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in a Three-Country Model?***



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Does the Home Market Effect Arise in a Three-Country Model?

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Abstract

It is uncertain whether the fundamental “home market effect” (HME) generalizes from a two-country model to a more realistic setting with multiple countries. We present a three-country version of the seminal model by Krugman (1980) and analyse under which circumstances the HME is present once third country effects are taken into account. We show that both expenditure shifts and exogenous enlargements among foreign countries can rule out the HME.

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1) Introduction

There are two principal theories of international trade. The “old” neoclassical approach with perfect competition and constant returns to scale focuses on differences in tastes, technology and endowments to explain the pattern of trade flows across countries, whereas the “new trade theory” (Krugman, 1980) stresses the role of increasing returns and product differentiation. A distinguishing feature of the new trade theory is the *home market effect* (HME). In their well known two-country, two-sector model, Helpman and Krugman (1985: ch.10) show that the larger country will have a world production share of the modern (increasing returns) good that exceeds its world expenditure share, thus making the larger country a net exporter of this good.¹ In a dynamic interpretation, an increase in the expenditure share of some country should therefore result in an over-proportional increase in the production share if the HME is present.

In the aftermath of this seminal contribution a broad discussion emerged about the robustness of the HME in different settings.² Although many modifications and generalization have been considered, one assumption largely remained unchanged, namely that the world consists of only two countries. In the course of international trade theory it has been proven many times that most of the fundamental insights of such two-country models carry over to more realistic settings. Recently, however, it has been argued that matters might be more complicated when it comes to the HME (Head and Mayer, 2004). This uncertainty about whether the HME can be generalized to a multi-country setting is due to *third country effects*. Behrens, Lamorgese, Ottaviano and Tabuchi (2004) [from now on labelled as ‘BLOT’], who develop a M-country version of the model by Krugman (1980), point out that

The HME itself may not arise in a multi-country setting [...] This is due to the fact that, once “third country effects” are taken into account, an increase in one country's expenditure share may well map into a less than proportionate increase in its output share as other countries “drain away” some firms. In more extreme cases, an increase in the expenditure share may even lead to a decrease in industry share (“home market shadow”). (BLOT, 2004: p. 5)

¹ Trionfetti (2001) and Davis and Weinstein (2003) have shown that the HME is not present in traditional trade models à la Heckscher-Ohlin or Ricardo. The HME has therefore proved to be a prominent criterion in empirical research to discriminate between the relative explanatory power of the “new” versus the “old” theory of international trade (see Davis and Weinstein 1999, 2003; Head and Mayer, 2004; Hanson and Xiang, 2004).

² A list of “robustness checks” of the HME must surely include Davis (1998), who has shown that the introduction of trade costs in the traditional sector is sufficient to overturn the HME. Head, Mayer and Ries (2002) have demonstrated that the HME is quite robust with respect to changes in the specific assumptions about competition. Hanson and Xiang (2004) and Holmes and Stevens (2005) study the HME in a setting with more than two sectors. Medin (2004) looks at the HME under fixed export costs.

The way how BLOT prove this result is the following: They consider an increase in the expenditure share of some country 1 and look at the effects on the country's industry share ("dynamic HME"). Provided that trade costs are not pair-wise symmetric across countries, they show that there exists some parallel perturbation in the expenditure shares of the other economies (third country effects) such that the reaction of the industry share of country 1 is under-proportional or even negative (p. 16). Thus, BLOT show that the HME does not easily generalize if parallel developments in the foreign world are taken into account, and if "geography matters" in the sense that there are trade cost differences across countries. However, they do not provide an analysis about the conditions under which the HME holds, but suffice with pointing out that it is not generally present in a multi-country world.

The purpose of this paper is to show under which circumstances there is a HME and for which types of third country effects there is none. For reasons of transparency we will use the simplest possible model with more than two countries, namely a version of Krugman (1980) with three countries. Three-country models are of growing popularity in trade theory and have been used to address a number of related issues. But the fundamental question under which circumstances the HME is present has not yet been analysed. Baldwin and Venables (1995) show that with transportation costs, monopolistic competition and increasing returns the formation of an integration agreement between two countries tends to favour industry location in the bloc to the disadvantage of the outside country. The attractiveness of "transportation hubs" as production locations has been emphasized by Krugman (1993). He shows that if one country offers better accessibility than the other two, it will host a larger industry share even if all countries are of equal size. Baldwin et al. (2003:ch. 14) study preferential trading agreements (PTAs) with a slightly different set-up, namely a three-country version of the "foot-loose capital model", initially due to Martin and Rogers (1995). They verify the result of Baldwin and Venables (1995), while showing that economic integration can also magnify spatial inequalities inside the bloc if the trade integrating regions are of different size and/or if one country is a "hub". This corroborates the findings of Puga and Venables (1997), who study PTAs in a setup that is closer to the "new economic geography", since it allows for endogenous agglomeration forces due to factor mobility.

In our three-country model we explicitly derive the conditions for the pervasiveness of the HME. We call one economy the "home country", whereas the other two form the "foreign world". Reminiscent of the dynamic interpretation of the HME we analyse under which conditions an increase in the expenditure share of the home country maps into an over-proportional increase of its production share.

At first we show that if there is only an exogenous increase in the expenditure level of the home country, holding constant the sizes of both foreign countries, then the HME will always be present. The effect thus generalizes from a two- to a three-country model if third country effects play no role. But then we study the impact of developments in the foreign world that have an impact on the industry share of the home country.

As a first type of third country effects we analyse an expenditure shift from one foreign economy to the other. This shift does not change the domestic expenditure share. Nevertheless, the domestic industry share is negatively affected if the shift is from the more remote towards the better accessible foreign economy. If this shift occurs parallel to an enlargement of the home country, the HME will only be present if the domestic enlargement is sufficiently large to overcompensate the negative impact of the third country development. The second foreign development that we analyse is an exogenous enlargement of one foreign economy. If the size of the home country and one foreign country increase to the same extent, the domestic expenditure share rises. However, the HME might not arise, as the increase of the domestic industry share can be under-proportional.

In sum, the analysis in this paper demonstrates that the HME can be generalized if there is only an exogenous increase in the size of one country. But if one does not abstract from parallel developments in the outside world, we point at the direction and the necessary strength of third country effects to rule out the HME in a multi-country setting.

2) The Model

The model is a three-country version of Helpman and Krugman (1985: ch.10). Each country $i=1,2,3$ is populated with L_i individuals, who inelastically supply one unit of labor. The world population has the size $\bar{L} = L_1 + L_2 + L_3$. Labor is the only factor of production and immobile across countries. There are two sectors in each economy between which labor can move freely. In the “traditional sector” a homogenous good is produced under perfect competition and constant returns. One unit of labor is transformed into one unit of output. The good is freely tradable across countries, hence the law of one price holds. The price of this good is the numéraire and normalized to unity. If this sector is active in all countries (which we will assume to focus on interior equilibria) there is factor price equalization and the wage is equal to one everywhere. The “modern” Dixit-Stiglitz sector manufactures a large variety of differentiated products. Each variety is produced by a single firm under increasing returns to scale. Every firm faces a fixed and a variable labor input requirement, F and c , respectively. The sector is monopolistically competitive, but profits for any firm can not be strictly positive due

to the potential entry of competitors. The total amount of firms and varieties in the world is determined by entry and exit and denoted by $\bar{N} = n_1 + n_2 + n_3$. Transportation across countries is subject to “iceberg” costs, where $\tau_{ij} > 1$ units have to be dispatched in country i in order for one unit to arrive in country j .

2.1. Demand and supply

The preferences of the representative consumer in country i are described by the following utility function

$$U_i = X_i^\mu \cdot H_i^{1-\mu} \quad 0 < \mu < 1 \quad (1)$$

where H_i denotes the homogenous good and X_i the differentiated consumption aggregate, which is of a CES form,

$$X_i = \left[\int_{\omega=1}^{\bar{N}} x_i(\omega)^{(\sigma-1)/\sigma} \cdot d\omega \right]^{\sigma/(\sigma-1)} \quad (2)$$

The parameter $\sigma > 1$ measures the own price elasticity and the elasticity of substitution between any pair of differentiated varieties, and μ is the expenditure share on the modern good. It turns out that the formal condition for the traditional sector to be active in all countries (and thus, the formal condition for factor price equalization) is that this expenditure share μ is not too large (see Appendix).

The preference structure (1) and (2) yields the following aggregate demand from country j for a variety produced in country i

$$x_{ij} = \frac{p_{ij}^{-\sigma}}{P_j^{1-\sigma}} \cdot \mu \cdot E_j \quad (3)$$

p_{ij} is the delivered price in country j (inclusive trade costs)³, E_j is the aggregate consumption expenditure in country j and P_j is the standard CES price index,

$$P_j = \left(\int_{\omega=1}^{\bar{N}} [p_{ij}(\omega)]^{1-\sigma} \cdot d\omega \right)^{1/(1-\sigma)} = \left(\sum_i n_i \cdot p_{ij}^{1-\sigma} \right)^{1/(1-\sigma)} \quad (4)$$

³ Due to symmetry all n_i firms from country i will charge the same producer price. The delivered price in country j is thus p_{ij} and we do not need firm subscripts.

A firm from country i must ship $\tau_{ij}x_{ij}$ units in order for x_{ij} units to arrive in country j . Taking into account (3) and the fact that wages are equal to one everywhere, the profit function for a typical firm is

$$\pi_i = \sum_j \left[(p_{ij} - c \cdot \tau_{ij}) \cdot \frac{p_{ij}^{-\sigma}}{P_j^{1-\sigma}} \cdot \mu \cdot E_j \right] - F \quad (5)$$

Maximizing (5) with respect to p_{ij} , taking P_j as given due to the absence of strategic price setting in this Chamberlinian model of monopolistic competition, yields the familiar pricing rule

$$p_{ij} = \frac{\sigma}{\sigma - 1} \cdot c \cdot \tau_{ij} \quad (6)$$

Inserting (6) in (5) and using the fact that profits have to be non-positive in equilibrium, we find that the equilibrium scale for every active firm must satisfy $x_i \leq F(\sigma - 1)/c$, where $x_i = \sum_j (\tau_{ij} \cdot x_{ij})$ is total firm production including the fraction lost in transportation. Using (3), the pricing rule (6) and the fact that $E_j = L_j$, the market clearing condition commands that

$$\sum_j \left[\frac{\phi_{ij} L_j}{\sum_k \phi_{kj} \cdot n_k} \right] \leq \frac{\sigma F}{\mu} \quad \text{for } i=1,2,3 \quad (7)$$

where $\phi_{ij} \equiv \tau_{ij}^{1-\sigma} \in [0,1]$ is the usual measure of trade freeness (or, trade “phi-ness”) between countries i and j . If (7) holds with a strict inequality for country j , then $n_j^* = 0$ in equilibrium, since no firm can break even in this location. Multiplying (7) by the positive n_i ’s and summing across the three countries, we can derive the total number of firms in the modern sector, $\bar{N} = \mu \bar{L} / F \sigma$, which is fixed in equilibrium and proportional to the world population. This allows us to express the equilibrium conditions in terms of the expenditure (population) shares $\theta_i = E_i / \bar{E} = L_i / \bar{L}$, where $\bar{E} = \bar{L}$, and the production shares, $\lambda_i = n_i / \bar{N}$. We obtain

$$\sum_j \left[\frac{\phi_{ij} \theta_j}{\sum_k \phi_{kj} \cdot \lambda_k} \right] \leq 1 \quad \text{for } i=1,2,3 \quad (8)$$

Referring to the definition of Head and Mayer (2004), the left-hand side of (8) can be understood as the *real market potential* (RMP) of country i , given the distribution of expenditure (the θ_j 's), and the accessibility of the countries (or “geography”, the ϕ_{ij} 's). The three equilibrium conditions in (8) imply that in an interior equilibrium with $0 < \lambda_i^* < 1$ for $i=1,2,3$ the RMP of all three countries must be equalized. Note that the θ_i 's and the ϕ_{ij} 's are exogenously given, whereas the output shares λ_1, λ_2 and λ_3 are the endogenous variables.

2.2. General equilibrium

In their M-country model, BLOT show that factor price equalization across countries implies that a unique and globally stable equilibrium exists for all admissible values of θ_i and ϕ_{ij} . They derive a simple necessary and sufficient condition for existence, uniqueness and stability of interior equilibrium. We adapt this condition for the three-country case in the appendix. Assuming an interior equilibrium, in which case (8) holds with equality, closed form solutions for the three-dimensional system of equations can be derived. The equilibrium output share of the home country can be written in the following form (with analogous expressions for λ_2^* and λ_3^*).

$$\lambda_1^* = I_{11}\theta_1 + I_{12}\theta_2 + I_{13}\theta_3 \quad (9)$$

We call the coefficient I_{ij} the “impact factor” that depicts how country j 's expenditure share θ_j affects the domestic industry share λ_1^* . The impact factors depend on the bilateral levels of trade freeness only and are given by

$$I_{11} = \frac{f_{11}}{f_{11} + f_{12} + f_{13}} = \frac{1 - (\phi_{23})^2}{1 - \phi_{12} - \phi_{13} + \phi_{12}\phi_{23} + \phi_{13}\phi_{23} - (\phi_{23})^2} \quad (10)$$

$$I_{12} = \frac{f_{12}}{f_{21} + f_{22} + f_{23}} = \frac{-(\phi_{12} - \phi_{13}\phi_{23})}{1 - \phi_{12} + \phi_{12}\phi_{13} - (\phi_{13})^2 - \phi_{23} + \phi_{23}\phi_{13}} \quad (11)$$

$$I_{13} = \frac{f_{13}}{f_{31} + f_{32} + f_{33}} = \frac{-(\phi_{13} - \phi_{12}\phi_{23})}{1 - (\phi_{12})^2 + \phi_{12}\phi_{13} - \phi_{13} - \phi_{23} + \phi_{23}\phi_{12}} \quad (12)$$

In the equations (10)-(12), f_{ij} is the cofactor ij of the general (3×3) trade cost matrix Φ . With respect to the trade cost structure we assume $\phi_{ii} = 1$ and $\phi_{ij} = \phi_{ji}$. There are no trade costs inside one country, and trade freeness between any two countries does not depend on the direction of the trade flow. Moreover, we require that $\tau_{ij} < \tau_{ik} \cdot \tau_{kj} \Rightarrow \phi_{ij} > \phi_{ik} \cdot \phi_{kj}$. It is not cheaper

for producers from country i to ship goods to j via the third country k . This restriction is necessary, since the profit maximization problem (5) is set up such that goods are shipped directly from one country to another.⁴ We can then establish the following important properties of the impact factors that will turn out to be useful below.

Lemma 1: Impact factors

- (i) The own impact factor I_{11} is strictly positive.
- (ii) Both foreign impact factors I_{12} and I_{13} are strictly negative.
- (iii) If $\phi_{12} > \phi_{13}$, i.e. if country 2 is better accessible than country 3 from the point of view of the home country, we have $(I_{12}-I_{13}) < 0$. With $\phi_{12} < \phi_{13}$ we have $(I_{12}-I_{13}) > 0$ and $I_{12}=I_{13} < 0$ if $\phi_{12} = \phi_{13}$.

Proof: See Appendix.

The result $I_{11} > 0$ implies that the home country has a positive impact on itself, whereas $I_{12} < 0$ and $I_{13} < 0$ state that a higher foreign expenditure share would (ceteris paribus) lead to a lower domestic industry share. The third result shows that the impact of the better accessible foreign country is stronger negative than the impact of the more remote foreign country.

Some tedious calculations show that an increase in ϕ_{12} will lead to a higher own impact factor ($\partial I_{11} / \partial \phi_{12} > 0$), whereas the impact of country 2 gets stronger negative ($\partial I_{12} / \partial \phi_{12} < 0$) and the impact of country 3 gets weaker ($\partial I_{13} / \partial \phi_{12} > 0$). Analogous results can be derived for an exogenous increase of ϕ_{13} ($\partial I_{11} / \partial \phi_{13} > 0$, $\partial I_{12} / \partial \phi_{13} > 0$, $\partial I_{13} / \partial \phi_{13} < 0$). Freer trade among the two foreign countries will lead to a lower own impact factor ($\partial I_{11} / \partial \phi_{23} < 0$). The effect of an increase of ϕ_{23} on I_{12} and I_{13} is ambiguous. If both foreign countries are equally well accessible for the home country ($\phi_{12} = \phi_{13}$), then ($\partial I_{12} / \partial \phi_{23} = \partial I_{13} / \partial \phi_{23} = 0$). With differences in accessibility the impact factor of the more remote foreign economy increases, whereas the impact factor of the other foreign country gets stronger negative.

2.3. The home market effect (HME)

To analyze the HME in the “dynamic” definition, we are interested in the effect of an increase in θ_1 on λ_1^* . To this end, we totally differentiate (9) and obtain

⁴ Alternatively, one could neglect the parameter restriction $\phi_{ij} > \phi_{ik} \cdot \phi_{kj}$ and simply assume that transportation via a third country is ruled out. We will briefly consider the consequences of this modification below.

$$d\lambda_1^* = I_{11} \cdot d\theta_1 + I_{12} \cdot d\theta_2 + I_{13} \cdot d\theta_3 \quad (13)$$

Since an expenditure *share* can not exogenously increase in isolation, it will turn out to be crucial not only to think in terms of expenditure shares, but also in terms of the expenditure *levels* $E_i=L_i$. By the definition of θ_i we have

$$d\theta_1 = \left(\frac{E_2 + E_3}{\bar{E}^2} \right) dE_1 - \left(\frac{E_1}{\bar{E}^2} \right) (dE_2 + dE_3) \quad (14)$$

$$d\theta_2 = \left(\frac{E_1 + E_3}{\bar{E}^2} \right) dE_2 - \left(\frac{E_2}{\bar{E}^2} \right) (dE_1 + dE_3) \quad (15)$$

$$d\theta_3 = \left(\frac{E_1 + E_2}{\bar{E}^2} \right) dE_3 - \left(\frac{E_3}{\bar{E}^2} \right) (dE_1 + dE_2) \quad (16)$$

Using (14)-(16) in (13), the change in λ_1^* can be written as

$$d\lambda_1^* = \frac{1}{\bar{E}^2} \begin{bmatrix} I_{11} \left((E_2 + E_3) dE_1 - E_1 (dE_2 + dE_3) \right) + \\ I_{12} \left((E_1 + E_3) dE_2 - E_2 (dE_1 + dE_3) \right) + \\ I_{13} \left((E_1 + E_2) dE_3 - E_3 (dE_1 + dE_2) \right) \end{bmatrix}, \quad (17)$$

which is a function of the trade cost structure (via the impact factors), the initial sizes of the three countries and the respective absolute changes of the countries' sizes.

To reduce notation we assume from now on that all three countries initially have the same size. With $E_1 = E_2 = E_3 = E$ and $\bar{E} = 3E$, equation (17) simplifies to

$$d\lambda_1^* = \frac{1}{3} \left[(2I_{11} - I_{12} - I_{13}) dE_1 + (2I_{12} - I_{11} - I_{13}) dE_2 + (2I_{13} - I_{11} - I_{12}) dE_3 \right] \quad (18)$$

or equivalently,

$$\frac{d\lambda_1^*}{d\theta_1} = \left[\frac{(2I_{11} - I_{12} - I_{13}) dE_1 + (2I_{12} - I_{11} - I_{13}) dE_2 + (2I_{13} - I_{11} - I_{12}) dE_3}{2dE_1 + dE_2 + dE_3} \right] \quad (19)$$

The HME requires an over-proportional increase of λ_1^* following an increase in θ_1 . That is,

$$\frac{d\lambda_1^*}{d\theta_1} \cdot \frac{\theta_1}{\lambda_1^*} > 1 \Leftrightarrow \frac{d\lambda_1^*}{d\theta_1} > \frac{\lambda_1^*}{\theta_1} = I_{11} + I_{12} + I_{13}, \quad (20)$$

where $\lambda_1^*/\theta_1 = I_{11} + I_{12} + I_{13}$ follows from (9) and the fact that in the initial situation we have $\theta_1 = \theta_2 = \theta_3 = 1/3$. Note that $I_{11} + I_{12} + I_{13} = 1$ with pair-wise symmetrical trade costs, as any country would host 1/3 of the modern sector if all countries have the same size and are equally well accessible. The term $d\lambda_1^*/d\theta_1$ then measures directly the elasticity of the output share.

Combining (19) and (20) and using lemma 1 we can write down the following general condition for the pervasiveness of the HME.⁵

$$dE_1 > \frac{(I_{12} - 2I_{11} - 2I_{13})dE_2 + (I_{13} - 2I_{11} - 2I_{12})dE_3}{3(I_{12} + I_{13})} \equiv \Psi(\Phi, dE_2, dE_3) \quad (21)$$

The HME holds if the increase of the home country's size (dE_1) exceeds the expression $\Psi(\Phi, dE_2, dE_3)$ on the right hand side of (21). With $\Psi(\Phi, dE_2, dE_3) \leq 0$, the HME is valid for any $dE_1 > 0$, since the inequality would always be satisfied. If $\Psi(\Phi, dE_2, dE_3) > 0$, it sets a lower bound for dE_1 relative to third country effects dE_2 and dE_3 in order for the HME to arise, given the trade cost structure Φ entailed in the impact factors.

With (21) we readily have the first important comparative static result. Since $\Psi(\bullet) = 0$ if the size of both foreign countries remains constant ($dE_2 = dE_3 = 0$), we can be sure that the HME generalizes from a two- to a three-country model if the only exogenous change is an enlargement of the home country (with an automatic adjustment of all expenditure shares). Going back to (19), the *strength* of the effect is determined by $\frac{1}{2} \cdot (2I_{11} - I_{12} - I_{13})$, which is larger the higher ϕ_{12} and ϕ_{13} , and the lower ϕ_{23} . We can state

Proposition 1: Exogenous increase in the size of the home country

Without third country effects the HME holds in an interior equilibrium. The effect is stronger the freer trade between the home country and any foreign country, and the lower trade freeness among the two foreign economies.

⁵ Since we focus on increases of θ_1 in presence of potential third country effects, we have naturally assumed $(2dE_1 + dE_2 + dE_3) > 0$. Moreover, the results from lemma 1 do not depend on the assumption of equal country sizes, since the impact factors are determined by transportation costs only.

To give a concrete illustrative example, one might think of the three countries as Germany (prior to reunification), France and Great Britain, which roughly had the same size. An exogenous enlargement of Germany, e.g. the reunification, increases the market size and the real market potential. The attractiveness as a production location increases and the industry share will rise over-proportionally. Higher trade freeness between Germany and either France or Britain leads to a stronger HME, which is reminiscent of the “magnification effect” from the two-country model that implies a stronger HME at higher bilateral trade freeness (see e.g. Baldwin et al., 2003: ch.13).

In reality there have been few historical situations where the size of only one country has increased exogenously. Using real world data at two points in time, the size of all countries will generally have changed. In terms of the model one can say that dE_2 and dE_3 (and thus $\Psi(\bullet)$) are unlikely to be equal to zero all the time. Therefore we study the pervasiveness of the HME in presence of third country effects. Unfortunately, neither the sign of $\Psi(\bullet)$ is unambiguous, nor whether $\Psi(\bullet)$ is increasing or decreasing in dE_2 and dE_3 .⁶ There is thus no general analytical answer whether the HME holds once third country effects are allowed for, but the validity of the HME depends on the specific circumstances (i.e., on the impact factors and the signs and magnitudes of dE_2 and dE_3). In the remainder of this paper we will analyse two benchmark cases of third country effects that give rise to clear cut insights.

2.4. Expenditure shift in the foreign world

The first type is a pure shift in the expenditure from one foreign country to the other. Clearly, such a shift can not occur in a world consisting only of two economies, but requires at least three countries. Suppose that $dE_2 = -dE_3 = d\tilde{E}$. That is, with $d\tilde{E} > 0$ we consider an expenditure shift from country 3 to country 2, and vice versa. Note that this shift does not alter the domestic expenditure share θ_1 , whereas the industry share λ_1^* can change. This clarifies why it is not always useful to think only in terms of expenditure and production *shares*.

At first we consider the effects of this shift in isolation. Using (18) with $d\tilde{E}$ and $dE_1 = 0$, the effect on the domestic industry share is given by

$$d\lambda_1^* = (I_{12} - I_{13})d\tilde{E} \quad (22)$$

⁶ The denominator of $\Psi(\bullet)$ is unambiguously negative by lemma 1. The sign of the numerator is ambiguous, however, because the two terms in the parentheses can be either positive or negative.

Taking into account lemma 1 we know that $(I_{12} - I_{13}) < 0$ if $\phi_{12} > \phi_{13}$, i.e. if country 2 is better accessible than country 3 from the point of view of the home country. Hence, $d\lambda_1^*/d\tilde{E}$ is negative in this case. With $\phi_{13} > \phi_{12}$ we have $d\lambda_1^* > 0$ if $d\tilde{E} > 0$ and $d\lambda_1^* < 0$ if $d\tilde{E} < 0$. With $\phi_{12} = \phi_{13}$ we have $I_{12} = I_{13}$ and thus $d\lambda_1^*/d\tilde{E} = 0$. Focussing on the case with $\phi_{12} > \phi_{13}$, the term $(I_{12} - I_{13})$ is stronger negative the higher ϕ_{12} and the lower ϕ_{13} , i.e. the better accessible the enlarged foreign country and the more remote the diminished foreign country. It is also stronger negative the higher ϕ_{23} , i.e. the freer trade between the foreign countries, because this will exacerbate the industry reallocation from country 3 to country 2. This gives rise to

Proposition 2: Foreign expenditure shift

An expenditure shift in the foreign world towards (away from) the better accessible economy negatively (positively) affects the equilibrium industry share in the home country (λ_1^*) in an interior equilibrium. The effect is larger the greater the difference between ϕ_{12} and ϕ_{13} and the lower ϕ_{23} . An expenditure shift has no impact on the home country if both foreign countries are equally well accessible.

Now think of an exogenous increase in the home country's size ($dE_1 > 0$) parallel to an expenditure shift towards the better accessible foreign economy (without loss of generality, country 2). Condition (21) for the pervasiveness of the HME reduces to

$$dE_1 > \frac{(I_{12} - I_{13})}{(I_{12} + I_{13})} d\tilde{E} \equiv \hat{\Psi}(\Phi, d\tilde{E}) \quad (23)$$

The coefficient $\hat{\Psi}(\Phi, d\tilde{E})$ is strictly positive with $\phi_{12} > \phi_{13}$ and (23) sets a lower bound for dE_1 relative to $d\tilde{E}$ in order to guarantee the validity of the HME. It is possible to show that $\partial\hat{\Psi}/\partial\phi_{12} > 0$, $\partial\hat{\Psi}/\partial\phi_{13} < 0$, and (with $\phi_{12} > \phi_{13}$) $\partial\hat{\Psi}/\partial\phi_{23} > 0$. For a given magnitude of $d\tilde{E}$, the compensating increase in the home country's size (dE_1) that guarantees the validity of the HME must be larger, the stronger the industry reallocation effects of the expenditure shift. I.e., the better accessible the foreign country 2 whose size increases, the worse the accessibility of the foreign country 3 that gets smaller, and the freer trade between the two foreign countries. Summarizing these results we state

Proposition 3: HME with third country effects (I)

For any given magnitude of the foreign expenditure shift towards the better accessible economy ($d\tilde{E} > 0$), the increase in the size of the home country dE_1 must exceed the lower bound $\hat{\Psi}(\Phi, d\tilde{E}) > 0$ in order for the HME to arise. The bound $\hat{\Psi}(\Phi, d\tilde{E})$ is increasing in ϕ_{12} and ϕ_{23} . It is decreasing in ϕ_{13} .

To consider again the concrete example from above, suppose that from Germany's point of view, France (country 2) is better accessible than Great Britain (e.g. due to the Northern Sea). If expenditure shifts from England to France, the domestic German industry is sheltered less from competition, thus making Germany less attractive as industry location. To compensate this effect, Germany's size (and thus, its real market potential) must sufficiently increase in order for the HME to arise.

2.5. Expenditure increase in the foreign world

In this section we analyse an increase in the size of one foreign economy. This type of exogenous change can also occur in a two-country model, where the enlargement of the foreign country will lead to a decrease in the domestic expenditure share. In such a model it is unambiguous that the domestic industry share will over-proportionally decline in an interior equilibrium (Helpman and Krugman, 1985).

An exogenous enlargement of, say, country 3 also leads to a lower domestic expenditure share θ_1 in a three-country model. What will happen to the industry share λ_1^* ? It is reasonable to expect a negative reaction, since the domestic modern sector faces a larger number of competitors located in the increased foreign economy. This intuition is in fact confirmed by the model. Considering (18) with $dE_3 > 0$ and $dE_1 = dE_2 = 0$, we have

$$\frac{d\lambda_1^*}{dE_3} = \frac{I_{13} - I_{11} + (I_{13} - I_{12})}{3} < 0 \quad (24)$$

It turns out that expression (24) is unambiguously negative. This is most straightforward to see if $\phi_{13} \geq \phi_{12}$, i.e. if the enlarged country 3 is at least as well accessible as country 2, since all three terms of the numerator are negative. In the case with $\phi_{12} > \phi_{13}$, the term $(I_{13} - I_{12})$ is positive. However, it is not possible that $(d\lambda_1^*/dE_3) > 0$, as it can be shown that this would be inconsistent with the conditions for interior equilibrium and only direct transportation from

one country to another ($\phi_{ij} > \phi_{ik} \cdot \phi_{kj}$).⁷ Hence, the domestic industry share λ_1^* will decline following an exogenous increase in the size of one foreign country, because this enlargement makes the foreign economy more attractive in terms of its real market potential. This drains away some of the modern sector out of the home country.

It is possible to show that the term $(2I_{13} - I_{11} - I_{12})$ is stronger negative the higher ϕ_{13} . The freer trade between the home country and the enlarged foreign country 3, the more adversely affected is the domestic industry. Similarly, one can show that $\partial(2I_{13} - I_{11} - I_{12})/\partial\phi_{23} > 0$. The intuition for this result is that an enlargement of country 3 will harm the modern sector in the other foreign country 2 the stronger, the freer trade between them. The industry reallocation mainly occurs among the two foreign countries, and the industry share in the home country is affected to a lesser extent the larger ϕ_{23} . Lastly, the implications of the foreign industry reallocation for the domestic modern sector is also weaker the lower ϕ_{12} , which explains the comparative static result $\partial(2I_{13} - I_{11} - I_{12})/\partial\phi_{12} > 0$. To sum up,

Proposition 4: Exogenous increase of one foreign country

An exogenous enlargement of one foreign economy reduces the industry share of the home country in an interior equilibrium. The decline is stronger the better accessible the enlarged foreign country, the more remote the other foreign country and the more restricted trade between the two foreign economies.

After having established the effects of an *isolated* enlargement of one foreign economy, we can now think of this exogenous change as a third country effect that occurs parallel to an equivalent enlargement of the home country. Suppose that $dE_1=dE_2>0$, whereas $dE_3=0$. Note that this implies an increase in the expenditure share θ_1 . Using (18), the effect on λ_1^* is described by the term $\frac{1}{3}(I_{11} + I_{12} - 2I_{13})$, which must be strictly positive, as the expression is the inverse of (24). The domestic industry share is thus going to rise. But contrary to a two-country model, and contrary to an exogenous *isolated* enlargement of the home country in our

⁷ If we would simply assume that transportation via a third country is ruled out (neglecting the parameter restriction $\phi_{ij} > \phi_{ik} \cdot \phi_{kj}$), it is even possible that $d\lambda_1^*/dE_3>0$ in an interior equilibrium. This requires an extreme parameter constellation, where country 2 exhibits a strong hub effect. The two necessary conditions that need to hold for this case are (i) $\phi_{12} > 2\phi_{13}$ and (ii) $\phi_{13} < \underline{\phi} < \phi_{23} < \bar{\phi} < \phi_{12}$, where $\underline{\phi} = \phi_{13} + \left[\frac{(1 - \phi_{12})^2}{(1 + \phi_{12} - 2\phi_{13})} \right]$ and $\bar{\phi} = \frac{1}{2} \left[3 + \phi_{13} (2\phi_{12} - 3) - \sqrt{(\phi_{13} - 1)(17\phi_{13} - 1 + 4\phi_{12} (\phi_{12} - 3)(\phi_{13} + 1))} \right]$. In this constellation, a parallel increase of the home country and the foreign hub country ($dE_1=dE_2>0$) would even lead to a decline in the domestic industry share. An exemplary parameter setting where this is the case is $\phi_{12} = 0.5$, $\phi_{13} = 0.245$ and $\phi_{13} = 0.493$. As one can easily check, $\phi_{23} \cdot \phi_{12} = 0.2465 > 0.245 = \phi_{13}$.

model (see proposition 1), the increase of λ_1^* can be under-proportional. We use the general condition for the HME, equation (21), with $dE_2 > 0$ und $dE_3 = 0$, and obtain the following inequality.

$$dE_1 > \frac{(I_{12} - 2I_{11} - 2I_{13})}{3(I_{12} + I_{13})} dE_2 \equiv \Psi(\Phi, dE_2)$$

With $dE_1/dE_2 = 1$ this can be rewritten as $I_{11} + I_{12} + \frac{5}{2} \cdot I_{13} < 0$. Finally, using the expressions (10)-(12) for the impact factors, we can write the condition for the pervasiveness of the HME also in the following form

$$\tilde{\Psi}(\phi_{12}, \phi_{13}, \phi_{23}) \equiv \underbrace{\frac{1 + \phi_{23}}{1 - \phi_{12} - \phi_{13} + \phi_{23}}}_{I_{11}} + \underbrace{\frac{\phi_{13}\phi_{23} - \phi_{12}}{(1 - \phi_{13})(1 - \phi_{12} + \phi_{13} - \phi_{23})}}_{I_{12}} + \underbrace{\frac{5(\phi_{12}\phi_{23} - \phi_{13})}{2(1 - \phi_{12})(1 + \phi_{12} - \phi_{13} - \phi_{23})}}_{\frac{5}{2} \cdot I_{13}} < 0 \quad (25)$$

With a parallel increase of E_1 and E_2 the HME is only valid if inequality (25) is satisfied. If $\tilde{\Psi}(\phi_{12}, \phi_{13}, \phi_{23}) > 0$, the exogenous change $dE_1 = dE_2 > 0$ only leads to an under-proportional rise of λ_1^* . The sign of $\tilde{\Psi}$ is in general ambiguous and, thus, whether the HME holds depends on the specific values of the trade freeness parameters, i.e. on the “geographical circumstances” in this three-country world.⁸ We therefore state at first

Proposition 5: HME with third country effects (II)

If the size of one foreign country and the home country increase parallel and by the same amount, the industry share of the home country will increase. However, this increase can be under-proportional relative to the increase of the expenditure share and thus the HME need not arise in the three-country model.

Interestingly, not even a configuration with pair-wise symmetrical trade costs guarantees the validity of the HME. With $\phi_{12} = \phi_{13} = \phi_{23} = \phi$, the term $\tilde{\Psi}(\phi)$ reduces to $(5/2) - (3/2)(1 - \phi)$, which is negative only if $\phi > 0.4$, i.e. if trade is sufficiently free. With $0 < \phi < 0.4$ there is no HME, as the elasticity of the output share ($d\lambda_1^*/d\theta_1$) is less than one. Higher trade freeness strengthens the case for the validity of the HME with the third country effect $dE_2 > 0$ if there

⁸ Note that since the three countries are ex-ante identical, the conclusions about the pervasiveness of the HME for the home country 1 also apply to the foreign country 2. That is, if the HME holds for the home country, it must also hold for country 2, and vice versa.

are no accessibility differences across countries. This again corresponds with the “magnification effect” from the two-country model.

With differences in trade costs across countries, the comparative statics of $\tilde{\Psi}(\phi_{12}, \phi_{13}, \phi_{23})$ are somewhat difficult to determine. Note that a positive sign of the partial derivative $\partial\tilde{\Psi}/\partial\phi_{ij}$ implies that the HME is less likely to arise the higher trade freeness between countries i and j . But although analytical expressions for the partial derivatives of $\tilde{\Psi}(\phi_{12}, \phi_{13}, \phi_{23})$ can be derived, their signs are in general ambiguous. It is therefore helpful to interpret the exogenous change $dE_1=dE_2>0$ as a combination of two exogenous enlargements, of the home country and the foreign country 2. In propositions 1 and 4 we have described the effects of these two isolated changes on λ_1^* , and how their respective strength changes with the three trade freeness parameters. In short, we have shown that the impact of $dE_1>0$ on λ_1^* is positive and stronger the higher are ϕ_{12} and ϕ_{13} and the lower is ϕ_{23} . On the other hand, the impact of $dE_2>0$ on λ_1^* is negative and stronger the higher ϕ_{12} , and the lower are ϕ_{13} and ϕ_{23} . From these results we can infer that the HME will be more likely to arise the higher ϕ_{13} (i.e., $\partial\tilde{\Psi}/\partial\phi_{13} < 0$), but the signs of $\partial\tilde{\Psi}/\partial\phi_{12}$ and $\partial\tilde{\Psi}/\partial\phi_{23}$ remain unclear. Freer trade between countries 1 and 2 implies a stronger positive effect of dE_1 on λ_1^* , but also a more adverse effect of dE_2 . Similarly, the positive effect of dE_1 is weaker the freer trade between the two foreign economies, whereas the negative impact of dE_2 is also weaker the higher ϕ_{23} .

In order to analyze which effect dominates, we present a graphical illustration of $\tilde{\Psi}$ as a function of ϕ_{12} and ϕ_{23} in figure 1, where we have assigned a specific numerical value to ϕ_{13} (=0.5) and chosen the domain of the other two parameters such that an interior equilibrium is always implied for equal initial country sizes (ϕ_{12}, ϕ_{23} between 0.4 and 0.63).

- Figure 1 about here -

The HME holds if the greyly shaded surface runs below the plane where $\tilde{\Psi} = 0$, and the HME does not hold if the surface runs above. As can be seen, the HME holds for all admissible values of ϕ_{12} if ϕ_{23} is large, and it holds for all admissible values of ϕ_{23} if ϕ_{12} is small. Moving along the ϕ_{12} -axis at a low value of ϕ_{23} , we see that the HME holds at low values of ϕ_{12} , but it ceases to hold at high values of ϕ_{12} . Similarly, moving along the ϕ_{23} -axis at a high level of ϕ_{12} , the HME holds for high values of ϕ_{23} , but not for low values.

All in all, the simulation suggests that the HME is less likely to occur the higher ϕ_{12} and the lower ϕ_{23} .⁹ To illustrate the intuition for these results, return to the example with (West) Germany, France and Great Britain. A hypothetical historical situation, where Germany and France are enlarged to the same extent, implies a higher German industry share. But the increase can be under-proportional. This failure of the HME is more likely the freer trade between the two enlarged countries, because the negative exacerbation effect of the enlarged France is greater than the positive magnification effect that results from Germany's own enlargement. On the other hand, the freer trade with Great Britain of either Germany or France, the more likely is the HME, because the British industry share will be more adversely affected the higher ϕ_{13} and ϕ_{23} , leaving room for over-proportional output expansions in both Germany and France.

3) Conclusion

In this paper we have presented a three-country version of the model by Krugman (1980). Compared to the two-country setup in this seminal paper, we have shown that the home market effect does not always arise if third country effects occur parallel to an exogenous increase in the home country's size. We have pointed at two different types of third country effects that can rule out the HME. The first is an expenditure shift from a more remote to a better accessible foreign economy. To compensate this effect, the increase in "home's" expenditure must be sufficiently strong to actually see an over-proportional output reaction. The second type is a parallel enlargement of "home" and one foreign economy, particularly if this country is well accessible for the home economy.

That the HME does not easily generalize from a two-country model to a more realistic setting if third country effects play a role has already been pointed out by Behrens, Lamorgese, Ottaviano and Tabuchi (2004). The main contribution of this paper is to show more clearly *why* this is the case and under which conditions we can actually expect to see the HME in a world consisting of more than two countries.

⁹ Lowering the exogenous value of ϕ_{13} tends to flatten the surface and to shift it upwards, thereby increasing the parameter domain for which the HME does not hold. This confirms that $\partial\tilde{\Psi}/\partial\phi_{13} < 0$. The figure also demonstrates why clear cut analytical results for the partial derivatives are not available: When moving along the ϕ_{12} -axis at a high value of ϕ_{23} , one can see that the surface has an inverted U-shape although $\tilde{\Psi} < 0$ is always implied.

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Appendix

In their general M-country model, BLOT have shown that a condition for an interior equilibrium is factor price equalization (FPE) across countries, which arises if the labor demand in the modern sector does not exceed the inelastic total labor supply in every country (see their appendix 1). Adjusted for the three-country case, the necessary and sufficient condition for existence, uniqueness and stability of interior equilibrium with $\lambda_i^* > 0$ for $i=1,2,3$ reads as

$$0 < \mu \cdot \sum_{j=1}^3 \frac{f_{ij}}{f_{1j} + f_{2j} + f_{3j}} \cdot \theta_j < \theta_i \quad \text{for } i=1,2,3 \quad (26)$$

The share μ of the modern good must be sufficiently small for (26) to hold. This entails the following (weaker) necessary condition for an interior equilibrium with FPE: $\theta_i < \varphi_i$ for $i=1,2,3$, where φ_i is the sum of the i^{th} row elements of the inverse matrix $\varphi = \Phi^{-1}$. That is,

$$\theta_i < \varphi_i \equiv \frac{f_{i1} + f_{i2} + f_{i3}}{|\Phi|} \quad \text{for } i=1,2,3 \quad (27)$$

must hold. They furthermore show that the trade cost matrix Φ will be positive definite if distance is measured by an Euclidian norm (see appendix 3), hence the determinant $|\Phi|$ is strictly positive. Taking into account that $|\Phi| > 0$, we can infer from (27) that

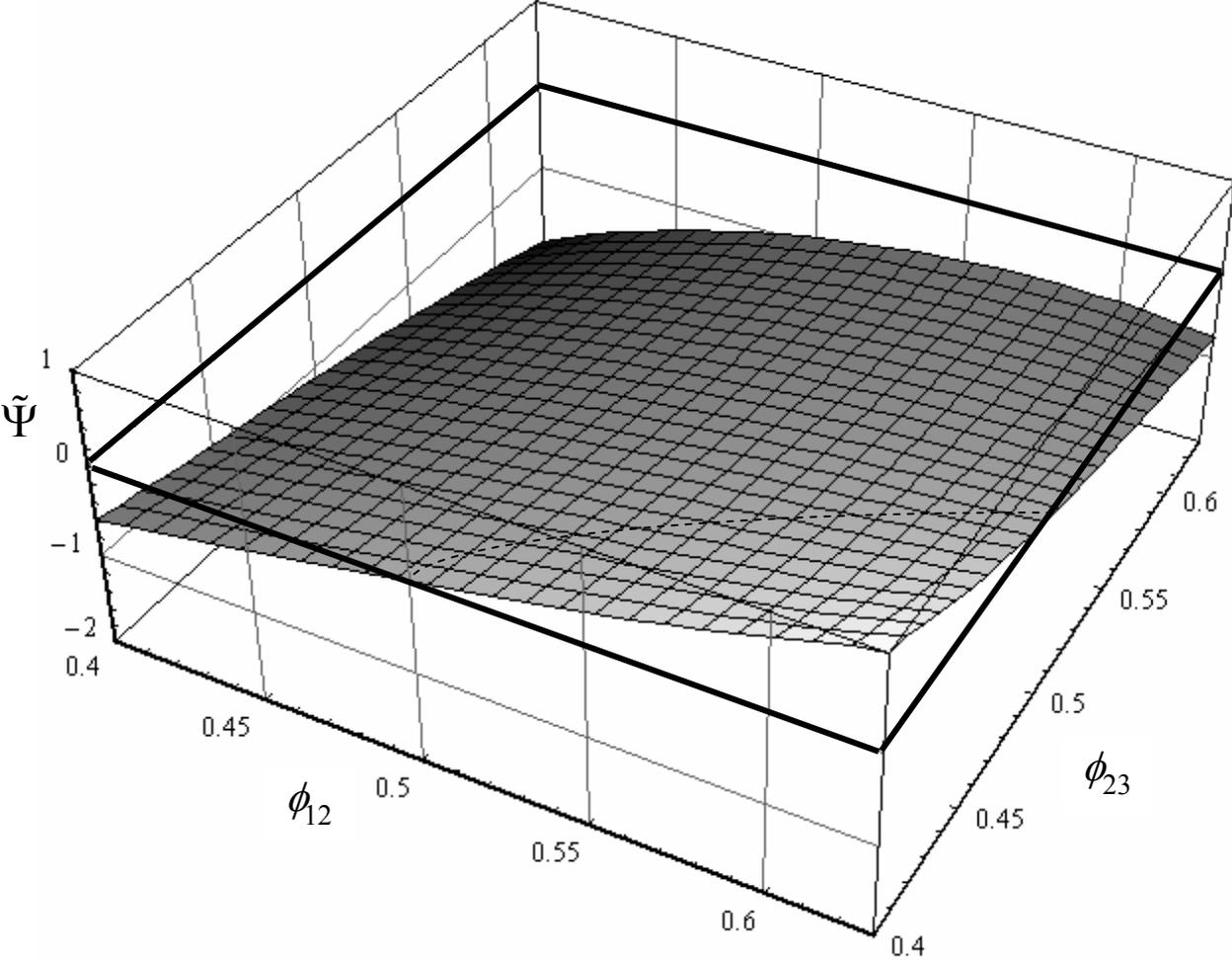
$$f_{i1} + f_{i2} + f_{i3} > 0 \quad \text{for } i=1,2,3 \quad (28)$$

Equations (10)-(12) then imply that the signs of the impact factors I_{11} , I_{12} and I_{13} are determined only by the signs of the cofactors f_{11} , f_{12} and f_{13} , respectively. We now prove the three parts of lemma 1 one after the other.

- (i) Since $f_{11} = 1 - (\phi_{23})^2 > 0$, we have $I_{11} > 0$.
- (ii) Applying the condition $\phi_{ij} > \phi_{ik} \cdot \phi_{kj}$, both $f_{12} = \phi_{13}\phi_{23} - \phi_{12}$ and $f_{13} = \phi_{12}\phi_{23} - \phi_{13}$ must be strictly negative. Note that if we would drop the parameter restriction on the ϕ 's and simply assume that transportation via a third country is ruled out, it is possible that an impact factor can also be positive. However, one can prove that at most one impact factor can be positive, whereas at least one impact factor as well as the sum ($I_{12} + I_{13}$) remains strictly negative.
- (iii) With $\phi_{12} > \phi_{13}$, the numerator of I_{12} must be stronger negative than the numerator of I_{13} , because $(\phi_{12}\phi_{23} - \phi_{13}) < (\phi_{13}\phi_{23} - \phi_{12}) < 0 \Leftrightarrow \phi_{23} < -1$ would be a contradiction. Moreover, the (positive) denominator of I_{12} , $(1 - \phi_{13})(1 - \phi_{23} - (\phi_{12} - \phi_{13}))$, must be smaller than the (positive) denominator of I_{13} , $(1 - \phi_{12})(1 - \phi_{23} + (\phi_{12} - \phi_{13}))$, because both individual (positive) terms must be smaller. Hence, I_{12} is stronger negative than I_{13} if $\phi_{12} > \phi_{13}$, and vice versa. With $\phi_{12} = \phi_{13} = \phi$, we have $I_{12} = I_{13} = -(\phi/(1 - \phi)) < 0$.

Figure 1: The comparative statics of (25)

$$\phi_{13} = 0.5$$



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