 and negative outputs occur.

Substituting (25) into (21) under the assumption of balanced trade ($TB=0$) and a balanced public deficit ($G=T$) yields:

$$M^0 = \frac{1-c}{c}\frac{\overline{ex}}{\overline{im}}eE^* - \frac{1-c}{c}G \tag{26}$$

Under the condition of balanced trade and a balanced public deficit, nominal money supply M^0 is therefore fixed in the long run by purely exogenous parameters.

IV. Effects of a Devaluation in the Large Open Economy

In this section the effects of a devaluation on the economy shall be examined. Since these effects depend on the time horizon considered, three Marshallian time "periods" will be distinguished: the short run, in which wages are fixed; the medium run, in which prices and wages adjust to equilibrium; and the long run, in which trade is balanced.

The general case of a large economy is considered by taking into account that variables of the foreign economy may vary as a reaction to the exchange rate change. I.e. the domestic economy is large enough to have at least some influence on the foreign economy. Although an explicit macroeconomic model of the foreign economy will not be built, some simple assumptions allow one to compare the case of a small economy (where foreign parameters do not react) to the case of a large economy (in which they do).

In order to analyze the effects of a devaluation in a large economy, the impact on domestic variables is derived, starting from a situation of balanced trade, as functions of the exogenously treated reactions of foreign variables (foreign wages and foreign expenditure). The results will then be discussed as they evolve endogenously over time, i.e. in the different time horizons.

1. Derivation of the Effects in General Form

As the effects of a devaluation on market share, the trade balance, and national income will be derived as functions of the reactions of domestic and foreign prices and wages, the elasticity of the latter is defined as:

$$\varphi = \frac{\partial P}{\partial e}\frac{e}{P}, \quad \omega = \frac{\partial w}{\partial e}\frac{e}{w}, \quad \omega^* = \frac{\partial w^*}{\partial e}\frac{e}{w^*}, \quad \varphi^* = \frac{\partial P^*}{\partial e}\frac{e}{P^*}. \tag{27}$$

The elasticity of the domestic price with respect to the exchange rate indicates the degree to which prices are affected by exchange rate changes and it corresponds therefore to the degree of exchange rate pass-through. An elasticity φ of unity indicates that there is 100% exchange rate pass-through, i.e. that prices vary proportionally to the exchange rate. The value $(1-\varphi)$ is the corresponding degree of pricing to market, i.e. the relative price stickiness or the degree to which exchange rate changes are absorbed by profit margins due to strategic interaction of oligopolistic firms. The elasticity of the domestic wage is denoted ω. It indicates to which degree the domestic wage reacts to the exchange rate change in the time horizon considered. For the foreign economy the degree of exchange rate pass-through of the foreign price (in foreign currency) is defined as φ^* and the reaction of the foreign wage as ω^*. The degree of pricing to market in the foreign market is $(1-\varphi^*)$.

These definitions help to analyze the reactions of market shares. Since these correspond to the propensities to import $\overline{im}$ and to export $\overline{ex}$, the elasticity of foreign market share in the domestic market μ and that of domestic market share in the foreign market μ^* can be derived using equations (20):

(28a) $$\mu = \frac{\partial \overline{im}}{\partial e}\frac{e}{\overline{im}} = \frac{\varphi - \omega^* - 1}{\frac{P}{ew^*} - 1}$$

(28b) $$\mu^* = \frac{\partial \overline{ex}}{\partial e}\frac{e}{\overline{ex}} = \frac{1 + \varphi^* - \omega}{\frac{eP^*}{w} - 1}$$

Since the assumption of imperfect competition implies that prices exceed marginal cost, the denominators of the two equations are positive and the sign is determined by the numerators. The elasticities of market shares depend therefore on the elasticities of prices and wages and as a result also on the degree of pricing to market.

Deriving the equation of the trade balance (21) with respect to the exchange rate e under the assumption of initially balanced trade yields:

(29a) $$\frac{\partial TB}{\partial e} = \frac{\overline{im}E}{e}\left(1 + \mu^* + \varepsilon^* - \mu - \varepsilon\right) \text{ with } \varepsilon = \frac{\partial E}{\partial e}\frac{e}{E} \text{ and } \varepsilon^* = \frac{\partial E^*}{\partial e}\frac{e}{E^*}$$

The elasticity of domestic expenditure is denoted ε and that of foreign expenditure ε^*. Since expenditure is given as the product of price and demand, the elasticity of domestic and foreign expenditure includes variations in demand as well as in price. The reaction of demand can therefore be

determined if the reaction of corresponding expenditure and the exchange rate pass-through behavior are given.

The effect of a devaluation depends on the elasticities of domestic and foreign market share, and domestic and foreign expenditure. A trade surplus causes an increase in domestic income and therefore in domestic expenditure. The rise in expenditure induces counteractive effects, since it increases imports (for a given domestic propensity to import), and has therefore a negative effect on the trade balance. The positive elasticity ε therefore reduces the reaction of the trade balance. Since the foreign trade balance must show a deficit if the domestic trade balance is positive, foreign national income decreases and thus foreign expenditure E^*. As a result, domestic exports decrease due to the reduction of nominal demand. Therefore the negative ε^* also reduces the reaction of the domestic trade balance. Equation (29a) shows that the effects of a devaluation on the domestic trade balance must be weaker in the case of a large domestic economy (in which reactions of foreign variables ($\varepsilon^*<0$) are taken into account) than in the case of a small economy (in which such reactions are disregarded ($\varepsilon^*=0$)).

Differentiating equation (23) with respect to the exchange rate yields the effect on domestic national income:

$$\frac{\partial Y}{\partial e} = \frac{\overline{im}E}{e}\left(1+\mu^* + \varepsilon^* - \mu + \frac{1-\overline{im}}{\overline{im}}\varepsilon\right) \tag{30a}$$

Since domestic expenditure E is via equation (5a) a function of domestic income, the derivative of income can be eliminated in (30a), thus yielding the elasticity of domestic income ε as an endogenous variable.

$$\varepsilon = \frac{c\cdot\overline{im}}{1-c\left(1-\overline{im}\right)}\left(1+\mu^* + \varepsilon^* - \mu\right) \tag{31}$$

The effect on domestic expenditure is therefore dependent on the elasticity of market shares and on the elasticity of foreign expenditure. It is less important than in the case of a small economy, since its extent is reduced by the reaction of foreign expenditure ($\varepsilon^*<0$).

Substituting (31) into (29a) and (30a) yields:

$$\frac{\partial TB}{\partial e} = \frac{\overline{im}E}{e}\frac{1-c}{1-c\left(1-\overline{im}\right)}\left(1+\mu^* + \varepsilon^* - \mu\right) \tag{29b}$$

$$\frac{\partial Y}{\partial e} = \frac{\overline{im}E}{e}\frac{1}{1-c\left(1-\overline{im}\right)}\left(1+\mu^* + \varepsilon^* - \mu\right) = \frac{1}{1-c}\frac{\partial TB}{\partial e} \tag{30b}$$

The effects of a devaluation on the trade balance and on national income depend therefore on the parameters of the initial situation ($\overline{im}$, E, c and e), on the elasticities of market shares (μ and μ^*), and on the elasticity of foreign expenditure ε^*. The elasticity of foreign and domestic market share (28) are determined by the elasticity of foreign and domestic prices and wages and therefore by pricing to market behavior or exchange rate pass-through. Only the elasticity of foreign expenditure ε^* and the elasticity of the foreign wage ω^* are exogenous and depend on the influence of the domestic economy (or of the domestic exchange rate) on the foreign economy.

2. Short Run Effects with Fixed Wages

Domestic and foreign wages are considered to be fixed in the short run. The exchange rate elasticity of the domestic and the foreign wage is therefore:

$$\omega = \frac{\partial w}{\partial e}\frac{e}{w} = 0\,, \qquad \omega^* = \frac{\partial w^*}{\partial e}\frac{e}{w^*} = 0 \tag{32}$$

For given wages, the degree of exchange rate pass-through φ can be derived from the equilibrium price (13):

$$\varphi = \frac{\partial P}{\partial e}\frac{e}{P} = \frac{n^* ew^*}{nw + n^* ew^*} < 1 \tag{33a}$$

$$\text{or} \quad \varphi = \frac{n^*}{n+n^*}\frac{ew^*}{\overline{w}} < 1 \quad \text{with} \quad \overline{w} = \frac{n}{n+n^*}w + \frac{n^*}{n+n^*}ew^*\,. \tag{33b}$$

Since in equation (33a) the numerator exceeds the denominator, the (positive) elasticity is less than unity. The domestic price reacts less than proportionally to an exchange rate change, which implies that the exchange rate pass-through is incomplete. There is a degree (1-φ) of pricing to market, since the oligopolistic firms interact and adjust their mark-up. Equation (33b) shows that the exchange rate pass-through rises (the pricing to market behavior declines) with the relative number of foreign firms and with their relative wage in domestic currency compared to the average wage.

If the number of foreign firms tends towards infinity ($n^* \to \infty$), the exchange rate pass- through φ tends towards unity. This corresponds to the limiting case of a small country with perfect competition in which the price of the good is set in the world market and varies proportionally to the exchange rate. In the other extreme, if the relative number of foreign firms in the market is small, pricing to market is important, since the few foreign firms adjust their prices

to a large degree to the prices of domestic firms. If there are no foreign firms in the market, domestic price is not affected by an exchange rate change.

For the foreign market, the elasticity φ^* of the foreign price in foreign currency is derived from equation (18). It indicates the exchange rate pass-through in the foreign market:

$$\varphi^* = \frac{\partial P^*}{\partial e}\frac{e}{P^*} = -\frac{n'\frac{w}{e}}{n'\frac{w}{e} + n^{*\prime} w^*} = -\frac{n'}{n'+n^{*\prime}}\frac{w}{\overline{ew}^*} > -1 \tag{34}$$

$$\text{with} \quad \overline{w}^* = \frac{n'}{n'+n^{*\prime}}\frac{w}{e} + \frac{n^{*\prime}}{n'+n^{*\prime}} w^*$$

These equations for the exchange rate elasticities correspond to the equations in Dornbusch (1987, p. 98) for a constant elasticity of demand and to the exchange rate elasticity in Dixon (1994, p. 58) in the case of a duopoly ($n=n^*=1$). When wages are fixed in the short run, pricing to market and exchange rate pass-through is determined by the prevailing market structure, since an exchange rate change only affects part of the firms.

Substituting equations (32) to (34) into the elasticity of market share (28) yields:

$$\mu = \frac{\varphi - 1}{\frac{P}{\overline{ew}^*} - 1} < 0, \quad \text{since} \quad 0<\varphi<1 \quad \text{and} \quad \omega^*=0. \tag{35a}$$

$$\mu^* = \frac{1+\varphi^*}{\frac{eP^*}{w} - 1} > 0, \quad \text{since} \quad -1<\varphi^*<0 \quad \text{and} \quad \omega=0. \tag{35b}$$

As a consequence of the devaluation, domestic firms become more competitive in both markets, since their relative labor costs decrease. Their market share increases in both markets and that of the foreign firms declines, which increases the propensity to export and reduces the propensity to import. The extent of this effect rises with the degree of pricing to market (i.e. when φ and φ^* are close to zero).

The increase in domestic market share has a positive effect on the domestic trade balance, since the volume of exports increases and that of imports declines. The increase in the competitiveness of domestic firms raises profits and leads to an increase in domestic output. Domestic income increases, since profits rise and since an increase in output implies higher employment and therefore higher labor income. However, the positive effect on income also

leads to higher domestic expenditure and therefore higher imports, which reduces the initial trade surplus. By the same mechanism, a domestic trade surplus, which corresponds to a foreign trade deficit, reduces foreign income and therefore the volume of exports. This further reduces the initial effect on the national trade balance and income.

In equations (29b) and (30b), the overall effect is determined by the term $(1+\mu^*+\varepsilon^*-\mu)$ and depends on the elasticity of foreign expenditure ε^*. To discuss the possible range of values of ε^*, we shall consider the small country case first, in which ε^* equals zero. A change in the domestic exchange rate has no impact on the foreign economy and the effects on the domestic trade balance and on income is determined by the term $(1+\mu^*-\mu)$ which is positive and exceeds unity.

As a next step, the situations of the home and the foreign economy shall be reversed. The foreign economy is considered to be the small country and the home economy to be so large that an exchange rate change has no effect on domestic variables. A devaluation of the domestic currency which corresponds to an appreciation of the foreign currency therefore only affects foreign variables. Since a similar structure of home and domestic economy is considered, the result is symmetric to that in the case of the small domestic economy. The elasticity of domestic expenditure ε must now equal zero, which implies that the elasticity of foreign expenditure ε^* equals $(-1-\mu^*+\mu)$, since equation (31) holds.

In the general (or intermediate) case of a large economy, domestic variables show reactions to an exchange rate shock and have at least some influence on foreign variables. The values of the elasticity of domestic and foreign expenditure must lie between their values in the limiting cases of the small domestic economy and the small foreign economy, since the elasticity of domestic expenditure declines with that of foreign expenditure (31). The elasticity in either case reaches its maximum value in the case of the small domestic economy and its minimum value in the case if the small foreign economy. This implies that ε^* ranges from $(-1-\mu^*+\mu)$ to zero in the general case. Thus, the term $(1+\mu^*+\varepsilon^*-\mu)$ in equations (29b) and (30b) exceeds zero and therefore the effects on the trade balance and on national income are positive but less important than in the small country case. A devaluation has in the short run therefore a clear expansionary effect on the domestic economy.

3. Medium Run Effects with Equilibrium on the Labor Market

The labor market is in the medium run in equilibrium, which implies that the real wage adjusts itself to the marginal disutility of labor θ. Since the domestic price has risen in the short run, nominal wages increase to re-establish the equilibrium real wage. Equation (22) shows that in equilibrium

the nominal wage w is proportional to the foreign wage in domestic currency ew^*. The elasticity of the nominal wage is derived from equation (22), treating the foreign wage as a function of the exchange rate, since in the case of a large economy foreign wages may adjust:

$$\omega = \frac{\partial w}{\partial e}\frac{e}{w} = 1 + \frac{\partial w^*}{\partial e}\frac{e}{w^*} = 1 + \omega^* \tag{36}$$

If the possibility of a reaction of the foreign wage ($\omega^*=0$) is ignored, as in the small country case, a devaluation of the domestic currency ($\Delta e>0$) causes a proportional increase in the domestic wage, since the short run increase in price induces a rise in the domestic wage. The marginal costs of domestic firms increases which causes another rise in price etc., until price and wage have both developed proportionally to the exchange rate. However, in the large country case, the adjustment of the foreign wage also has to be taken into account. Since a devaluation of the domestic currency corresponds to an appreciation of the foreign currency, it also causes a decrease in the foreign wage (analogous to the increase in domestic wage), which implies that the elasticity of the foreign wage ω^* is negative. Equation (36) shows that the domestic wage has to adjust itself less than proportionally to the exchange rate change ($0<\omega<1$) in the presence of a simultaneous reaction of the foreign wage ($-1<\omega^*<0$). The decrease in the foreign wage reduces the marginal costs of foreign firms and therefore the extent of the increase in domestic price.

The equations for the extent of exchange rate pass-through (34) and (35) do not hold in the medium run, since wages are no longer fixed. Because in the equilibrium on the labor market the real wage equals the marginal disutility of labor (5), the domestic price P varies proportionally to the domestic wage w, which yields for the medium term exchange rate pass through:

$$\varphi = \omega = 1 + \omega^* \tag{37}$$

The exchange rate pass-through elasticity φ depends directly on the elasticity of the nominal wage ω which is itself linked to the elasticity of the foreign wage ω^*. Medium run exchange rate pass-through is performed via the labor market as pointed out by Dixon (1994, p. 58). However, unlike in a small country setting, the exchange rate pass-through remains incomplete, since the nominal wage reacts less than proportionally to the exchange rate when foreign wages adjust themselves.

In the foreign market, the degree of medium run exchange rate pass-through is derived from the foreign equilibrium price (18a), taking wage adjustments into consideration and using equation (36) as:

(38) $$\varphi^* = \omega^*$$

As in the domestic market, medium run exchange rate pass-through in the foreign market is entirely determined by the elasticity of the foreign wage ω^*.

The adjustment of domestic and foreign wages re-establishes the relative wage of equation (22). The initial positive effect on the domestic firms' competitiveness disappears, since foreign and domestic firms face the same relative (marginal) cost as before the devaluation. Market shares return to its initial value. Substituting (37) and (38) into equations (35) yields therefore for the medium run elasticities of market shares:

(39) $$\mu = 0 \quad \text{and} \quad \mu^* = 0$$

This reduces the short run positive effect on the trade balance and on national income, since the return of market share to its initial value implies an increase in imports and a decrease in exports. Equations (29b), (30b) and (31) simplify to:

(40) $$\frac{\partial TB}{\partial e} = \frac{\overline{im}E}{e}\frac{1-c}{1-c\left(1-\overline{im}\right)}\left(1+\varepsilon^*\right)$$

(41) $$\frac{\partial Y}{\partial e} = \frac{\overline{im}E}{e}\frac{1}{1-c\left(1-\overline{im}\right)}\left(1+\varepsilon^*\right) = \frac{1}{1-c}\frac{\partial TB}{\partial e}$$

(42) $$\varepsilon = \frac{c\cdot\overline{im}}{1-c\left(1-\overline{im}\right)}\left(1+\varepsilon^*\right)$$

As in the short run, the overall medium run effect on the domestic economy depends on the elasticity of foreign expenditure ε^*. Therefore, the ranges of plausible values of the exogenous parameters of the foreign economy (the elasticity of foreign expenditure ε^* and the elasticity of the foreign wage ω^*) in the medium run need to be analyzed.

Again, we shall consider the small country case first ($\omega=0$, $\varepsilon^*=0$) to derive working hypotheses about ε^* and ω^* for the medium run. In this case, the elasticity of domestic expenditure is positive but less than unity, since in equation (42) the (positive) denominator $(1-c+c\cdot\overline{im})$ exceeds the (positive) numerator $(c\cdot\overline{im})$. Equation (36) determines the elasticity of the domestic wage as a function of the reaction of the foreign wage. The results for a small (home) country are therefore:

(43a) $$0 < \varepsilon < 1 \quad \omega = 1 \quad \varepsilon^* = 0 \quad \omega^* = 0$$

Now the hypothetical case is considered in which the foreign economy is the small country and the home economy is so large that an exchange rate change has no effect on domestic variables. Under this assumption, the results for a small foreign country can be derived as symmetrical to (43a), where negative signs stem from the fact that the devaluation of the foreign currency corresponds to an appreciation of the domestic currency:

(43b) $$\varepsilon = 0 \quad \omega = 0 \quad -1 < \varepsilon^* < 0 \quad \omega^* = -1$$

In the intermediate situation of a large domestic economy, conditions (43a) and (43b) serve again as limiting cases, since ε decreases with ε^* (43) and since ω decreases with ω^* (36). The values ε, ε^*, ω, and ω^* must therefore lie between the values in the extreme examples, which yields for the general case of a large domestic economy:

(43c) $$0 \leq \varepsilon < 1 \quad 0 \leq \omega \leq 1 \quad -1 < \varepsilon^* \leq 0 \quad -1 \leq \omega^* \leq 0$$

These conclusions serve for a further analysis of the effects on the domestic trade balance and on domestic income. The overall effect on the trade balance remains positive, since the elasticity of foreign expenditure exceeds minus unity (40). A devaluation's direct positive effect on the trade balance, which is due to an appreciation of exports, overcompensates the negative effect from the increase in domestic expenditure and the decrease in foreign expenditure. The effect on domestic income is also positive. Again, equations (40) and (41) show that the effects in the large country case ($\varepsilon^*<0$) are less important than in the small country case ($\varepsilon^*=0$). However, the medium run effects on trade balance and income are less important than the short run effects, since the impact on market shares disappears after wage adjustments.

Another important issue is the effect on domestic demand (5b) respectively the output for the domestic market which is determined by reactions of price and domestic expenditure.

In the small country case, prices are fixed to the domestic wage and rise proportionally to the exchange rate in the medium run, since the domestic wage increases with the exchange rate (ω=1). On the other hand, domestic expenditure rises less than proportionally to the exchange rate (ε<1). The rise in price exceeds therefore the increase in expenditure, which induces a decrease in domestic demand and therefore leads to a real contraction in the domestic market in the medium run.

However, in the large country case, the elasticity of domestic expenditure is linked by (41) to ε^*, and the elasticity of the domestic price is linked by (37) to ω^*. Whether price or domestic expenditure rise to a higher degree can now no longer be determined, since they depend on exogenous foreign variables ω^* and ε^*. Therefore, and different from the small country case, the impact on demand is not clear and depends on the (relative) importance of the domestic economy for the foreign economy and vice versa.

4. Long Run Effects with Balanced Trade

In the long run trade balances through adjustment of the domestic money supply. The short and medium run trade surpluses cause an increase in income and therefore in household savings. End of period money balances M rise, which increases the household's initial money balances M^0 of the next period. This specie flow mechanism continues until the increase in domestic money supply (and therefore in income) leads to balanced trade.

Equation (26) gives the long run equilibrium initial money supply under the condition of a balanced public budget. For a given foreign expenditure E^* domestic money supply rises more than proportionally to the devaluation, if nominal government expenditure remains constant. However, the effect on the foreign economy (a decline in foreign expenditure E^*) reduces the increase in money supply necessary to re-establish long run equilibrium. The monetary expansion induced by a devaluation is therefore less important in the large country case than in the small country case.

Substituting (26) into (25) yields:

$$Y = \frac{\overline{ex}}{im} eE^* \tag{44}$$

The long run equilibrium income only depends on the market structure in the domestic and the foreign market, the nominal exchange rate, and foreign expenditure which is directly linked to foreign national income. In the small country case, long run income rises proportionally to the devaluation, since foreign expenditure is supposed to be constant, whereas in the large country case income increases less than proportionally, since foreign expenditure declines.

In the small country case, all real effects disappear in the long run, because domestic income, expenditure (which equals income if trade is balanced), wage, and price all rise proportionally to the devaluation. The demand and therefore the output in the domestic market both return to their initial values so that there are only nominal effects.

On the other hand, long run effects are not as clear in the large country case. The long run elasticity of national income and therefore that of national expenditure can be derived from equation (44):

$$\varepsilon = \frac{\partial Y}{\partial e}\frac{e}{Y} = 1 + \varepsilon^{*} \tag{45}$$

Whether expenditure (45) and price (37) rise to the same or to a different degree depends on the long run elasticity of foreign expenditure ε^{*} and foreign wage ω^{*}. If the absolute value of ω^{*} exceeds that of ε^{*}, the domestic elasticity of expenditure ε exceeds that of wage ω, and there is a long run real positive effect on the economy in terms of demand. If ε^{*} equals ω^{*}, there is no real long run effect, and if the absolute value of ε^{*} exceeds that of ω^{*}, the real effect is negative in the long run.

In both cases there is an additional positive effect on domestic private consumption if government expenditure and taxes are fixed in nominal terms. The share of public consumption in total demand declines if the price rises, and the share of private consumption increases, since the amount of taxes becomes less important in real terms. This implies that if expenditure and price develop in line, private consumption increases to a higher degree.

However, if long run nominal government expenditure G and taxes T are fixed in real terms and therefore adjust to the new long run equilibrium, the expansionary monetary effect becomes less important, although the long run income is not affected. Total domestic expenditure E, government expenditure G, and private consumption expenditure PC develop in line, which implies that private consumption C varies proportionally to long run demand Q respectively to output in the domestic market.

V. Conclusion

In this paper, the effects of a devaluation on a large open economy with imperfect competition have been analyzed. In the short-term where nominal wages are fixed, pricing to market is due to the strategic interactions between oligopolistic firms and determines the evolution of market share. Domestic market share in both markets rises, since domestic firms become more competitive, which has a positive effect on the trade balance. Domestic income rises as well, since profits and labor income increase. In the medium term, wages adjust themselves, and firms face the same relative costs as before the devaluation. Market share returns to its initial value and pricing to market in the sense of a strategic adjustment of profit margins disappears. However, in the large economy case foreign wages also react, which implies that incomplete exchange rate pass-through persists in the sense of a less than

proportional variation of prices to the exchange rate change. Since the impact on market share disappears, the medium-term effect is smaller than the initial positive effect. In the long run, trade balances through the adjustment of the domestic money supply. Unlike in the small economy, real effects may persist in the large economy, since foreign income has also been affected by the exchange rate change.

The results for the large country case differ from those found by Dixon (1994) for a small economy which can be interpreted as a special case. Effects are generally weaker in a large economy, real effects may persist in the long term, and incomplete exchange rate pass-through is observed in the short, in the medium, and in the long run. This paper offers therefore an explanation for the persistence of incomplete exchange rate pass-through in a macroeconomic large country setting with imperfect competition and shows that pricing to market behavior influences the reactions of the trade balance and income.

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Determinants of the Real Exchange Rate, Capital Stock, and Net Foreign Debt in a Medium-Sized Economy Dependent on Raw Material Imports

Christoph Fischer

I. Introduction

Because of the predominance of purchasing power parity (PPP) suggesting a constant or at least a stationary real exchange rate, the long-run determination of the real exchange rate has been widely considered a non-issue for a long time. However, the hypothesis of the real exchange rate following PPP runs counter to conventional economic wisdom. On the one hand, each country produces and consumes a different basket of tradable commodities. Furthermore, a national commodity basket also contains non-tradable goods. On the other hand, economies are subject to real shocks, e. g. technological shocks, changing preferences and exogenous price shocks. Since both of these characteristics undoubtedly apply to industrialized countries, PPP is not a sensible hypothesis for the real exchange rate.[1] Instead, the real exchange rate must be considered a relative price of two goods, i. e. two commodity baskets. This view of the real exchange rate raises the question of how it is determined.

Up to now, several ideas and models of real exchange rate determination have been developed, e. g. the famous hypothesis of Balassa (1964) and Samuelson (1964) exploiting the existence of non-tradables, or more recently the models of Neary (1988), Wyplosz (1991), and Faruqee (1995). In a series of papers published in the nineties, Stein developed a framework for analyzing the long-run time path of real exchange rates, which he called the NATREX model.[2] The equilibrium concept for the real exchange rate in these models refers to

$$S - I = CA \,, \tag{1}$$

[1] *Engel* (1996), *O'Connell* (1998), and *Fischer / Porath* (1998) cast serious doubts on recent empirical evidence in favor of PPP.

[2] See e. g. *Stein* (1990, 1995, and 1996), *Allen* (1995), *Lim / Stein* (1995), *Stein / Sauernheimer* (1996), and *Stein / Paladino* (1998).

where S are savings, I is investment, and CA is the current account surplus. Equation (1) describes the commodity market equilibrium of an open economy (internal equilibrium) as well as the equivalence of net capital exports, (S - I), with the current account surplus (external equilibrium). The medium-run natural real exchange rate (NATREX) is the real exchange rate which maintains internal and external equilibrium in the sense of (1). Therefore, the set of determinants of the real exchange rate must consist of the determinants of I, S, and CA. Since the model is designed to explain long-run developments, it must also depict the influence of the flow variables in (1) on stocks:

$$\dot{K} = I, \tag{2}$$

$$\dot{F} = I - S, \tag{3}$$

where K is the capital stock, and F is net foreign debt. The model considers the adjustment of K and F to their respective steady states and its interrelation with the real exchange rate. As the title of this paper suggests, the determinants of K and F are essentially the same as the determinants of the real exchange rate.

As a result of its long-term character, a NATREX model assumes money market equilibrium in all currency areas, issues concerning the nominal exchange rate are ignored, and all variables are real. Hence, the model is applicable as well to fixed as to flexible exchange rate regimes. Note that the real character of the model makes it applicable even to a single country in a monetary union, e. g. to Germany in the EMU. Speculative capital movements can be ignored since they are assumed to be white noise. Finally, NATREX models are full capacity models without any concern for cyclical movements.

II. The Model

The model presented in this paper is designed for medium-sized industrialized countries up to the size of Germany, but is applicable to some smaller ones such as Switzerland, too. These countries can be characterized as follows: They are small in world capital markets and, because of their high financial standing, creditors do not demand a risk premium. Thus, the real domestic interest rate, r, converges to the one prevailing on world capital markets, r^f.[3]

[3] *Wu / Chen* (1998), and *Stein / Sauernheimer* (1996), for example, provide empirical support for real interest rate convergence for different countries.

(4a) $$\frac{d(r - r^f)}{dt} = -\nu(r - r^f)$$

with $\nu > 0$, and f meaning foreign. Note carefully that (4a) does not describe a causality but only a tendency. It is the only equation of the model refering to a shorter than medium-run horizon, which NATREX models do not claim to explain. Thus, (4a) can be understood as a concession of a positive theory to short-term real world interest divergences which may arise from less than perfect capital mobility in the short run, central bank interventions, or short-run speculation in financial markets. However, in the medium run portfolio balance

(4b) $$r = r^f$$

is assumed to hold.

Stein / Sauernheimer (1996), who have been the first to present a NATREX model for Germany, and Stein (1997) claim that the terms of trade are exogenous for Germany. In our view this is an inappropriate oversimplification. Exogenous terms of trade require an infinitely large price elasticity of export demand, which for most medium-sized industrialized countries is regularly contradicted in empirical work (see e. g. Hooper / Marquez 1995, Hung et al. 1993, and Goldstein / Khan 1985). Evidence of incomplete pass-through further strengthens our view that export elasticities are finite. Therefore, we model the domestic country as large on export markets. Finally, most industrialized countries are highly dependent on imported raw materials and intermediate products.[4] Thus we extend the usual NATREX model, where only consumption goods are imported, by adding primary products as a second import good. For simplicity, the domestic country is assumed to be small in both of these import markets. In sum, our model can be applied to any country that is small in the world capital market and in import markets but large in its export market, which is dependent on raw material imports, and whose creditors do not demand a risk premium.

Consider a production function, G, which combines the factors capital, K, and labor, L, and which has the usual properties. Now, a third factor, the primary product N is integrated in the production function.[5] To keep things simple, N is used in fixed proportion to output Q, N = aQ, with a positive input coefficient a. As a result Q = min[G(K, L; u); N/a]; u denotes a productiv-

[4] *Stein / Sauernheimer* (1996) and *Stein* (1997) show, for example, that prices of raw material imports are essential determinants of the German terms of trade.

[5] The way how to integrate N into the production function of a NATREX model is due to *Sauernheimer / Grassinger* (1995).

ity parameter. With efficient production $N = aG(K, L; u) = ag(K; u)$, where the second equality follows from the assumption of a fixed labor force. Thus, the production function is given by

$$Q = g(K; u), \tag{5}$$

where $\partial Q/\partial K > 0$ and $\partial Q/\partial u > 0$. Since on the one hand capital K adjusts only slowly and on the other, the domestic country is small on the world market for primary products, N is a residual which adjusts immediately to allow efficient production. Since labor force is constant, one can interpret stock and flow variables of the model as levels but also as intensities (units per capita). Note that there is no *deterministic* technical progress in the model.[6]

In NATREX models consumption and investment decisions are made independently of each other.[7] The consumption function comes from Merton (1990), who uses dynamic programming to derive it given an uncertain return on investment. We slightly generalize the usual NATREX assumption of a logarithmic utility function and suppose a CES utility function, where the intertemporal substitution elasticity is assumed to be large enough that actual absorption as a whole reacts negatively to an increase in real interest: $\partial C/\partial r < |\partial I/\partial r|$. Merton's consumption function can be summarized as

$$C = C(K, F, r; \rho), \tag{6}$$

where actual consumption is positively dependent on actual wealth $W \equiv K - F$, i. e. $\partial C/\partial K > 0$ and $\partial C/\partial F < 0$, and of the time preference parameter ρ, $\partial C/\partial \rho > 0$. The model does not separate public from private consumption and therefore does not deal with the issue of Ricardian equivalence.

Denote the trade balance in consumption goods as $B^C \equiv X - M$, where X are real consumption exports and M are real consumption imports, and real means 'in units of the domestically produced consumption good' which is identical to the investment good. Since only the levels of consumption and investment are derived via intertemporal optimization for the sake of simplicity, we model the consumption structure through the following three uncontroversial assumptions on B^C: First, real exchange rate changes induce a normal consumption trade balance reaction, $\partial B^C/\partial R < 0$, where $R \equiv p_Q/p_M$ and p_Q (p_M) denotes the domestic monetary price of the exported (imported) consumption good. A rise in R symbolizes a real appreciation from the perspective of the domestic

[6] The lack of deterministic population or productivity trends are usual simplifying assumptions in NATREX models. However, stochastic shocks to productivity, u, play an important role.

[7] *Stein* (1995) discusses the use of *Merton's* (1990) consumption function and the investment function of *Infante / Stein* (1973) in the NATREX approach.

country. Second, imports M (exports X) depend on a taste parameter in the domestic country (rest of the world) concerning the relative preference of the two consumption goods. Define τ (τ^f) such that a rise in τ (τ^f) implies a taste shift in the domestic (foreign) country towards domestic goods. Therefore, $\partial B^C/\partial\tau > 0$ ($\partial B^C/\partial\tau^f > 0$). Taste shifts are assumed not to affect the consumption level C, which like X, M, I, S etc. is measured in units of the domestic good. Third, imports (exports) are positively dependent on the domestic (foreign) consumption level C (C^f), $\partial B^C/\partial C < 0$ ($\partial B^C/\partial C^f > 0$). With (6) one can summarize consumption trade balance as

$$B^C = B^C\left(R, K, F; \rho, K^f, \rho^f, \tau, \tau^f\right) = B^C(R, K, F; \rho, D), \tag{7}$$

where vector D summarizes K^f, ρ^f, τ, and τ^f, and it is assumed that $\partial B^C/\partial r = 0$. Since the domestic country is small in the world capital market $\partial C^f/\partial F = 0$, such that $\partial B^C/\partial F > 0$.

Trade balance B does not only include consumption trade but also raw material imports: $B \equiv B^C - (p_N/p_Q)N = B^C - (ap/R)Q$, where p_N is the domestic monetary price of imported raw materials, $p \equiv p_N/p_M$, and the second equation makes use of the constant input coefficient property $N = aQ$. Note that the real exchange rate R is defined as the relative price of consumption goods, which excludes raw material prices. This is innocous since only export prices p_Q are endogenous, whereas both import prices p_M and p_N are exogenous by the small country assumption. To obtain the current account CA, subtract interest payments on foreign debt from the trade balance:

$$CA \equiv B - rF = B^C - \frac{ap}{R}Q - rF. \tag{8}$$

Real GDP is defined as $GDP \equiv Q - (p_N/p_Q)N = [1 - (ap/R)]Q$, where $(ap/R) < 1$. Subtracting interest payments on foreign debt leads to $GNP \equiv [1-(ap/R)]Q - rF$, and to an expression for savings,

$$S \equiv GNP - C = \left(1 - \frac{ap}{R}\right)Q - rF - C. \tag{9}$$

NATREX models typically use as an investment function the 'suboptimal feedback control law', SOFC, developed by Infante / Stein (1973) by means of dynamic programming. They assume such a high degree of uncertainty that individuals simply do not know the equilibrium value of capital intensity. Therefore, they cannot follow a saddle path since they do not know its location. Instead they follow a feedback rule: In each period they adjust their investment behavior with the help of current values of per capita production and capital intensity. The SOFC enables them to converge to an unknown and changing steady state value of capital intensity. The resulting investment function is $I = I(K, r; u)$ with $\partial I/\partial K < 0$, $\partial I/\partial r < 0$, and $\partial I/\partial u > 0$. This invest-

ment function is *qualitatively* identical to Tobin's q theory,[8] where investment is determined by a comparison of marginal productivity of capital and real interest rate. Our model requires a modification of this investment function: If one intends to invest in order to increase production, one must allow for a share of (ap/R) of the additional output to be spent on additional raw material imports (see e. g. the definition of real GDP above). This obligatory additional expenditure lowers the marginal product of capital. Thus, when individuals consider the profitability of an investment they will be concerned with the 'net' marginal product of capital, $[1 - (ap/R)]\partial Q/\partial K$. Therefore, we use the investment function[9]

$$I = I\left(K, r; \frac{ap}{R}; u\right) \tag{10}$$

with $\partial I/\partial a < 0$, $\partial I/\partial p < 0$, and $\partial I/\partial R > 0$.

Inserting equations (5) to (10) in (1) to (3), we can sum up the model as

(1')

$$\left(1 - \frac{ap}{R}\right)Q(K;u) - rF - C(K,F,r;\rho) - I\left(K,r;\frac{ap}{R};u\right) = B^C(R,K,F;\rho,D) - \frac{ap}{R}Q(K;u) - rF\,,$$

$$\frac{d(r - r^f)}{dt} = -\nu(r - r^f)\,, \qquad \text{or, alternatively} \tag{4a}$$

$$r = r^f\,, \tag{4b}$$

$$\dot{K} = I\left(K,r;\frac{ap}{R};u\right), \tag{2'}$$

$$\dot{F} = I - S = I\left(K,r;\frac{ap}{R};u\right) - \left[\left(1 - \frac{ap}{R}\right)Q(K;u) - rF - C(K,F,r;\rho)\right]. \tag{3'}$$

The exogenous variables of the model (the fundamentals) are u, ρ, a, p, r^f, D, and will often be summarized as vector Z in the following. The real interest rate is given by (4), and the endogenous variables are R, K, and F.

[8] For such an investment function see e. g. *Abel / Blanchard* (1983).

[9] A rigorous derivation of this investment function in the framework of Tobin's q theory is available from the author upon request.

III. Dynamics of the Model

In the following we will impose four assumptions on the model, which will be explained in the course of this section:

assumption 1: $\Delta_1 \equiv \left(-\frac{\partial B^C}{\partial R} - \frac{\partial I}{\partial R}\right) > 0$,

assumption 2: $\Sigma_F = \left(\frac{ap}{R^2} Q \frac{\partial R}{\partial F} - r - \frac{\partial C}{\partial F}\right) > 0$,

assumption 3: $\Delta_2 \equiv (\Sigma_K J_F - J_K \Sigma_F) = \left[\frac{\partial J}{\partial R}\frac{\partial R}{\partial F}\Sigma_K - \left(\frac{\partial J}{\partial K} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial K}\right)\Sigma_F\right] > 0$,

assumption 4: $\Sigma_K = \left[\left(1 - \frac{ap}{R}\right)\frac{\partial Q}{\partial K} + \frac{ap}{R^2} Q \frac{\partial R}{\partial K} - \frac{\partial C}{\partial K}\right] > 0$ and

$S_K = \left(1 - \frac{ap}{R}\right)\frac{\partial Q}{\partial K} - \frac{\partial C}{\partial K} > 0$,

where investment J and savings Σ are defined in (12).

To be able to solve the system, we make use of the fact that the stock variables K and F will adjust slower to shocks than R and r. Thus, we treat K and F in the medium run as predetermined, which implies $\dot{K} = \dot{F} = 0$, and the medium-run system reduces to (1'), (4). As soon as the portfolio balance (4b) is reached, the system is in its medium-run equilibrium. The real exchange rate which maintains (1') in this medium-run equilibrium is the medium-run NATREX, R(K, F; Z).

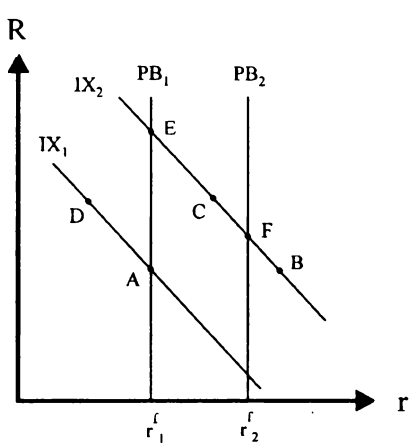

Figure 1

Portfolio balance is depicted in fig. 1 as a vertical line, PB. External equilibrium (1'), which corresponds to goods market equilibrium, is shown as IX-curve. Assumption 1 guarantees its negative slope: Starting from point A, a rise in interest will lower absorption. So, to the right of IX, net capital exports (imports) exceed (fall short of) the current account surplus (deficit), (S - I) > CA. Under assumption 1, this gap will be closed by a real depreciation that is a fall in R, which increases the current account surplus. Assumption 1 guarantees that the second effect of a depreciation, falling investment because of more expensive raw material imports,[10] will be smaller than the first.[11] The medium-run equilibrium is given by the intersection of IX and PB. Note that the NATREX approach does not model explicitly the adjustment path to such a medium-run equilibrium. The adjustment is, however, quite plausible: Consider e. g. a shift of the IX curve from IX_1 to IX_2, where portfolio balance is given by PB_1. In point A there is now excess demand for domestic goods and for domestic currency, respectively. Because of full capacity production, the price of the domestic good will rise. Furthermore, the nominal exchange rate will increase, if exchange rates are flexible. In fixed-exchange rate regimes, foreign exchange reserves and thus money supply per GDP will rise. All these mechanisms imply a real appreciation up to a point like E. During the adjustment process temporary deviations from the portfolio balance might occur. If e. g. in a fixed-exchange rate regime, investment suddenly tends to rise, and if savings are low and the current account is balanced, domestic real interest rates may rise, and the economy may jump from point A to B. Soon, however, capital imports will restore portfolio balance in point E. In each case, however, it is not determined whether the economy follows ABE (as proposed by Stein, e. g. 1995), ACE or AE, because the adjustment processes to a medium-run equilibrium are not modeled. On the other hand the model determines clearly the new medium-run equilibrium at E. Thus, in the end, the real exchange rate has to bear the entire burden of adjustment.

As long as $\dot{K} \neq 0$ and/or $\dot{F} \neq 0$, this medium-run equilibrium is no steady state. In order to calculate the long-run interdependencies, insert the medium-run equilibrium values of R and r into (2') and (3') to obtain

$$\dot{K} = J\left[K, r\left(r^f\right), \frac{ap}{R(K,F;Z)}, u\right] = J(K,F;Z), \tag{11}$$

[10] The price of raw material imports, p_N, is exogenous, but the relative price of raw material imports to exports, p/R, is endogenous. A real depreciation raises p/R and thus makes primary product imports more expensive in terms of export goods.

[11] If assumption 1 did not hold, IX would have a positive slope. Since at points to the right of the IX-curve (S - I) > CA, the real exchange rate would generally tend to depreciate in this area. Since, further, r adjusts to r^f, a positively sloped IX-curve would render the system unstable.

(12)

$$\dot{F} = J\left[K, r\left(r^f\right), \frac{ap}{R(K,F;Z)}, u\right] - \Sigma\left[K, F, r\left(r^f\right), \frac{ap}{R(K,F;Z)}, \rho, u\right] = J(K,F;Z) - \Sigma(K,F;Z)$$

where J is the investment function and Σ is the savings function, each with endogenous alternative medium-run equilibrium values of R and r.

As a first step to describe long-term interrelations, we calculate from (1') the reaction of R to a marginal change in K and F,

(13) $$\left(\frac{\partial R}{\partial K}\right) = -\frac{1}{\Delta_1}\left(\frac{\partial Q}{\partial K} - \frac{\partial C}{\partial K} - \frac{\partial I}{\partial K} + \frac{\partial M}{\partial C}\frac{\partial C}{\partial K}\right) < 0,$$

(14) $$\left(\frac{\partial R}{\partial F}\right) = -\frac{1}{\Delta_1}\left(\frac{\partial M}{\partial C} - 1\right)\frac{\partial C}{\partial F} < 0.$$

A rise in capital will increase domestic production and consumption. Savings as a whole will rise according to assumption 4, whereas investment decreases, which results in a tendency for net capital exports. This and the increase in consumption imports (which is another effect of the rise in capital) clearly shifts IX in fig. 1 to the left (e. g. from IX_2 to IX_1). As explained above this will induce the real exchange rate to depreciate. In sum, $\partial R/\partial K < 0$.

A rise in the net foreign debt lowers consumption and thus imports. Because consumption not only contains imports but also domestic goods, $\partial M/\partial C < 1$. Therefore, savings and thus net capital exports will increase by more than the current account. Hence, the IX curve shifts to the left and the real exchange rate depreciates, $\partial R/\partial F < 0$.

Now we can depict the long-term dynamics of the model in a phase diagram of (11), (12) in (K×F)-space, see fig. 2. The slope of the $\dot{K} = 0$ -curve is negative:

(15) $$\left.\frac{dF}{dK}\right|_{\dot{K}=0} = -\frac{J_K}{J_F} = -\frac{\frac{\partial J}{\partial K} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial K}}{\frac{\partial J}{\partial R}\frac{\partial R}{\partial F}} < 0.$$

If, starting from point O in fig. 2, capital rises, the marginal product of capital and thus investment will fall. As a second effect, the real exchange rate depreciates according to (13), which is equivalent to a price increase of raw material imports and again results in a fall of net marginal product of capital and thus investment. In sum, $J_K < 0$, and to the right (left) of the $\dot{K} = 0$ -curve investment J is negative (positive). If then net foreign debt decreases, the real exchange rate will appreciate as explained above, raw material imports become cheaper and investment increases. In sum, $J_F < 0$.

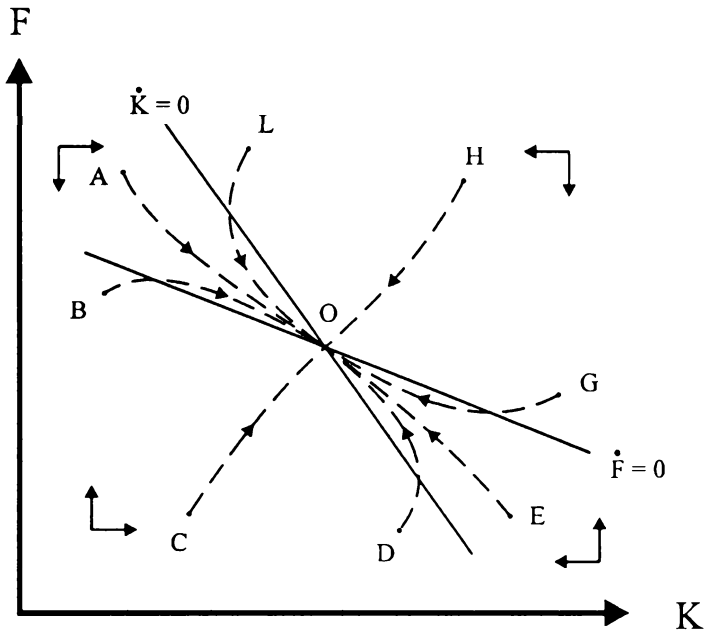

Figure 2

The slope of the $\dot{F} = 0$ -curve is negative, too:

$$(16)\quad \left.\frac{dF}{dK}\right|_{\dot{F}=0} = -\frac{J_K - \Sigma_K}{J_F - \Sigma_F} = -\frac{\frac{\partial J}{\partial K} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial K} - \left[\left(1 - \frac{ap}{R}\right)\frac{\partial Q}{\partial K} + \frac{ap}{R^2}Q\frac{\partial R}{\partial K} - \frac{\partial C}{\partial K}\right]}{\frac{\partial J}{\partial R}\frac{\partial R}{\partial F} - \left(\frac{ap}{R^2}Q\frac{\partial R}{\partial F} - r - \frac{\partial C}{\partial F}\right)} < 0.$$

The slope of this curve does not only depend on investment J but also on savings Σ. A rise in the net foreign debt affects savings through three channels: It lowers consumption, it raises interest payments on foreign debt and thus decreases real GNP. Finally, it depreciates the real exchange rate, which again lowers real GNP. Without further restrictions, the sign of Σ_F is indeterminate. Here, it is assumed to be positive (assumption 2). If it were negative, the model would be unstable: any small rise in net foreign debt would acceler-ate and finally result in a net foreign debt explosion. Since this scenario is implausible and incompatible with reality, it is excluded by assumption 2.

A rise in capital also affects savings in three ways: It raises production as well as consumption and finally depreciates the real exchange rate according to (13), which decreases real GDP. Assumption 4 guarantees that the net effect

on savings, Σ_K, is positive. This assumption is made just for reasons of plausibility. It is hard to deny that a rise in capital will result in a rise in the level of savings in the long run.

Now, if, starting from a point on the $\dot{F} = 0$ -curve in fig. 2, net foreign debt increases, savings will rise and investment will fall. Hence, the area above (below) the $\dot{F} = 0$ -curve is characterized by net capital exports (imports) and a current account surplus (deficit). If then capital decreases, savings will fall and investment will rise. Finally, the economy will eventually return to a state where $\dot{F} = 0$. Thus, the $\dot{F} = 0$ -curve has a negative slope.

Assumption 3 concerns the Jacobian of (11), (12). It guarantees that the $\dot{K} = 0$ -curve is steeper than the $\dot{F} = 0$ -curve and, thereby, the complete stability of the system. If assumption 3 did not hold, the long-run equilibrium (point O in fig. 2) would be a saddle point. This has to be excluded because both, capital and net foreign debt, are stocks, and thus cannot serve as jump variables. Furthermore, a saddle point equilibrium would be incompatible with imperfect foresight: Since agents do not know the saddle path exactly, they cannot jump on it. Note that assumptions 1 to 3 are designed to guarantee the stability of adjustment processes and as such are indispensable for the model, whereas assumption 4 is made just for reasons of plausibility.[12]

In steady state, which is located at the intersection of the $\dot{K} = 0$ -curve and the $\dot{F} = 0$ -curve, K = K* and F = F*, which implies zero investment and savings, a balanced capital and current account, and a trade surplus equal to interest payments on net foreign debt. The steady state real exchange rate, the long-run NATREX, is R* = R[K*(Z), F*(Z); Z] = R*(Z). To find the impact of a shock on the long-run NATREX, calculate

$$\frac{dR^*}{dZ} = \frac{\partial R}{\partial K}\frac{dK^*}{dZ} + \frac{\partial R}{\partial F}\frac{dF^*}{dZ} + \frac{\partial R}{\partial Z}, \tag{17}$$

where $\partial R/\partial K < 0$, $\partial R/\partial F < 0$ according to (13), (14), $\partial R/\partial Z$ describes the medium-term reaction, and the first two terms on the right hand side are the additional long-term effects. To summarize, an observed value of the real exchange rate, R, can be decomposed as

$$R = R^*(Z) + \left[R(K,F;Z) - R^*(Z)\right] + \left[R - R(K,F;Z)\right], \tag{18}$$

the long-run NATREX, deviations of the medium-run NATREX from R*(Z) due to a not yet accomplished adjustment of K and F to their respective steady state values, and finally deviations from the medium-run NATREX due to

[12] *Stein* (1990) discusses the consequences of a negative reaction of savings on capital. If in our model assumption 4 did not hold, results would change only slightly.

non-fundamental factors not modeled in a NATREX approach and assumed to be white noise. Note that in contrast to PPP theory the real exchange rate is neither constant nor stationary but varies with changes in the fundamentals Z and with induced changes in K and F.

IV. Shocks

1. A Positive 'Autonomous' Shock to the Current Account

$$\left(\frac{\partial R}{\partial D}\right) = \frac{1}{\Delta_1}\frac{\partial B^C}{\partial D} > 0 \tag{19}$$

$$\left(\frac{\partial K^*}{\partial D}\right) = \frac{1}{\Delta_2}\left(\Sigma_F \frac{\partial J}{\partial R}\frac{\partial R}{\partial D} - J_F \frac{ap}{R^2} Q \frac{\partial R}{\partial D}\right) > 0 \tag{20}$$

$$\left(\frac{\partial F^*}{\partial D}\right) = \frac{1}{\Delta_2}\left(J_K \frac{ap}{R^2} Q \frac{\partial R}{\partial D} - \Sigma_K \frac{\partial J}{\partial R}\frac{\partial R}{\partial D}\right) < 0 \tag{21}$$

A rise in D signifies an increase in wealth in the rest of the world, a rise in time preference in the rest of the world, or a preference shift from foreign consumption goods to domestic consumption goods either in the domestic or the foreign country. All these shocks have in common that their only effect on the system is a rise in the consumption trade surplus B^C. In fig. 1 this corresponds to a shift from IX_1 to IX_2 given PB_1. As explained in the previous chapter, the increased demand for domestic goods will induce a real appreciation and, thereby, a decrease in the trade balance. In fig. 1, the new medium-run equilibrium E replaces the old one, A.[13]

In the usual NATREX models, an 'autonomous' current account shock will not trigger off further adjustments. The only permanent effect of the shock is the real appreciation, which re-establishes internal and external equilibrium. This shows that NATREX models contrast sharply with PPP, where external equilibrium is exactly defined as the constancy of the real exchange rate. It further demonstrates that in NATREX models, the current account usually does not drive the capital account. Shocks to the capital account, however, generally require adjustments of the current account, as will be shown immediately.

[13] As explained in the previous chapter, a temporary rise in real interest may occur in the course of the adjustment process.

Our NATREX model differs slightly from the usual ones because the resulting real appreciation corresponds to a reduction of the relative price of raw material imports. This will induce on the one hand a rise in net marginal product of capital and thus investment, and on the other hand an increase in real GDP. This in turn causes a rise in savings (see (20) and (21), where $J_D = (\partial J/\partial R)(\partial R/\partial D)$ and $\Sigma_D = (ap/R^2)Q(\partial R/\partial D)$). The rise in net marginal product of capital shifts the $\dot{K} = 0$ -curve in fig. 2 to the right: capital begins to accumulate. Since in the medium run both investment and savings rose, both net capital exports (for $J_D < \Sigma_D$) and net capital imports (for $J_D > \Sigma_D$) could have resulted. Whereas the former implies that the $\dot{F} = 0$ -curve in fig. 2 shifts to the left, the latter implies a shift to the right. In any case, the $\dot{K} = 0$ -curve will shift further to the right than the $\dot{F} = 0$ -curve[14] because the rise in investment clearly shifts both curves to the right, but the rise in savings shifts only the $\dot{F} = 0$ -curve to the left.

Equations (20) and (21) show that in the new steady state, capital will be larger and the net foreign debt will be smaller than in the old one. During the adjustment process the economy will follow the trajectory AO or BO in fig. 2. If in the medium run the rise in investment is smaller than the rise in savings, net capital exports will reduce net foreign debt right from the start (trajectory AO). If, however, savings increase less than investment, net capital imports begin to raise the net foreign debt (trajectory BO). Now, the rise in capital will cause savings to go up (see assumption 4), which will reduce net capital imports more and more and finally turn them into net capital exports. The latter will grow so large that, in the new steady state, the net foreign debt will be smaller than in the old one.

In the course of the variations in capital and net foreign debt, the IX-curve in fig. 1 shifts again. In line with (13) and (14), the rise in capital shifts IX to the left and the (ultimate) fall in net foreign debt shifts IX to the right. Accordingly, the rise in capital c. p. depreciates the domestic currency, whereas the fall in net foreign debt c. p. appreciates it. As can be calculated with (17) using (13), (14), (19), (20), and (21), the long-run effect of an autonomous current account shock on the real exchange rate remains indeterminate, although there is a clear appreciation in the medium run.

[14] This can easily be shown formally and is, by the way, implied by the sign of (21).

2. An Increase in the Relative Price of Imported Raw Materials

$$\left(\frac{\partial R}{\partial p}\right) = \frac{1}{\Delta_1}\frac{\partial I}{\partial p} < 0 \tag{22}$$

$$\left(\frac{\partial K^*}{\partial p}\right) = \frac{1}{\Delta_2}\left[\Sigma_F\left(\frac{\partial J}{\partial p} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial p}\right) - J_F\left(\frac{ap}{R^2}Q\frac{\partial R}{\partial p} - \frac{a}{R}Q\right)\right] < 0 \tag{23}$$

$$\left(\frac{\partial F^*}{\partial p}\right) = \frac{1}{\Delta_2}\left[J_K\left(\frac{ap}{R^2}Q\frac{\partial R}{\partial p} - \frac{a}{R}Q\right) - \Sigma_K\left(\frac{\partial J}{\partial p} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial p}\right)\right] > 0 \tag{24}$$

First note that p is defined as the relative price of imported raw materials and imported consumption goods. An increase in p can thus either be due to a rise in the price of imported raw materials or to a fall in the price of imported consumption goods. Both of these prices are exogenous. Note, however, that the real exchange rate is defined as the price of exported consumption goods per price of imported consumption goods. Therefore, a fall in the price of imported consumption goods would not only raise p but also have a direct impact on R. To keep things simple, we only consider an increase in the (monetary) price of raw materials. It can be shown, however, that the qualitative results of a fall in the (monetary) price of imported consumption goods are completely identical to the results presented here.

An increase in the raw materials price will cause a current account deficit, but it also lowers real income and savings. The resulting capital imports will match the current account deficit exactly so that these developments c. p. do not affect the commodity market equilibrium. As a third effect of the price shock, however, net marginal product of capital and thus investment will fall, which corresponds to a shift from IX_2 to IX_1 in fig. 1. Consequently, net capital exports will c. p. arise, which causes a real depreciation (see (22)) and by that improves the current account till the new medium-run equilibrium (point A in fig. 1 given PB_1) is reached. During the adjustment process, domestic real interest rates might have been reduced, temporarily.

Now, the fall in the net marginal product of capital and the real depreciation shift the $\dot{K} = 0$ -curve in fig. 2 to the left and capital starts to decumulate. The $\dot{F} = 0$ -curve will shift to the right (left) if in the medium run savings fall more (less) than investment. It will, however, never shift as far to the left as the $\dot{K} = 0$ -curve. Because of high disinvestment in the medium run, for example, net foreign debt may fall at the start of the long term (see trajectory GO in fig. 2). The decreasing capital stock will soon reduce savings so that net foreign debt stops falling and instead rises up to the new steady state (point O), where F* is larger and K* is smaller than in the old steady state, cf. (23), (24). Alternatively, the fall in savings may have already been so large in the medium run that the net foreign debt increases right from the start (trajectory EO). Although the price increase in imported raw materials clearly causes a

real depreciation in the medium run, its long-term effect calculated with (17) remains unclear, since capital falls and net foreign debt rises.

Note that at least the medium-run results reflect closely the economic data of several industrialized countries (e. g. West Germany) during or shortly after the oil crises of the seventies, i. e. a fall in real income, savings, investment, the current account, and the real exchange rate.

In a next step we could calculate the effects of a reduction in the raw material input coefficient a, which signifies an increase in the efficiency of raw material input. However, the results are exactly the same for a reduction in the relative price of imported raw materials and thus need not be presented here.

3. A Rise in Domestic Time Preference

(25) $$\left(\frac{\partial R}{\partial \rho}\right) = \frac{1}{\Delta_1}\left(1 - \frac{\partial M}{\partial C}\right)\frac{\partial C}{\partial \rho} > 0$$

(26) $$\left(\frac{\partial K^*}{\partial \rho}\right) = \frac{1}{\Delta_2}\left[\Sigma_F \frac{\partial J}{\partial R}\frac{\partial R}{\partial \rho} - J_F\left(\frac{ap}{R^2}Q\frac{\partial R}{\partial \rho} - \frac{\partial C}{\partial \rho}\right)\right]$$

(27) $$\left(\frac{\partial F^*}{\partial \rho}\right) = \frac{1}{\Delta_2}\left[J_K\left(\frac{ap}{R^2}Q\frac{\partial R}{\partial \rho} - \frac{\partial C}{\partial \rho}\right) - \Sigma_K \frac{\partial J}{\partial R}\frac{\partial R}{\partial \rho}\right]$$

A rise in domestic time preference, for instance as a consequence of expansive fiscal policy,[15] raises consumption and thus net capital imports. In addition, higher time preference raises consumption imports and thus generates a current account deficit. Since only a part of consumption is imported, ($\partial M/\partial C < 1$), net capital imports increase more than consumption imports. The resulting excess demand for domestic goods causes a real appreciation (a move from A to E in fig. 1).

The real appreciation induces investment and clearly shifts the $\dot{K} = 0$ -curve to the right. The net medium-run impact on savings and thus on net foreign debt is not clear: Initially, savings decrease, but the real appreciation raises real income and thus savings. Since during the long-run dynamics medium-run equilibrium, (S - I) = CA, is given, we can use the current account for analyzing how the $\dot{F} = 0$ -curve is affected:

[15] If expansive fiscal policy causes a rise in time preference Ricardian equivalence does not hold. Of course, the rise in time preference can be due to private agents as well.

$$\left.\frac{dK}{d\rho}\right|_{\dot{F}=0} = \frac{1}{J_K - \Sigma_K}\left(\frac{\partial B^C}{\partial R}\frac{\partial R}{\partial \rho} - \frac{\partial M}{\partial C}\frac{\partial C}{\partial \rho} + \frac{ap}{R^2}Q\frac{\partial R}{\partial \rho}\right). \tag{28}$$

The terms in brackets represent effects on the current account: First, the real appreciation c. p. entails a consumption trade deficit, as does the initial rise in consumption imports (the second term). Third, the real appreciation cheapens raw material imports, which c. p. causes a trade surplus. Presumably, the first two effects will exceed the last one such that, in sum, a current account deficit arises, which is equivalent to net capital imports. Thence, the $\dot{F} = 0$ -curve shifts to the right, and in fig. 2 the economy follows trajectory BO, CO, or DO.[16] In any case both capital and net foreign debt increase initially. Soon, however, contrary tendencies arise: On the one hand the capital accumulation increases savings, which runs counter to the rise in the net foreign debt and may well lead to a reversal of this trend (see trajectory BO). If the rise in investment was large and the current account deficit small, the new equilibrium value of F may even fall short of its old equilibrium value. On the other hand the increasing net foreign debt lowers the real exchange rate and, thereby, the net marginal product of capital and investment. Thus, capital may eventually begin to decumulate and its new equilibrium value may even be smaller than the old one (trajectory DO). This becomes more probable the flatter the $\dot{K} = 0$ -curve is, i. e. the more investment falls when net foreign debt rises. As (26) and (27) show, the new equilibrium value of K and F is indeterminate. The same can be deduced with the help of (17) for the long-run real exchange rate.

Now, we compare the effects of a rise in time preference in our model to the NATREX models of Stein (1995) for the USA and of Stein / Sauernheimer (1996) for Germany.[17] In all the models, a real appreciation occurs in the medium run. In our approach, however, capital clearly rises at least at the beginning, and the new K* may even be larger than the old one. In contrast, K* definitely falls in Stein (1995). Since he models a large country, the USA, the rise in time preference raises real interest rates on world capital markets, which reduces investment permanently. In our model on the other hand the domestic country is small on world capital markets and its real interest rate is exogenous in the medium to long run. Furthermore, the real appreciation

[16] In the improbable case where this curve shifts to the left instead, trajectory AO would result.

[17] We did not perform such a comparison for the shocks discussed previously, since the usual NATREX model only considers variations in time preference, ρ, and productivity, u. A comparison with the model of *Stein* (1997) is not possible because it ignores equation (2), which is the repercussions of exogenous shocks on capital. In that model the raw material price is used as an exogenous variable representing exogenous terms of trade.

implying cheaper raw material imports even induces additional investment. Since this is not modeled by Stein and Sauernheimer, capital remains constant there.

Our approach differs from the others in a second respect: Net foreign debt rises in all models because of the current account deficit. In the model for the USA capital decumulation causes a reduction in savings, which reinforces this tendency. In our model, however, capital rises at least temporarily, which prompts additional savings and thus runs counter to the rise in the net foreign debt. Therefore, the new F* can here be smaller or larger than the old one, whereas it must rise in the other NATREX models.

There is a third difference: Since in the other models the new equilibrium net foreign debt is higher than the old one, the interest burden must be higher, as well. Because in steady state the current account is balanced, the higher interest burden implies a higher trade surplus. To generate the latter, a real depreciation must occur in the long run, which exceeds the real appreciation of the medium run. In our model this is only a special case out of several possibilities.

4. A Rise in Productivity in the Domestic Country

$$\left(\frac{\partial R}{\partial u}\right) = \frac{1}{\Delta_1}\left(\frac{\partial I}{\partial u} - \frac{\partial Q}{\partial u}\right) \tag{29}$$

$$\left(\frac{\partial K^*}{\partial u}\right) = \frac{1}{\Delta_2}\left\{\Sigma_F\left(\frac{\partial J}{\partial u} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial u}\right) - J_F\left[\frac{ap}{R^2}Q\frac{\partial R}{\partial u} + \left(1 - \frac{ap}{R}\right)\frac{\partial Q}{\partial u}\right]\right\} \tag{30}$$

$$\left(\frac{\partial F^*}{\partial u}\right) = \frac{1}{\Delta_2}\left\{J_K\left[\frac{ap}{R^2}Q\frac{\partial R}{\partial u} + \left(1 - \frac{ap}{R}\right)\frac{\partial Q}{\partial u}\right] - \Sigma_K\left(\frac{\partial J}{\partial u} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial u}\right)\right\} \tag{31}$$

Technical progress in the domestic country on the one hand raises the marginal product of capital and thereby investment. On the other hand it also raises domestic output and thus savings. Now we distinguish between two cases: In *case 1*, investment increases more than savings and in fig. 1 IX shifts to the right. The resulting net capital imports cause the real exchange rate to increase ($\partial R/\partial u$ is positive in (29)), which generates a current account deficit. In *case 2*, investment increases less than savings, IX shifts to the left, net capital exports, a real depreciation, and a current account surplus occur ($\partial R/\partial u$ is negative in (29)).[18]

In *case 1*, investment rises not only as a direct consequence of technical progress but also because of the real appreciation. The $\dot{K} = 0$ -curve clearly shifts to the right in fig. 2. Similarly, the rise in productivity raises savings not only directly but also indirectly through the real appreciation. Thus, it seems unclear in which direction the $\dot{F} = 0$ -curve shifts. Again, we can resort to considering the current account reaction:

$$\left.\frac{dK}{du}\right|_{\dot{F}=0} = \frac{1}{J_K - \Sigma_K}\left(-\frac{ap}{R}\frac{\partial Q}{\partial u} + \frac{\partial B^C}{\partial R}\frac{\partial R}{\partial u} + \frac{ap}{R^2}Q\frac{\partial R}{\partial u}\right). \tag{32}$$

The expression in brackets shows three effects: Rising output requires higher raw material imports, the real appreciation deteriorates consumption trade balance and also cheapens raw material imports. Only if this last effect surpasses the other ones, will the current account as a whole improve. Only in this highly implausible case will net foreign debt decline right from the start (trajectory AO in fig. 2). In a much more realistic view, the current account declines in the medium run causing net capital imports and a rising net foreign debt, i. e. a shift of the $\dot{F} = 0$ -curve to the right. Using the same argument as above, it can be shown that the $\dot{K} = 0$ -curve generally shifts more to the right than the $\dot{F} = 0$ -curve. Therefore, in case 1, only the trajectories AO and BO are possible, and only trajectory BO is really plausible: There, the increase in investment initially exceeds the increase in savings, i. e. both capital and net foreign debt start rising. Soon, the capital accumulation raises savings such that the net foreign debt stops to rise and begins to fall. In the new steady state, K* is higher and F* lower than in the old one, that is $(\partial K^*/\partial u) > 0$ in (30), and $(\partial F^*/\partial u) < 0$ in (31). Note that this not only holds in case 1 but generally if both the conditions $J_u > 0$ and $\Sigma_u > 0$ are fulfilled. The long-run reaction of the real exchange rate is indeterminate again. After the medium-run appreciation, the real exchange rate will clearly start to depreciate when the e-

[18] In the NATREX models published up to now, only case 1 has been considered. This might be explained by the fact that capital already installed is often not subject to technical progress. To make use of technical progress, a firm must buy the new high-productivity investment goods, before it can raise output. However, the model equations do not support this argument. Furthermore, the rise in output can immediately follow the rise in investment, so that the two effects need not be separated in a long-term analysis like NATREX. Finally, the rise in the productivity parameter u can also represent Harrod-neutral technical progress. Although a rise in u is defined as raising not only output but also the marginal product of capital, this is still consistent with labor being multiplied by u, e. g. in a CES production function, because there a rise in u also increases the marginal product of capital. Only the resulting capital accumulation maintains the marginal product of capital constant in the long run. If the rise in u represents Harrod-neutral technical progress, however, the rise in investment is only concomitant and not necessary for the rise in output.

conomy follows trajectory BO. Later on, however, the falling net foreign debt tends to increase the real exchange rate again.

In *case 2*, technical progress directly increases investment and savings (primary effects), the latter more than the former. In this second case, however, net capital exports result and the consequent real depreciation induces investment and savings to fall (secondary effects). In principle, therefore, any trajectory of fig. 2 is possible depending on the strengths of the primary and secondary effects. If the primary effects dominate the secondary effects, that is if in the medium run the net effect on investment and savings is positive, $J_u > 0$ and $\Sigma_u > 0$, again (30) is positive and (31) is negative , and again only the trajectories AO and BO can occur. Contrary to case 1, however, AO is as plausible as BO. For the real exchange rate all the paths of case 1 are possible. Additionally, if the economy follows trajectory AO, the real exchange rate could continually appreciate without any phase of depreciation.

Stein (1995) and Stein / Sauernheimer (1996) only consider case 1. Contrary to the time preference shock, their results concerning a productivity shock are mainly in line with ours, albeit the adjustment mechanisms may differ partly.

5. A Rise in the Real Interest Rate in the World Capital Market

(33) $$\left(\frac{\partial R}{\partial r^f}\right) = \frac{1}{\Delta_1}\left(\frac{\partial C}{\partial r} + \frac{\partial I}{\partial r}\right) < 0$$

(34) $$\left(\frac{\partial K^*}{\partial r^f}\right) = \frac{1}{\Delta_2}\left[\Sigma_F\left(\frac{\partial J}{\partial r} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial r^f}\right) - J_F\left(\frac{ap}{R^2}Q\frac{\partial R}{\partial r^f} - F - \frac{\partial C}{\partial r}\right)\right]$$

(35) $$\left(\frac{\partial F^*}{\partial r^f}\right) = \frac{1}{\Delta_2}\left[J_K\left(\frac{ap}{R^2}Q\frac{\partial R}{\partial r^f} - F - \frac{\partial C}{\partial r}\right) - \Sigma_K\left(\frac{\partial J}{\partial r} + \frac{\partial J}{\partial R}\frac{\partial R}{\partial r^f}\right)\right]$$

In (33) - (35) use is made of $dr/dr^f = 1$. In fig. 1, a rise in world interest rates shifts PB_1 to the right (e. g. to PB_2) given the IX-curve, e. g. IX_2. According to (4), the real domestic interest rate also increases, which hampers investment and could influence consumption in a positive or negative way. Our assumptions guarantee, however, that absorption as a whole will fall, i. e. a possible rise in consumption will not compensate for the reduction in investment. The resulting net capital exports induce a real depreciation until F in fig. 1 is reached. The clear disinvestment in the medium run indicates that the $\dot{K} = 0$ -curve shifts to the left.

How does the rise in interest affect savings? First, the direct reaction of consumption and thus savings is indeterminate. Second, if the domestic country is an international net debtor (creditor), real interest payments to (from) the rest of the world increase, which c. p. lowers (raises) GNP and savings. Third, the real depreciation is a price increase of raw material imports, which c. p. lowers GNP and savings.

Suppose first that $\partial C/\partial r \geq 0$ and that the domestic country is a net debtor, $F \geq 0$.[19] These assumptions are sufficient for the net effect on savings to be negative in the medium run. This can entail a shift of the $\dot{F} = 0$ -curve to the left or to the right, but excludes a shift to the left exceeding that of the $\dot{K} = 0$ -curve. Hence, in fig. 2 only GO or EO are possible trajectories. If savings fall more (less) than investment, the economy will follow EO (GO). In the new steady state, capital is lower and the net foreign debt higher than in the old one. Expression (34) is negative and expression (35) is positive, if $\partial C/\partial r \geq 0$ and $F \geq 0$.

Now, we relax these assumptions. The lower the initial net foreign debt and the more the real interest increase reduces consumption, the lower the probability that savings will fall more than investment in the medium run (trajectory EO). In fact, even the probability that savings will fall at all will decline. Trajectory EO occurs if the $\dot{F} = 0$ -curve shifts to the left. This can be excluded if the interest shock generates net capital exports, that is a current account surplus, in the medium run:

$$\left.\frac{dK}{dr^f}\right|_{\dot{F}=0} = \frac{1}{J_K - \Sigma_K}\left(\frac{\partial B^C}{\partial R}\frac{\partial R}{\partial r^f} + \frac{ap}{R^2}Q\frac{\partial R}{\partial r^f} - F\right). \tag{36}$$

The real depreciation c. p. generates a consumption trade surplus, but raw material imports are now more expensive. Finally, the reaction of the services account depends on whether the domestic country is a net creditor (positive reaction) or a net debtor (negative reaction). A current account deficit in the medium run is impossible if e. g. $F \leq 0$ and the second effect on the current account (making raw materials more expensive) is smaller than all the others together.

In such a case, both capital and net foreign debt will start falling, and the economy follows trajectory GO, HO, or LO. As described above, the trends of K and F reduction may be reversed by counter-running tendencies in the course of the adjustment process. For example, trajectory LO can result if, in the medium run, savings had soared up whereas investment had only fallen slightly. Thus, net foreign debt decreases drastically, but capital decumulates

[19] A logarithmic utility function implies $\partial C/\partial r = 0$, for example.

only slightly. The lower debt induces investment such that capital soon tends to rise again.

Again, there is no clear tendency for the long-term equilibrium real exchange rate. Even if the economy follows trajectory HO, where falling K and F clearly enforce a real long-term appreciation, it is unclear whether this appreciation offsets the medium-term depreciation.

6. Shocks to the Model in Retrospect

Table 1

Reaction of Various Aggregates to Shocks to the Economy

Z	$\partial R/\partial Z$	$\partial J/\partial Z$	$\partial \Sigma/\partial Z$	$\partial K^*/\partial Z$	$\partial F^*/\partial Z$	$\partial R^*/\partial Z$
D	+	+	+	+	-	?
p	-	-	-	-	+	?
a	-	-	-	-	+	?
ρ	+	+	?	?	?	?
u	?	(+)	(+)	(+)	(-)	?
r^f	-	-	?	?	?	?

Table 1 sums up the effects of the various shocks. First, the table confirms that a price increase of raw material imports affects the model in the same way as an increase in the input coefficient of raw materials.

Second, note that, generally, sign($\partial R/\partial Z$) = sign($\partial J/\partial Z$). If, on the one hand, investment (J) rises because of some shock Z, this additional investment c. p. has to be financed through net capital imports, which induce a real appreciation. Only if the shock entails a rise in savings (Σ) at least as large as the rise in investment, the appreciation is avoided, as it might be the case for a positive productivity shock. If, on the other hand, some shock causes a real appreciation, i. e. cheapens raw material imports, this always raises the net marginal product of capital and thus investment. So, even if a shock to the model did not directly affect investment, the variation in the real exchange rate alone would guarantee sign($\partial R/\partial Z$) = sign($\partial J/\partial Z$).

Note that the latter mechanism implies an accelerating effect on investment: Any shock which results in excess demand on the domestic goods market generates capital imports and a real appreciation. As just explained, the real appreciation generally raises investment. There is no counteracting effect, since real interest is given by world capital markets.

Third, table 1 shows that sign($\partial J/\partial Z$) = sign($\partial \Sigma/\partial Z$), if anything definite can be said at all. This can be explained by the fact that every shock implies a variation of the real exchange rate. A real appreciation, for instance, not only raises investment but also real GDP and thus savings (because the real appreciation implies cheaper raw material imports). The general presence of this effect causes the signs of J_Z and Σ_Z to be equal or unclear. Furthermore, since the relative sizes of J_Z and Σ_Z are unclear, the direction of the shift of the $\dot{F} = 0$ -curve, which is determined by (J_Z - Σ_Z), is unclear as well.

Fourth, according to table 1, sign($\partial K^*/\partial Z$) = - sign($\partial F^*/\partial Z$), if anything definite can be said at all. If because of sign($\partial J/\partial Z$) = sign($\partial \Sigma/\partial Z$) a shock raises both investment and savings, capital will normally rise and the net foreign debt will normally fall in the long run. On the one hand, additional investment causes a further capital accumulation, which raises savings and thus lowers the net foreign debt. On the other hand, additional savings reduce the net foreign debt, which entails a real appreciation. The appreciation raises investment, increasing the capital stock. Note that these mechanisms imply that even a fictive shock which affects investment (savings), but not savings (investment) guarantees sign($\partial K^*/\partial Z$) = - sign($\partial F^*/\partial Z$). Returning to a shock that raises both investment and savings, one may object that the initial rise in investment may be larger than the rise in savings, so that the rise in capital goes along with a rise in net foreign debt. However, it is exactly this relatively large increase in investment which usually raises capital and thus savings so much that the initial trend of a rising net foreign debt will soon be reversed. In sum, the model suggests that a shock usually (albeit not neccesarily) will cause the steady state values of capital and net foreign debt to move in opposite directions.

Note that this statement only applies to steady state values. A simultaneous rise or a simultaneous fall of both capital and investment *for a while* is not only possible but will even occur regularly as a consequence of most shocks, see trajectories BO or GO in fig. 2. Thus, the model can naturally explain real world phenomena as, for instance, an increase in domestic capital financed through borrowing abroad.

Fifth, the sign of the change in the long-run equilibrium value of the real exchange rate is unclear for each of the shocks. This follows from sign($\partial K^*/\partial Z$) = - sign($\partial F^*/\partial Z$) and ($\partial R/\partial K$) < 0 and ($\partial R/\partial F$) < 0 (see (13), (14)): Ultimately, each shock will move capital and net foreign debt in opposite directions, if anything definite can be said. But according to ($\partial R/\partial K$) < 0 and ($\partial R/\partial F$) < 0, rising capital entails a depreciation and falling net foreign debt an appreciation. Thus, opposing forces influence the real exchange rate in the long run.

V. Summary and Conclusions

Stein's NATREX methodology provides an equilibrium concept of the real exchange rate and a general framework to investigate the medium to long-run causes and consequences of real exchange rate variations. The concept implies that the determination of the real exchange rate must be analyzed in conjunction with the determination of capital and net foreign debt. Since the model is entirely real, it is applicable as well to fixed exchange rate regimes as to flexible exchange rate regimes and even to monetary unions.

The model presented in this paper is designed for countries that depend on raw material imports and are small in world capital markets, small in import markets, but large in export markets. We claim that this set of characteristics applies to several industrialized countries. The model identifies a wide range of real exchange rate, capital, and net foreign debt fundamentals. These fundamentals are the real interest rate on world capital markets, domestic and foreign time preference, a domestic and a foreign (consumption) taste parameter, productivity, the relative price of raw material imports, the efficiency of raw material input in domestic production, and wealth in the rest of the world. The effects of shocks to each of these variables are analyzed in detail for the medium and for the long run.

In comparison to the basic models of Stein (e. g. 1990, 1995, and 1996) and Stein / Sauernheimer (1996), who mainly confine their analysis to the fundamentals productivity and time preference, this paper considerably expands the set of fundamentals. Furthermore, we extend their models through endogenizing export prices and integrating raw material imports into the model, in order to mirror typical characteristics of medium-sized industrialized countries more closely. These modifications clearly qualify their results concerning a time preference shock.

In spite of the complexity of the model, the qualitative impact of shocks on the medium run equilibrium real exchange rate and on the steady state values of capital and the net foreign debt are clearly determinate in most cases. Whether a shock positively or negatively affects the steady state value of the real exchange rate, generally remains unclear. To clarify this point and to obtain some quantitative measures of the multipliers derived from the model, our next step will be to estimate these multipliers empirically for some countries.

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Tobin Tax and Exchange Rate Volatility

Gregor Kolck and Dirk Rübesamen

I. Introduction

The proposal for taxing foreign exchange transactions to hamper speculative exchange rate movements dates back to 1978. It was formulated for the first time by James Tobin (1978) and is now referred to as *Tobin tax*.

The rationale of a Tobin tax seems to be simple and convincing at first sight. Taxing all foreign exchange transactions with a proportional tax lowers the yield of foreign financial assets the more the shorter the maturity of the investment. If one assumes that speculative capital movements are more short-term orientated than other capital movements (e.g. FDIs and portfolio-investments) the tax builds up a restriction that hinders speculative capital movements more than other capital movements. Even a small tax of 0.2% lowers the return p.a. of a one-day round-trip transaction by nearly 146 points. In contrast, the return p.a. of a one-year round-trip is reduced only by 0.4 points.

Nevertheless, the Tobin tax has not been on the agenda of political and economic discussions for a long time. Only the crisis of the European Monetary System (1992, 1993), the peso crisis (1994) , and the ongoing Asian turmoil (since 1997), has made the Tobin tax – strengthened by political suggestions – subject to an intensive economic discussion for the first time.

In the past, research has concentrated on questions of tax base, tax rate and a variety of other fiscal aspects. With a few exceptions[1] there has been little effort to integrate the tax into exchange rate models.

This paper has two purposes. First of all, the Tobin tax is integrated into the Dornbusch-overshooting-model. Despite the fact that only a small proportion of exchange rate volatility is caused by fundamentals, an analysis of the effects of a Tobin tax in a monetary model reveals some interesting insights. In this part we focus on modifications of the interest-rate parity and the resulting exchange rate movements (section II.). Further, interaction between exchange

[1] For example *Frankel* (1996) and *Gandolfo/Padoan* (1992).

rate volatility and market volume is subject of the second part (section III.). The question is whether the positive correlation of volatility and trading volume, found by many empirical tests, allows the conclusion that the expected reduction of trading volume due to a Tobin tax stabilizes foreign exchange markets.

II. Tobin Tax in the Dornbusch-Model

1. Tobin Tax and Interest-Rate Parity

The arbitrage condition for capital movements (uncovered interest parity: UIP) requires:

$$(1+i) = (1+i^*)\overline{E} / E \tag{1}$$

i and i^* are the domestic and foreign interest rates, respectively, E is the spot rate and $\overline{E}$ the long-run expected exchange rate.[2] To cover a Tobin tax with the tax rate τ we have to distinguish two cases: capital outflows and capital inflows. For capital outflows (i.e. capital exports) UIP becomes

$$(1+i) = (1+i^*)\frac{\overline{E}}{E}\frac{(1-\tau)}{(1+\tau)} \tag{2}$$

and for capital inflows (i.e. capital imports)

$$(1+i) = (1+i^*)\frac{\overline{E}}{E}\frac{(1+\tau)}{(1-\tau)}. \tag{3}$$ [3]

By rearranging both equations we get tax-modified UIPs for capital outflows and capital inflows respectively.

$$\frac{(i-i^*)}{(1+i^*)} = \frac{(1-\tau)\overline{E}/(1+\tau)-E}{E} \tag{4}$$

[2] Interest rates and expected exchange rate refer to the same time horizon.

[3] See *Gandolfo/Padoan* (1992), p. 44.

(5) $$\frac{(i-i^*)}{(1+i^*)}=\frac{(1+\tau)\overline{E}/(1-\tau)-E}{E}$$

(4) and (5) are valid under the assumption that the tax is levied twice for a round-trip: once at the initial transaction and once at the closing transaction. Furthermore, it is assumed that the tax is levied either in domestic currency each time *or* in foreign currency each time.[4]

As a result, a neutral band around UIP without Tobin tax arises.[5] There are no capital movements within this band. Every interest rate within this band can be interpreted as an equilibrium.[6]

2. Tobin Tax and Overshooting Exchange Rates

The reason for the overshooting in the Dornbusch-model is the assumption of different speeds of adjustment in financial markets and in goods markets. Financial markets are assumed to react immediately to a monetary shock, while the price adjustment on goods markets is sluggish. According to UIP the spot exchange rate has to exceed its long-run expected value (determined by purchasing power parity).

The following considerations are an extension to the original Dornbusch-model[7]. To simplify the analysis only the case of capital exports is referred to. Using the tax-modified UIP (4)[8] in logarithmic form yields

(8) $$i=i^*+\theta(\overline{e}-e-2\tau)$$

where θ is the constant coefficient of adjustment.

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[4]If the tax is levied in different currencies (domestic currency at the initial transaction and foreign currency at the closing transaction *or* vice versa) we have to use

(6) $$(i-i^*)/(1+i^*)=\left[(1+\tau)^2\overline{E}-E\right]/E$$

for capital outflows and

(7) $$(i-i^*)/(1+i^*)=\left[(1+\tau)^{-2}\overline{E}-E\right]/E$$

for capital inflows instead of (4) and (5).

[5] See *Gaab* (1983), p.192.

[6] See *Frenkel/Levich* (1975), p. 326.

[7] See *Dornbusch* (1976).

[8] Using $\ln(1+\alpha)=\alpha$ as an approximation for small values of α, we get $\ln(1+i)=i$, $\ln(1+i^*)=i^*$ and $\ln((1-\tau)/(1+\tau))=-2\tau=\ln(1-\tau)^2$.

Money market equilibrium remains unchanged and is given by

$$m - p = \phi\bar{y} - \lambda i \tag{9}$$

where m is the money supply, p is the price level and $\bar{y}$ is the full employment income.[9]

(8) together with (9) represents the equilibrium in the financial markets

$$p = m - \phi\bar{y} + \lambda\left[i^* + \theta\left(\bar{e} - e - 2\tau\right)\right]. \tag{10}$$

Domestic demand for goods D is a function of the real exchange rate $e - p$, the real income $\bar{y}$, the interest rate i, and a shift parameter u.[10, 11] Domestic demand can be written as:

$$\ln D = u + \delta\left(e - p\right) + \gamma\bar{y} - \sigma i \tag{11}$$

Taking the rate of inflation $\dot{p}$ as proportional to excess demand we get

$$\dot{p} = \pi \ln\left(D / \bar{Y}\right) = \pi\left[u + \delta\left(e - p\right) + \left(\gamma - 1\right)\bar{y} - \sigma i\right]. \tag{12}$$

Equilibrium on goods markets requires $\dot{p} = 0$ and from (12) follows

$$p = \frac{u + \left(\gamma - 1\right)\bar{y} - \sigma i}{\delta} + e. \tag{13}$$

Together with (8) we obtain

$$p = \frac{u + \left(\gamma - 1\right)\bar{y} - \sigma\left[i^* + \theta\left(\bar{e} - e - 2\tau\right)\right]}{\delta} + e. \tag{14}$$

[9] All variables except i are expressed in logarithmic form.

[10] Foreign price level is normalized to $P^* = 1$.

[11] A modification of the purchasing power parity is also possible but neglected here.

Since $\bar{e} = e$ must hold in the long run we get from (14)

$$\bar{p} = \frac{u + (\gamma - 1)\bar{y} - \sigma\left[i^* - 2\theta\tau\right]}{\delta} + \bar{e} \tag{15}$$

which is the long-run equilibrium of the economy represented by the 45°-line in fig. 1.

Fig. 1 covers basic relationships of the Dornbusch-model. The QQ-line represents the equilibria in financial markets without a Tobin tax. The money market is in equilibrium and UIP holds. The line $\dot{p} = 0$ describes equilibria in the goods market and in the money market without a Tobin tax with a zero rate of inflation. A is the general equilibrium in all domestic markets without the Tobin tax.

Adding the Tobin tax both the QQ-line and the $\dot{p} = 0$-line shift parallel downwards. The lines $Q^T Q^T$ and $\dot{p} = 0^T$ are now valid. The 45°-line shifts parallel upwards. The reason for this upward shift is that the long-run ($\bar{e} = e$) domestic interest rate is lower than the foreign interest rate. This implies a higher money demand and a lower price level in the long run (for a given income and a constant money supply). The lower long-run interest rate leads to a higher demand on the goods market which can only be offset by a lower real exchange rate (when income is constant). Therefore, the nominal exchange rate has to decrease by more than the price level. After the imposition of the tax, changes in money supply result in proportional changes in the price level and in the nominal exchange rate (as in the case without tax). Hence the slope of the new curve is still 1.

The new long-run equilibrium is A^T. As can be seen from (10) and (15), the tax is a shift parameter for the QQ-line and for the 45°-line that does not change the slopes of the lines.

An exogenous increase in money supply causes an overshooting of the exchange rate e. As money supply increases, the interest rate decreases immediately to restore equilibrium in the money market. UIP is also fulfilled and the economy is in equilibrium in financial markets.

With sticky prices this requires the exchange rate to jump from A to B (without Tobin tax) or from A^T to B^T (with Tobin tax), respectively (fig. 2). The price level increases only slowly due to the excess demand in goods market caused by the real depreciation of the home currency. The interest rate rises at the same time to restore money market equilibrium instantaneously. This process is portrayed as a saddle-path movement on the (shifted) line $\tilde{Q}\tilde{Q}$ from B to $\tilde{A}$ and on the line $\tilde{Q}^T\tilde{Q}^T$ from B^T to $\tilde{A}^T$.

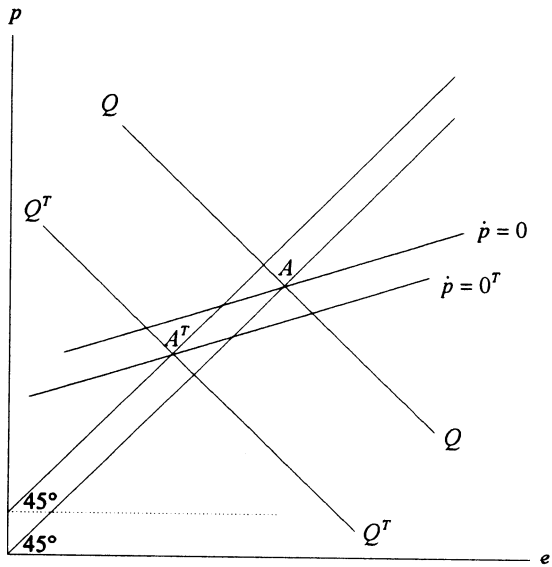

Fig. 1: Dornbusch-model with and without Tobin tax

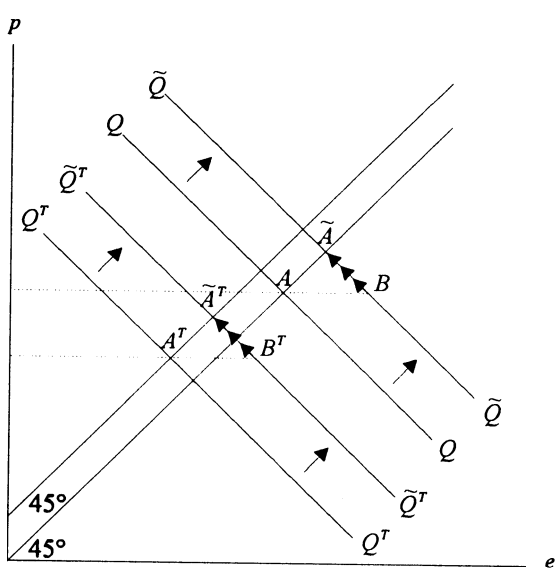

Fig. 2: Overshooting with and without Tobin tax

This leads to the following important results: The horizontal distance between B and A is equal to the horizontal distance between B^T and A^T. Measuring the overshooting as the differential of logarithms, the overshooting is independent of the Tobin tax. The same result follows from (10) using $dm = d\bar{e}$.

$$\frac{de}{dm} = 1 + \frac{1}{\theta\lambda} \tag{16}$$

The immediate change of the exchange rate following a monetary expansion is independent of the tax rate τ. The rationale is that the economy starts in a long-run equilibrium A^T with $i < i^*$ if (8) holds. This interest rate differential equals the costs of the Tobin tax at a swap rate of zero as shown above. The Tobin tax leads to a downward shift of the long-run equilibrium domestic interest rate i, leaving the deviation of e from $\bar{e}$ unchanged.[12]

All the considerations made above depend crucially on the assumption that the tax-modified UIP (8) permanently holds before a monetary shock, during the adjustment process and in the long-run equilibrium. There are good arguments for this assumption during the adjustment process from B^T to $\tilde{A}^T$. The decrease in the interest rate leads to capital outflows and UIP is at the edge of the neutral band, so that (8) is valid. The problem is much more difficult in case of the economywide equilibria in A^T and $\tilde{A}^T$. A deviation from (8) cannot be excluded a priori. All interest rates inside the neutral band can be interpreted as equilibria. In other words, i can move inside the following borders without causing capital movements:

$$i^* + \bar{e} - e - 2\tau \leq i \leq i^* + \bar{e} - e + 2\tau \tag{17}$$

Assuming a starting situation A^T with $i = i^*$ and an interest rate that is moved to the edge of the band by capital exports and remains there in the long-run equilibrium $\tilde{A}^T$, the Tobin tax lowers the overshooting of the exchange rate.[13]

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[12] *Buch/Heinrich/Pierdzioch* (1998) use a similar approach with a differing function of the tax rate. In their model the Tobin tax works as a parameter that lowers the extrapolative component of the expectation formation of market participants. It therefore changes the slope of the saddle path (which is referred to above as line QQ) and leads to a reduction of the overshooting.

[13] *Da Silva* (1998) does not refer to the Tobin tax in his model explicitely. He uses a reduced capital mobility instead but gets a similar result.

III. Tobin Tax, Trading Volume, and Foreign Exchange Rate Volatility

1. Market Structure of Foreign Exchange Markets

Hitherto we have ignored some important aspects in our analysis. Because of the deterministic nature of the Dornbusch-model exchange rate movements only take place if fundamentals (for example money supply or income) change. In reality, however, a good deal of foreign exchange markets' volatility cannot be attributed to fundamentals, but it is due to the occurrence of news that force market participants to restructure their portfolios.

A further aspect not captured by many approaches of exchange rate theory is the association of trading volume and exchange rate volatility. The following considerations focus on the effects of a Tobin tax on the trading volume. Our purpose is to examine the possible effects of the tax on exchange rate volatility.

Several empirical studies state a positive correlation between trading volume and price volatility on financial markets.[14]

A first hypothesis concerning the effect of a Tobin tax on volatility could be that the Tobin tax reduces the trading volume on foreign exchange markets because it makes speculation less profitable. With the positive correlation between volume and volatility this may lead to the conclusion that the exchange rate volatility will be reduced.

This result holds only if the number of traders on the market is constant. A more detailed analysis based on the work of Tauchen/Pitts (1983) reveals two factors determining the relation between volume of trade and price volatility.[15] At first we present the ideas of Tauchen/Pitts adapted to the foreign exchange market and than insert the Tobin tax into the model.

Tauchen/Pitts first consider the intra-day trade. The market passes through a sequence of distinct equilibria within one day. They assume the desired position D_{it} of a trader i at time t to be proportional to the difference between his reservation exchange rate (expected exchange rate) e_{it}^{e} and the spot rate e_t. Reservation rates higher than the current market rate force traders to build up long positions in foreign currency.

$$D_{it} = \alpha\left(e_{it}^{e} - e_t\right), \ \alpha > 0 \tag{18}$$

[14] See *Bessembinder/Seguin* (1993), *Fung/Patterson* (1999), *Andersen/Bollerslev* (1998) and *Karpoff* (1987).

[15] See also *Jorion* (1996).

The equilibrium exchange rate ensues from the market clearing condition. The sum of excess demands of all n traders must equal zero at every within-day equilibrium. In consequence, the equilibrium exchange rate is the average of the reservation exchange rates.

(19) $$e_t = \frac{1}{n}\sum_{i=1}^{n} e_{it}^{e}$$

Therefore, changes in the equilibrium spot rate between two trading times result from altering exchange rate expectations. The corresponding trading volume V_t is exactly one half of the sum of the changes in all traders' positions.

(20) $$\Delta e_t = \frac{1}{n}\sum_{i=1}^{n} \Delta e_{it}^{e}$$

(21) $$V_t = \frac{1}{2}\sum_{i=1}^{n}\left|D_{it} - D_{i,t-1}\right| = \frac{\alpha}{2}\sum_{i=1}^{n}\left|\Delta e_{it}^{e} - \Delta e_t\right|$$

If new information occurs, market participants react to these news by altering their expectations. The reaction may be different between traders. To model this behaviour, Tauchen/Pitts assume that the change of the expected exchange rate of a trader consists of a common component ϕ_t equal for all traders and a disagreement component ψ_{it} which is specific to each trader.

(22) $$\Delta e_{it}^{e} = \phi_t + \psi_{it}$$

with

(23) $$E[\phi_t] = E[\psi_{it}] = 0\,,\ Var[\phi_t] = \sigma_{\phi}^{2},\ Var[\psi_{it}] = \sigma_{\psi}^{2}$$

Both of these components are assumed to be independent through time and across traders. Furthermore, they are assumed to be normally distributed. Thus the change of the spot rate is

(24) $$\Delta e_t = \phi_t + \overline{\psi}_t$$

with

(25) $$\overline{\psi}_t = \frac{1}{n}\sum_{i=1}^{n}\psi_{it} \; .$$

Hence the equilibrium trading volume is

(26) $$V_t = \frac{\alpha}{2}\sum_{i=1}^{n}\left|\psi_{it} - \overline{\psi}_t\right| .$$

The common component ϕ_t reflects new information upon which market participants react in the same manner. If such news occur, all traders revise their expectations about the exchange rate equivalently. In consequence, all traders wish to change their currency position uniformly, so that there is only a change in the spot rate with no trading volume at all. This can be seen from (26). The trading volume is independent of the common component ϕ_t.

The specific component ψ_{it} covers news to which the traders react differently as a result of a disagreement between market participants. In this case there are only small changes of the exchange rate while the trading volume is relatively high. Since both ϕ_t and ψ_{it} have expected values of zero, this holds for the change of the spot rate too.

(27) $$E\left[\Delta e_t\right] = 0$$

The variance of the changes of the exchange rate depends positively on the variance of the common and the disagreement component. A higher number of traders reduces $Var\left[\Delta e_t\right]$.

(28) $$\sigma_{\Delta e}^2 \equiv Var\left[\Delta e_t\right] = \sigma_\phi^2 + \frac{\sigma_\psi^2}{n}$$

The reason is that with an increasing number of traders, differing specific judgements concerning future exchange rate movements neutralize each other. Therefore, volatility is reduced. As shown in (29) the expected trading volume increases with the number of traders and with the variance of the disagreement component.

(29) $$\mu_{Vt} \equiv E\left[V_t\right] = \frac{\alpha}{2}\sigma_\psi\sqrt{\frac{2}{\pi}\left(n^2 - n\right)}$$

We get the daily exchange rate change Δe and the daily trading volume V by aggregating the intra-day exchange rate changes Δe_t and trading volumes.

The number of intra-day equilibria is a random variable that is influenced by the occurrence of new information. The more news appear the higher is the number of equilibria J during a trading day.

(30) $$\Delta e = \sum_{j=1}^{J} \Delta e_t$$

(31) $$V = \sum_{j=1}^{J} V_t$$

As can be shown, the variance of the daily price changes depends on the factors that determine the intra-day changes Δe_t, and on the number of intra-day equilibria J. The daily trading volume is positively correlated with the number of news. Besides, it depends on the factors determining the intra-day volume V_t.

Both the daily exchange rate change and the daily trading volume are normally distributed.

(32) $$\Delta e \sim N\left(0, \sigma_{et}^2 J\right)$$

(33) $$V \sim N\left(\mu_{Vt} J, \sigma_{Vt}^2 J\right)$$

2. Tobin Tax, Market Structure, and Volatility

Although the Tauchen/Pitts-model does not contain taxes, two simple considerations concerning the taxation of foreign exchange can be made in this model. The first one refers to the exchange rate volatility with a fixed number of traders while the second argument accounts for market entries or exits.

A Tobin tax has no effects on the occurence of new information, but it reduces speculative transactions of the traders because of higher costs. Traders act on the same information with a lower expected exchange rate change.

This could be modeled by integrating a factor γ into equation (22) that reduces the expected change in the spot rate.

(34) $$\Delta e_{it}^e = \gamma\left(\phi_t + \psi_{it}\right)$$

with $0 < \gamma < 1$.

From a trader's viewpoint it is irrelevant whether expectation changes are due to the common or the disagreement component. Therefore the resulting exchange rate change between every two subsequent within-day equilibria is

$$\Delta e_t = \gamma(\phi_t + \overline{\psi}_t) \tag{35}$$

and the variance of expected spot rate changes is given by (36)

$$\sigma_{et}^2 \equiv Var[\Delta e_t] = \gamma^2\left(\sigma_\phi^2 + \frac{\sigma_\psi^2}{n}\right) \tag{36}$$

Since $0 < \gamma < 1$ the expected exchange rate volatility is reduced by the Tobin tax.

The second aspect we have to take into account is the number of traders on the foreign exchange market. This number may be dependent on the Tobin tax. This point has been insufficiently considered in the discussion about the taxation of international capital flows so far. Among others Frankel (1996) pointed out that the tax may reduce the chartists' share in the market so that fundamentalists get more influence on exchange rate determination. But these considerations are only due to the shares of both chartists and fundamentalists. They do not explicitly refer to the number of traders.

A taxation of foreign exchange transactions may lead to a withdrawal of traders from the market because of a lower profitability of speculation. In consequence a reduced number of traders n increases exchange rate volatility (see equation (28)). The reason is that there is more disagreement between traders when the numbers of traders is relatively low, so that there is only a small neutralizing effect. If the number of traders is small, the influence of a single trader's activities on equilibrium exchange rates increases.[16] Hence speculative transactions of a few market participants can cause relatively large changes of the exchange rate. As can be seen from equation (28) this result stems from the variance of the disagreement component.

Taking both effects together, a taxation of foreign exchange transactions does not necessarily stabilize exchange rates. With a constant number of traders exchange rate volatility is likely to be reduced but the Tobin tax may decrease the number of traders on the foreign exchange markets so that volatility is increased. Therefore, the total effect is indeterminate so it is not certain that a Tobin tax lowers exchange rate volatility.

[16] See also *Buch/Heinrich/Pierdzioch* (1998), p. 7.

IV. Conclusion

The purpose of this paper is to analyze the influence of a taxation of foreign exchange transactions on exchange rate volatility. We used the Dornbusch-model to show that a Tobin tax has no effect on the rate of overshooting. This result only holds if the home interest rate moves at the lower edge of the neutral band around UIP (in case of capital exports). If this condition is not fulfilled, overshooting may be reduced. Considering the market structure of foreign exchange markets, we showed that a Tobin tax reduces the volatility if the number of traders is constant. It may also decrease the number of active traders so that this effect increases volatility. Summing up, there are no unambiguous effects of a Tobin tax on exchange rate volatility.

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Part III: European Monetary Union

European Monetary Union

The New Macroeconomics

Michael Carlberg*

I. Introduction

This paper explores the new macroeconomics of the European Monetary Union. It carefully discusses the effects of shocks and policy measures on employment, prices, and the current account. Take for instance a shock or a policy measure in a specific union country. Then what will be the results in the specific country, in the other union countries, and in the rest of the world? The targets of economic policy are full employment and price stability in each of the union countries. The instruments of economic policy are monetary policy by the European Central Bank and fiscal policies by national governments. What is the appropriate policy mix? A striking feature of this paper is the numerical estimation of shock and policy multipliers. Money wages are fixed, flexible or downward rigid. The paper is organized as follows: basic model, fiscal policy, monetary policy, diagrams, policy mix, extensions, conclusion.

As a starting point take the classic papers by Fleming (1962) and Mundell (1963, 1964, 1968). They discuss monetary and fiscal policy in an open economy characterized by perfect capital mobility. The exchange rate can either be flexible or fixed. They consider both the small open economy and the world economy made up of two large countries. The seminal papers by Levin (1983) as well as by Rose and Sauernheimer (1983) are natural extensions of the papers by Fleming and Mundell. They deal with stabilization policy in a jointly floating currency area. It turns out, however, that the joint float produces results for the individual countries within the currency area and for the area as a whole that in some cases differ sharply from those in the Fleming and Mundell papers. The important book by Hansen, Heinrich and Nielsen (1992) is devoted to the economics of the European Community. As far as the macroeconomics of monetary union is concerned, the main topics are policy coordination, exchange rate expectations, and slow prices.

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II. Basic Model

In this section we make the following assumptions. The monetary union is an open economy with perfect capital mobility. The world interest rate is given exogenously $r^* = \text{const}$. Under perfect capital mobility, the union interest rate corresponds to the world interest rate $r = r^*$. Thus the union interest rate is constant, too. The exchange rate between the union and the rest of the world is flexible.

The monetary union in turn consists of two countries, say country 1 and country 2. Country 1 produces good 1, and country 2 produces good 2. These goods are imperfect substitutes. P_1 is the price of good 1, and P_2 is the price of good 2. In the short run, money wages and prices are sticky. For ease of exposition, let be $P_1 = P_2 = 1$.

We come now to the goods market of union country 1. The consumption of country 1 is an increasing function of the income of country 1 $C_1 = C_1(Y_1)$. Here $c_1 = dC_1 / dY_1$ is the marginal consumption rate, with $0 < c_1 < 1$. The investment of country 1 is a decreasing function of the interest rate $I_1 = I_1(r)$. And $b_1 = -\, dI_1 / dr$ is the sensitivity of investment to the interest rate, with $b_1 > 0$. The government of country 1 fixes its purchases of goods and services $G_1 = \text{const}$.

The exports of country 1 to country 2 are an increasing function of the income of country 2 $X_{12} = X_{12}(Y_2)$. Here $m_2 = dX_{12} / dY_2$ is the marginal import rate of country 2 relative to country 1, with $m_2 > 0$. The exports of country 1 to non-union countries are an increasing function of the exchange rate $X_{13} = X_{13}(e)$. Strictly speaking, e denotes the exchange rate of the union (e.g. the price of the dollar in terms of the euro). $h_1 = dX_{13} / de$ is the sensitivity of exports to the exchange rate, with $h_1 > 0$. The imports of country 1 are an increasing function of the income of country 1 $Q_1 = Q_1(Y_1)$. More exactly, Q_1 is the imports of country 1 from country 2 and from non-union countries. $q_1 = dQ_1 / dY_1$ is the marginal import rate of country 1, with $q_1 > 0$.

Net exports are defined as the difference between exports and imports $H_1 = X_{12} + X_{13} - Q_1$. More precisely, H_1 is net exports of country 1 to country 2 and to non-union countries. Accordingly, net exports of country 1 are an increasing function of the exchange rate, a decreasing function of the income of country 1, and an increasing function of the income of country 2 $H_1 = H_1(e, Y_1, Y_2)$. The total differential of net exports is:

$$dH_1 = h_1 de - q_1 dY_1 + m_2 dY_2 \tag{1}$$

The output of country 1 is determined by the demand for good 1 $Y_1 = C_1 + I_1 + G_1 + H_1$. Taking account of all of the behavioural functions, we arrive at the goods market equation:

$$Y_1 = C_1(Y_1) + I_1(r) + G_1 + H_1(e, Y_1, Y_2) \tag{2}$$

Here Y_1, C_1, I_1, G_1 and H_1 are expressed in terms of good 1.

The next point refers to the goods market of union country 2. The consumption of country 2 is an increasing function of the income of country 2 $C_2 = C_2(Y_2)$. And $c_2 = dC_2 / dY_2$ is the marginal propensity to consume, with $0 < c_2 < 1$. The investment of country 2 is a decreasing function of the interest rate $I_2 = I_2(r)$. Here $b_2 = -\, dI_2 / dr$ is the sensitivity of investment to the interest rate, with $b_2 > 0$. The government of country 2 sets its purchases of goods and services $G_2 = \text{const}$.

The exports of country 2 to country 1 are an increasing function of the income of country 1 $X_{21} = X_{21}(Y_1)$. And $m_1 = dX_{21} / dY_1$ is the marginal import rate of country 1 relative to country 2, with $m_1 > 0$. The exports of country 2 to non-union countries are an increasing function of the exchange rate of the union $X_{23} = X_{23}(e)$. Here $h_2 = dX_{23} / de$ is the sensitivity of exports to the exchange rate, with $h_2 > 0$. The imports of country 2 are an increasing function of the income of country 2 $Q_2 = Q_2(Y_2)$. Properly speaking, Q_2 symbolizes the imports of country 2 from country 1 and from non-union countries. $q_2 = dQ_2 / dY_2$ is the marginal import rate of country 2, with $q_2 > 0$.

Net exports are defined as the excess of exports over imports $H_2 = X_{21} + X_{23} - Q_2$. More exactly, H_2 is net exports of country 2 to country 1 and to non-union countries. After what has just been said, net exports of country 2 are an increasing function of the exchange rate, an increasing function of the income of country 1, and a decreasing function of the income of country 2 $H_2 = H_2(e, Y_1, Y_2)$. The total differential of net exports is:

$$dH_2 = h_2 de + m_1 dY_1 - q_2 dY_2 \tag{3}$$

The output of country 2 is driven by the demand for good 2 $Y_2 = C_2 + I_2 + G_2 + H_2$. Fitting the pieces of the puzzle together, the goods market equation is:

$$Y_2 = C_2(Y_2) + I_2(r) + G_2 + H_2(e, Y_1, Y_2) \tag{4}$$

Here Y_2, C_2, I_2, G_2 and H_2 are stated in terms of good 2.

We proceed now to the money market of the union. The money demand of country 1 is a decreasing function of the interest rate and an increasing function of the income of country 1 $L_1 = L_1(r, Y_1)$. In this connection, $j_1 = -\partial L_1 / \partial r$ is the sensitivity of money demand to the interest rate, with $j_1 > 0$. And $k_1 = \partial L_1 / \partial Y_1$ is the sensitivity of money demand to income, with $k_1 > 0$. Along the same lines, the money demand of country 2 is a decreasing function of the interest rate and an increasing function of the income of country 2 $L_2 = L_2(r, Y_2)$. Here $j_2 = -\partial L_2 / \partial r$ is the sensitivity of money demand to the interest rate, with $j_2 > 0$. And $k_2 = \partial L_2 / \partial Y_2$ is the sensitivity of money demand to income, with $k_2 > 0$. Of course, the money demand of the union is $L = L_1 + L_2$. The central bank of the union fixes the money supply of the union M = const. The money supply of the union equals the money demand of the union $M = L_1 + L_2$. Putting the building blocks together, we reach the money market equation $M = L_1(r, Y_1) + L_2(r, Y_2)$.

Resting on this foundation, the model can be represented by a system of three equations:

$$Y_1 = C_1(Y_1) + I_1(r) + G_1 + H_1(e, Y_1, Y_2) \tag{5}$$

$$Y_2 = C_2(Y_2) + I_2(r) + G_2 + H_2(e, Y_1, Y_2) \tag{6}$$

$$M = L_1(r, Y_1) + L_2(r, Y_2) \tag{7}$$

To sum up, (5) is the goods market equation of union country 1, (6) is the goods market equation of union country 2, and (7) is the money market equation of the union as a whole. The exogenous variables are the world interest rate r, the government purchases of union country 1 G_1, the government purchases of union country 2 G_2, and union money supply M. The endogenous variables are the union exchange rate e, the income of union country 1 Y_1, and the income of union country 2 Y_2.

Over and above that, it is useful to take the total differential of the system (5) until (7):

$$dY_1 = c_1 dY_1 - b_1 dr + dG_1 + h_1 de - q_1 dY_1 + m_2 dY_2 \tag{8}$$

$$dY_2 = c_2 dY_2 - b_2 dr + dG_2 + h_2 de + m_1 dY_1 - q_2 dY_2 \tag{9}$$

$$dM = k_1 dY_1 - j_1 dr + k_2 dY_2 - j_2 dr \tag{10}$$

Here dr, dG_1, dG_2 and dM are given, while de, dY_1 and dY_2 adjust themselves.

Finally have a closer look at the current account of the union. X_{ij} stands for exports from country i to country j. Net exports of country 1 can be defined as $H_1 = X_{12} + X_{13} - X_{21} - X_{31}$. Similarly net exports of country 2 are $H_2 = X_{21} + X_{23} - X_{12} - X_{32}$. And net exports of the union are $H = X_{13} + X_{23} - X_{31} - X_{32}$. This implies $H = H_1 + H_2$. As a significant outcome, net exports of the union are the sum of net exports of country 1 and net exports of country 2. Observing the behavioural functions $H_1 = H_1(e, Y_1, Y_2)$ and $H_2 = H_2(e, Y_1, Y_2)$, net exports of the union can be written as:

(11) $$H = H_1(e, Y_1, Y_2) + H_2(e, Y_1, Y_2)$$

III. Fiscal Policy

1. Identical Countries

Fiscal policy is the only policy instrument available at national level to fight unemployment (or, for that matter, inflation). Take for instance an increase in German government purchases. What will be the effect on German income? And what about French income?

For easy reference, the basic model will be reproduced here:

(12) $$Y_1 = C_1(Y_1) + I_1(r) + G_1 + H_1(e, Y_1, Y_2)$$

(13) $$Y_2 = C_2(Y_2) + I_2(r) + G_2 + H_2(e, Y_1, Y_2)$$

(14) $$M = L_1(r, Y_1) + L_2(r, Y_2)$$

We assume here that the union countries are the same size and have the same behavioural functions:

(15) $$b = b_1 = b_2$$

(16) $$c = c_1 = c_2$$

(17) $$h = h_1 = h_2$$

(18) $$j = j_1 = j_2$$

(19) $$k = k_1 = k_2$$

(20) $$m = m_1 = m_2$$

(21) $$q = q_1 = q_2$$

This assumption proves to be particularly fruitful. In general country 1 will be called Germany, and country 2 will be called France. But this is not meant literally to be true. These are just names to simplify presentation.

We address now fiscal policy in country 1. Think of the German government buying more German goods. The total differential of the system (12) until (14) is:

(22) $$dY_1 = cdY_1 + dG_1 + hde - qdY_1 + mdY_2$$

(23) $$dY_2 = cdY_2 + hde + mdY_1 - qdY_2$$

(24) $$0 = kdY_1 + kdY_2$$

From (24) follows immediately:

(25) $$dY_1 + dY_2 = 0$$

Then subtract (23) from (22) to verify $(1 - c + q + m)(dY_1 - dY_2) = dG_1$. Further note (25) to achieve:

(26) $$\frac{dY_1}{dG_1} = \frac{1}{2(1-c+q+m)}$$

(27) $$\frac{dY_2}{dG_1} = -\frac{1}{2(1-c+q+m)}$$

As a fundamental result, these are the fiscal policy multipliers. Obviously, they are independent of the exchange rate sensitivity h and the income sensitivity k.

A fiscal expansion in Germany raises German income. On the other hand, it lowers French income. Strictly speaking, the fall in French income is equal to the rise in German income. That is to say, union income does not respond at all. Fiscal policy in Germany is effective in Germany. However, fiscal policy in Germany has a negative externality on France.

To illustrate this, consider a numerical example with $c = 0.72$, $m = 0.16$ and $q = 0.24$. In other words, the marginal import rate of country 1 is $q = 0.24$.

The marginal import rate of country 1 relative to country 2 is m = 0.16. And the marginal import rate of country 1 relative to non-union countries is q – m = 0.08. According to (26), the fiscal policy multiplier is $dY_1 / dG_1 = 0.735$. An increase in German government purchases of 100 causes an increase in German income of 74 (that's not much). On the other hand, it causes a reduction in French income of 74 (that's a lot). Put another way, it leaves no impact whatsoever on union income (that's nothing). To sum up, the domestic effect of fiscal policy is rather small. But the negative externality of fiscal policy is quite large.

We turn next to the exchange rate of the union. Add up (22) and (23) paying heed to (25), to check $0 = dG_1 + 2hde$. Then solve for:

$$\frac{de}{dG_1} = -\frac{1}{2h} \tag{28}$$

This holds irrespective of c, k, m and q. A fiscal expansion in Germany cuts back the exchange rate. Put differently, the euro appreciates.

Beyond that we investigate the current account of the union. The total differential of $H = H_1(e, Y_1, Y_2) + H_2(e, Y_1, Y_2)$ amounts to $dH = hde - qdY_1 + mdY_2 + hde + mdY_1 - qdY_2$. Combine this with (25) to ascertain dH = 2hde. Then make use of (28):

$$\frac{dH}{dG_1} = -1 \tag{29}$$

The multiplier does not hinge on the parameters of the model. A fiscal expansion in Germany diminishes net exports of the union. In the numerical example, an increase in German government purchases of 100 causes a decline in union net exports of 100.

Having done this, we are able to present the process of adjustment in a coherent way. A fiscal expansion in Germany leads to an appreciation of the euro. Half of the appreciation falls on Germany, the other half falling on France. That is why German exports to non-union countries drop. And the same applies to French exports to non-union countries. The net effect is that German income goes up, whereas French income goes down. Union income stays constant. Conversely, a fiscal expansion in France raises French income and lowers German income.

Last but not least, regard a fiscal expansion in both Germany and France. More precisely, suppose $dG_1 = dG_2$. We still have (25) $dY_1 + dY_2 = 0$. And due to full symmetry we get $dY_1 = dY_2$. As a consequence, we figure out:

(30) $$dY_1 = dY_2 = 0$$

That means, a fiscal expansion in both Germany and France does affect neither German income nor French income. In this sense, common fiscal policy proves to be ineffective. This is in sharp contrast to the results obtained for country-specific fiscal policy, which indeed is effective.

What is the intuition behind this? The primary effect is that the fiscal expansion in both Germany and France enhances German income as well as French income. The secondary effect is that the appreciation of the euro depresses both German and French exports to non-union countries. On balance, neither German income nor French income do move.

Coming to an end, imagine a fiscal stimulus in Germany and a fiscal response in France. It all begins with a fiscal expansion in Germany. This measure pushes up German income and pulls down French income. To counteract this, the French government increases its purchases of goods and services. This augments French income and diminishes German income. The net effect is that both German income and French income remain unchanged.

2. Different Money Demand Functions

In the current section we postulate that the union countries differ in the income sensitivity of money demand $k_1 \neq k_2$. Apart from this we take the same approach as before. The total differential of the model is:

(31) $$dY_1 = cdY_1 + dG_1 + hde - qdY_1 + mdY_2$$

(32) $$dY_2 = cdY_2 + hde + mdY_1 - qdY_2$$

(33) $$0 = k_1 dY_1 + k_2 dY_2$$

From (33) one can deduce:

(34) $$dY_2 = -(k_1 / k_2) dY_1$$

That is, the variation in French income does not equal the variation in German income $dY_2 \neq dY_1$. Now subtract (32) from (31) to come up with $(1 - c + q + m)(dY_1 - dY_2) = dG_1$. Then insert (34) to get to the fiscal multiplier:

(35) $$\frac{dY_1}{dG_1} = \frac{1}{(1 - c + q + m)(1 + k_1 / k_2)}$$

Apparently, a fiscal expansion in Germany raises German income. A rise in the income sensitivity of money demand in country 1 (k_1) depresses the multiplier. The other way round, a rise in the income sensitivity of country 2 (k_2) enhances the multiplier.

To illuminate this, consider a numerical example with $k_1 = 0.3$, $k_2 = 0.25$, $c = 0.72$, $m = 0.16$ and $q = 0.24$. This yields $dY_1 / dG_1 = 0.668$. And with the help of (34) we calculate $dY_2 / dG_1 = -0.802$. An increase in German government purchases of 100 brings about an increase in German income of 67. On the other hand, it brings about a reduction in French income of 80. And what is more, it brings about a decline in union income of 13. Next have a look at a fiscal expansion in France. The relevant multipliers are $dY_2 / dG_2 = 0.802$ and $dY_1 / dG_2 = -0.668$. A rise in French government purchases of 100 leads to a rise in French income of 80. On the other hand, it leads to a fall in German income of 67. Over and above that, it leads to a rise in union income of 13. Finally catch a glimpse of a fiscal expansion in both Germany and France, with $dG_1 = dG_2$. This action does affect neither German income nor French income nor union income.

To sum up, the high money demand country has a small fiscal multiplier and a large fiscal externality. Conversely, the low money demand country has a large fiscal multiplier and a small fiscal externality. This is in clear contrast to the results obtained for the case of identical countries.

3. Different Labour Productivities

In this section we posit that the union countries differ in labour productivity. We return to the premise that the union countries agree in the income sensitivity of money demand $k_1 = k_2$. Properly speaking, we assume a fixed-coefficients technology. Let capital be abundant. a_i denotes the labour productivity in country i. The production function can be written as $Y_i = a_i N_i$, where N_i is labour input. Then solve this for labour demand $N_i = Y_i / a_i$.

To clarify this point, contemplate a numerical example with $c = 0.72$, $m = 0.16$ and $q = 0.24$. Let us start with identical labour productivities $a_1 = a_2 = 1$. Along the same lines as in section 3.1., an increase in German government purchases of 100 causes an increase in German labour demand of 74. On the other hand, it causes a reduction in French labour demand of 74. Union labour demand does not move.

Now suppose, for the sake of argument, that German labour productivity exceeds French labour productivity, say $a_1 = 1.1$ and $a_2 = 0.9$. Then an increase in German government purchases of 100 raises German labour demand by 67. On the other hand, it lowers French labour demand by 82. And

what is more, it lowers union labour demand by 15. Conversely, an increase in French government purchases of 100 drives up French labour demand by 82. On the other hand, it cuts back German labour demand by 67. Over and above that, it lifts union labour demand by 15.

To conclude, the high productivity country has a small employment multiplier and a large employment externality. The low productivity country, however, has a large employment multiplier and a small employment externality.

IV. Monetary Policy

1. Identical Countries

This section deals with monetary policy by the European Central Bank. We assume here that the union countries are the same size and have the same behavioural functions. Consider an increase in union money supply. What will be the effect on German income? And what about French income?

The total differential of the basic model is:

$$dY_1 = cdY_1 + hde - qdY_1 + mdY_2 \tag{36}$$

$$dY_2 = cdY_2 + hde + mdY_1 - qdY_2 \tag{37}$$

$$dM = kdY_1 + kdY_2 \tag{38}$$

Subtract (37) from (36) to get:

$$dY_1 = dY_2 \tag{39}$$

Then substitute this into (38) and reshuffle terms:

$$\frac{dY_1}{dM} = \frac{dY_2}{dM} = \frac{1}{2k} \tag{40}$$

As a principal result, these are the monetary policy multipliers. Evidently they have the same magnitude. And what is more, they are independent of c, h, m and q. A monetary expansion by the European Central Bank raises both German income and French income to the same extent.

To illustrate this, take a numerical example with k = 0.25. Hence the monetary policy multiplier is 1/(2k) = 2. An increase in union money supply of 100 causes an increase in German income of 200, an increase in French

income of equally 200, and an increase in union income of 400. The next point refers to growth rates. Due to symmetry, let be $Y_1 = Y_2$. Together with (39) this yields $dY_1 / Y_1 = dY_2 / Y_2$ or $\hat{Y}_1 = \hat{Y}_2$, where the hat denotes the growth rate. Further let money demand be proportionate to income $L_1 = kY_1$ and $L_2 = kY_2$, which empirically seems to be sound. Thus the money market equation can be stated as $M = kY_1 + kY_2 = 2kY_1$, which implies $\hat{M} = \hat{Y}_1$. As a consequence we reach:

$$\hat{Y}_1 = \hat{Y}_2 = \hat{M} \tag{41}$$

In other words, the growth rate of national income is equal to the growth rate of union money supply. A 1 percent increase in union money gives rise to a 1 percent increase in German income, a 1 percent increase in French income, and a 1 percent increase in union income.

In addition have a look at the exchange rate of the union. Link (36) to (39) and ascertain $hde = (1 - c + q - m)dY_1$. Then insert this into (40) to achieve:

$$\frac{de}{dM} = \frac{1 - c + q - m}{2hk} \tag{42}$$

From $c < 1$ and $m < q$ follows $1 - c + q - m > 0$. By virtue of that, a monetary expansion in the union brings up the exchange rate. Put another way, the euro depreciates.

Beyond that we are concerned with the net exports of the union. The total differential of $H = H_1(e, Y_1, Y_2) + H_2(e, Y_1, Y_2)$ is $dH = hde - qdY_1 + mdY_2 + hde + mdY_1 - qdY_2$. Now it is helpful to rewrite (36) and (37) as $(1 - c)dY_1 = hde - qdY_1 + mdY_2$ and $(1 - c)dY_2 = hde + mdY_1 - qdY_2$. By means of this we find out $dH = (1 - c)dY_1 + (1 - c)dY_2$. Take account of (39) to get $dH = 2(1 - c)dY_1$. Then combine this with (40) and check:

$$\frac{dH}{dM} = \frac{1 - c}{k} \tag{43}$$

This holds irrespective of h, m and q. A monetary expansion in the union lifts net exports of the union. Consider the numerical example with $c = 0.72$ and $k = 0.25$, so we have $(1 - c)/k = 1.12$. An increase in union money of 100 leads to an increase in union net exports of 112.

Coming to an end, what is the underlying mechanism? First of all, a monetary expansion by the European Central Bank causes a depreciation of the euro. Half of the depreciation falls on Germany, the other half falling on France. This in turn enhances German exports to non-union countries. And

the same is true of French exports to non-union countries. That is why both German income and French income go up.

2. Different Exchange Rate Sensitivities

In this section we postulate that the union countries differ in the sensitivity of exports to the exchange rate $h_1 \neq h_2$. This can be ascribed to differences in the size of the export industry or, what is similar, to differences in the openness to non-union countries. It is convenient to suppose here that the marginal import rate relative to the other union country is zero $m = 0$.

The total differential of the basic model is:

(44) $$dY_1 = cdY_1 + h_1 de - qdY_1$$

(45) $$dY_2 = cdY_2 + h_2 de - qdY_2$$

(46) $$dM = kdY_1 + kdY_2$$

From (44) and (45) one can infer:

(47) $$h_2 dY_1 = h_1 dY_2$$

In conjunction with (46) this provides the monetary policy multipliers:

(48) $$\frac{dY_1}{dM} = \frac{h_1}{(h_1 + h_2)k}$$

(49) $$\frac{dY_2}{dM} = \frac{h_2}{(h_1 + h_2)k}$$

The first lesson taught by (48) and (49) is that a monetary expansion in the union raises both German income and French income.

Now assume, for the sake of argument, that the sensitivity of German exports to the exchange rate surpasses the sensitivity of French exports $h_1 > h_2$. Then, as a consequence, the rise in German income surpasses the rise in French income $dY_1 > dY_2$. Generally speaking, the high sensitivity country has a large monetary multiplier. The other way round, the low sensitivity country has a small monetary multiplier.

To elucidate this, take a numerical example with $h_1 = 0.6$, $h_2 = 0.4$ and $k = 0.25$. Hence the monetary policy multipliers are $dY_1 / dM = 2.4$ and

$dY_2 / dM = 1.6$. An increase in union money of 100 brings about an increase in German income of 240, an increase in French income of 160, and an increase in union income of 400. The reason is that Germany benefits more from the depreciation of the euro than France does.

3. Different Money Demand Functions

In this section we start from the premise that the union countries differ in the income sensitivity of money demand $k_1 \neq k_2$. At the same time we return to the assumption that the union countries agree in the exchange rate sensitivity of exports $h_1 = h_2$. The marginal import rate relative to the other union country is again positive $m > 0$.

The total differential is:

(50) $$dY_1 = cdY_1 + hde - qdY_1 + mdY_2$$

(51) $$dY_2 = cdY_2 + hde + mdY_1 - qdY_2$$

(52) $$dM = k_1 dY_1 + k_2 dY_2$$

Owing to the full symmetry of (50) and (51) we have:

(53) $$dY_1 = dY_2$$

Insert this into (52) and regroup:

(54) $$\frac{dY_1}{dM} = \frac{dY_2}{dM} = \frac{1}{k_1 + k_2}$$

As a result, the countries have the same monetary policy multipliers, in spite of the fact that they differ in money demand functions.

4. Different Labour Productivities

In this section we posit that the union countries differ in labour productivity. We come back to the assumption that the countries agree in the income sensitivity of money demand $k_1 = k_2$. Still the same holds for the exchange rate sensitivity of exports $h_1 = h_2$. Consider a technology with fixed coefficients. Let capital be abundant. a_i symbolizes labour productivity. The

production function can be written as $Y_i = a_i N_i$, where N_i is labour input. Then solve this for labour demand $N_i = Y_i / a_i$.

To clarify this point, have a look at a numerical example with $k = 0.25$. Let us begin with identical labour productivities $a_1 = a_2 = 1$. Along the same lines as in section 4.1., an increase in union money of 100 leads to an increase in German labour demand and French labour demand of 200, respectively. Now suppose instead that German labour productivity exceeds French labour productivity, say $a_1 = 1.1$ and $a_2 = 0.9$. Then a rise in union money of 100 causes a rise in German labour demand of 182 and a rise in French labour demand of 222. That means, the high productivity country has a small employment multiplier. Conversely, the low productivity country has a large employment multiplier.

V. Diagrams

For easy reference, the basic model will be reproduced here:

$$Y_1 = C_1(Y_1) + I_1(r) + G_1 + H_1(e, Y_1, Y_2) \tag{55}$$

$$Y_2 = C_2(Y_2) + I_2(r) + G_2 + H_2(e, Y_1, Y_2) \tag{56}$$

$$M = L_1(r, Y_1) + L_2(r, Y_2) \tag{57}$$

Equation (57) gives the downward sloping MM curve, see figure 1. Along the MM curve, the money market of the union is in equilibrium. Now consider a movement along the MM curve to the right. The rise in German income causes a rise in German money demand. But the fall in French income causes a fall in French money demand. On balance, union money demand is constant. And what is more, an increase in union money supply shifts the MM curve to the right.

Equations (55) and (56) give the upward sloping YY curve, see figure 1. Along the YY curve, the goods markets of the union are in equilibrium. Now have a look at a movement along the YY curve to the right. The rise in German income pushes up the demand for both German and French goods. Similarly, the rise in French income pushes up the demand for both French and German goods, in this order. Over and above that, an increase in German government purchases shifts the YY curve to the right. The other way round, an increase in French government purchases shifts the YY curve to the left. The point of intersection of the MM and YY curves represents the simultaneous equilibrium of the money market and the goods markets, see figure 1.

An increase in German government purchases shifts the YY curve to the right, see figure 2. German income goes up, whereas French income comes down, as can be learnt from the diagram. Conversely, an increase in French government purchases shifts the YY curve to the left, see figure 3. As a consequence, French income grows, but German income declines.

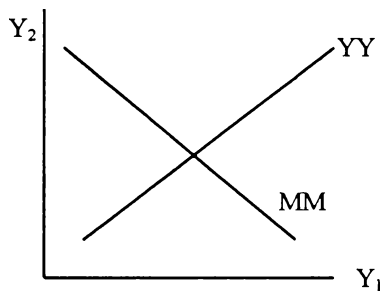

Figure 1:
Small Union of
Two Countries

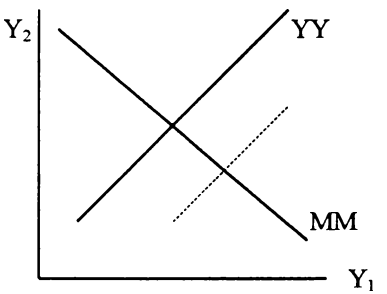

Figure 2:
Increase in German
Government Purchases

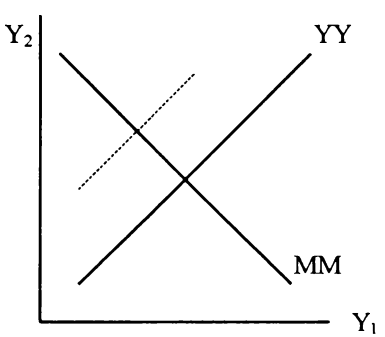

Figure 3:
Increase in French
Government Purchases

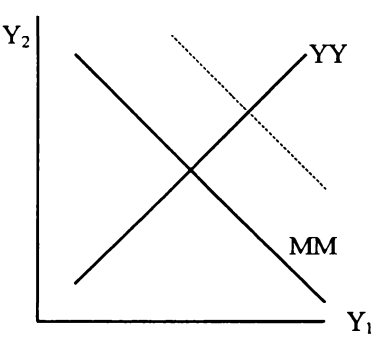

Figure 4:
Increase in Union
Money Supply

An increase in union money supply shifts the MM curve to the right, see figure 4. This policy action raises both German income and French income. A reduction in German exports shifts the YY curve to the left. The lesson taught by the diagram is that German income falls while French income rises. An

increase in the world interest rate shifts the MM curve to the right. This disruption brings up both German income and French income.

VI. Policy Mix

In this section we assume that there are two targets of macroeconomic policy in the union:

1. full employment and price stability in Germany
2. full employment and price stability in France

$\overline{Y}_1$ denotes full-employment output of Germany, and $\overline{Y}_2$ is full-employment output of France. In the diagram, this gives rise to four regions, see figure 5.

In region A there is unemployment in both countries. In region C, the other way round, there is inflation in both countries (due to overemployment and capital shortage). In region B there is unemployment in Germany and inflation in France. In region D there is inflation in Germany and unemployment in France. In point 1 there is full employment and price stability in both countries.

First of all, which stance of monetary policy is required in the union? What is needed in region A is a monetary expansion. Conversely, what is needed in region C is a monetary contraction. In region B, the European Central Bank faces a policy dilemma. And the same is true of region D.

Generally speaking there are three instruments of macroeconomic policy:

1. monetary policy in the union
2. fiscal policy in Germany
3. fiscal policy in France

Fiscal policy is the only policy instrument available at national level to fight unemployment or inflation. The big issues are: What is the appropriate policy mix? And should macroeconomic policy be coordinated?

1. Isolated fiscal policy in Germany, see figure 6. Initially let there be unemployment in both countries. In the diagram this is marked by point 1. The policy target of the German government is full employment in Germany, which in the diagram is point 2. So what is needed is a fiscal expansion in Germany. This policy measure shifts the YY curve to the right. Unfortunately, the fiscal expansion in Germany increases unemployment in France.

2. Isolated fiscal policy in France, see figure 7. At the start let there be again unemployment in both countries. In the diagram, this is represented by point 1. The policy target of the French government is full employment in France, which in the diagram is point 2. Hence what is needed is a fiscal

expansion in France. Accordingly the YY curve travels to the left. As a side effect, the fiscal expansion in France increases unemployment in Germany.

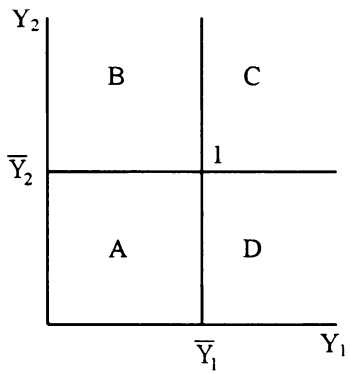

Figure 5:
Full Employment
and Price Stability

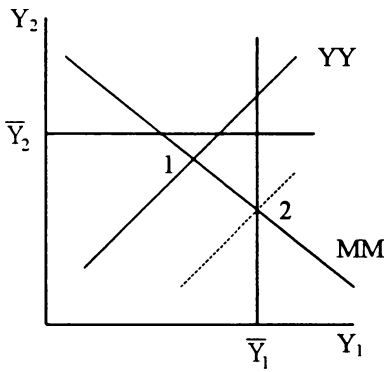

Figure 6:
Isolated Fiscal Policy
in Germany

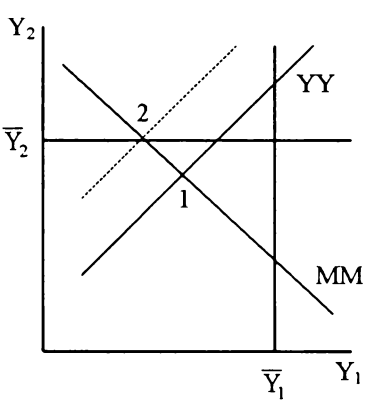

Figure 7:
Isolated Fiscal Policy
in France

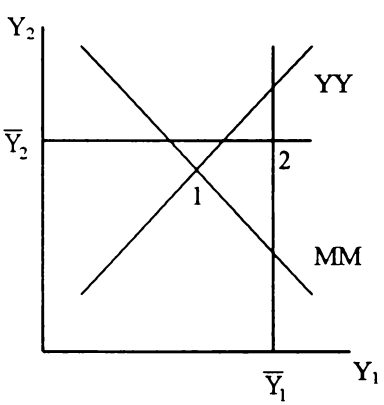

Figure 8:
Coordinated Fiscal Policy

3. Coordinated fiscal policy in Germany and France, see figure 8. At the beginning let there be once more unemployment in both countries. In the diagram this is point 1. The policy targets of the German and French governments are full employment in Germany and France, respectively. In the

diagram this is point 2. Obviously there is no way to reach both of these goals at the same time.

4. Isolated monetary policy in the union, see figure 9. Initially let there be unemployment in both countries. In the diagram this is marked by point 1. The natural policy target of the European Central Bank, in the case depicted in figure 5, is full employment in France. In the diagram this is point 2. Thus what is needed is a monetary expansion in the union. This policy action moves the MM curve to the right. The monetary expansion in the union reduces unemployment in Germany, too. But there is still some unemployment left. An alternative target of the European Central Bank could be full employment in Germany, which in the diagram were point 3. However, this would mean inflation in France.

5. Mix of monetary and fiscal policy, see figure 10. At the start let there be unemployment in both countries. In the diagram this is represented by point 1. The target of the policy mix is full employment in each of the countries, which in the diagram is point 2. So what is needed, in the case given in figure 6, is a monetary expansion in the union and a fiscal expansion in Germany. These policy measures shift both the MM curve and the YY curve to the right. In addition there is a second policy mix. What does the job as well is a monetary expansion in the union and a fiscal contraction in France. In the diagram, both curves travel to the right. Hence there is one degree of freedom.

As an important result, fiscal policy in Germany and France generally cannot establish full employment in Germany and France. What is needed, therefore, is a mix of monetary and fiscal policy. In this sense, macroeconomic policy should be coordinated between the European Central Bank, the German government, and the French government.

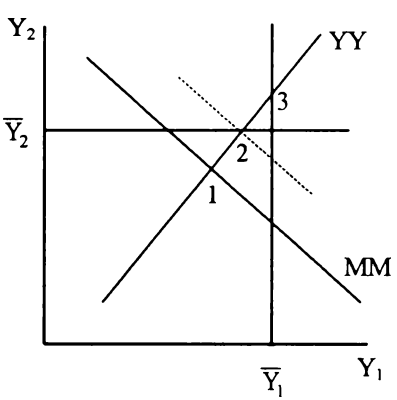

Figure 9:
Isolated Monetary Policy
in the Union

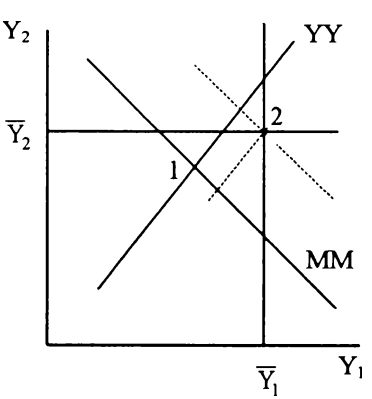

Figure 10:
Mix of Monetary
and Fiscal Policy

VII. Extensions

1. Wage shock. An increase in German money wages and hence in German prices causes a decline in German exports. The concomitant appreciation of the euro reduces both German and French exports. As a consequence, German output comes down. To a certain extent this holds for French output, too. In the numerical example, a 1 percent increase in German money wages causes a 0.79 percent decline in German output, a 0.21 percent decline in French output, and a 0.5 percent decline in union output.

2. Flexible wages. Take for instance a reduction in German investment. This depresses German money wages and thus German prices. Conversely the shock enhances French money wages and French prices. The price level of the union remains unaffected. In the numerical example, suppose that German investment falls by 1 percent of German income. Then German money wages and German prices fall by 1.25 percent, respectively. The other way round, French money wages and French prices rise by 1.25 percent each.

3. Large monetary union of two identical countries. The world economy consists of two identical regions, the monetary union and the rest of the world. The monetary union, in turn, consists of two identical countries, say Germany and France. A fiscal expansion in Germany causes an appreciation of the euro and an increase in the world interest rate. An increase in German government purchases of 100 produces an increase in German income of 143, a decline in French income of 49, and an increase in rest-of-the-world income of 94. A monetary expansion by the ECB causes a depreciation of the euro and a decline in the world interest rate. A 1 percent increase in union money supply produces a 0.78 percent increase in German income, a 0.78 percent increase in French income, and a 0.28 percent decline in rest-of-the-world income.

4. Small country in large monetary union, say the Netherlands. An increase in Dutch government purchases of 100 produces an increase in Dutch income of 192, a decline in rest-of-the-union income of 98, and an increase in rest-of-the-world income of 94.

VIII. Conclusion

The monetary union is an open economy with perfect capital mobility. The world interest rate is given exogenously. Under perfect capital mobility, the union interest rate agrees with the world interest rate. Hence the union interest rate is constant, too. The monetary union consists of two identical countries, say Germany and France.

First consider fiscal policy. A fiscal expansion in Germany causes an appreciation of the euro. This in turn lowers both German and French exports. The

net effect is that German income goes up. On the other hand, French income goes down. And what is more, union income does not change. In the numerical example, an increase in German government purchases of 100 produces an increase in German income of 74 and a decline in French income of equally 74. That means, fiscal policy in Germany is effective in Germany. However, it has a negative externality on France. The domestic effect of fiscal policy is rather small, but the negative externality is quite large. Conversely, a fiscal expansion in France raises French income and lowers German income. Over and above that, a fiscal expansion in both Germany and France (with $dG_1 = dG_2$) does affect neither German nor French income.

Second consider monetary policy. A monetary expansion by the European Central Bank causes a depreciation of the euro. This in turn raises both German and French exports. As a consequence, German and French income move up, to the same extent respectively. A 1 percent increase in union money supply produces a 1 percent increase in German income, a 1 percent increase in French income, and a 1 percent increase in union income.

As an important result, fiscal policy in Germany and France generally cannot establish full employment in Germany and France. What is needed, therefore, is an appropriate mix of monetary and fiscal policy. In this sense, macroeconomic policy should be coordinated between the European Central Bank, the German government, and the French government.

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Coordinating Monetary Policy between Ins and Outs

Sylvia Staudinger

I. Introduction

The aim of this paper is to analyze how monetary policy of ins and outs should work in the third stage of EMU. With outs one should not only think about current EU countries which do not participate on the EMU but also about eastern Europe countries which will join the European Union in a couple of years. Should there be a symmetric regime where both central banks target inflation like New Zealand or Great Britain or is an asymmetric regime like ERM II where the ECB targets inflation and the outside central bank targets the exchange rate a better solution.

There is a remarkable consensus in the literature, which analyze only the behavior of the ECB and do not investigate the outsiders economy, that the ECB should implement an inflation target (for example Cukierman 1996, Svensson 1997a, 1998). Svensson (1997a) suggests that inflation targeting should be implemented as inflation forecast targeting in the sense that the CB inflation forecast is treated as an explicit (intermediate) target. The CB has to set its instrument such that its inflation forecast equals the inflation target. If the forecast is on target monetary policy is appropriate. If the forecast is above (below) the target, monetary policy should be tightened (eased). The instrument of monetary policy is an endogenous variable (the interest rate in the Svensson model) which react to "news" (i.e. shocks) in the economy.

Alex Cukierman (1995) deals with the trade-off between controllability and visibility of an inflation target and compares it with a money target. Announcements of an inflation target are more visible to the public, but not fully controllable by the central bank. On the other hand a monetary target would be fully controllable, but has the disadvantage that the public pays little attention to this target when it forms its expectations. Cukierman uses a strategic approach to show that if the reputation of a central bank is very high, inflation targeting is preferable and that the advantage of money targeting increases with the visibility of the target.

Spaventa (1996) suggests an arrangement that is different from the EMS and relies on discretion and flexibility. This arrangement should be the sum of bilateral arrangements with individual outsider currencies, each of them setting the currency's central rate with the Euro and defining the permitted

fluctuation margins. Person and Tabellini (1996) showed that inflation targeting is superior to an exchange rate system of ERM-type and approximates the first best solution of policy coordination. They argue that in a system of inflation targets monetary policy responds automatically to shocks (in their paper they analyze supply, velocity and speculative shocks) and these shocks are distributed symmetrically across countries. Canzoneri, Nolan and Yates (1997) used a modified Barro-Gordon model to show that inflation targeting is better then a new ERM if political pressures do not distort the stabilization effort in the first place, if the shocks causing the stabilization problem are of regional nature (unilateral shocks) or if the policy objectives are very different. Ghironi and Giavazzi (1997, 1998) have shown that outsiders of non-negliable size should prefer to control the exchange rate rather than the money supply. They deduce that there is a conflict of interest in the union because the outcome for inflation is better if the outside country targets the money supply but the employment losses are smaller in an exchange rate system. De Grauwe (1997) suggests that an ERM will be only successful if there is a broader band of fluctuation and the possibility of speedy realignments. Otherwise speculative attacks will finally lead to a collapse of the ERM II as the ERM I in 1992-93.

In this paper we investigate two different target regimes for policy coordination between the ECB and the outside central bank. We use the cooperative solution as benchmark and compare it with a scenario where both central banks target inflation and a second scenario where the ECB targets inflation and the outside central bank targets the nominal exchange rate, a system which is similar to the ERM.

We used a Mundell-Flemming type model to investigate the influence of supply and demand shocks on key macroeconomic variables. Furthermore we used a quadratic loss function to deduce a ranking of the various policy rules for both central banks.

The main findings of our work are: The key parameters for the quality of a particular target regime are the marginal propensity to import and non surprising the weight that a central bank gives to employment. It turns out that for realistic assumptions about the weights on employment (unless the weights are too large) inflation targeting in both countries is in most situations superior to an ERM II and comes next to the cooperative solution. Furthermore we obtain that in case of supply shocks the preferred regime is equal in both countries whereas demand shocks lead to a conflict about the preferred policy.

Section II describes the macroeconomic model and the objective functions in the monetary union and abroad. Section III presents two different regimes and compares them with the cooperative and the Nash solution. Specially we analyze the case where both central banks follow an inflation target regime and the case where the ECB has an inflation target and the outside central

bank a nominal exchange rate target (a situation similar to the ERM). Section IV analyses the loss of both countries under different shocks and presents some numerical results and Section V recapitulates the main points of the paper.

II. The Model

We consider a log-linear two-country model of Mundell-Flemming type as common in the literature on spillovers of monetary policies. The specification of the model is in the spirit of Canzoneri and Henderson (1991). The only stochastic factors of the model are shocks with expectation zero, therefore the rational expectations solution is straight forward, since in absence of time-consistency problems all expectations are equal to zero.

The two countries are the monetary union and a country outside the union, each of them specialized in production of a single good. The behavior of the two economies is described by the following equations. The variables represent deviations of the actual values from a zero-shock equilibrium. All variables except interest rates are expressed in logarithms and asterisks denotes variables of the country outside the union.

$$L = 0.5\left((q - q_{-1})^2 + \Phi n^2\right)$$

$$L^* = 0.5\left((q^* - q^*_{-1})^2 + \Phi^* n^{*2}\right)$$

The loss of policy makers, i.e. the central banks in both countries increases with deviations from full-employment level of zero and increases also if inflation is positive. Φ (Φ^*) measures the weight policymakers give to employment relative to inflation. In the following sections we will assume that the outside CB cares more about employment then the ECB, i.e. $\Phi \leq \Phi^*$.

If we assume that q_{-1} and q^*_{-1} are zero then CPI indices q and q^* are the same as inflation and the loss functions are simplified to:

(1) $$L = 0.5\left(q^2 + \Phi n^2\right)$$

(2) $$L^* = 0.5\left(q^{*2} + \Phi^* n^{*2}\right)$$

(3) $$y = \alpha n - x$$

(4) $$y^* = \alpha n^* - x^*$$

Assuming Cobb-Douglas production functions and taking capital as fixed, output in each country (y and y^*) is an increasing function of employment (n and n^*) and a decreasing function of a productivity shock (x and x^*). These shocks are identically and independently distributed with zero mean.

(5) $$w - p = \ln\alpha - (1-\alpha)n - x$$

(6) $$w^* - p^* = \ln\alpha - (1-\alpha)n^* - x^*$$

Firms maximize their profit and demand labor up to the point where its marginal product equals the real product wage.

(7) $$w - p_{t|t-1} = \ln\alpha$$

(8) $$w^* - p^*_{t|t-1} = \ln\alpha$$

Nominal wages are chosen at the end of period $t-1$ in that way, that the expected employment is at the full employment level of zero. $p_{t|t-1}$ and $p^*_{t|t-1}$ are the expected product prices of period t based on the information available at period $t-1$.

The real exchange rate z is given by

(9) $$z = e + p^* - p$$

(10) $$q = p + \gamma z$$

(11) $$q^* = p^* - \gamma z$$

CPIs are weighted averages of the price of the home good and the price in home currency of the import good. The average propensity to import $\gamma(0 < \gamma < 1)$, is the same in both countries.

(12) $$i = i^* + e_{t+1|t} - e$$

Bonds denominated in the two currencies are perfect substitutes therefore their expected returns in a common currency are equal and open interest parity holds.

Real interest rates are

(13) $$r = i - q_{t+1|t} + q$$

(14) $$r^* = i^* - q^*_{t+1|t} + q^*$$

where i and i^* are the nominal interest rates on home and foreign currency bonds and $q_{t+1|t}$ and $q^*_{t+1|t}$ are the expected CPIs of the next period based on the information available this period.

The goods market equilibrium conditions are given by

(15) $$y = \eta(1-\gamma)y + \eta\gamma y^* - \varepsilon(1-\gamma)r - \varepsilon\gamma r^* + \delta z + u$$

(16) $$y^* = \eta(1-\gamma)y^* + \eta\gamma y - \varepsilon(1-\gamma)r^* - \varepsilon\gamma r - \delta z + u^*$$

For simplicity we assume that the marginal propensities to consume and the marginal propensities to import are equal in the two countries and that the marginal propensity to import is equal to the average propensity to import. ε denotes the semi-elasticity of demand with respect the interest rate and is also equal for both countries. u and u^* are identically and independently distributed demand shocks with zero mean.

The following equations characterize money market equilibrium

(17) $$m = p + y - \lambda i$$

(18) $$m^* = p^* + y^* - \lambda i^*$$

where λ denotes the semi-elasticity of money demand with respect to the interest rate.

We assume arbitrary covariances across pairs of structural shocks and covariances equal to zero across all other shocks.

The timing of the model is as follows:

(a) expectations are formed,
(b) structural shocks are revealed,
(c) policies are set,
(d) macroeconomic outcomes are realized,
(e) nominal wages for the next period are set .

III. Different Target Regimes

1. Cooperative Solution

First we determine the cooperative solution as benchmark for our further analysis. The central banks choose their inflation rates to minimize a joint loss function $E(L+L^*)$ Then they use the monetary base as instrument to achieve these inflation rates.

Deducing n and n^* as function of the shocks and the optimal inflations rates and using the joint loss function we obtain the first order conditions for q and q^*:

$$\partial(L+L^*)/\partial q = q + \Phi n\, \partial n/\partial q + \Phi^* n^*\, \partial n^*/\partial q = 0$$

$$\partial(L+L^*)/\partial q^* = q^* + \Phi n\, \partial n/\partial q^* + \Phi^* n^*\, \partial n^*/\partial q^* = 0$$

Solving for q and q^* and substituting for employment we obtain the cooperative solution (The coefficients are listed in appendix A):

$$q = \frac{\left(\varphi_{q1}\gamma\left(\rho\left(u^*-u\right)-\left(\eta\gamma+\mu\right)\left(x-x^*\right)\right)+\varphi_{q2}x+\varphi_{q3}x^*\right)}{\left(\varphi_3\varphi_4-\left(\Phi+\Phi^*\right)^2\varphi_1^2\varphi_2^2\right)}$$

$$q^* = \frac{\left(\varphi_{q^*1}\gamma\left(\rho\left(u^*-u\right)-\left(\eta\gamma+\mu\right)\left(x-x^*\right)\right)+\varphi_{q^*2}x+\varphi_{q^*3}x^*\right)}{\left(\varphi_3\varphi_4-\left(\Phi+\Phi^*\right)^2\varphi_1^2\varphi_2^2\right)}$$

$$n = \frac{\left(\varphi_{n1}\gamma\left(\rho\left(u^*-u\right)-\left(\eta\gamma+\mu\right)\left(x-x^*\right)\right)+\varphi_{n2}x+\varphi_{n3}x^*\right)}{\Lambda\rho\left(\varphi_3\varphi_4-\left(\Phi+\Phi^*\right)^2\varphi_1^2\varphi_2^2\right)}$$

$$n^* = \frac{\left(\varphi_{n^*1}\gamma\left(\rho\left(u^*-u\right)-\left(\eta\gamma+\mu\right)\left(x-x^*\right)\right)+\varphi_{n^*2}x+\varphi_{n^*3}x^*\right)}{\Lambda\rho\left(\varphi_3\varphi_4-\left(\Phi+\Phi^*\right)^2\varphi_1^2\varphi_2^2\right)}$$

Using the coefficients from the appendix we obtain that the solution is completely symmetric if the weights given to employment are equal. If both weights on employment in the loss functions are zero the cooperative solution reduces to inflation targeting in both countries.

Furthermore one sees that (independent of the weights on employment) only the difference of the demand shocks affects the main macroeconomic variables but not the level of the shock, therefore a symmetric demand shock is completely offset by an appropriate reaction of the central banks and has no effect on both inflation and employment. A unilateral demand shock causes an expansive episode with increasing employment and decreasing inflation in the country of its origin whereas in the other country employment decreases and inflation increases.

All kinds of supply shocks increase inflation and decrease employment in both countries. It depends on the magnitude of the weights in which country the effect of the supply shock is stronger.

2. Nash Solution

Next we determine the Nash solution. Each central bank chooses an inflation rate as target that minimizes its loss function and adjusts the money supply in an appropriate way to achieve this inflation rate. Since there is no inflation bias all expectations are equal to zero and the solution is straight forward.

Deducing n and n^* as function of the shocks and the optimal inflation rates and differentiating the two loss functions and setting the first derivatives equal to zero leads to:

$$\partial L/\partial q = q + \Phi n \, \partial n/\partial q = 0$$

$$\partial L^*/\partial q^* = q^* + \Phi^* n^* \, \partial n^*/\partial q^* = 0$$

Solving these equations for q and q^* and substituting for employment one obtains the Nash-solution

$$q = \Phi\varphi_1 \frac{\left(\left(\psi_2 + \Phi^*\varphi_1\varphi_2\right)\gamma\left(\rho\left(u^* - u\right) - \left(\eta\gamma + \mu\right)\left(x - x^*\right)\right) + \psi_2\Lambda x - \Phi^*\Lambda\varphi_1\varphi_2 x^*\right)}{\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)}$$

$$q^* = \Phi^*\varphi_1 \frac{\left(\left(\psi_1 + \Phi\varphi_1\varphi_2\right)\gamma\left(\rho\left(u - u^*\right) - \left(\eta\gamma + \mu\right)\left(x^* - x\right)\right) - \Phi\Lambda\varphi_1\varphi_2 x + \Lambda\psi_1 x^*\right)}{\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)}$$

$$n = \Lambda\rho \frac{\left(\left(\psi_2 + \Phi^*\varphi_1\varphi_2\right)\gamma\left(\rho\left(u - u^*\right) - \left(\eta\gamma + \mu\right)\left(x^* - x\right)\right) - \psi_2\Lambda x + \Phi^*\Lambda\varphi_1\varphi_2 x^*\right)}{\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)}$$

$$n^* = \Lambda\rho\frac{\left((\psi_1 + \Phi\varphi_1\varphi_2)\gamma\left(\rho\left(u^* - u\right) - (\eta\gamma + \mu)\left(x - x^*\right)\right) + \Phi\Lambda\varphi_1\varphi_2 x - \Lambda\psi_1 x^*\right)}{\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)}$$

with $\psi_1 = \Lambda^2\rho^2 + \Phi\varphi_1^2 > 0$ and $\psi_2 = \Lambda^2\rho^2 + \Phi^*\varphi_1^2 > 0$

Looking at the solution we see once again that in the case of equal weights on employment in the loss functions the solution is completely symmetric. If the weight a central bank gives to employment is zero then the Nash solution is equivalent with inflation targeting in that country.

As in the cooperative case only the difference of the demand shocks affects the main macroeconomic variables but not the level of the shock, therefore a symmetric demand shock has no effect on both inflation and employment. A unilateral demand shock increases employment and decreases inflation in the country of its origin. In the other country it causes stagflation since it leads to a depreciation of the currency of that country and to a fall in the real producer wages which causes the reduction of employment.

A symmetric supply shock increases inflation and reduces employment in both countries. It is obvious that the rise in the consumer price is higher and the reduction in employment is smaller in the country with the higher relative weight on employment. A unilateral supply shock in one of the countries also rises inflation and reduces employment in both countries. If the weights are equal the reaction of inflation and employment to the shock is stronger in the country of its origin. If the weights are not equal it depends mainly on the magnitude of the weights where a stronger reaction occurs.

3. Inflation Targeting

In this section we assume that both central banks commit to follow an inflation target of $q = q^* = 0$ and let the bilateral exchange rate fluctuate. The solution for the variables of main interest is:

$$n = \Lambda^{-1}\left(\gamma\rho^{-1}(\eta\gamma + \mu)\left(x - x^*\right) + \gamma\left(u - u^*\right)\right) - \rho^{-1}x$$

$$n^* = \Lambda^{-1}\left(\gamma\rho^{-1}(\eta\gamma + \mu)\left(x^* - x\right) + \gamma\left(u^* - u\right)\right) - \rho^{-1}x^*$$

If both central banks follow an inflation target we get a solution which is similar to the cooperative or the Nash solution. Comparing the outcome under inflation targets with the cooperative solution we obtain that inflation targeting coincides with the cooperative solution for the extreme case that both weights

on employment are zero. Moreover under inflation targeting we always get a completely symmetric solution.

Prices are fully stabilized, by definition, under this regime. Furthermore employment in both countries is affected only by the difference of the demand shocks. Therefore symmetric demand shocks do not influence employment, unilateral demand shocks increase employment in country where they occur and decrease employment abroad.

All kinds of supply shocks lead to lower employment in both countries. If the shock is symmetric the fall of employment is equal in the monetary union and the outside country. If the shock is unilateral the reduction of employment is stronger in the country of the origin of the shock.

4. The ERM II where the ECB Targets Inflation

Now we want to compare the solutions above with a regime where the ECB targets inflation and the outside CB is targeting the nominal exchange rate, $q = 0, e = 0$.

We get the solution of this regime:

$$q^* = \Lambda_{ie}^{-1}(1-2\gamma)\left(\rho\left(u^* - u\right) - (\eta\gamma + \mu)\left(x - x^*\right)\right)$$

$$n = \Lambda_{ie}^{-1}\left(\gamma\rho^{-1}(\eta\gamma + \mu)\left(x - x^*\right) + \gamma\left(u - u^*\right)\right) - \rho^{-1}x$$

$$n^* = \Lambda_{ie}^{-1}\left(\rho^{-1}(1-\gamma)(\eta\gamma + \mu)\left(x^* - x\right) + (1-\gamma)\left(u^* - u\right)\right) - \rho^{-1}x^*$$

with $\Lambda_{ie} = \rho\left(\varepsilon(2\gamma - 1)^2 + 2\delta\right) + \alpha(\eta\gamma + \mu) > 0$

Now we get an asymmetric solution since the outside central bank targets the exchange rate. Furthermore we observe that inflation in the outside country depends only on the difference of the supply and demand shocks in the two countries but not on the level of the shocks. Even though the solution is non-symmetric we obtain the same outcome for the relevant variables if the shocks are symmetric. Moreover in the case of symmetric shocks we obtain exactly the same solution as in the inflation targeting regime.

Once more symmetric demand shocks do not influence employment. A unilateral demand disturbance in the monetary union increases employment in the union and reduces both the CPI and employment in the foreign country. A unilateral demand shock abroad rises inflation and employment in the foreign country and causes a fall in employment in the monetary union.

All kinds of supply shocks lead to lower employment in both countries. If the shock is symmetric the fall of employment is equal in the monetary union and the outside country, whereas inflation in the outside country is unchanged. If a unilateral shock occurs the fall in employment is larger in the country of the origin of the shock. The reaction of the consumer price index in the outside country depends on the value of γ. If $\gamma < 1/2$ then the inflation rate increases if the supply shock has its origin in the outside country but decreases if the shock hits the monetary union. If $\gamma > 1/2$ the opposite is true: the outside CPI decreases in case of a supply shock in the outside country and rises in case of a shock in union.

IV. What Happens under Different Shocks?

1. Supply Shocks

Since investigating the influence of various shocks gives rather complicated expressions we study in detail only the influence of symmetric and unilateral shocks in both countries. For some of these special cases we can also give general analytical results, for the other cases we use some calculations (see appendix C) to get an idea what regime comes next to the cooperative or the Nash solution.

a) Symmetric Supply Shocks

Assume that a symmetric supply shock occurs in both countries, i.e. $x = x^* > 0$.

Starting with the loss under a cooperative solution one gets

$$E(L_{co}) = \frac{0.5\left(\Lambda^2\rho^2\left(\varphi_{q2}+\varphi_{q3}\right)^2+\Phi\left(\varphi_{n2}+\varphi_{n3}\right)^2\right)\sigma_x^2}{\Lambda^2\rho^2\left(\varphi_3\varphi_4-\left(\Phi+\Phi^*\right)\varphi_1^2\varphi_2^2\right)^2}$$

$$E(L_{co}^*) = \frac{0.5\left(\Lambda^2\rho^2\left(\varphi_{q^*2}+\varphi_{q^*3}\right)^2+\Phi^*\left(\varphi_{n^*2}+\varphi_{n^*3}\right)^2\right)\sigma_x^2}{\Lambda^2\rho^2\left(\varphi_3\varphi_4-\left(\Phi+\Phi^*\right)\varphi_1^2\varphi_2^2\right)^2}$$

Calculating the loss for the Nash solution we obtain

$$E(L_{na}) = 0.5\Phi\left(\psi_1\psi_2-\Phi\Phi^*\varphi_1^2\varphi_2^2\right)^{-2}\left(\Phi\varphi_1^2+\Lambda^2\rho^2\right)\left(\psi_2-\Phi^*\varphi_1\varphi_2\right)^2\Lambda^2\sigma_x^2$$

$$E(L^*_{na}) = 0.5\Phi^*\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)^{-2}\left(\Phi^*\varphi_1^2 + \Lambda^2\rho^2\right)\left(\psi_1 - \Phi\varphi_1\varphi_2\right)^2\Lambda^2\sigma_x^2$$

Deducing the expected losses under inflation targeting we obtain for the ECB

$$E(L_{ii}) = 0.5\Phi\rho^{-2}\sigma_x^2$$

and for the loss of the outside central bank respectively

$$E(L^*_{ii}) = 0.5\Phi^*\rho^{-2}\sigma_x^2 .$$

If the shocks are symmetric the loss is higher in the country with the higher weight on employment.

If the ECB targets inflation and the outside central bank targets the nominal exchange rate we get as loss of the ECB

$$E(L_{ie}) = 0.5\Phi\rho^{-2}\sigma_x^2 .$$

It follows immediately that in case of a symmetric supply shock the losses for both regimes are equal. In this case a fixed exchange rate regime is as good as inflation targeting and the ECB is indifferent between inflation targeting and an ERM II regime.

Next we investigate the situation for the country outside the monetary union:

$$E(L^*_{ie}) = 0.5\Phi^*\rho^{-2}\sigma_x^2 .$$

For the outside country holds the same as for the monetary union: in the case of a symmetric supply shock a policy of inflation targeting is equivalent to an ERM II regime.

Furthermore we see if one central bank gives no weight to employment the two regimes are equivalent to the Nash solution for this central bank.

b) A Unilateral Supply Shock in the Monetary Union

Suppose the supply shock hits only the monetary union , i.e. $x > 0, x^* = 0$.

One obtains the following expected losses for the union and the outside country for the cooperative solution.

$$E(L_{co}) = \frac{0.5\left(\Lambda^2\rho^2\left(\varphi_{q2} - \varphi_{q1}\gamma(\eta\gamma + \mu)\right)^2 + \Phi(\varphi_{n2} - \varphi_{n1}\gamma(\eta\gamma + \mu))^2\right)\sigma_x^2}{\Lambda^2\rho^2\left(\varphi_3\varphi_4 - \left(\Phi + \Phi^*\right)\varphi_1^2\varphi_2^2\right)^2}$$

$$E(L_{co}^*) = \frac{0.5\left(\Lambda^2\rho^2\left(\varphi_{q^*2} - \varphi_{q^*1}\gamma(\eta\gamma + \mu)\right)^2 + \Phi^*\left(\varphi_{n^*2} - \varphi_{n^*1}\gamma(\eta\gamma + \mu)\right)^2\right)\sigma_x^2}{\Lambda^2\rho^2\left(\varphi_3\varphi_4 - \left(\Phi + \Phi^*\right)\varphi_1^2\varphi_2^2\right)^2}$$

Next we deduce the expected losses for the union and the outside country for a Nash regime.

$$E(L_{na}) = \frac{0.5\Phi\left(\Phi\varphi_1^2 + \Lambda^2\rho^2\right)\left(\left(\psi_2 + \Phi^*\varphi_1\varphi_2\right)\gamma(\eta\gamma + \mu) - \Lambda\psi_2\right)^2\sigma_x^2}{\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)^2}$$

$$E(L_{na}^*) = \frac{0.5\Phi^*\left(\Phi^*\varphi_1^2 + \Lambda^2\rho^2\right)\left(\left(\psi_1 + \Phi\varphi_1\varphi_2\right)\gamma(\eta\gamma + \mu) - \Lambda\Phi\varphi_1\varphi_2\right)^2\sigma_x^2}{\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)^2}$$

Next we calculate the loss under inflation targeting:

$$E(L_{ii}) = 0.5\Phi\Lambda^{-2}\rho^{-2}\left(\Lambda - \gamma(\eta\gamma + \mu)\right)^2\sigma_x^2$$

$$E(L_{ii}^*) = 0.5\Phi^*\Lambda^{-2}\rho^{-2}\gamma^2(\eta\gamma + \mu)^2\sigma_x^2.$$

If the weights given to employment are equal the loss of the union where the origin of the shock is, is larger then the loss of the outside country. The smaller γ, i.e. the smaller the degree of openness, the smaller is the loss of the outside country. Moreover the magnitude of losses increases with a larger weight on employment.

On the other hand the two losses under an exchange rate target are as follows:

$$E(L_{ie}) = 0.5\Phi\Lambda_{ie}^{-2}\rho^{-2}\left(\Lambda_{ie} - \gamma(\eta\gamma + \mu)\right)^2\sigma_x^2$$

$$E(L_{ie}^*) = 0.5\Lambda_{ie}^{-2}\rho^{-2}(\eta\gamma + \mu)^2\left(\rho^2 + \Phi^*(1-\gamma)^2\right)\sigma_x^2.$$

Comparing the loss of an inflation target regime with the loss of an exchange target regime for the ECB we deduce the difference of the two losses and use that $\Lambda_{ie} = \Lambda + \alpha(1 - 2\gamma)(\eta\gamma + \mu)$ holds. For the difference of the losses we obtain (values of the coefficients are shown in appendix B):

$$E(L_{ii}) - E(L_{ie}) = 0.5\Phi\gamma\alpha(\eta\gamma + \mu)^2 \Lambda_{ie}^{-2} \Lambda^{-2} \rho^{-2} (1 - 2\gamma)\Gamma_{11} \sigma_x^2 .$$

Since Γ_{11}<0 the sign of the difference depends only on the sign of $(1 - 2\gamma)$. If $(1 - 2\gamma)$>0, i.e. γ<1/2, then $E(L_{ii}) - E(L_{ie})$<0 and therefore the loss under inflation targeting is smaller than the loss under an ERM regime. If on the other hand $(1 - 2\gamma)$<0, i.e. γ>1/2, then $E(L_{ii}) - E(L_{ie})$>0 and the ECB is worse off under inflation targeting then under an ERM regime. Remembering that γ is the marginal (and average) propensity to import we would expect a value of γ smaller then 1/2 and therefore the ECB will be better off under inflation targeting. These findings reflect the usual argument that fixed exchange rates do not handle asymmetric shocks very well. If the ECB gives no weight to employment the two regimes are equal and coincides with the Nash solution.

What about the outside country if a supply shock in the monetary union occurs. The difference of the two losses turns out to be

$$E(L_{ii}^*) - E(L_{ie}^*) = 0.5(\eta\gamma + \mu)^2 \Lambda_{ie}^{-2} \Lambda^{-2} \rho^{-2} \left(\Phi^* (1 - 2\gamma)\Gamma_{31} - \Lambda^2 \rho^2\right)\sigma_x^2$$

with Γ_{31}<0.

From this expression it follows immediately that the outside central bank should prefer inflation if the weight on employment is zero. Furthermore we can deduce that the difference is negative for $(1 - 2\gamma) \geq 0$, i.e. $\gamma \leq 1/2$. In this case the outside country is better off with inflation targeting just as the EMU.

On the other hand for $(1 - 2\gamma)$<0, γ>1/2 the sign of this difference is not unambiguous and it depends on the parameters of the model and the weight given to employment if inflation targeting is superior to an ERM regime or not. In appendix C we calculate the losses for different specifications of γ and Φ^*. To all other parameters we assign a fixed value: α=0.7, λ=0.5, ε=0.4, η=0.85, δ=0.7 and Φ=0.1. We consider two values for γ namely γ=0.6 and γ=0.75 and three values for Φ^*, Φ^*=0.1 (outside country gives the same weight to employment than the ECB), Φ^*=0.2 (outside country gives a higher weight to employment than the ECB) and Φ^*=0.5 (outside country gives a very high relative weight to employment). The parameters are not estimated, they are simply selected to be not unreasonable. From these calculations we found that for the outside central bank inflation targeting is in most situations better than an exchange rate targeting, except the outside central bank gives an extremely high weight to employment and the marginal propensity to import is large (γ=0.75, Φ^*=0.5), a scenario which is rather unrealistic. For all plausible parameter values inflation targeting is undoubtedly the better policy. These findings are consistent with the results of Canzoneri, Nolan and Yates (1997) and Person and Tabellini (1996).

c) A Unilateral Supply Shock in the Outside Country

Next we assume that the supply shock hits only the country outside the union, i.e. $x = 0, x^* > 0$.

The analysis of the loss functions for this kind of shock gives the following loss under cooperative loss minimization :

$$E(L_{co}) = \frac{0.5\left(\Lambda^2\rho^2\left(\varphi_{q1}\gamma(\eta\gamma+\mu)+\varphi_{q3}\right)^2+\Phi(\varphi_{n1}\gamma(\eta\gamma+\mu)+\varphi_{n3})^2\right)\sigma_{x^*}^2}{\Lambda^2\rho^2\left(\varphi_3\varphi_4-\left(\Phi+\Phi^*\right)\varphi_1^2\varphi_2^2\right)^2}$$

$$E(L_{co}^*) = \frac{0.5\left(\Lambda^2\rho^2\left(\varphi_{q^*1}\gamma(\eta\gamma+\mu)+\varphi_{q^*3}\right)^2+\Phi^*\left(\varphi_{n^*1}\gamma(\eta\gamma+\mu)+\varphi_{n^*3}\right)^2\right)\sigma_{x^*}^2}{\Lambda^2\rho^2\left(\varphi_3\varphi_4-\left(\Phi+\Phi^*\right)\varphi_1^2\varphi_2^2\right)^2}$$

We get the expected losses for the union and the outside country for the Nash solution.

$$E(L_{na}) = \frac{0.5\Phi\left(\Phi\varphi_1^2+\Lambda^2\rho^2\right)\left(\Lambda\Phi^*\varphi_1\varphi_2-\gamma\left(\psi_2+\Phi^*\varphi_1\varphi_2\right)(\eta\gamma+\mu)\right)^2\sigma_{x^*}^2}{\left(\psi_1\psi_2-\Phi\Phi^*\varphi_1^2\varphi_2^2\right)^2}$$

$$E(L_{na}^*) = \frac{0.5\Phi^*\left(\Phi^*\varphi_1^2+\Lambda^2\rho^2\right)\left(\Lambda\psi_1-\gamma(\psi_1+\Phi\varphi_1\varphi_2)(\eta\gamma+\mu)\right)^2\sigma_{x^*}^2}{\left(\psi_1\psi_2-\Phi\Phi^*\varphi_1^2\varphi_2^2\right)^2}$$

If both countries have an inflation target one obtains the following loss:

$$E(L_{ii}) = 0.5\Phi\Lambda^{-2}\rho^{-2}\gamma^2(\eta\gamma+\mu)^2\sigma_{x^*}^2$$

$$E(L_{ii}^*) = 0.5\Phi^*\Lambda^{-2}\rho^{-2}\left(\Lambda-\gamma(\eta\gamma+\mu)\right)^2\sigma_{x^*}^2 .$$

One sees that the loss in the outside country is larger (if the weights are similar) since this country is hit originally by the shock. Next we deduce the loss in the ERM regime.

$$E(L_{ie}) = 0.5\Phi\Lambda_{ie}^{-2}\rho^{-2}\gamma^2(\eta\gamma+\mu)^2\sigma_{x^*}^2$$

$$E(L_{ie}^*) = 0.5\Phi^*\Lambda_{ie}^{-2}\rho^{-2}\left((\eta\gamma+\mu)^2\rho^2+\Phi^*\left(\Lambda_{ie}-(1-\gamma)(\eta\gamma+\mu)\right)^2\right)\sigma_{x^*}^2 .$$

What kind of policy is better for the ECB? The difference of losses is the following:

$$E(L_{ii}) - E(L_{ie}) = 0.5\Phi\gamma\alpha(\eta\gamma + \mu)^2 \Lambda_{ie}^{-2} \Lambda^{-2} \rho^{-2} (1 - 2\gamma)\Gamma_{13} \sigma_{x^*}^2 .$$

Since $\Gamma_{13} > 0$, it depends only on the value of γ if inflation targeting or an fixed exchange rate regime is better for the ECB. For $\gamma > 1/2$ it follows that $E(L_{ii}) - E(L_{ie}) < 0$ and inflation targeting is better, for $\gamma < 1/2$ $E(L_{ii}) - E(L_{ie}) > 0$ holds and therefore inflation targeting gives a higher loss. The ranking of policies is just the opposite as in case of a unilateral supply shock in the monetary union. Once again the two regimes are equivalent to the Nash solution if the ECB gives no weight to employment.

We have seen that the advantages of a particular regime for the ECB depend mainly on the origin of the supply shock and on the value of the marginal propensity to import.

Next we investigate the situation for the country outside the monetary union. After some algebra we obtain the difference of losses as

$$E(L_{ii}^*) - E(L_{ie}^*) =$$

$$\frac{0.5(\eta\gamma + \mu)\left((\eta\gamma + \mu)\Lambda_{ie}^{-1}\Lambda^{-1}\left(\Phi^*(1-2\gamma)\Gamma_{31} - \Lambda^2\rho^2\right) + 2\Phi^*(1-2\gamma)\Gamma_{32}\right)\sigma_{x^*}^2}{\Lambda_{ie}\Lambda\rho^2}$$

with $\Gamma_{32} > 0$.

Except the extreme case $\Phi^* = 0$, where an inflation target should be preferred the sign of this difference is not unambiguous and it depends on the parameters of the model if inflation targeting is superior to an ERM regime or not. With the same parameter specifications as before but for γ now using four values namely $\gamma = 0.3$, $\gamma = 0.4$, $\gamma = 0.6$ and $\gamma = 0.75$ we evaluate the loss for the outside country under different policy regimes. For $\gamma = 0.5$ it can easily be seen that inflation targeting gives a smaller loss than an exchange rate target. Our calculations suggest that for almost every situation inflation targeting is less costly then an ERM II. For values of $\gamma > 0.5$ inflation targeting comes always next to the cooperative solution. If $\gamma < 0.5$ it depends also on the weight on employment if inflation targeting or an ERM II is better for the outside CB. For small weights inflation targeting is better then ERM II, but the situation is inverted if the weight increases.

2. Demand Shocks

a) Symmetric Demand Shocks

In the special case of symmetric demand shocks $u = u^* > 0$ we get

$$E(L_{co}) = E(L_{na}) = E(L_{ii}) = E(L_{ie}) = 0$$

for the monetary union and for the loss of the outside central bank respectively

$$E(L^*_{co}) = E(L^*_{na}) = E(L^*_{ii}) = E(L^*_{ie}) = 0$$

For both countries the loss under an ERM and the loss under inflation targeting are equal to zero and correspond to the cooperative and the Nash solution. Therefore from the point of loss-minimizing the central banks are indifferent between inflation targeting and exchange rate targeting and these two regimes coincide with an optimal policy.

b) Unilateral Demand Shocks

Next we assume that a demand disturbance occurs only in one country either in the monetary union $u > 0, u^* = 0$ or in the outside country $u = 0, u^* > 0$. Since the coefficients of the variances are equal in both cases the results are the same independent of the origin of the demand shock.

The expected losses in case of a cooperative solution are:

$$E(L_{co}) = 0.5\Lambda^{-2}\left(\varphi_3\varphi_4 - \left(\Phi + \Phi^*\right)\varphi_1^2\varphi_2^2\right)^{-2}\left(\varphi_{q1}^2\rho^2 + \Phi\varphi_{n1}^2\right)\gamma^2\sigma_u^2 \quad (\text{or } \sigma_{u^*}^2)$$

$$E(L^*_{co}) = 0.5\Lambda^{-2}\left(\varphi_3\varphi_4 - \left(\Phi + \Phi^*\right)\varphi_1^2\varphi_2^2\right)^{-2}\left(\varphi_{q^*1}^2\rho^2 + \Phi^*\varphi_{n^*1}^2\right)\gamma^2\sigma_u^2 \quad (\text{or } \sigma_{u^*}^2)$$

Given a Nash solution the losses are:

$$E(L_{na}) = 0.5\Phi\gamma^2\rho^2\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)^{-2}\left(\Phi\varphi_1^2 + \Lambda^2\rho^2\right)\left(\psi_2 + \Phi^*\varphi_1\varphi_2\right)^2\sigma_u^2$$
(or $\sigma_{u^*}^2$)

$$E(L^*_{na}) = 0.5\Phi^*\gamma^2\rho^2\left(\psi_1\psi_2 - \Phi\Phi^*\varphi_1^2\varphi_2^2\right)^{-2}\left(\Phi^*\varphi_1^2 + \Lambda^2\rho^2\right)\left(\psi_1 + \Phi\varphi_1\varphi_2\right)^2\sigma_u^2$$
(or $\sigma_{u^*}^2$)

For the expected loss of the ECB under inflation targeting we obtain

$$E(L_{ii}) = 0.5\Phi\Lambda^{-2}\gamma^2\sigma_u^2 \quad (\text{or } \sigma_{u^*}^2)$$

and for the loss of the outside central bank respectively

$$E(L_{ii}^*) = 0.5\Phi^*\Lambda^{-2}\gamma^2\sigma_u^2 \quad (\text{or } \sigma_{u^*}^2).$$

Deducing the loss under the exchange rate system we get

$$E(L_{ie}) = 0.5\Phi\Lambda_{ie}^{-2}\gamma^2\sigma_u^2 \quad (\text{or } \sigma_{u^*}^2)$$

$$E(L_{ie}^*) = 0.5\Lambda_{ie}^{-2}\left((1-2\gamma)^2\rho^2 + \Phi^*(1-\gamma)^2\right)\sigma_u^2 \quad (\text{or } \sigma_{u^*}^2).$$

Comparing the loss of the ECB under an ERM II with the loss under inflation targeting we obtain that the difference of the losses under the two regimes depends only on the sign of $(1-2\gamma)$. For $(1-2\gamma)>0$, i.e. $\gamma<1/2$ the loss under an ERM regime is smaller than the loss under inflation targeting. For $(1-2\gamma)=0$, i.e. $\gamma=1/2$ the ECB is indifferent between the two regimes and for $(1-2\gamma)<0$, i.e. $\gamma>1/2$ inflation targeting is better then an ERM regime. As we supposed already at the supply shock, $\gamma<1/2$ is the more plausible case and therefore the ECB is better off under an ERM II.

$$E(L_{ii}^*) - E(L_{ie}^*) = 0.5\Lambda_{ie}^{-2}\Lambda^{-2}\left(\Phi^*(1-2\gamma)\Gamma_2 - \Lambda^2\rho^2(1-2\gamma)^2\right)\sigma_u^2$$

with $\Gamma_2 <0$.

Since Γ_2 is negative and the second term is clearly positive the difference of the losses is unambiguously negative for $\gamma<1/2$ and inflation targeting is better for the outside country. For $\gamma=1/2$ the outside CB is indifferent between the two policies and if the marginal propensity to import is larger than 1/2 the sign of the difference is ambiguous, except the extreme case that the central bank does not care about employment Φ^*, in this case it is obvious that the central bank should target inflation. In appendix C we run some calculations to investigate this case for two values for γ namely $\gamma=0.6$ and $\gamma=0.75$ and three values for Φ^*, $\Phi^*=0.1$, $\Phi^*=0.2$ and $\Phi^*=0.5$. First it follows from our calculations that the loss of a demand shock is much smaller then the loss of a supply shock. Furthermore we obtain that the outside central bank is better off with an exchange rate target even if the weight on employment is small, since the exchange rate target comes next to the cooperative solution. A unilateral

demand shock leads to a conflict of the preferred regime if the weights on employment are positive because the ECB prefers inflation targeting in both countries whereas the outside CB prefers to target the exchange rate for $\gamma > 1/2$ and the other way round for $\gamma < 1/2$.

V. Conclusions

What policy regime should the ECB and an outside central bank choose after the introduction of the single currency in Europe? In this paper we investigated two possible regimes namely inflation targeting in both countries and an exchange rate target like the ERM. These two regimes are compared with the cooperative and the Nash solution.

We distinguish the effects of various supply and demand shocks on the domestic and the foreign economy. If we turn first to supply shocks we see that if a symmetric supply shock occurs the two policies are equivalent. The situation is more complex in case of a unilateral shock. If the unilateral shock has its origin in the monetary union than both central banks are better off with implementing an inflation target as long as the marginal propensity to import γ is smaller or equal to 0.5. If $\gamma > 1/2$ the ECB prefers an ERM whereas the outside central bank continues to prefer inflation targeting in both countries. If the supply shock hits only the country outside the monetary union and $\gamma < 1/2$ the ECB is better off if the outside bank targets the exchange rate, and so is the outside central bank if the weight on employment is large. For smaller weights the outside central bank should choose an inflation target. If $\gamma > 1/2$ inflation targeting is superior to an ERM II for both central banks.

Looking at a demand shock we obtain that a symmetric demand shock does not affect the two economies and both policies are equal and coincide with the cooperative solution. In case of a unilateral shock (independent of its origin) the ECB prefers an ERM II if $\gamma < 1/2$ and inflation targeting for $\gamma > 1/2$. The ranking of policies is reversed if we look to the outside central bank. The outside central bank prefers inflation targeting if $\gamma < 1/2$ and an exchange rate target regime for $\gamma > 1/2$ unless the weight to employment is too small (a weight of 0.1 is sufficient that the ERM II is superior to inflation targeting). In this case we obtain obviously a conflict about the preferred policy between the central banks.

From our findings we can conclude that the outside central bank is better off if it follows a policy of inflation targeting as long as the economy is not too open and the weight on employment is not too large.

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VII. Appendix A

Coefficients of variables for the cooperative solution

$$q = \frac{\left(\varphi_{q1}\gamma\left(\rho\left(u^* - u\right) - \left(\eta\gamma + \mu\right)\left(x - x^*\right)\right) + \varphi_{q2}x + \varphi_{q3}x^*\right)}{\left(\varphi_3\varphi_4 - \left(\Phi + \Phi^*\right)^2\varphi_1^2\varphi_2^2\right)}$$

$$q^* = \frac{\left(\varphi_{q^*1}\gamma\left(\rho\left(u^* - u\right) - \left(\eta\gamma + \mu\right)\left(x - x^*\right)\right) + \varphi_{q^*2}x + \varphi_{q^*3}x^*\right)}{\left(\varphi_3\varphi_4 - \left(\Phi + \Phi^*\right)^2\varphi_1^2\varphi_2^2\right)}$$

$$n = \frac{\left(\varphi_{n1}\gamma\left(\rho\left(u^* - u\right) - \left(\eta\gamma + \mu\right)\left(x - x^*\right)\right) + \varphi_{n2}x + \varphi_{n3}x^*\right)}{\Lambda\rho\left(\varphi_3\varphi_4 - \left(\Phi + \Phi^*\right)^2\varphi_1^2\varphi_2^2\right)}$$

$$n^* = \frac{\left(\varphi_{n^*1}\gamma\left(\rho\left(u^* - u\right) - \left(\eta\gamma + \mu\right)\left(x - x^*\right)\right) + \varphi_{n^*2}x + \varphi_{n^*3}x^*\right)}{\Lambda\rho\left(\varphi_3\varphi_4 - \left(\Phi + \Phi^*\right)^2\varphi_1^2\varphi_2^2\right)}$$

with

$$\varphi_{q1} = \varphi_4\left(\Phi\varphi_1 - \Phi^*\varphi_2\right) - \varphi_1\varphi_2\left(\Phi + \Phi^*\right)\left(\Phi\varphi_2 - \Phi^*\varphi_1\right)$$

$$\varphi_{q2} = \Phi\varphi_1\Lambda\left(\varphi_4 - \left(\Phi + \Phi^*\right)\varphi_2^2\right)$$

$$\varphi_{q3} = \Phi^*\varphi_2\Lambda\left(\varphi_4 - \left(\Phi + \Phi^*\right)\varphi_1^2\right)$$

$$\varphi_{q^*1} = \varphi_3\left(\Phi\varphi_2 - \Phi^*\varphi_1\right) - \varphi_1\varphi_2\left(\Phi + \Phi^*\right)\left(\Phi\varphi_1 - \Phi^*\varphi_2\right)$$

$$\varphi_{q^*2} = \Phi\varphi_2\Lambda\left(\varphi_3 - \left(\Phi + \Phi^*\right)\varphi_1^2\right)$$

$$\varphi_{q^*3} = \Phi^*\varphi_1\Lambda\left(\varphi_3 - \left(\Phi + \Phi^*\right)\varphi_2^2\right)$$

$$\varphi_{n1} = \varphi_2\varphi_3\left(\Phi\varphi_2 - \Phi^*\varphi_1\right) - \varphi_4\left(\Phi^*\varphi_2\Lambda + \Lambda^2\rho^2\right) + \varphi_1\varphi_2\left(\Phi + \Phi^*\right)\left(\Phi^*\Lambda^2 - \varphi_2\varphi_1\left(\Phi + \Phi^*\right)\right)$$

$$\varphi_{n2} = \Lambda\left(\Phi\left(\varphi_1^2\varphi_4 + \varphi_2^2\varphi_3\right) + \varphi_1^2\varphi_2^2\left(\Phi + \Phi^*\right)\left(\Phi^* - \Phi\right) - \varphi_3\varphi_4\right)$$

$$\varphi_{n3} = \Phi^*\varphi_1\varphi_2\Lambda\left(\left(\varphi_4 + \varphi_3\right) - \left(\Phi + \Phi^*\right)\left(\varphi_1^2 + \varphi_2^2\right)\right)$$

$$\varphi_{n^*1} = \varphi_1\varphi_3\left(\Phi\varphi_2 - \Phi^*\varphi_1\right) + \varphi_4\left(\Phi\varphi_1\Lambda + \Lambda^2\rho^2\right) - \varphi_1\varphi_2\left(\Phi + \Phi^*\right)\left(\Phi\Lambda^2 - \varphi_2\varphi_1\left(\Phi + \Phi^*\right)\right)$$

$$\varphi_{n^*2} = \Phi\varphi_1\varphi_2\Lambda\left(\left(\varphi_4 + \varphi_3\right) - \left(\Phi + \Phi^*\right)\left(\varphi_1^2 + \varphi_2^2\right)\right)$$

$$\varphi_{n^*3} = \Lambda\left(\Phi^*\left(\varphi_1^2\varphi_3 + \varphi_2^2\varphi_4\right) - \varphi_1^2\varphi_2^2\left(\Phi + \Phi^*\right)\left(\Phi^* - \Phi\right) - \varphi_3\varphi_4\right)$$

$$\mu = \left(1 - \eta\left(1 - \gamma\right)\right) > 0$$

$$\rho = \left(1 - \alpha\right) > 0$$

$$\Lambda = 2\alpha\gamma\left(\mu + \eta\gamma\right) + \rho\left(\varepsilon\left(2\gamma - 1\right)^2 + 2\delta\right) > 0$$

$$\varphi_1 = \Lambda - \alpha\gamma\left(\mu + \eta\gamma\right) > 0$$

$$\varphi_2 = \alpha\gamma\left(\mu + \eta\gamma\right) > 0$$

$$\varphi_3 = \Lambda^2\rho^2 + \Phi\varphi_1^2 + \Phi^*\varphi_2^2 > 0$$

$$\varphi_4 = \Lambda^2\rho^2 + \Phi\varphi_2^2 + \Phi^*\varphi_1^2 > 0$$

VIII. Appendix B

Loss of inflation target -loss of ERM for the ECB in case of a supply shock

$$E(L_{ii}) - E(L_{ie}) = 0.5\Phi\gamma\alpha\left(\eta\gamma + \mu\right)^2\Lambda_{ie}^{-2}\Lambda^{-2}\rho^{-2}\left(1 - 2\gamma\right)\left(\Gamma_{11}\sigma_x^2 + \Gamma_{12}\sigma_{xx^*} + \Gamma_{13}\sigma_{x^*}^2\right).$$

$$\Gamma_{11} = -2\rho^2\left(\varepsilon\left(2\gamma - 1\right)^2 + 2\delta\right)^2 - 2\rho\left(\mu + \eta\gamma\right)\left(\varepsilon\left(2\gamma - 1\right)^2 + 2\delta\right)\left(\alpha + \gamma\left(2\alpha - 1\right)\right)$$
$$- \alpha\gamma\left(\mu + \eta\gamma\right)^2\left(4\alpha - \left(1 + 2\gamma\right)\right) < 0$$

$$\Gamma_{12} = 2\rho^2\left(\varepsilon(2\gamma-1)^2+2\delta\right)^2 + 2\rho(\mu+\eta\gamma)\left(\varepsilon(2\gamma-1)^2+2\delta\right)(\alpha-2\rho\gamma)$$
$$-2\alpha\gamma(\mu+\eta\gamma)^2(1+2\gamma-2\alpha)$$
$$\Gamma_{13} = \gamma(\mu+\eta\gamma)\left(\alpha(\mu+\eta\gamma)(1+2\gamma)+2\rho\left(\varepsilon(2\gamma-1)^2+2\delta\right)\right) > 0$$

Loss of inflation target -loss of ERM
for the outside CB in case of a demand shock

$$E(L_{ii}^*) - E(L_{ie}^*) = 0.5\Lambda_{ie}^{-2}\Lambda^{-2}\left(\Phi^*(1-2\gamma)\Gamma_2 - \Lambda^2\rho^2(1-2\gamma)^2\right)\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right).$$

$$\Gamma_2 = (2\gamma-3)\alpha^2\gamma^2(\mu+\eta\gamma)^2 - \rho^2\left(\varepsilon(2\gamma-1)^2+2\delta\right)^2$$
$$+2\alpha\gamma\rho(\gamma-1)(\mu+\eta\gamma)\left(\varepsilon(2\gamma-1)^2+2\delta\right) < 0$$

Loss of inflation target -loss of ERM
for the outside CB in case of a supply shock

$$E(L_{ii}^*) - E(L_{ie}^*) = 0.5(\eta\gamma+\mu)\Lambda_{ie}^{-1}\Lambda^{-1}\rho^{-2} *$$
$$\left\{(\eta\gamma+\mu)\Lambda_{ie}^{-1}\Lambda^{-1}\left(\Phi^*(1-2\gamma)\Gamma_{31} - \Lambda^2\rho^2\right)\left(\sigma_x^2 - 2\sigma_{xx^*} + \sigma_{x^*}^2\right)\right.$$
$$\left.+2\Phi^*(1-2\gamma)\Gamma_{32}\left(\sigma_x^2 - \sigma_{xx^*}\right)\right\}$$

$$\Gamma_{31} = -\rho^2\left(\varepsilon(2\gamma-1)^2+2\delta\right)^2 - 2\alpha\gamma\rho(\mu+\eta\gamma)\left(\varepsilon(2\gamma-1)^2+2\delta\right)(2-\gamma)$$
$$+\alpha^2\gamma^2(2\gamma-3)(\mu+\eta\gamma)^2 < 0$$

$$\Gamma_{32} = \alpha\gamma(\mu+\eta\gamma) + \rho\left(\varepsilon(2\gamma-1)^2+2\delta\right)^2 > 0$$

IX. Appendix C

Loss for the Outside Country for a Unilateral Supply Shock in the Union

	$E(L^*_{co})$	$E(L^*_{na})$	$E(L^*_{ii})$	$E(L^*_{ie})$
γ=0.6, Φ^*=0.5	.12672 σ_x^2	.16121 σ_x^2	.6909 σ_x^2	1.229 σ_x^2
γ=0.75, Φ^*=0.5	.16093 σ_x^2	.22834 σ_x^2	.83759 σ_x^2	.65274 σ_x^2
γ=0.6, Φ^*=0.2	.09299 σ_x^2	.10679 σ_x^2	.27636 σ_x^2	.59973 σ_x^2
γ=0.75, Φ^*=0.2	.11803 σ_x^2	.1458 σ_x^2	.33504 σ_x^2	.55188 σ_x^2
γ=0.6, Φ^*=0.1	.06538 σ_x^2	.068294 σ_x^2	.13818 σ_x^2	.52108 σ_x^2
γ=0.75, Φ^*=0.1	.08239 σ_x^2	.090898 σ_x^2	.16752 σ_x^2	.51823 σ_x^2

Loss for the Outside Country for a Unilateral Supply Shock in the Outside Country

	$E(L^*_{co})$	$E(L^*_{na})$	$E(L^*_{ii})$	$E(L^*_{ie})$
γ=0.3, Φ^*=0.5	.28733 $\sigma_{x^*}^2$	.31321 $\sigma_{x^*}^2$	1.4545 $\sigma_{x^*}^2$	.92792 $\sigma_{x^*}^2$
γ=0.4, Φ^*=0.5	.21968 $\sigma_{x^*}^2$	.8704 $\sigma_{x^*}^2$	1.0913 $\sigma_{x^*}^2$	1.0485 $\sigma_{x^*}^2$
γ=0.6, Φ^*=0.5	.12842 $\sigma_{x^*}^2$	.16356 $\sigma_{x^*}^2$	.698 $\sigma_{x^*}^2$	1.5231 $\sigma_{x^*}^2$
γ=0.75, Φ^*=0.5	.09622 $\sigma_{x^*}^2$	.12845 $\sigma_{x^*}^2$	.56471 $\sigma_{x^*}^2$	2.0633 $\sigma_{x^*}^2$
γ=0.3, Φ^*=0.2	.21774 $\sigma_{x^*}^2$	.22639 $\sigma_{x^*}^2$	.5818 $\sigma_{x^*}^2$	.53207 $\sigma_{x^*}^2$
γ=0.4, Φ^*=0.2	.16259 $\sigma_{x^*}^2$	.17615 $\sigma_{x^*}^2$	.43653 $\sigma_{x^*}^2$	.62371 $\sigma_{x^*}^2$
γ=0.6, Φ^*=0.2	.09421 $\sigma_{x^*}^2$	.10834 $\sigma_{x^*}^2$	.2792 $\sigma_{x^*}^2$	.8747 $\sigma_{x^*}^2$
γ=0.75, Φ^*=0.2	.071597 $\sigma_{x^*}^2$	.082018 $\sigma_{x^*}^2$	.22588 $\sigma_{x^*}^2$	1.116 $\sigma_{x^*}^2$
γ=0.3, Φ^*=0.1	.15517 $\sigma_{x^*}^2$	.15934 $\sigma_{x^*}^2$	.2909 $\sigma_{x^*}^2$	.40012 $\sigma_{x^*}^2$
γ=0.4, Φ^*=0.1	.11367 $\sigma_{x^*}^2$	.11934 $\sigma_{x^*}^2$	.21826 $\sigma_{x^*}^2$	.4821 $\sigma_{x^*}^2$
γ=0.6, Φ^*=0.1	.066197 $\sigma_{x^*}^2$	.069289 $\sigma_{x^*}^2$	.1396 $\sigma_{x^*}^2$	.65856 $\sigma_{x^*}^2$
γ=0.75, Φ^*=0.1	.05112 $\sigma_{x^*}^2$	.051133 $\sigma_{x^*}^2$	.11294 $\sigma_{x^*}^2$	.80027 $\sigma_{x^*}^2$

Loss for the Outside Country for Demand Shocks

	$E(L^*_{co})$	$E(L^*_{na})$
γ=0.6, Φ^*=0.5	$.01145\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.02125\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.75, Φ^*=0.5	$.008528\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.01976\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.6, Φ^*=0.2	$.01019\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.01075\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.75, Φ^*=0.2	$.008219\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.00826\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.6, Φ^*=0.1	$.005874\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.00601\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.75, Φ^*=0.1	$.006719\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.00677\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$

	$E(L^*_{ii})$	$E(L^*_{ie})$
γ=0.6, Φ^*=0.5	$.04542\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.02702\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.75, Φ^*=0.5	$.03712\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.01283\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.6, Φ^*=0.2	$.01817\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.01151\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.75, Φ^*=0.2	$.01485\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.00835\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.6, Φ^*=0.1	$.00909\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.00634\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$
γ=0.75, Φ^*=0.1	$.00742\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$	$.00686\left(\sigma_u^2 - 2\sigma_{uu^*} + \sigma_{u^*}^2\right)$

European Monetary Union and the CEECs - Who's In and Who's Out

Christiane Nickel

I. Introduction

Stage Three of the European Monetary Union (EMU) began on January 1, 1999, and the next challenge the European Union faces is its enlargement. The decision whether or not a new member country is admitted to the Union depends on the fulfillment of the Copenhagen criteria established by the European Council in 1993. One of the three criteria is the ability to take on the obligations of membership, including adherence to the aims of political, economic and monetary union. So far, the applicants for membership consist of a "first wave" group including the Czech Republic, Estonia, Hungary, Poland, Slovenia, and Cyprus, a "second wave" group comprising Bulgaria, Latvia, Lithuania, Romania, and Slovakia which should follow on a somewhat slower lane to membership, and further applicants like Turkey and Malta. A possible enlargement towards the EFTA countries (Switzerland, Norway, Iceland) is always in discussion but these countries have not yet applied for membership.

Since each new EU member is a potential candidate for EMU, two questions arise: First, how can the system work best for the future? Second, how fit are the EU candidates for EMU? An answer to the first question lies in the newly established Exchange Rate Mechanism (ERM II) which aims at linking potential member countries to the Euro, with a view to prepare them for EMU membership. However, the objective of this paper is to shed some light on the second question. One implication of monetary unification is that economies have to absorb shocks without using monetary policy or the exchange rate instrument. In addition, due to the stability pact, there are also limits to the use of fiscal policy for macroeconomic stabilization. How serious these limitations are mainly depends on the degree of symmetry in shocks. Where there is no large symmetry in shocks, the region should have alternative means to offset the asymmetries. These means include wage and price flexibility, factor mobility and industrial diversification. To measure the ability of a country to join EMU we expand an approach first applied by Bayoumi and Eichengreen (1997). Our paper refines their method and

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examines EMU countries, non EMU EU countries, first and second wave EU candidates, the Mediterranean applicants (Turkey, Malta), the US and Canada.

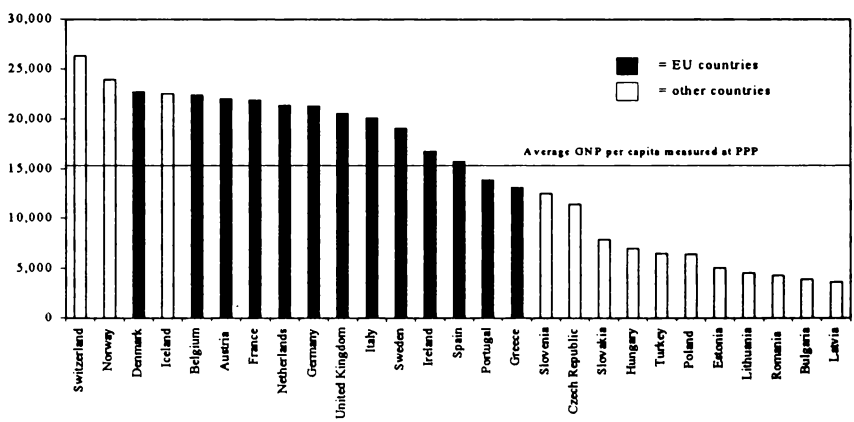
The paper is structured as follows: Section II presents a survey of relevant data for the countries in question. Section III explains the theoretical basis and the estimation methodology. Section IV shows the results of the empirical investigation about the countries' ability to join EMU. Section V contains the summary and conclusions.

II. Stylized Facts

In this section, we take a look at the progress made so far by the countries that aspire to join the EU and later on EMU. It focuses on facts that are closely related to the optimum currency area theory. Hence, we focus more on the prospects for an EMU rather than an EU membership even though these topics are interdependent. We compare the data for the EU countries with data for the EFTA countries, the first wave EU candidates, the second wave EU candidates, and further EU applicants (Malta, Turkey). We cross-examine output growth, per capita GNP levels, the size of the economies, their trade relations, their production structure, and their performance concerning the Maastricht criteria.

Output declines during the transition have been very large. However, the worst is over in the central and eastern European economies; growth rates became positive in 1993-94 (Fischer/Sahay/Végh, 1998, p. 5-6). Compared to the EU or the EFTA countries, it can be seen in Appendix II that the average annual GDP growth rate from 1990-1997 was very low or negative for most CEECs with the exception of Poland which grew by 3.9 percent. However, comparing the real GDP growth rates in 1997 with the average growth rates of previous years confirms that in the meanwhile the CEECs are growing faster than the EU or EFTA countries. While the annual growth rate in the EMU member countries was 3.7 percent (on average), the average growth rate in the first wave countries was 5.3 percent. Most remarkable is Estonia's GDP growth rate which climbed to 11.4 percent in 1997 while it declined on average annually by 4.3 percent between 1990 and 1997. With an average growth rate of 5.2 percent, Turkey and Malta represent almost the same picture as the first wave candidates. Even for the second wave countries, growth was on average higher than in the EU or EFTA countries. These data suggest that the CEECs are catching up. However, Fischer, Sahay, and Végh (1998, p. 33-34) calculated that if growth continues like this in the CEECs it still should take them 20 years to reach current OECD per capita levels. The following figure *1* reveals how dramatic the difference between the EU countries and the CEECs per capita is.

Figure *1* shows the GNP per capita levels of the countries in question converted into international dollars using the purchasing power parity (PPP) exchange rate. At the PPP rate, the GNP levels allow a standard comparison between countries because one dollar has the same purchasing power over domestic GNP that the US dollar has over U.S. GNP. While EU members exhibit a per capita GNP measured at PPP exchange rates around $19,000, the first wave EU candidates enjoy less than half of this number. For the second wave candidates, the difference is even more striking: here, the average is $5,075. The Turkish per capita GNP measured at PPP exchange rates is between these two numbers. A look at individual countries reveals that only the Czech Republic and Slovenia come close to at least the Greece's level of per capita GNP. The EFTA countries are all among the highest per capita GNP levels.



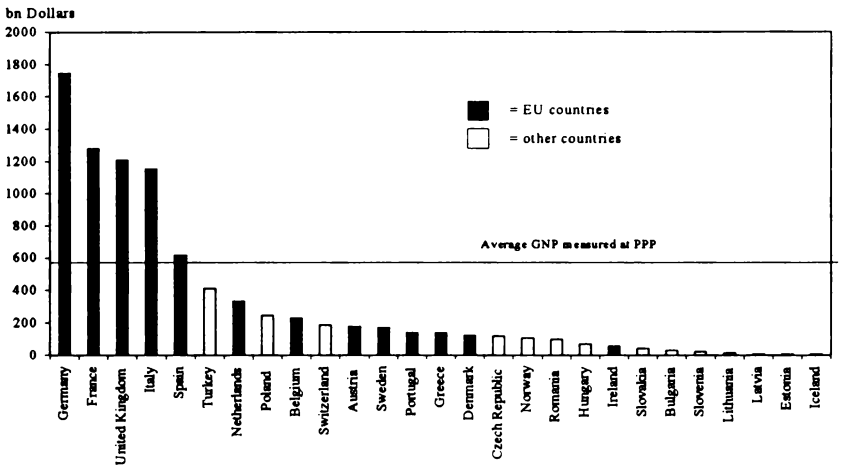
Data Source: World Bank (1998): World Development Report 1998/99.

Figure 1: Gross National Product per Capita in 1997 Measured Using Purchasing Power Parity Exchange Rates (US Dollars)

While the GNP per capita measured at PPP rates is a welfare indicator, the size of an economy is gauged by absolute GDP or GNP levels. For reasons of consistence, we do not assess nominal or real GDP levels here[1]; instead we review the absolute GNP measured at PPP exchange rates in 1997. This indicates that the difference between the EU countries and the CEECs is not that striking (Figure *2*). Poland, the Czech Republic, Romania, and Hungary are even larger than Ireland, the smallest EU country. However, all those countries are still relatively small. From the above it can be concluded that the

[1] See Appendix II for this kind of data.

CEECs are fairly poor and small countries. This implies that these countries will profit immensely from an entry into the EU and the EMU. Furthermore, an entry into the EU will give these countries a further incentive to converge to Maastricht standards in order to enter EMU. Integration will be fostered significantly.



Data Source: World Bank (1998): World Development Report 1998/99.

Figure 2: Absolute Gross National Product in 1997 Measured Using Purchasing Power Parity Exchange Rates (bn. US Dollars)

Another important criterion is the trade integration of the applicant countries into world trade and into EU trade. From table *1* it can be concluded that most of the CEECs are highly integrated into the international division of labor since foreign trade is a large share of their GDP. Furthermore, the geographical reorientation of trade towards the EU was part of the initial phase of the transition process the CEECs went through. This reorientation is an inevitable result of the collapse of the Comecon system. Obviously, the level of trade integration does not necessarily correspond to the level of political integration. Among the first wave candidates there are a lot of countries that exhibit as much trade integration with the EU as the EU countries do, however, the CEECs political integration is much less developed. The level of trade integration with the EU does not divide the country groups into non-EMU EU members, first wave candidates, EFTA countries, or the Mediterranean applicants. However, EU trade integration with the second wave candidates is still fairly low.

Table 1: Trade Integration with the EU (1997)

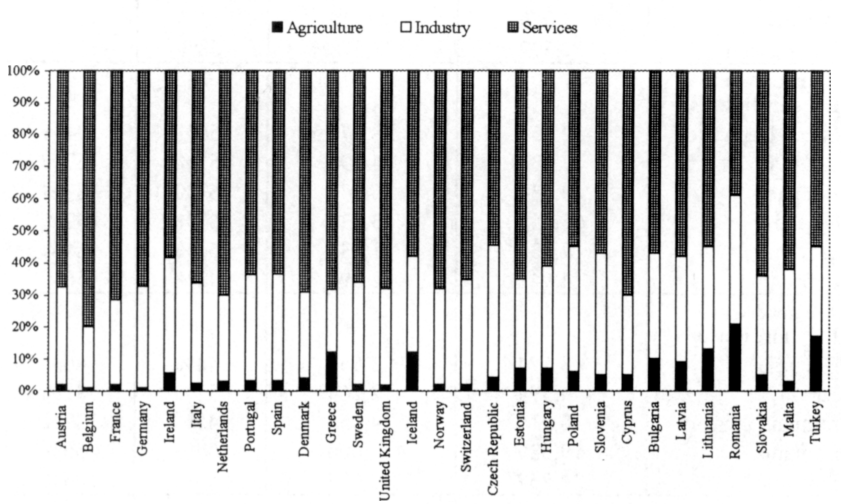
	Exports and Imports to and from the world mn. US dollars	Exports and Imports to and from the EU mn. US dollars	Share of EU Trade in % of total trade	Exports + Imports in % of nom. GDP
EMU members				
Austria	122,867	80,102	65%	60%
Belg./Lux.	321,668	228,138	71%	125%
Finland	69,098	37,653	54%	58%
France	559,334	340,277	61%	40%
Germany	947,416	520,446	55%	45%
Ireland	91,713	55,955	61%	127%
Italy	446,444	256,374	57%	39%
Netherlands	373,748	263,349	70%	104%
Portugal	56,656	43,766	77%	56%
Spain	226,887	152,283	67%	43%
Non-EMU EU-members				
Denmark	93,240	63,533	68%	55%
Greece	36,751	23,796	65%	31%
Sweden	148,133	87,155	59%	65%
U.K.	580,830	286,287	49%	44%
EFTA countries				
Iceland	3,859	2,272	59%	52%
Norway	83,059	60,920	73%	54%
Switzerland	151,597	103,578	68%	59%
"First wave" EU candidates				
Czech Republic	52,151	28,979	56%	94%
Estonia	7,037	4,592	65%	167%
Hungary	40,334	26,843	67%	83%
Poland	65,059	43,533	67%	47%
Slovenia	17,730	11,631	66%	84%
Cyprus	4,941	2,094	42%	56%
"Second wave" EU candidates				
Bulgaria	8,174	3,557	44%	80%
Latvia	4,394	2,264	52%	89%
Lithuania	8,916	4,056	45%	132%
Romania	19,529	10,600	54%	56%
Slovakia	21,857	10,073	46%	106%
Further EU applicants				
Malta	4,197	2,708	65%	126%
Turkey	74,902	37,083	50%	39%
Other countries				
Canada	428,029	31,804	7%	68%
USA	1,586,242	303,450	19%	20%

Data Source: IMF (1998): Direction of Trade Statistics Yearbook 1998.

To sum up, trade integration with the EU is at least as developed for the first wave candidates (excluding Cyprus), the Mediterranean and the EFTA countries as for the EU (or EMU) members. Regarding EMU entry, it can be inferred that these countries suffer from significant transaction costs due to e.g. currency conversion and accounting costs.

Moreover, we investigate the production structure of the countries in question. A basic but common way of doing this, is to review the value added as a percentage of GDP divided into the agricultural, the industrial and the service sector.

Within the group of the non-EMU EU members, Greece is the one with the highest share of agriculture in its GDP (12%). This observation reflects the notion that the production structure of Greece is least similar to the rest of the EU countries. Only Iceland, Lithuania, Romania, and Turkey show a similar or even bigger agricultural sector. This indicates that the production structure of at least the first wave candidates plus the EFTA countries Switzerland and Norway is not seriously different from the EU production structure even though the industry sector for some countries is still larger in size. In section III.1, the implication of a similar production structure will be discussed in the context of the optimum currency area theory.



Data Source: World Bank (1998): World Development Report 1998/99.

Figure 3: The Diversification of the Production Structure
(Value Added as a Percentage of GDP)

Table 2: Maastricht Convergence Criteria in 1996 and 1997

	Budget Deficit		Debt		Inflation		Interest Rates	
	96	97	96	97	96	97	96	97
EMU members								
Austria	-4.5	-2.5	72.3	66.1	2.4	1.2	6.2	5.7
Belgium	-3.9	-2.1	133.0	122.2	2.2	1.6	6.7	5.8
Finland	-1.7	-0.9	68.0	55.8	2.0	1.2	6.9	6.4
France	-4.7	-3.0	54.5	58.0	2.1	1.3	6.7	5.6
Germany	-3.4	-2.7	60.1	61.3	1.7	1.5	6.0	5.5
Ireland	-2.5	0.9	84.2	66.3	2.5	1.2	7.7	6.7
Italy	-6.5	-2.7	125.0	121.6	4.8	1.9	11.2	5.5
Netherlands	-2.8	-1.4	77.4	72.1	2.4	1.9	6.2	5.6
Portugal	-4.3	-2.5	70.4	62.0	3.7	1.9	10.0	6.3
Spain	-5.3	-2.6	65.6	68.3	4.3	1.9	9.9	6.4
Non-EMU EU members								
Denmark	-1.5	0.7	74.0	64.1	2.5	2.2	7.0	6.3
Greece	-8.6	-2.4	116.0	108.7	7.5	5.6	12.5	8.8
Sweden	-5.2	-0.4	81.0	76.6	3.0	1.8	8.2	6.6
U.K.	-3.7	-1.9	54.0	53.4	3.7	1.9	7.6	7.2
"First wave" EU candidates								
Czech Republic	-1.2	-2.1	10.2	10.9	8.8	8.4	12.5	13.2
Estonia	-1.5	2.0	6.9	5.6	16.7	11.3	12.3	11.4
Hungary	-5.1	-5.7	74.1	68.0	23.6	18.0	28.2	23.1
Poland	-3.3	-3.6	49.2	48.2	19.9	15.1	19.6	23.9
Slovenia	-0.1	-1.8	23.5	24.1	9.7	9.1	23.7	21.3
Cyprus	-3.4	-5.1	54.3	53.4	3.0	3.5	7	6.5
"Second wave" EU candidates								
Bulgaria	-13.4	-4.4	105.8	105.2	123.0	1082.2	300.1	209.9
Latvia	-1.3	1.3	13.8	10.8	17.6	8.4	26.2	14.4
Lithuania	-4.6	-1.9	23.7	22.2	24.7	8.8	24.1	13.0
Romania	-3.9	-3.5	23.4	31.3	38.8	155.0	71.5	107.0
Slovakia	-1.3	-4.8	24.5	26.7	5.8	6.1	13.5	20.9
Further EU applicants								
Malta	-8.6	-8.0	42.1	47.0	3.0	3.0	7.7	7.9
Turkey	-11.5	-9.1	37.8	36.0	82.3	85.7	132.4	105.2
Threshold in percent	-3.0		60.0		3.3	2.7	8.3	8.3

= not in line with convergence criterion

Source: EMI (1998); Temprano-Arroyo/Feldman (1998), p.26

Finally, we check the Maastricht convergence criteria. This examination completes our survey because they reflect the official criteria for an entry into EMU. We omit the exchange rate criterion because this can not be fulfilled by all countries outside the EU. Table *2* shows a) the deficit criterion (the general government deficit must not exceed 3 percent of GDP unless this ratio has been declining substantially and continually), b) the debt criterion (public debt must not exceed 60 percent of GDP unless this ratio has been declining substantially and continually), c) the inflation criterion (annual consumer price

inflation must not exceed that of the three best performing countries by more than 1.5 percentage points), and d) the interest rate criterion (interest rates on long-term government securities must not be more than 2 percentage points higher than those in the three member states with the lowest inflation). A shaded cell indicates a violation of the convergence criterion.

An analysis of the convergence criteria shows that the deficit criterion in 1997 is fulfilled only by the Czech Republic, Estonia, Slovenia, Latvia and Lithuania. Almost all first wave and second wave candidates (with the exception of Hungary and Bulgaria) are in compliance with the debt criterion. One reason for this observation is that these countries had limited access to the international capital markets and hence were not able to borrow intensively in the past. Furthermore, it can be seen that the biggest problem is the inflation rate and the long-run interest rate. A reason for the high inflation rate in transition economies is the price liberalization for goods and services. Another reason is that in countries with a fixed exchange rate capital inflows drive inflation upwards.[2] At least the first wave candidates fought successfully inflation. However, the interest rate criterion shows that the agents do not believe in a persistent reduction of inflation.

From all of the above it follows that based on output growth, per capita GNP levels, the size of the economies, their trade relations, and their production structure the prospects for an early entry into the EU and the EMU are fairly positive. However, the official convergence criteria indicate that even the first wave candidates will face severe problems to entry EMU as fast as they entry the EU.

III. Theoretical Considerations and Estimation Methodology

A monetary union (or currency area) is defined as a domain in which exchange rates are permanently and completely fixed or in which there is only a single currency. The incentive for individual countries to join EMU rests on the perceived benefits and costs of membership. Hence, the theory of optimum currency areas is the theory of comparing costs and benefits for the whole world (rather than for individual countries) of a monetary union.[3] The following section briefly discusses the main criteria mentioned by the basic optimum currency area (OCA) theory. In Section 2 these criteria are

[2] With flexible exchange rates, high capital imports lead to a (real) appreciation of the exchange rate.

[3] Consequently, it can well be that the whole world gains from a monetary union while some individual countries loose. That means: OCA theory does not necessarily say anything about the distribution of the welfare gains among the participating countries.

aggregated to define a small set of indicators that can be handled empirically to measure the viability of an enlargement of EMU.

1. The Optimum Currency Area Theory

Mundell (1961) first posed the question of the optimality of currency areas and found that appropriate domain for a currency area is a homogenous region rather than an area marked by national boundaries. He defined a homogeneous region by perfect internal factor mobility and external immobility.

With imperfect factor mobility, the costs of a fixed exchange rate regime will largely depend on the similarity of the economies because ideally a currency area should consist of a region that depicts a high degree of symmetry in shocks. Where this is not the case the region should have alternative means to offset its asymmetries. These include wage and price flexibility, factor mobility and industrial diversification.

Unless shocks to the economy are symmetric within a certain area, a unified monetary policy may not be adequate, in that it will either over- or undercorrect certain local shocks. Changes in the nominal exchange rate would thus be required to alleviate the effects of these discrepancies. Alternatively, flexibility in nominal wages and prices may be able to sufficiently offset the demand and supply shocks, making nominal exchange rate changes redundant. As long as wages and prices are sticky, however, variability in the nominal exchange rate is necessary to induce real adjustment. The effectiveness of the exchange rate instrument will be determined by the extent to which wages and prices are indexed for exchange rate changes, since real price rigidity will severely limit the impact of exchange rate variability.

If prices and wages are sticky factors of production have to be mobile to offset the effects of an asymmetric shock (i.e. unemployment). In face of an asymmetric shock workers should migrate from the country with unemployment to the country with excess demand for labor. Generally, the degree of labor mobility in contrast to the degree of capital mobility is regarded as low especially for industrialized countries.

Diversification in production determines the degree to which the effects of shocks in the region will be similar. The impact of supply and demand shocks in highly diversified countries will tend to be limited to the industry level, so that diversified economies will depict a higher degree of symmetry between them (Kenen, 1969). In this regard an area of well diversified countries will fare better under a single monetary policy than an area that comprises countries with a high degree of specialization.

The benefits from establishing a currency area increase proportionally with the degree of openness and interdependence of the economies constituting this

union (McKinnon, 1963). The reasons lie mainly in a reduction of the transaction costs, since goods are now denominated in the same currency, and in the further encouragement of trade. The latter is of course an immediate result of the former as it improves the conditions for trade within the union. In a dynamic perspective the elimination of transaction costs results in efficiency gains as trade and the division of labor within a union face fewer impediments.

2. Measuring the Optimality of a European Monetary Union for Central and Eastern European Countries

Bayoumi and Eichengreen (1997) present a model that combines selected criteria of the basic OCA theory to evaluate the desirability of a monetary union. In this section, first their approach is characterized. Then their approach is refined and applied to central and eastern European countries (CEECs).

As already stated above, the entry into the EMU means that the bilateral (nominal) exchange rate between the newcomer and the Euro as a possible shock absorber ceases to exist. However, if the nominal exchange rate was not varying a lot during a certain period of time, there is good reason to assume that the nominal exchange rate is not really needed as a shock absorber. It can be argued that this could be either the result of largely symmetric shocks due to the convergence process before the entry into the monetary union or the result of other adjustment mechanisms like an diversified production structure or factor mobility. Therefore, Bayoumi and Eichengreen (1997) try to explain the variability of the bilateral exchange rate by criteria mentioned in the OCA literature. They create an OCA index which uses the asymmetry of business cycles between the two partner countries, the diversification of their trade across agricultural, manufacturing and service sector, a bilateral openness ratio and the size of the countries. Their results, obtained for European countries support the theory of optimum currency areas in the sense that on the one hand asymmetries in business cycles and in trade structures as well as the relative size of an economy increase the variability of the nominal exchange rate. On the other hand, a relatively stable exchange rate is the result of a high degree of openness and a diversified production structure. Bayoumi and Eichengreen do not take factor mobility into further considerations because it has not played "a significant role in responding to shocks that are felt asymmetrically across countries" (1997, p. 763). Therefore, we do not pay any attention to this variable either. Another reason for the omission of factor mobility is that there is hardly any data available for labor mobility in the CEECs. Furthermore, the point of interest is not so much the *actual* labor mobility (which might be quite low) but the *potential* labor mobility (which might be relatively high in CEECs).

Like in Bayoumi and Eichengreen (1997), first a simple regression model is constructed to show that the exchange rate variability is significantly influenced by proxies for OCA criteria. The variability of the nominal exchange rate between two countries is the dependent variable. It is measured as the standard deviation of the change in the logarithm of the quarterly nominal exchange rate:

$$(1) \qquad SD(e_{ig}) = SD(\log e_{ig} - \log e_{ig}(-1)) \cdot 100 \qquad \text{with } g = \text{Germany}$$

e_{ig} represents the quarterly nominal exchange rate of currency i against currency g. Furthermore, the procedure requires that a partner country is chosen, otherwise one had to calculate bilateral OCA indices for all pairs of countries. For the purpose of this article, it is reasonable to choose Germany as a partner country since it was the dominant country under the EMS. Of course, an approach that takes into account the variation of the Euro instead of the variation of the Deutschmark would be preferable, however, this kind of data is not yet available for a longer period of time. It could be argued that choosing the real exchange rate would be more appropriate, however, choosing the nominal exchange rate bears the advantage of a simple interpretation: The variability of the nominal exchange rate is zero in a monetary union – this is not necessarily the case for the real exchange rate especially at the beginning of a monetary union.

The dependent variable $SD(e_{ig})$ is influenced by the following three OCA criteria. First, a proxy for asymmetric shocks is constructed. An asymmetric shock is defined as the standard deviation of the difference in the logarithm of real output (industrial production, IP) during one year between country i and Germany g:

$$(2) \qquad SD(IP_{ig}) = SD\left(\log \frac{IP_i}{IP_i(-4)} - \log \frac{IP_g}{IP_g(-4)}\right) \cdot 100$$

In contrast to the standard deviation of the exchange rate where the change from quarter to quarter is used, here, the yearly variations are taken into account to omit the seasonal trend of output. The more symmetric the shocks between the two countries are the smaller the value of this proxy should be, and hence, the smaller should be the variations in the nominal exchange rate.[4]

[4] Elsewhere, we decompose the shocks into supply and demand shocks (Frenkel / Nickel / Schmidt, 1999). However, this method is not applicable for all countries of interest in this paper.

Second, the country size influences the benefits of a stable exchange rate. Small countries tend to be more open.[5] In more open economies the elimination of transaction costs[6] will weigh more heavily because firms and consumers buy and sell a large fraction of goods and services in foreign countries. Furthermore, the agents are more subject to decision errors because they face large foreign markets with different currencies. Hence, the welfare gains from eliminating these risks will be higher in small and open economies than in large and relatively closed countries. The size of the country is defined relatively to Germany:

$$\text{(3)} \qquad SIZE_{ig} = \frac{RGDP_i}{RGDP_g} \cdot 100$$

$SIZE_{ig}$ is the ratio of real GDP (RGDP) measured in US-Dollars of country i to Germany g. The smaller the variable SIZE is, the more open the economy tends to be; hence, the higher are its welfare gains and the smaller is the variation of its nominal exchange rate against Germany.

Third, we use a proxy for production diversification. Countries are considered as more symmetric if they perform a high degree of intra-industry trade (Bénassy-Quéré / Lahèche-Révil, 1998). Intra-industry trade is also important for the reaction of the nominal exchange rate. If the Czech Republic imports German cars and exports Czech cars to Germany, an industry-specific shock in the car industry will hurt Germany's and the Czech Republic's trade relations in the same way, and hence, the bilateral nominal exchange rate does not need flexibility. Consequently, two-way-trade does not require the exchange rate as an adjustment mechanism. The conclusion is that the higher the share in intra-industry trade between two countries is, the smaller is the variation of the nominal exchange rate.

The most widely used indicator to measure the extent of intra-industry trade is the Grubel-Lloyd-Index:

$$\text{(4)} \qquad GL_{ig} = 1 - \frac{\sum_{c=1}^{n} \left| (X_c / X) - (M_c / M) \right|}{\sum_{c=1}^{n} \left[(X_c / X) + (M_c / M) \right]}$$

[5] See Appendix I for a regression on openness versus size for the countries in our sample. The regression shows that there is indeed a negative relation among the two.

[6] The term "transaction costs" comprises all costs connected with the use of different currencies instead of a common currency such as costs of currency conversion and accounting costs.

X_c/X (or M_c/M) is the percentage of the country's total exports (or imports) in product category c with Germany. $|X_c/X - M_c/M|$ indicates the absolute value of the differences between the share of exports and imports in the category. The $[X_c/X + M_c/M]$ indicates the sum of the export and import shares in the category. The Σ means that it is summed over all n commodity groups. The index would equal 1.0 if exports were equal to imports in all categories ("total" intra-industry trade or "total" two way trade). The index would be zero if, in each category, there were exports or imports but not both (one way trade).

For the purpose of this paper, it is necessary to calculate a relative Grubel-Lloyd-Index because we are interested in the relative position a country has in comparison to Germany concerning its intra-industry trade. This is explained best with a short example: 7 percent of the total trade between Iceland and Germany is intra-industry trade; whereas 79 percent of the total trade between France and Germany is intra-industry-trade. Germany's total volume of intra-industry trade with all countries in the world is 78 percent (GL_{wg}). That means that in comparison to all other trading partners of Germany, Iceland performs only 9 percent of intra-industry trade with Germany. However, France performs even more intra-industry trade with Germany than Germany does with all its other trading partners. This means that France and Germany are similar in their factor endowments and development level and consequently similar to each other. Because we are always interested in the relative position a country has in comparison to Germany we calculate a relative Grubel-Lloyd-Index:

$$RGL_{ig} = \frac{GL_{ig}}{GL_{wg}} \cdot 100 \tag{5}$$

The more similiar countries are the larger is the value of the RGL-Index and the smaller should be the variation of the nominal exchange rate.

The estimation equation is therefore:

$$SD(e_{ig}) = \alpha + \beta_1 \cdot SD(IP_{ig}) + \beta_2 \cdot SIZE_{ig} + \beta_3 \cdot RGL_{ig} + u_{ig} \tag{6}$$

It is expected that $\beta_1 > 0$ since the bigger the difference between output growth in Germany and in the partner country is, the bigger is the variability of the nominal exchange rate. Likewise, size influences the variability of the exchange rate flexibility positively: $\beta_2 > 0$. And $\beta_3 < 0$ since the more intra-industry trade between country i and Germany, the smaller is the variability of the exchange rate. The constant α has no reasonable economic interpretation.

IV. Estimation Results

Comparing EU countries with central and eastern European countries involves several problems. First, given the transformation process in the central and eastern European countries, there were a number of structural changes, in particular in the early 1990s. This limits the existence of stable relationships between economic variables. Second, countries in central and eastern Europe have only started the transformation process around 1990. This restricts the time series that are sensible to use in our analysis. In order to exclude the initial dynamics, we only use data since 1992. Third, the data quality may not yet be comparable to the one that can be found in more mature economies in Europe. Against the background of these limitations, our analysis can only be interpreted as a first empirical investigation of these countries and the results need to be interpreted with caution.

Equation (6) is estimated for cross-country data of 31 countries.[7] Exchange rate data was taken from the IMF's International Financial Statistics (IMF, 1999) and covers the period from 1992:1 to 1997:4.[8] The data for industrial production stems from the IMF's International Financial Statistics.[9] Real GDP data for calculating the relative size was taken from the IMF's International Financial Statistics for the basis year 1997 (IMF, 1999). Since relative size does not fluctuate a lot during the six year's period, we only take one year's real GDP into consideration.[10] The (relative) Grubel-Lloyd-Index is calculated by using import and export data for Germany in 1997 decomposed into the 2-digits-Standard International Trade Classification (SITC). The data source is the Statistische Bundesamt (1998).

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[7] The countries are the following 14 EU-countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. Plus three EFTA countries: Switzerland, Norway, Iceland. Plus the following six EU membership applicants of the fast lane: the Czech Republic, Estonia, Hungary, Poland, Slovenia, and Cyprus. Plus the following CEECs of the slower lane: Latvia, Lithuania, Romania, and Slovakia). Turkey and Malta are included, and for the construction of a benchmark the approach covers the USA and Canada, too. Appropriate data for Luxemburg was not available since it often is listed combined with Belgium. Bulgaria was also excluded because of a lack of data.

[8] For some CEECs (the Czech Republic, Estonia, Latvia, and Slovakia) the year 1992 was not or only partly covered by the IMF's International Financial Statistics. However, this only influenced the calculation of the standard deviation.

[9] For some countries (Estonia, Latvia, and Malta) data for industrial production was not available. We used real GDP data instead.

[10] Of course, we also could have chosen nominal GDPs. However, first the value of size does not differ a lot if we take real or nominal GDPs and second, for a forecast we later on have to use real GDP because otherwise the often high inflation rates in transition countries overestimate the relative size of these countries.

Since the standard deviations of the bilateral nominal exchange rates vary substantially in different observations, the problem of heteroscedasticity is present and the standard errors are incorrect. The problem is avoided by using White's heteroskedasticity consistent standard errors and covariances. For the period from 1992:1 to 1997:4 the estimation yielded the following results:

$$SD(e_{ig}) = \underset{(0.115313)}{0.993794} \cdot SD(IP_{ig}) + \underset{(0.001920)}{0.006115} \cdot SIZE_{ig} - \underset{(0.007037)}{0.016456} \cdot RGL_{ig} \tag{7}$$

R^2=0.729530 S.E.=2.090724

Since the constant has no reasonable economic interpretation and moreover, since the estimate is not significant, the constant is omitted. All three coefficients have the expected signs. The coefficients β_1 and β_2 differ significantly from zero at the 1%-significance level. The coefficient β_3 differs significantly from zero at the 5%-significance level. Of course, it would have been desirable to test this equation for stability over time. However, the relatively short length of the time series included in our estimation makes it impossible to do that. What we have done instead is to test the equation for different country groups: EU countries only, all Western countries (EU plus EFTA countries plus Canada and the United States) and CEECs – although the coefficients differ in their size, the anticipated signs are always the same. Even with regard to the limited data these results can be seen as a support of the OCA theory. Consequently we proceed with equation (7.

Now the OCA indices are calculated with Germany as the partner country. Since the regression includes all countries, the actual value of $SD(e_{ig})$ differs from the calculated OCA index which only considers two countries (Germany and country i). Consequently, the OCA index is the fitted value of our regression line. Smaller values for the OCA index indicate a higher ability to join EMU. For the period of 1992-1997, the results are shown in table 3.

The next step is to forecast the OCA index for the period from 1998 to 2003. Therefore, the independent variables need to be projected. Data for industrial production (for some countries) are available by the IMF's International Statistics till 1998:3. The missing periods for $SD(IP_{ig})$ are extrapolated by using exponential smoothing. For economic size, we use the WEFA forecasts for the year 2003. The Grubel-Lloyd-Index is assumed to be constant.

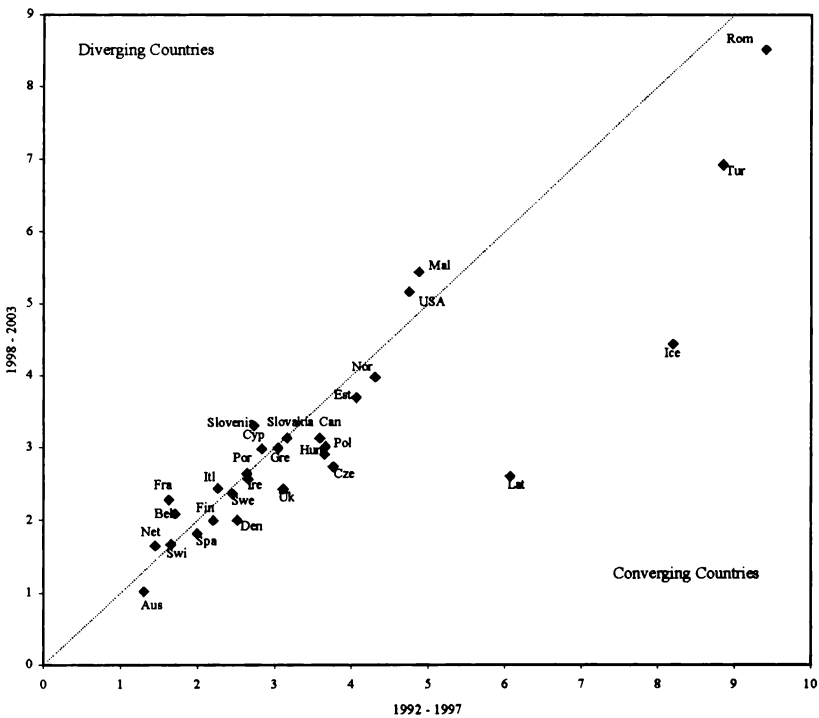
The results for the actual and the forecasted OCA indices are reported in table 3. A graphical representation of the same results can be found in figure 4. Countries to the left of the diagonal are countries for which the OCA index gets bigger during 1998-2003 compared to the situation during 1992-1997. In this sense they are diverging countries. EMU countries which have converged closest to Germany are Austria, the Netherlands, Belgium, France and Spain

accompanied by the EFTA country Switzerland. All these countries have indices under 2.09 during 1998-2003 which means that their OCA index is smaller than the standard error of the regression. Hence, their OCA index can be assumed not to be significantly different from zero which is a sign that the variability of the nominal exchange is not significantly different from zero, too – consequently, their nominal exchange rate already behaves like they were part of a monetary union. This result is not remarkable for Austria and the Benelux countries because they have been closely linked to Germany throughout several years. However, Spain's presence in this group is surprising. This can be explained by an ongoing convergence process. This is also supported by Bayoumi and Eichengreen (1997) where Spain converges significantly from 1987 to 1995. France is part of this first group, but it's OCA index worsens. One explanation for this finding is that on the one hand their relative Grubel-Lloyd-Index is biggest among European countries however, on the other hand the asymmetry in business cycles counteracts this effect. In Switzerland, all these variables are similar to Germany; in line with the findings of Bayoumi/Eichengreen (1997), it joins the first group of countries even though it is not a member of the EU.

Finland, Italy, Sweden, Denmark, Portugal, Ireland and the United Kingdom constitute a second group of EU countries. Remarkably, one can hardly see a difference between the non-EMU EU countries and the EMU countries. For Denmark and the United Kingdom this can be explained by the fact that the decision not to join EMU was a more a political than an economic decision. However, Sweden seems to be quite close to an EMU entry compared to the EMU members Portugal and Ireland. A reason for this result could be that the variability of output is smaller in Sweden then in Portugal and Ireland, and Sweden's production structure is more similar to Germany. Bayoumi and Eichengreen state: "there is strikingly little correlation between the deficit ratio (a key Maastricht criterion) and our OCA index" (1997, p. 767). This is indication that membership in EMU need not be confirmed in all cases by the OCA index.

By the standard of the OCA index, the fourth non-EMU EU country Greece is similarly prepared for EMU like Cyprus, Slovenia, Slovakia, Hungary, Poland and the Czech Republic are. This can also be confirmed by the criteria "real integration" or "structural similarity" of Greece in comparison to these countries seeking membership. This implies that from the OCA theory's point of view the entry of these countries into the EU and into EMU might not be that far away. The convergence of almost all countries during 1998-2003 supports this argument. Press releases in November 1998 confirm Latvia's striking convergence process which is also praised by the European commission; furthermore the commission chided the backsliding of Slovenia (Economist, 1998).

For the other applicants, Romania, Turkey, and Malta the OCA index is not in favor of their membership in EMU. The same holds for Iceland and Norway. In all cases this is due to large output gaps towards Germany plus a low relative Grubel-Lloyd-Index.



Source: Author's calculations based on equation (7) in the text.

Figure 4: Development of the OCA Indices Versus Germany Over Time

Table 3: OCA indices versus Germany

	1992 – 1997	*1998 - 2003*
Austria	1.3056918	1.0212248
Belgium	1.7099743	2.0853554
Canada	3.5869357	3.1274520
Cyprus	2.8359388	2.9749044
Czech Republic	3.7614910	2.7329599
Denmark	2.5161803	1.9950644
Estonia	4.0611206	3.6927425
Finland	2.2049334	1.9961497
France	1.6285764	2.2784749
Greece	3.0447986	2.9919641
Hungary	3.6500983	2.8991457
Iceland	8.2021326	4.4311752
Ireland	2.6580304	2.5590566
Italy	2.2624840	2.4347793
Latvia	6.0735828	2.5991559
Malta	4.8770716	5.4348501
Netherlands	1.4522605	1.6479915
Norway	4.3050762	3.9759344
Poland	3.6608312	3.0094556
Portugal	2.6430217	2.6362515
Romania	9.4134148	8.5133451
Slovakia	3.1589316	3.1260931
Slovenia	2.7303741	3.2996052
Spain	1.9969281	1.8196151
Sweden	2.4574572	2.3571877
Switzerland	1.6581313	1.6690365
Turkey	8.8593692	6.9211909
United Kingdom	3.1125368	2.4216926
USA	4.7499121	5.1615817
Lithuania[a)]	16.0061291	12.847804

[a)] Lithuania is not included in figure 4.
Source: Author's calculations based on equation (7) in the text.

The introduction of the USA into the survey shows that even though the standard deviation of the output gap is not extraordinary, the influence of the much higher relative size is striking. Since the U.S. grows significantly faster than Germany, it even diverges from Germany.

V. Summary and Conclusions

Based on the theoretical framework of optimum currency areas this paper assesses the readiness of non-EMU EU countries, the central and eastern European countries and other applicants including the EFTA countries to join EMU. First, we survey the stylized facts of these countries and conclude that at

least the first wave candidates appear to be as ready for EMU as some of the non EMU EU members are. However, the examination of the convergence criteria draws a more pessimistic picture: Almost all central and eastern European countries suffer from severe inflation problems even though they made progress in stabilizing their economies in recent years. Second, we construct an OCA index for the countries in question. Here, the results support the conclusion derived from the assessment of the stylized facts: The "first wave" candidates are as ready or as not-ready for EMU as Greece is. Thus, if Greece is admitted to the EMU there is hardly a reason to delay the entry of the other countries. This finding contradicts the outcome of the examination of the convergence criteria, however, even Bayoumi / Eichengreen (1997) notice that there is no correlation between the OCA index and the convergence criteria. It becomes clear that the decision of widening the EU and the EMU is a political rather than an economic decision. However, it also should be clear that EU membership also increases the readiness for EMU – the establishment of a common market fosters trade relations and this also influences the OCA index positively.

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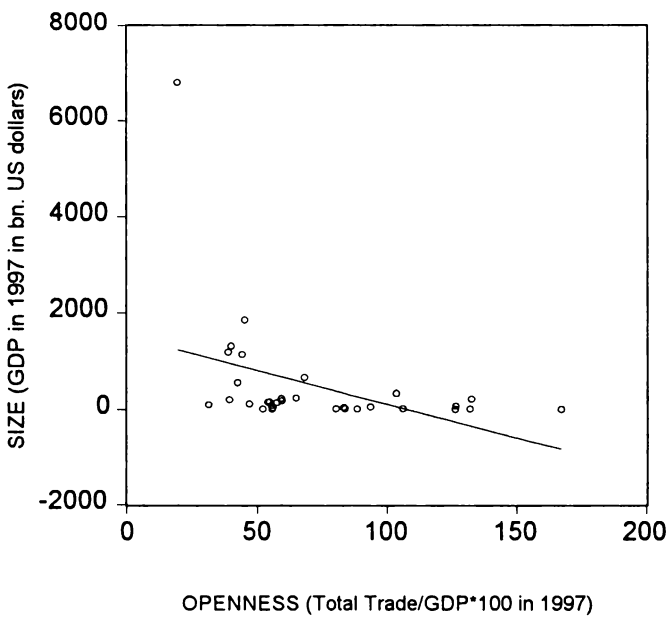
VII. Appendix

Appendix I: Size versus openness in our sample



Appendix II : Basic Economic Indicators in 1997

	Population	*Nom. GDP in bn. USD*	*Real GDP in 1990 prices in bn. USD*	*Av. ann. % GDP growth (1990-1997)*	*% growth of real GDP*
EMU members:					
Austria	8.07	206.23	183.27	1.6	2.5
Belgium	10.18	242.51	218.25	1.2	3.0
Finland	5.15	119.83	143.99	1.1	6.0
France	58.59	1,392.49	1,311.67	1.3	2.3
Germany	82.08	2,092.35	1,849.75	..	1.5
Ireland	3.66	72.44	69.30	6.5	9.8
Italy	57.52	1,145.37	1,181.92	1.1	1.5
Netherlands	15.61	360.48	335.99	2.3	3.3
Portugal	9.95	101.77	80.32	1.7	3.7
Spain	39.32	532.33	557.46	1.6	3.6
Non-EMU EU-members:					
Denmark	5.29	169.97	160.69	2.3	3.3
Greece	10.48	116.70	94.89	1.8	3.1
Sweden	8.85	227.75	242.33	0.9	1.8
United Kingdom	59.00	1,312.68	1,136.59	1.9	3.4
EFTA countries:					
Iceland	0.27	7.39	7.10	..	4.4
Norway	4.41	153.36	150.96	3.9	3.4
Switzerland	7.12	255.38	231.51	-0.1	1.7
"First wave" EU candidates:					
Czech Republic	10.30	55.63	46.32	-1.0	1.0
Estonia	1.45	4.21	3.43	-4.3	11.4
Hungary	10.20	48.33	40.25	-0.4	4.6
Poland	38.70	138.17	115.06	3.9	6.9
Slovenia	1.99	21.13	17.20	0.7[b]	3.8
Cyprus	0.75	8.85	7.61	..	4.2
"Second wave" EU candidates:					
Bulgaria	8.31	10.16	..	-3.5	..
Latvia	2.46	4.96	4.04	-10.7	5.9
Lithuania	3.71	6.75	5.50	-4.5	5.7
Romania	22.40	34.84	33.18	0.0	-0.7
Slovakia	5.40	20.59	17.14	0.4	6.5
Further EU applicants:					
Malta	0.37	3.32	2.62	..	2.9
Turkey	64.10	189.88	203.05	3.6	7.5
Other countries:					
Canada	29.96	625.63	664.68	2.1	3.7
USA	267.55	8,110.93	6,804.75	2.5	3.9

a) World Bank (1998): World Development Report 1998/99.
b) EBRD (1998): Transition Report 1998.

Data Source: (if not otherwise mentioned) IMF: International Financial Statistics.

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