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Should Sweden Join the EMU?

An Analysis of General Equilibrium Effects through Trade

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Contents

Abstract

The paper considers whether Sweden should join the EMU as based on general equilibrium (GE) effects through reduced trade barriers linked to the single currency. We use in this evaluation a gravity model for trade in Europe derived and estimated in the paper, and the estimates of trade barriers linked to EMU reached in the literature. First, we present an alternative derivation of the gravity equation for foreign trade, which is explicitly based on monopolistic competition in the export markets. In contrast to the usual specification, our model allows for the realistic assumption of asymmetry in mutual trade flows. We then present a straightforward methodology how to carry out a simulation, based on the estimated model, of GE effects related to a change in a trade barrier. Numerically, we apply this to analyse the effects of a possible Swedish entrance into EMU. The effects are quite clearly in favour of EMU enlargement, and do not indicate a trade diversion effect either for the incumbent EMU countries or the rest of the European countries. However, a stochastic simulation of the effects reveals that there is a substantial uncertainty related to the effects of such a change in policies.

Key words: EMU, Sweden, Gravity Model, General Equilibrium Effects, Trade Barriers

JEL: F12, F15

Tiivistelmä

Tutkimuksessa tarkastellaan sitä, pitäisikö Ruotsin liittyä EMUun. Tarkastelu perustetaan yleisen tasapainon ulkomaankauppavaikutusten selvittämiseen, jotka liittyvät yhtenäisvaluuttaan siirtymiseen. Vaikutusten analyysi perustuu ulkomaankaupan gravitaatiomalliin, joka johdetaan ja estimoidaan paperissa, sekä kirjallisuudessa saatuihin arvioihin EMUn kauppavaikutuksista. Gravitaatiomallille esitetään vaihtoehtoinen johtaminen, joka perustuu eksplisiittisesti monopolistiseen kilpailuun vientimarkkinoilla ja joka on yleisempi kuin aiemmin kirjallisuudessa. Päinvastoin kuin usein, johdettu malli sallii realistisen oletuksen epäsymmetrisistä keskinäisistä kauppavirroista. Tämän jälkeen malliin perustuen esitetään suoraviivainen metodi, jonka avulla voidaan päätellä kaupan esteen poistamisen yleisen tasapainon mukaiset vaikutukset. Numeerisesti sovellamme menetelmää Ruotsin mahdolliseen liittymiseen EMUun. Tulokset puoltavat EMUun laajenemista, eivätkä osoita tästä aiheutuvan kaupan siirtymää nykyisille euroalueen maille tai muille Euroopan maille. Toisaalta vaikutusten stokastinen simulointi osoittaa, että näihin vaikutusarvioihin liittyy merkittävä epävarmuus.

Asiasanat: EMU, Ruotsi, gravitaatiomalli, yleisen tasapainon vaikutukset, kaupan esteet

1 Introduction

Even though Sweden has no opt-out clause in its accession treaty with the European Union, the country has decided to stay outside the EMU, mainly because of political reasons.[1] However, at times it has quite severely pondered about joining the EMU. Thus, there was a referendum in 2003 with a clear negative outcome even though the then government endorsed adoption of the euro. More recently, during the current global and European financial, economic and debt crisis Sweden has performed quite well while staying outside the euro area. At first, the *krona* weakened markedly softening the recessionary blow. After February 2009 it has trendwise appreciated vis-à-vis the euro. The country has at times discussed with varying intensity about its joining the single currency. The possible Swedish accession is also interesting for incumbent EMU countries, as considered recently from the Finnish point of view by Alho, Kotilainen and Nikula (2010).

One core aspect of the effects of EMU is trade, which has been under an intensive investigation. Recently, for the Swedish debate and EMU preparation, Flam (2009) has made a summary evaluation of this field of research. However, no systematic general equilibrium effects have been derived in this research. We want to contribute to this research in two ways: first, we present an estimation result of a properly micro-based trade model. Second, more importantly, we present a general equilibrium (GE) framework based on this model to derive effects of a change in a trade barrier. Consequently, we can infer about the effects, both under certainty and uncertainty, pertaining to the impulses to be felt in the trade flows as a result of EMU membership. We do not present a separate GE model but rather a concise framework intimately based on the gravity model.

We build on a two-stage empirical approach. First, we need an estimate of the key parameter, the elasticity of substitution in foreign trade. Secondly, we base our evaluation on the estimated impact of the euro on trade, as reached in the recent literature, see Baldwin et al. (2008) and Flam (2009). As the estimations of the trade barrier linked to the euro are uncertain and vary markedly, in the second stage we also carry out a stochastic evaluation of the general equilibrium effects of a Swedish membership in the EMU.

Our results basically show that Sweden could reap sizeable gains from an EMU accession. The effects to the incumbent euro area are minor, revealing only a marginal impact, while they are quite large for the small country joining the monetary union. We come to clearly higher estimates of the gains of EMU to Sweden, in contrast to what Flam (2009) envisioned in his back-of-the-envelope calculations. The reason for this outcome is the fact the adoption of the euro improves competitiveness through disinflation which further boosts domestic production. However, there is also a major uncertainty related to the outcome as revealed by a stochastic simulation of the effects of these policies.

The paper proceeds as follows. We build on Alho (2005) in presenting the trade model, and the GE framework. The gravity model is derived in Section 2 and its estimation is presented for trade flows between 27 European countries. Section 3 derives the framework for finding out the GE effects of a change in a trade barrier. Section 4 then applies this method to evalu-

[1] We simply mean by the term 'joining the EMU' participation in its third stage, i.e., going over to adopt the common currency, the euro.

ate numerically the effects, through trade, of a possible Swedish accession to the EMU. Section 5 concludes.

2 The trade model and its estimation

2.1 The trade model

The analysis of trade using the classical gravity model has been very intense during the recent years, to analyze, e.g., the trade effects of currency unions. Baldwin et al. (2008) and Flam (2009) are recent summaries of the literature. There are, however, two shortcomings in these applications. First, it is commonly assumed that trade barriers are symmetric, i.e., identical in trade from country i to j and in trade from j to i, and no emphasis is paid to differences in exports and imports and the factors underlying them. This shortcoming has been avoided in the most recent contributions, see Baldwin et al. (2008) and Flam (2009). Second, the theoretical basis of the estimated gravity model is insufficient and often lacking totally, but see Baldwin et al. (2008) for a derivation of the gravity model.

This assumption of symmetry is very dominating in the empirical application of the gravity model,[2] but it is in sharp conflict with the actual situation. Take, for instance, trade flows within Europe. In 1999, the average absolute difference between the logs of the bilateral trade flows of 27 European countries was as high as 0.66, which implies that, on average, the smaller of the bilateral trade flows is only 52 per cent of the bigger. Therefore, it is not surprising that using a gravity model to explicitly test for the symmetry of trade barriers in Europe produces the outcome that they are strongly asymmetric (see Alho 2003).

Anderson and van Wincoop (2003) presented an important and novel analysis which claims to solve the famous "border puzzle" concerning the effects of a border on trade, originally found by McCallum (1995) to be extremely large between the USA and Canada. They build on the early derivation of the gravity model by Anderson (1979). Assuming CES-preferences, symmetric trade barriers, and imposing the general equilibrium constraint for trade, i.e., that total sales equal total production, Anderson and van Wincoop explicitly derive the following gravity equation for bilateral trade,

(1) $$X_{ij} = \frac{Y_i Y_j}{Y_W} \left(\frac{t_{ij}}{P_i P_j}\right)^{1-\sigma}.$$

Here X_{ij} is exports from country (region) i to country j, Y_i is the income (GDP) of country i, Y_W denotes world GDP, t_{ij} is the trade barrier factor (inverse of unity minus the ad valorem barrier per unit of exports) between countries (regions) i and j, assumed to be the same as t_{ji}, and P_i is their key notion of aggregate trade resistance, or simply, the consumer price index of country i. The parameter σ is the elasticity of substitution between imports from various origins. The authors' estimation results of (1) produced a much smaller effect of the USA–Canada border on trade than what was found out by McCallum.

[2] For instance, the analyses of the impact of EMU on trade by Micco, Stein and Ordonez (2003) and Barr, Breedon and Miles (2003) both built their trade model on the sum of exports and imports and thereby omitted the differences existing between them.

What is striking in (1) is that it implies total symmetry in trade flows, i.e., $X_{ij} = X_{ji}$, which does not prevail in reality, as mentioned above. Therefore, a more general approach is in place. In this paper we derive a model for bilateral trade flows, expanding on the framework used by Anderson and van Wincoop, by explicitly introducing monopolistic competition in the export market, and by also allowing for asymmetry in trade. We estimate the model for trade flows between European countries to determine the factors behind the trade asymmetries.

The specification of the demand for imports from various countries here follows that of Anderson and van Wincoop (2003), with some minor modifications. The import demand functions in country j, j = 1,…,N, are derived from a CES utility function for aggregate consumption D_j,

(2) $$D_j = \left[\sum_{i=1}^{N} a_{ij}^{1/\sigma} Q_{ij}^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}, \sigma > 0,$$

where Q_{ij} is the volume of exports from country i to j, the a_{ij}'s are the country-specific positive preference (distribution) parameters summing to unity and σ is, again, the elasticity of substitution between imports from various origins. The import demand functions are then

(3) $$Q_{ij} = a_{ij} D_j \left(\frac{p_{ij}}{P_j}\right)^{-\sigma},$$

where p_{ij} is the price set by the exporters of country i in the market of country j, inclusive of the cost of trade barriers and, being dual to the quantity index (2), P_j represents the CES price index of the consumption basket in country j,

(4) $$P_j = \left[\sum_{i=1}^{N} a_{ij} p_{ij}^{1-\sigma} \right]^{1/(1-\sigma)}.$$

From (3) we can derive the market share of exports $X_{ij} = p_{ij}Q_{ij}$ of country i in country j, in relation to its GDP, yielding

(5) $$\frac{X_{ij}}{Y_j} = a_{ij} \left(\frac{p_{ij}}{P_j}\right)^{1-\sigma},$$

where Y_j is the GDP (in nominal terms) of country j and the budget constraint $Y_j = P_j D_j$ is imposed.

We next consider the export supply decision of a monopolistic firm of country i to the market of country j. For this we need to specify that aggregate demand D_j is given by the function

(6) $$D_j = b_j P_j^{-\phi}, \phi > 0,$$

where b_j is a scale factor representing the size of the country concerned. Note that typically $\phi < \sigma$. Let there be K_i identical exporting firms in country i. The optimal supply decision of an exporter in country i maximizing profit in market j is given by

(7) $$p_{ij}(1 + \varepsilon(p_{ij}, Q_{ikj})) = t_{ij} c_i,$$

where c_i is the marginal cost of production in country i and Q_{ikj} denotes the volume of exports of firm k of country i in the market of country j, t_{ij} is, as in Eq. (1), the trade barrier factor (inverse of one minus the ad valorem barrier per unit of exports) between countries (regions) i and j, and $\varepsilon(z_i,z_j)$ denotes the elasticity of the variable z_i with respect to the variable z_j. Using (3), (6) and the general result from index number theory that $\varepsilon(D_j,Q_{ikj}) = s_{ikj} = X_{ikj}/Y_j$, i.e., the market share of exporter k in the market of country j, and summing over the identical K_i firms, we get from (7),

(8) $$p_{ij}\left[K_i(1-\sigma^{-1})+(\sigma^{-1}-\phi^{-1})(s_{ij}+h_j(1-s_{ij}))\right]=K_i c_i t_{ij}\,.$$

Here h_j is the conjectural variation parameter in the proportional output game[3] (see e.g., Smith and Venables, 1988 and Alho, 1996 and the Appendix 1 for more details) and s_{ij} is the aggregate market share of country i in the market of country j, $s_{ij} = \sum_{k=1}^{K_i} s_{ikj} = X_{ij}/Y_j$. The supply equation (8) allows for price discrimination between various export markets. It is therefore more general than the approach of Anderson and van Wincoop, who assume uniform pricing, which takes place when competition is perfect ($h_j = -s_{ij}(1-s_{ij})^{-1}$ and σ approaches infinity). Note that under perfect competition, the export price only depends on the unit cost and the respective trade barrier. But otherwise under imperfect competition, the bigger the country, measured by the number of firms, the lower the export price which its firms charge.

We next need a model for the determination of the cost levels c_i and introduce therefore the following framework. Assume simply that labour L is the only factor of production and that there are constant returns to scale, $Q_i = A_iL_i$, where Q is the volume of GDP. Let the utility function U of workers be simply, in a standard manner, $U_i = \log(D_i) - \frac{1}{\nu}L_i^{\nu}$, where $\nu > 0$. Now optimizing under the budget constraint $P_iD_i = W_iL_i + \pi_i$, where W is the wage rate and π aggregate profits, we get the result for wage formation,

(9) $$W_i = P_iD_iL_i^{\nu-1} = Y_iL_i^{\nu-1}\,.$$

In the next step, in deriving the unit cost $c_i = W_i/A_i$, we could take two approaches. First, we could take the technology, as incorporated in the parameter A, to be identical in all the countries. But, as the countries in our empirical sample of European countries, on which we shall estimate the gravity model, are widely apart from each other as to their income levels and thereby productivities, this assumption of uniformity is not very sensible. Therefore, we allow for differences in productivities and write A_i, being the average labour productivity, as $A_i = Q_i/L_i = Y_i/P_iL_i$.[4] So, we get for the unit cost

(10) $$c_i = W_i / A_i = P_iL_i^{\nu}\,.$$

It depends in a simple way on the price level in the country and positively on the size of the country, if ν is positive, measured by the labour force, which will be below captured by population. These items describe the competitiveness of the country.

3 I.e., the parameter h_j is in relative terms the output response by the competitors to a one percent rise in the output of the firm concerned in market j. If h_j is, e.g., zero, we have the case of Cournot competition.

4 Note that as aggregate demand is identically equal to aggregate supply (GDP), i.e. $P_i^Q Q_i = P_iD_i$ where P_i^Q is the price on GDP, these prices P_i^Q and P_i are also identical.

We further assume that that the average size $\bar{Q}$ of the firms is identical in all the countries, so that $K_i\bar{Q} = Q_i = Y_i/P_i$. Normalise then this average size to unity, and insert this and (10) into (8). We can, by equating export demand (4) with supply (8), then solve for the export price p_{ij} from the equilibrium condition,

$$(11) \qquad BY_i\left[P_i^{-1}(1-\sigma^{-1})-\frac{t_{ij}L_i^{\nu}}{p_{ij}}\right]-\frac{h_j}{1-h_j}=a_{ij}\left(\frac{p_{ij}}{P_j}\right)^{1-\sigma},$$

where $B^{-1} = (\phi^{-1}-\sigma^{-1})(1-h_j) > 0$. Insert next this equilibrium solution (11) for the export price in market j into the export demand equation (4). Using the approximation that $\log(x + y) \approx \log(x) + \log(y) + o(x^2) + o(y^2)$, we can solve for the bilateral exports to be as follows, returning back to a power function specification,

$$(12) \qquad X_{ij}=\frac{Y_jY_i^{\mu}t_{ij}^{-\mu}a_{ij}^{\mu}}{P_i^{\mu}P_j^{-\mu}L_i^{\mu\nu}}, \text{ where } \mu=\sigma^{-1}(\sigma-1).$$

The parameter μ is thus positive and smaller than unity, if the elasticity of substitution σ is higher than unity. In addition, the function (12) includes higher order terms for Y_i, P_i, and P_j and the parameter h is assumed to be uniform in all markets. Note that, as mentioned above, under perfect competition, the Y_i variable is not present in (10), and not in (12), either.

There are several differences between specifications (12) and (1). The coefficients of Y_i and Y_j are normally different from each other in (12), and the coefficients of the price level in the exporting and importing countries are now also equal, but of opposite sign, in contrast to Eq. (1) where they are identical.

In the recent literature, a separation has been made in the effect of the euro on trade through the extensive and intensive margin. The gravity model basically captures the latter effect, see on this Baldwin et al. (2008), chapter 5.

2.1 Estimation of the model for European trade flows

Let us next estimate the basic trade equation (12) for trade flows between 27 European countries and compare it to the specification (1) of Anderson and van Wincoop. We consider trade in 1999, the first year of Economic and Monetary Union (EMU), identifying the following regions of countries in our estimations: those countries belonging to EMU, the EU, EU Accession Countries in Central and Eastern Europe, EFTA and Russia. We specify the preference parameters a_{ij} to be simply a function of common language, representing a common culture in the exporting and importing country. The application of the model to a quite old data is not a crucial shortcoming, as we basically want to reap from this exercise an estimate of the elasticity of substitution in foreign trade. The other empirical estimate that we need is based on the estimates reached in the literature on the impact of the euro on trade, see the recent evaluations by Baldwin et al. (2008) and Flam (2009). As the estimates reached in the literature differ as to the impact of the euro on trade, we also let this estimate to vary in size from small to sizeable.

The trade barriers in (12) are captured by the following specification:

$$t_{ij} = cd_{ij}^{\lambda} e^{\varsigma b_{ij} + \delta n_i + \psi n_j + \sum_{k,m} \beta_{km} r_{ij}(k,m)} \quad (13)$$

Here c is a constant, d_{ij} is the geographical distance between countries i and j, b_{ij} is the common-border indicator, equal to unity if countries i and j share a common border and zero otherwise, and n_i is unity if i is an island. The term $r_{ij}(k,m)$ is the regional integration indicator for exports from the region of countries k to region m, and equals unity if country i belongs to region k and country j belongs to region m, and zero otherwise. So, we allow for trade barriers to be potentially asymmetric in exports from region k to m and from m to k, i.e. that β_{km} may be different from β_{mk}.[5] Trade within the EU Internal Market is the reference point.

The relative price indices, P_j relative to that in other countries, are here calculated from measured price data as the relation between the current exchange rate of the currency concerned in terms of USD and its corresponding purchasing power parity (PPP) rate. Anderson and van Wincoop (2003) recommend against using measured prices because they are largely based on prices of nontradables. However, normally nontradables and tradables prices are positively related to each other. On the other hand, this information on relative prices between the countries is readily available. Their use also offers a neat way to carry out general equilibrium type of simulations related to changes in trade barriers, see Section 4.

The estimation results, using SUR, are the following. The common culture variable did not turn out to be significant, and is therefore omitted from the results. The inclusion of the labour force in the exporting country, captured here by population, which should have a negative coefficient, see (12), was met as to this property, but otherwise this specification was not successful in the sense that then the coefficient of the income variable Y_i got a coefficient which is higher than unity and which is against our theoretical model (12). Therefore, we imposed in (12) the constraint that the disutility of labour parameter ν goes to zero, which removes the labour force from the unit cost c_i, see (9) above. The estimation results in Table 1 are based on this specification.

We see that the model of Anderson and van Wincoop, presented in Equation (1) above, is not very well supported by the data, see Model 1 in Table 1 and its rather weak explanatory power in comparison to the other models. Models 2 and 3 are, instead, based on our preferred specification in Equation (12) and its versions. Model 3 is based on our gravity equation as specified above in (12) and its constraints imposed.

The hypothesis that trade barriers representing the various stages of regional economic integration are symmetric, i.e., that $b_{km} = b_{mk}$ for all pairs of k and m, is clearly rejected, as shown in the estimation results of Model 3 and also Model 1. Also the coefficient of Y_i differs significantly from unity, which points to another asymmetry in the specification of the trade equation, in contrast to Equation (1). The effect of a common border on mutual trade is found to be 21 percent, which is similar to the estimate by Anderson and van Wincoop concerning the effect of the Canada–USA border on trade. The estimate of the elasticity of substitution, σ, is 6.5 on the basis of Model 3, as solved from Eq. (12) above.

[5] EMU is a subset of the EU, which has to be taken into in the interpretation of the coefficients of the respective dummy variables.

Table 1 Estimation of the bilateral trade model for European countries (the log of the market share of bilateral exports X_{ij}/Y_j as the dependent variable)

Explanatory variable	*Model 1 (Eq. (1))*		*Model 2*		*Model 3 (Eq. (12))*	
	Coeff.	*(St. dev)*	*Coeff.*	*(St. dev)*	*Coeff.*	*(St. dev)*
Constant	−8.650	(0.143)	−7.560	(0.259)	−7.497	(0.831)
$Log(Y_i)$	1.000	(0)	0.949	(0.019)	0.846	(0.037)
$Log(P_j)$	−0.360	(0.026)	−0.454	(0.022)	0.846	(0.037)
$Log(P_i)$	−0.360	(0.026)	−0.151	(0.052)	−0.846	(0.037)
Y_i^2					0.0^{+}	
P_j^2					−0.944	(0.136)
P_i^2					1.176	(0.132)
Log(distance)	−1.231	(0.020)	−1.313	(0.016)	−1.164	(0.062)
Common border	0.179	(0.031)			0.150	(0.104)
i island	0.129	(0.079)			0.251	(0.110)
j island	−0.216	(0.052)			−0.227	(0.122)
Regional integration dummies	Yes*		No		Yes	
R_C^2	0.559		0.801		0.916	
F-test of symmetry of regional trade barriers	11.487**		–		13.338**	
F-test of coeff. of Y_i being unitary	–		7.590***		–	

* The barriers are constrained to be symmetric, $\beta_{km} = \beta_{mk}$ for all k, m, in Eq. (12), similarly as in Eq. (1).
** $p < 0.001$.
*** $p < 0.01$.
\+ The t-statistic of this coefficient is 1.8.

3 General equilibrium effects of a change in a trade barrier

Simulating changes in trade barriers t_{ij}, so that their general equilibrium effects through the price variables and income levels are taken into account, is an important issue raised by Anderson and van Wincoop. We suggest a computationally straightforward way to carry this out. Like Anderson and van Wincoop, we first need to make an assumption about the elasticity of substitution s. But what is neat in our model, is that the estimation of it also produces us an estimate of this parameter, see Eq. (12).

The change in the trade barrier t_{ij} has both a direct impact on trade, and an indirect one through a change in the price level P_j. The latter is a result of the fact that also the equilibrium export price p_{ij} changes as a reaction to a change in exports caused by a change in the trade barrier t_{ij}. To find out this indirect effect, we first solve from Eq. (5) the induced change in the price ratio p_{ij}/P_j from the change in the market share of exports resulting from a change in t_{ij}. The elasticity of the relative price (p_{ij}/P_j) with respect to the export market share X_{ij}/Y_j can be solved from equation (5) to be $(1-\sigma)^{-1}$. Next we take into account that also the aggregate price level P_j changes as p_{ij} changes. Empirically, this channel is very important in the total effects. We can solve for the elasticity $\varepsilon(P_j, X_{ij}/Y_j)$ from the identity,

$$(14) \qquad \varepsilon(P_j,\frac{X_{ij}}{Y_j}) = \varepsilon(P_j, p_{ij})\varepsilon(p_{ij},\frac{X_{ij}}{Y_j}) = s_{ij}(\varepsilon(p_{ij} / P_j),\frac{X_{ij}}{Y_j}) + \varepsilon(P_j,\frac{X_{ij}}{Y_j}))$$

where we have used, again, the above-mentioned general property in index number theory that $\varepsilon(P_j,p_{ij}) = s_{ij}$ and in deriving the last stage of Eq. (14), we use the identity $p_{ij} = (p_{ij}/P_j)P_j$. From (14) we can solve the expression needed in the general equilibrium simulations of changes in trade barriers,

$$\varepsilon(P_j, \frac{X_{ij}}{Y_j}) = \frac{s_{ij}(1-\sigma)^{-1}}{1-s_{ij}} . \tag{15}$$

From the basic export equation (12) we get

$$\varepsilon(X_{ij}/Y_j, t_{ij}) = -\mu . \tag{16}$$

These elements allow us to take into account the indirect effect of a change in t_{ij} on P_j and further to the trade flow, using the gravity model, in addition to the direct effect estimated above. The elasticity in (15) is in general negative indicating that lower import barriers lead to a lower price level, boosting competitiveness of exports.

The changes in the trade barriers have an impact on the income levels, too. These can be captured using the identity, see Eq. (6) above,

$$dY_i = \sum_{j,i\neq j} dX_{ij} + dX_{ii} = \sum_{j,i\neq j} dX_{ij} + (1-\phi)d\log(P_i)Y_i - \sum_{j,j\neq i} dX_{ji} . \tag{17}$$

Here the first identity is the balance of resources and expenditure so that production equals sales abroad and domestically. The second stage uses the identity that the domestic sales are made by the total demand minus the rise in total imports to country j, where the domestic demand is based on Eq. (6) and differentiated under the constraint that the demand equals income, see the Appendix 2. In addition to these elements (15), (16) and (17) we need changes in the price indices, as based on the basic result in index number theory that $e(P_j,p_{ij}) = s_{ij}$.[6]

4 General equilibrium effects of a Swedish membership in the EMU

Let us now use this framework, and the estimated gravity model, to make an analysis of the general equilibrium effects of a possible accession of Sweden to the EMU. We disaggregate the countries into three groups: Sweden, the euro area and the rest of Europe. For this simulation, we take the trade equation as estimated in Model 3 in Table 1 and combine it with (16) the price impact as shown in (15) and the income identity in (17). We allow for the trade barrier to be dismantled from Swedish exports to the euro area and respectively in exports from the euro area to Sweden, if such barriers exist.

In our model, the relevant impacts of the trade barriers in the trade between Sweden and the euro area are the estimated coefficients, see the definition in (13) above, $\beta_{EMU,EU}$, $\beta_{EMU,EMU}$ and $\beta_{EU,EMU}$. The total initial impact on Swedish exports of joining EMU is then $\beta_{EMU,EMU} - \beta_{EU,EMU}$ and that for euro area exports to Sweden being $\beta_{EMU,EMU} - \beta_{EMU,EU}$. The estimates of these coefficients are according to our estimation, $\beta_{EMU,EU} = -0.617$ and $\beta_{EMU,EMU} = 0.499$ and $\beta_{EMU,EU} = 0.378$. Thereby the barrier (measured now by its impact on trade, see Eq. (12) to see the differ-

6 In addition to these elasticities, we need the identity $\varepsilon(P_j, p_{jj}) = s_{jj} = 1 - \sum_{i,i\neq j} s_{ij}$.

ence between barrier t_{ij} and its effect on trade, i.e. $t_{ij}^{-\mu}$) in Swedish exports to the euro area is their difference, i.e. −1.116, and which is zero with probability 0.0245. But the reverse barrier existing in EMU countries' exports into Sweden is 0.12, and does not differ significantly from zero. So, the estimation result shows that the impact of joining EMU would boost markedly the exports of Sweden, but not reverse. In our estimated gravity model, the test of equality of these two barriers, i.e. those in exports from a small outside country into the euro area and in the reverse trade, is strongly rejected.[7]

The demand function parameter ϕ has been fixed somewhat arbitrarily to the value of two.

In addition to these impulses, we could imagine that the EMU membership of Sweden could also boost its trade outside the euro area. Our estimates of the gravity model also give evidence on this kind of effect. We have, however, for the time being omitted enlargement of the analysis to cover these effects.

In the previous studies on the trade impact of EMU, like Micco, Stein and Ordonez (2003) and Barr, Breedon and Miles (2004), where only the case of symmetric trade barriers is considered, the barrier estimates, reached as to the impact of EMU vs. non-EMU membership, are much smaller than these estimates reached in our estimation. In the more recent evaluation, Baldwin et al. (2008, 33) report that the consensus estimate of the effect of the euro on trade is of 5 to 15 per cent, while Flam (2009) states that his preferred estimate is higher, around 30 per cent. Anyway, these estimates are smaller than those reached here above, see also Alho (2003, 2005).

So, let us consider two cases, first, that of abolishing identical barriers in exports and imports of Sweden with the euro area, and, secondly, that of asymmetric barriers, i.e., there being one only in Swedish exports to EMU but not in the reverse trade. Due to the markedly diverging estimates of barriers, reached in the literature, we also allow the estimate of the existing barrier to vary in size. This means that we let the barrier term, $t_{ij}^{-\mu\beta_{km}}$ to vary in magnitude.

We depict in Figure 1 the outcome on real GDP when symmetric barriers are assumed to be dismantled between Sweden and the euro area.

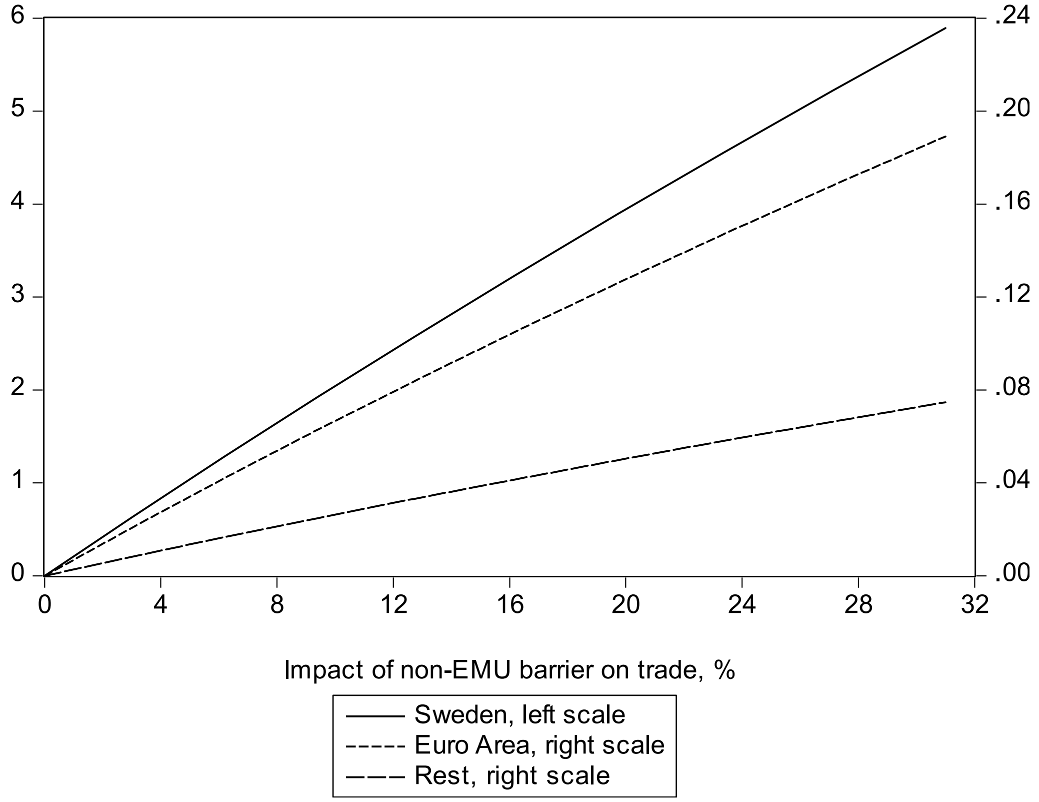
Both Sweden and the euro area gain from a liberalisation of trade, but Sweden, as normally, much more. This is also the basic effect of mutual trade liberalisation vis-à-vis a big region for a small country, being more open with respect to the bigger region than the reverse situation. The gains are, of course, the bigger, the larger the initial barrier existing in trade, which is removed by policies. There is also a slight positive effect, in spite of trade diversion, on those countries remaining outside. In Figure 2, we have the situation of asymmetric barriers so that they only apply presently to Swedish exports to the euro area, but not to the reverse trade.

In contrast to the UK entrance, analysed in Alho (2005), with a negative impact on the rest of the countries, we now have throughout a positive effect attached to the Swedish entrance into EMU.

In this case, as in the in the symmetric case, the incumbent euro area gains, but the gain to Sweden is now clearly smaller than before, as there is only a small offset through a rise in im-

[7] I.e. we test equality of estimates of the coefficients $\beta_{EMU,EU}$ and $\beta_{EU,EMU}$.

Figure 1 The impact of a Swedish entrance into EMU on real GDP, percentage deviation from the initial equilibrium, the case of a symmetric initial trade barrier existing between Sweden and the euro area

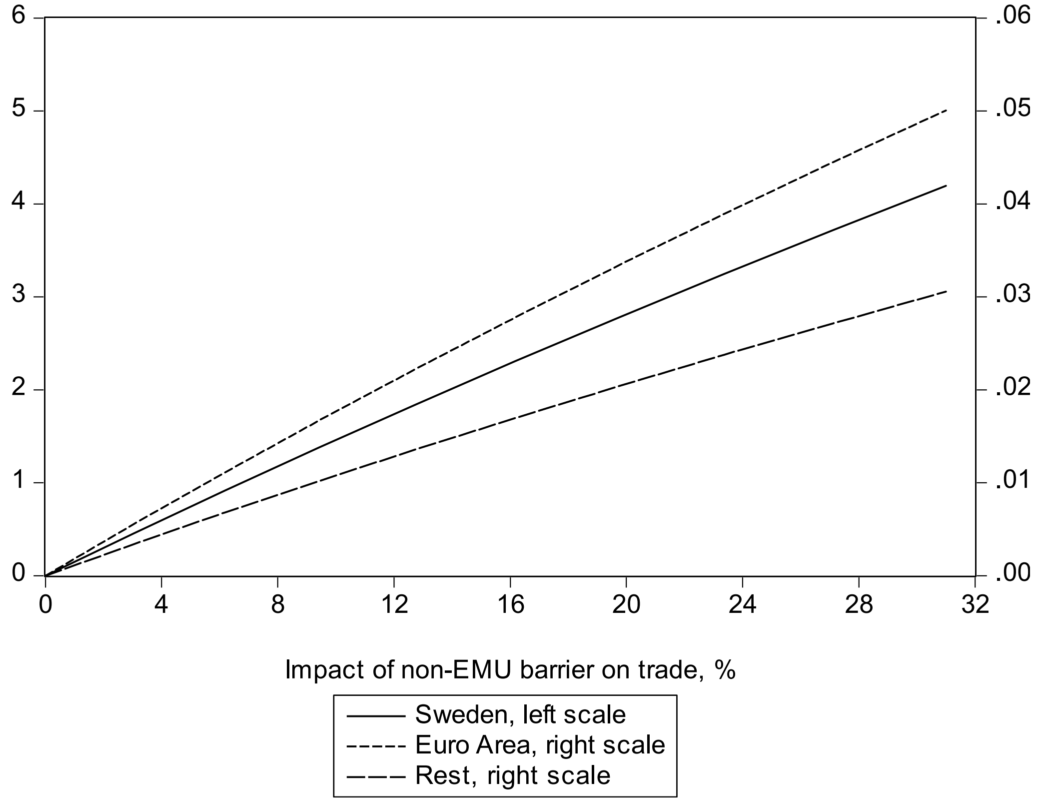


ports from the euro area to Sweden. Overall, EMU enlargement to Sweden seems to be a win-win situation so that everybody gains. The rest of Europe is not much affected by this policy change. The issue of symmetry vs. asymmetry of trade barriers is therefore to some extent an important aspect also as to the outcome of integration policies. Altogether, we reach an estimate of the gain related to EMU membership to be much higher than the back- of-the-envelope estimate by Flam (2009). The basic reason for that is we also take into account the gain through a lower price level induced by lower trade barrier.

As there is a quite a big uncertainty with respect to the size of the trade barrier which an EMU membership removes, we want to complete the above calculations with a stochastic simulation. We specify uncertainty with respect to two elements in the model. First, with respect to the impact related to the EMU trade barrier so that the standard deviation of an effect in the trade barrier is higher for higher barrier effects,[8] and secondly, related to our estimation above of the elasticity of substitution σ as based on that reported in Table 1.

8 In the numerical evaluation, the log trade barrier effect t was generated for the 10 numerical steps used in the simulation model with the equation $t = 0.03+t_{-1}+u$, t_1 being 0, with a standard deviation of the u term of 0.04. This means that at the upper end, at t being 33%, the standard deviation of the estimate of the impact of the EMU barrier on trade is 16%.

Figure 2 The impact of Swedish entrance into EMU on real GDP, percentage deviation from the initial equilibrium, the case of asymmetric trade barriers only applying in Swedish exports to EMU



This implies that the output effect for Sweden is quite uncertain, and only slightly higher than the standard deviation of the estimate at the upper end of the interval considered here.

Table 2 The impact on real GDP of an accession of Sweden into the EMU, mean effect and its standard deviation, %

Barrier effect on trade eliminated in EMU, %	*Sweden, mean*	*Sweden, st. dev.*	*Euro Area, mean*	*Euro Area, st. dev.*
3.1	0.61	3.78	0.02	0.06
9.8	2.25	4.11	0.07	0.08
20.7	4.04	4.51	0.13	0.09
32.8	6.22	4.78	0.20	0.10

5 Conclusions

We have in this paper derived a gravity model for trade, explicitly based on monopolistic competition, giving up the property that bilateral trade flows are symmetric. We have also found that this more general specification receives strong empirical support and is important as to the outcome of the trade policy simulations with the aid of the model, too.

We also developed a straightforward methodology as to derive general equilibrium effects of trade policy as based on the key parameters of the gravity model.

The Swedish accession to the EMU was found to bring gains to the country, and we could not find negative effects of the trade diversion type as in Alho (2005) related to the UK accession to the EMU. If the Swedish gain would be at most 1 per cent of GDP, the trade barrier effect on trade related to EMU should be at most 6 per cent.

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Appendix 1 Derivation of the elasticity in Equation (8)

Taking the standard result (7) as a starting point, we can express the elasticity term $\varepsilon(p_{ij}, Q_{ikj})$ in it as follows. Let us first write

(A1) $$p_{ij} = \frac{p_{ij}}{P_j} \frac{P_j}{D_j} D_j,$$

and then differentiate both sides logarithmically with respect to Q_{ikj}. Defining h_j as the conjectural variation parameter in the proportional output game, the last term of the differentiation of (A1) gives

(A2) $$\frac{d \log D_j}{d \log Q_{ikj}} = \frac{\partial \log D_j}{\partial \log Q_{ikj}} + \frac{d \log Q_j^R}{d \log Q_{ikj}} = s_{ikj} + (1 - h_j) s_{ikj},$$

where Q_j^R is the supply of other firms to the market j and where we have used the basic result of index number theory that $\varepsilon(D_j, Q_{ikj}) = s_{ikj} = X_{ikj}/Y_j$, i.e., the market share of exporter k of country i in the market of country j.

The first term of the logarithmic differentiation of (A1) is, on the basis of (5) and using (A2), equal to $-\sigma^{-1}(1-(s_{ikj} + (1-h_j)s_{ikj}))$. The second term is, using the definition (6), equal to $-(\phi^{-1}+1)(s_{ikj} + (1-h_j)s_{ikj})$. Combining these three terms gives us the elasticity between the export price and the quantity supplied, included in the export supply optimum, as

(A3) $$\varepsilon(p_{ij}, Q_{ikj}) = -\sigma^{-1} + (-\sigma^{-1} - \phi^{-1})(s_{ikj} + (1 - h_j) s_{ikj}).$$

This is then inserted into (7) and summed over the K_i firms in country i to give Equation (8).

Appendix 2 Derivation of the last stage in equation (17)

We start from the definition of D_i in Eq. (6) and identity $Y_i = P_i D_i$. Differentiating this identity, and using it and Eq. (6) repeatedly we can write

(A4) $$dY_i = (dP_i)D_i + P_i(dD_i) = (d \log P_i)Y_i - \phi D(dP_i) = Y_i(1 - \phi)d \log(P_i).$$

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