Positive OCA criteria: Microfoundations for the Rose effect

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1. INTRODUCTION

The euro is surely the largest and boldest economic policy innovation the world has seen since WWII. The year 1999 saw the formation of a monetary union among nations that account for about a quarter of world GDP and two-fifths of world trade. In 2001, this became a currency union. Preliminary empirical studies show the euro has had a positive and statistically effect on trade that came surprisingly quickly.

This article extracts a series of ‘stylised facts’ from the existing empirical literature and uses these to formulate a theoretical model – what might be called the microfoundations of the Rose effect (the trade impact of a currency union is commonly named after Rose 2000). We then go on to test several of the model’s implications with *de novo* empirical work.

As a side effect of our work, we identify a series of what might be called positive optimal currency area (OCA) criteria.

Current thinking in international macroeconomics views formation of a monetary union as involving microeconomic gains that must be weighed against macroeconomic costs. The literature highlights a handful of “OCA criteria”, which are aimed at identifying the nations that are most likely to gain from merging their monies. These criteria focus exclusively on the negative, macro side of monetary union. National monetary policies are useful in dealing with macro shocks, so the cost of foregoing national monetary policy autonomy depends on how asymmetric macro shocks will be among monetary union members. The OCA criteria identify national features that either reduce the likelihood of asymmetric shocks or allow nations to adjust to them in other ways. The three classic criteria are labour mobility, openness to trade, and diversified exports. To this, one might add two political criteria, namely homogeneous preferences regarding the aims of macroeconomic policies and tolerance for large intra-union fiscal transfers. These are “negative OCA criteria” since they identify nations for whom the costs of monetary union would be mild, but what about the positive side? What sorts of nations are most likely to reap large gains from monetary union?

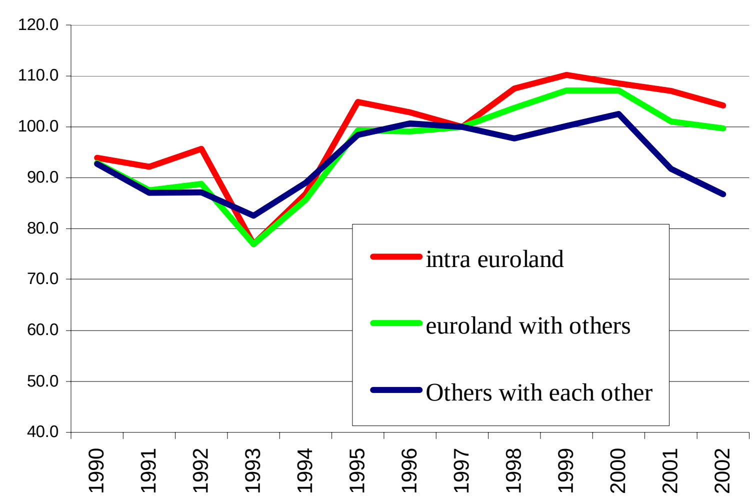
Positive OCA criteria, the missing effects

The theoretical and empirical results in this paper suggest two positive OCA criteria. The first concerns the initial level of integration among nations. As it turns out, the trade-boosting affects of monetary union are amplified by lower trade costs, so the gains from joining a monetary union are likely to be greatest for nations that are already tightly integrated on the real side. Since distance-related trade costs are so important, a corollary to this STOPPED o

1.1. *Organisation of the paper*

Section 2 quickly presents the prima facie case that the euro had a Rose effect to set the stage for the more formal empirical evidence that is reviewed in Section 3. Section 3 also identifies a set of stylised empirical results that are used in Section 4 as a guide to our theoretically modelling. Section 5 presents a list of testable predictions of the model that go beyond the stylised facts from Section 3. Section 6 presents our de novo empirical work aimed at testing these predictions. Our concluding remarks are in Section 7.

Figure 1: Eyeball evidence for the euro's trade effect



Source: Micco, Stein and Ordenez (2003).
Notes: For each nation, the authors calculated its trade with the Eurozone and other nations. The plot shows un-weighted average of the Eurozone nations' indices (1997=100) with each other and non-euro nations as well as the non-euro nations' trade indices with each other. Nations in the sample: euro11 Austria, Belgium-Luxembourg, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain, and the non-euro nations Norway, Canada, Denmark, Sweden, Switzerland, Britain, Australia, Japan, New Zealand, Iceland, and the United States (Greece, which joined in 2001, is counted as an non-euro nation).

2. A FIRST LOOK AT THE DATA

For many years, the trade-inhibiting effect of exchange rate volatility was an article of faith among international economists, the principal intellectual pillar for the Bretton Woods exchange rate system and the various postwar European currency arrangements. However, the breakdown of Bretton Woods, and extreme volatility in Europe did not have the anticipated trade effects. Indeed, despite extensive empirical efforts in the 1970s and 1980s, no one could convincingly demonstrate that volatility had statistically significant impact on trade, either positive or negative.

Recent use of vast data sets and panel estimation techniques have turned this situation on its head. Nowadays, everyone finds statistically significant negative trade effects from exchange rate volatility. More spectacularly, a sequence of papers spearheaded by Rose (2000) has found large positive trade effects of currency unions. The cause and indeed existence of these large effects is still being debated, but most estimates suggest that they are big enough to show up in crude eyeballing of the data.

Prima facie evidence of the Rose effect

One persistent critique of Rose's findings turned on the fact that most of the currency unions in his data samples involved poor and very, very small nations. A very recent study on the euro's trade impact suggests that the Rose effect is present even among large, advanced industrial nations. Figure 1, which is from Micco, Stein and Ordonez (2003), MSO henceforth, shows how bilateral trade flows evolved during the four years since the euro's adoption in 1999. Two salient features are worth noting. The data show that in the run-up to the creation of the single currency, intra-euroland trade flows increased more than bilateral flows between non-euroland nations. Also, the figure suggest that trade between euro and non-euro nations also increased, albeit not as much as intra-euroland flows. This sort of evidence is a very long way from proof that the euro affected trade. Many, many other things were going on at the same time; this, of course, is why one needs regression analyses.

3. SYNTHESIS OF EXISTING EMPIRICAL FINDINGS

Most of the literature on the 'currency union effect', or the Rose effect as we prefer to call it, has treated currency unions as magic wands – one touch and intra-currency union trade flows rise between 5%, 20% or 400%. The debate has been over how big the effect is, with the 'anti-Rose' crowd struggling to bring down the size, and Rose and co-authors struggling to keep it up. The flavour of this literature is best encapsulated by the titles of a pair of articles in the October 2001 issue of Economic Policy: Persson (2001) "Currency Unions and Trade: How Large is the Treatment Effect?" and Rose (2001) "Currency Unions and Trade: the Effect is Large". The best title in literature, however, surely goes to Nitsch (2001) with his "Honey, I shrunk the currency union effect".

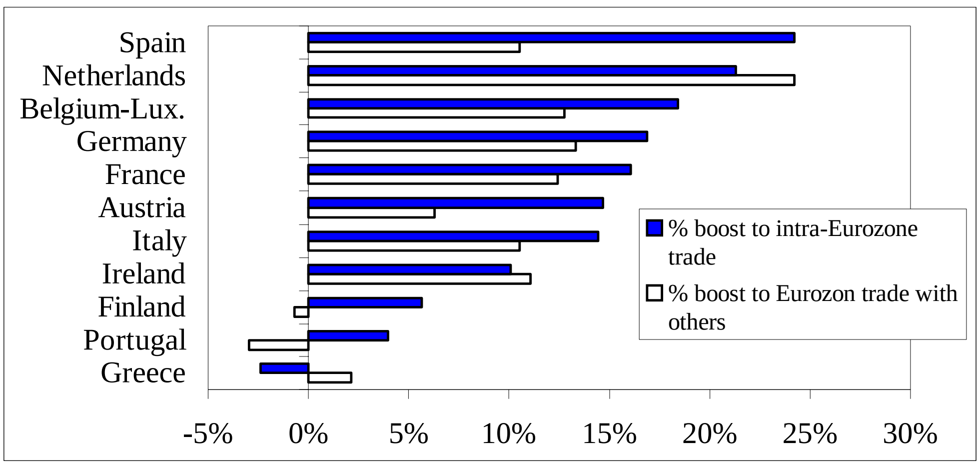
This literature has yet to settle firmly on an 'received wisdom' estimate, but it seems to us that the whole exercise is somewhat too blunt. Surely, the size of the trade effect would depend upon the nature of the partners.

What we do here is to distil stylised facts from the literature with the aim of identify characteristics that are associated with large Rose effects. Since we are not sure how to deal with vast heterogeneity of currency unions used in the general literature, we limit ourselves to studies of the euro's trade impact.

3.1. *The Micco, Stein and Ordonez findings*

The MSO study was the first to establish the existences of a Rose effect in the Eurozone. Following standard practice, they focus on finding 'the' number. As they write, "Controlling for a host of other factors, we find that the effect of EMU on bilateral trade between member countries ranges between 4 and 10 percent." This suggests that the "currency-union wand" is a good deal less magic than other papers indicate, but this is not much help to us in determining the types of trade that the benefit most from the euro. Fortunately, MSO report extensive robustness checks and deep within these are by-nation estimates the Rose effect for all Eurozone nations.

Figure 2: euro's trade effect by nation



Source: Our calculations based on Micco, Stein and Ordenez (2003), Table 8.

We have converted the raw coefficients into percent increases in trade and plotted the results by nation in Figure 2. The nations are ordered by decreasing Rose effect. Two features of these estimates are particularly relevant.

1. Apart from Spain, the nations with the highest Rose effects are those that are already the most tightly integrated: the Benelux nations and Germany. Two aspects of this group may be relevant in our search for positive OCA criteria.

- These nations have been in an informal, but very tight exchange rate arrangement called the DM-bloc for decades. As Figure 3 shows, intra-DM bloc volatility was very low, so the euro had only a very small impact on the bilateral exchange rate variability among these nations.

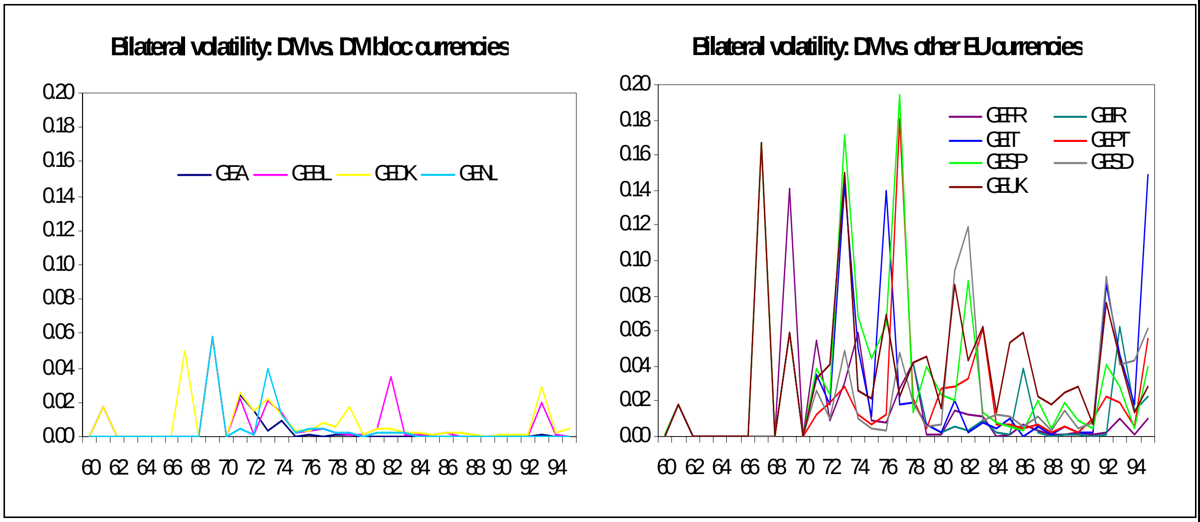
This, of course, is a bit puzzling since one might have thought that the trade effects would have been largest among nations that had the largest, pre-euro bilateral volatility.

- These nations are geographically proximate, so we suppose that the natural trade costs among these nations are quite low (gravity model estimates in Europe suggest that each doubling of the distance between capitals lowers trade by 70%). Moreover, these nations are among the most avid integrationists in the EU and thus have embraced the EU’s deep trade integration even more tightly than other members have. For example, the Benelux nations formed a customs union even before the EU was founded in 1958, and Belgium and Luxembourg have shared a common currency since just after the war.

2. The size of the euro’s trade impact is lowest in the geographically peripheral euroland nations: Greece, Portugal, Finland and Ireland. Again this suggests a negative relationship between trade costs and the Rose effect.

3. Apart from Portugal, there is a positive correlation between individual euro member’s EMU 2 coefficients and the importance of euroland in their trade pattern. This provides some support for the euro-as-a-trade-booster hypothesis since each nation’s euroland trade share indicates the fraction of its trade that is influenced by the euro on both the sending and receiving ends of the trade flow.

Figure 3: DM bloc exchange rate volatility, 1960-1994



Source: Anderton, Baldwin and Taglioni (2003).

3.1.1 Trade with non-Eurozone nations

Intriguingly, MSO also find that trade between Eurozone nations and other nations also rose with the euro’s introduction, but not quite as much. Specifically, they estimate what might be called a one-sided euro dummy; its value is unity for any trading pair that involves only one Eurozone member (the regular euro dummy, or two-sided dummy, is one only for trading pairs where both nations are in the Eurozone). The results, again translated into percent increase in trade, are shown as the light bars in Figure 2. Roughly speaking, the one-sided impact is lower than the two-sided effect, but the nations with large two-sided effects also seem to have large one-sided effects.

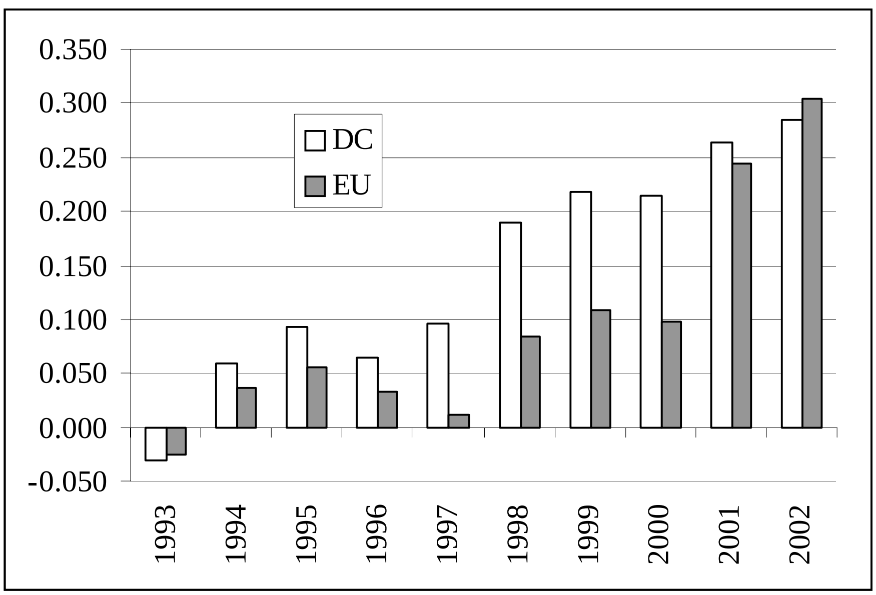
This result is intriguing. It provides a very significant hint as to the microeconomics of the Rose effect, or at least part of it. If one could model the trade-reducing effects of volatility as a frictional trade barrier, the one-sided dummy should have been negative. The euro would have been akin to a discriminatory liberalisation and this should have reduced the exports of non-euro nations to Euroland. What could be going on here?

One informal story that is often told in Europe concerns the impact of the euro on the cost of exchanging currencies. Remember, euroland did not become a currency union until 2001, so intra-euroland trade still involved foreign exchange transactions. It is possible, however, that the the elimination of exchange rate risk lowered the cost of these transaction. The point is that any volatility, indeed even the possibility of volatility, makes foreign exchange trading riskier for the market makers. Compensation for this risk is paid via a spread between bid and ask spreads.

3.1.2 Speed of the effect

Monetary union in Europe was never a sure thing until it actually happened. Although the treaty that laid out the path to the euro was signed in 1992, the Treaty had several major difficulties in becoming law. Moreover, the treaty laid down a series of conditions – the famous Maastricht conditions – for membership in the monetary union, and most European nations had trouble meeting these. Right up to the announcement of the names of the inaugural members in 1998, sceptics doubted that the monetary union would ever become a reality.

Figure 4: euro's trade effect over time



Source: Micco, Stein and Ordenez (2003),

Given this, the speed with which the euro's trade impact appeared is striking. Evidence for this comes from the MSO estimates of their gravity model that allows for year-by-year Rose effects. The results are illustrated in Figure 4, which shows the estimated year-by-year dummies for intra-Eurozone trade; the dark bars show the estimates for the sample that includes only EU nations and the light bars show the estimates for the sample that includes all industrialised nations The main points are that the Rose effect jumps up and becomes statistically significant in 1998. It jumps up again in 2001, especially for the EU sample, when the monetary union (zero volatility) became a currency union (common currency).

Hints from the sectoral results

While most studies of the euro's impact have focused on aggregate trade data, Baldwin, Skudelny and Tagloni (2003) run the standard gravity model using sectoral data. In addition to confirming the general findings of the aggregate studies when all the sectors are pooled, this paper also provides sector-specific estimates of the Rose effect. The results are shown in Table 1.

Table 1: Rose effect and volatility impact by sector.

isic	industry	Rose effect	t-stat	Volatility	t-stat
40-41	electricity, gas and water supply	1.64	4.47	-15.78	-1.87
351	……building and repairing of ships and boats	0.57	2.00	-15.87	-2.42
15-16	food products, beverages and tobacco	0.40	2.64	-7.78	-2.23
25	….rubber and plastics products	0.35	2.25	-10.73	-3.04
35	….other transport equipment	0.34	1.84	-17.72	-4.23
30	……office, accounting and computing machinery	0.32	1.91	-5.77	-1.50
34	….motor vehicles, trailers and semi-trailers	0.31	1.81	-13.78	-3.53
32	……radio, television and communication equipment	0.27	1.68	-14.06	-3.74
36-37	manufacturing nec; recycling	0.27	1.76	-6.25	-1.76
353	……aircraft and spacecraft	0.27	1.09	-16.89	-2.98
33	……medical, precision and optical instruments	0.27	1.76	-7.75	-2.22
31	……electrical machinery and apparatus, nec	0.26	1.64	-14.13	-3.94
28	….fabricated metal products	0.25	1.66	-9.78	-2.85
17-19	textiles, textile products, leather and footwear	0.25	1.54	-12.00	-3.25
24	….chemicals and chemical products	0.25	1.52	-8.80	-2.38
20	wood and products of wood and cork	0.23	1.41	-7.78	-2.08
29	….machinery and equipment, n.e.c.	0.23	1.44	-9.29	-2.54
27	….basic metals	0.19	1.16	-14.23	-3.70
26	other non-metallic mineral products	0.19	1.24	-10.29	-2.91
271+2731	……iron and steel	0.14	0.74	-13.25	-3.08
2423	……pharmaceuticals	0.13	0.70	-8.04	-1.90
272+2732	……non-ferrous metals	0.12	0.63	-20.52	-4.72
01-05	agriculture, hunting, forestry and fishing	0.09	0.50	-7.59	-1.91
23	….coke, refined petroleum products and nuclear fuel	0.03	0.12	-7.83	-1.33
352+359	……railroad equipment and transport equipment n.e.c.	-0.05	-0.23	-14.09	-2.96
10-14	mining and quarrying	-0.21	-1.15	-9.84	-2.37
Source:	Adapted from Baldwin, Skudelny and Taglioni (2003)				

What these results show is a rough correlation between the size of the Rose effect and what we loosely call ICIR sectors (imperfect competition and increasing return sectors). At the bottom of the list, we have agriculture as well as mining and quarrying, while near the top, we have various types of machinery and highly differentiated consumer goods such as food products, beverages and tobacco.

This finding opens the door to the possibility that ICIR like effects – for example, the impact of uncertainty on market structure – may be part of the story.

4. A MICRO MODEL OF THE ROSE EFFECT

A monetary union or a currency union could affect trade through many economic channels. The range, however, is greatly narrowed by one important clue in the empirical work. The effect happened very quickly, far too quickly for the new trade to be explained by important changes in production structures. Moreover, given the very small size of the likely transactions cost reductions entailed in monetary union (as opposed to currency union), the size of the effect seems to be too large to be explained by a standard export supply curve model using a reasonable export supply elasticity. One way to explain these facts – the way adopted in this paper – is to assert that monetary union leads to a big increase in the number of firms engaged in trade.

The particular model we present may be thought of as a Melitz (2003)-like extension of the 'beachhead model' of Baldwin (1988). The basic intuition is simple – monetary union increased the number of monopolistic firms in the Eurozone that are engaged in exporting to other Eurozone markets. This could explain both the speed and magnitude of the response, since in Europe, as in all nations, many firms operate only domestically. To the extent that exchange rate uncertainty influences their decision to export, a sudden and permanent reduction of bilateral volatility within the Eurozone could lead them to start exporting with little change in their basic production facilities. Moreover, following the standard monopolistic competition trade model, the volume of trade is proportional to the number of firms/varieties that are traded.

4.1. *Basic Model*

Consider a world with two nations (Home and Partner), three sectors and only one factor, labour. One sector, called the A sector, is Walrasian and its output is traded costlessly. The second sector, called the C sector (mnemonic for commodity), is also Walrasian but it faces trade costs. The third sector, called the M sector, is an ICIR sector (i.e. marked by imperfect competition and increasing returns); it has two types of firms. One type – domestic firms, or D-types, sell only locally, while the other type – exporting firms, or E-types, sell both locally and abroad.

Preferences are identical in all nations with quasi-linear preferences. The consumption of Walrasian good, 'A', enters linearly and the consumption of varieties of the ICIR sector enters quadratically. Specifically:

$$\textbf{(1)}\ U = C_A + C_C + C_m; \quad C_C \equiv \int_{i=0}^{n_C^w} (ac_i - c_i^{\,2}/2)di; \, C_M \equiv \int_{j=0}^{n_M^w} (ac_j - c_j^{\,2}/2)dj; \quad a > 0$$

where n^w and n_C^w are the masses (numbers) of M-sector and C-sector varieties. The fact that C_A enters linearly means that total expenditure on C-varieties and on M-varieties is unaffected by the level of income.

4.1.1 Preferences, technology, market structure and timing

Technology in the A-sector is kept as simple as possible. Producing A goods requires only labour, specifically, it takes a_A units of labour to make one unit of the A good.

The C-sector is marked by Davis-style intra-industry trade. That is to say, as in Davis (1995) we assume that the two nations have complementary technology in C-sector varieties. To get Davis-like trade with a minimum of complication, we make the extreme assumption on the nations' technology. Specifically, none of the varieties that Home knows how to make can be made in Partner; Partner firms simply do not know how to make them. Likewise, Partner can produce a distinct set of varieties that it alone knows how to make. As in Davis (1995), these differences are assumed not derived. For simplicity's sake, C-varieties are symmetric in production, viz. producing one unit of each variety of C requires a_C units of labour regardless of the scale of production.

M-sector technology is only slightly more complicated. Each variety of the M good is produced from labour where the variable cost involves 'm' units of labour per unit of output; it also involves a fixed cost of F units of labour, where F is market-specific. That is, firms must pay a fixed cost of F units of labour in order to sell in that given market; a crucial decision facing the firm will be the number of markets in which it operates. As in Baldwin (1988), we think of these as market-entry costs, i.e. the cost of establishing a beachhead in a new country.

The market structures for the A and C sectors involve perfect competition. In the M-sector, market structure is marked by Cournot competition in each market, in other words, we assume all markets are segmented. Differentiating the M-good is costless, but each M-variety is patented, so each M-sector firm produces a unique variety and is thus a monopolist for its own product in each market that it has entered.

Heterogeneous firms M-sector firms

As in Melitz (2003), we assume that M-sector firms are heterogeneous with respect to their marginal costs. Specifically, although M-sector firms produce varieties that are symmetric in terms of consumption, they have heterogeneous technology. In particular, they have different marginal production costs and we arrange firms according to decreasing marginal cost, with marginal cost ranging from zero to a maximum of m_0; these costs are in Home currency units; m_χ denotes the marginal cost of firms with index χ; below, we discuss the density of firms along the χ range. Since firms with low marginal costs will typically charge a lower price and thus sell more, we often also refer to the firms as being heterogeneous in terms of size.

Timing of the exchange rate uncertainty and firms' risk aversion

Any model with uncertainty must make assumptions concerning the timing of decisions relative to the realization of the uncertainty (Helpman and Razin 1978). In this model, all uncertainty stems from changes in the exchange rate. We assume that the market-entry decision is taken by firms before any particular realization of the exchange rate is known. Instead, firms use their knowledge of the stochastic process generating the exchange rate in order to formulate their expectations. Firms that have entered choose their level of sales, again without knowing the realisation of the exchange rate. This is meant to reflect the fact that production and sales decisions are taken only occasionally, but the exchange rate fluctuates continuously. Thus schematically the order of decision-making is:

1. Enter each market, or not,

2. Set sales per market.

3. Exchange rate observed and operating profits realized.

All steps are repeated each period, ad infinitum.

At all moments, firms take the exchange rate's stochastic process as given. In particular, changes in the process's volatility, including a shift to a common currency, are unanticipated.

Firms in our model are risk averse.[1] To focus sharply on the essential logic of the mechanism under study, we adopt the simplest form of risk aversion. Namely, we assume that the typical firm discounts an uncertain stream of revenue using a risk premium that is related to the stream's variance and a risk-aversion parameter. Formally, the firm maximizes utility of profits, where the utility function is:

(2) $U = E\Pi - R[\sigma^2]$

where Π is pure profit (this includes operating profit and fixed costs), σ^2 is the variance of the exchange rate and R is the function that defines the risk premium.

4.1.2 Short run equilibrium expressions

We first work out prices and quantities in the short run, i.e. taking the number of activity firms per market as given.

Derivation of A-sector short-run results is straightforward. Utility optimisation implies that the demand function for A is C_A=(Y-E_M) /p_A where E_M is total expenditure on M-varieties and p_A is the price of A. Perfect competition in the A-sector forces marginal cost pricing, i.e. p_A=a_Aw and p_A*=a_Aw*, where an asterisk indicates a Partner variable (lack of an asterisk indicates a Home variable). In addition, costless trade in A equalises international prices and thus indirectly equalises wage rates internationally, viz. w=w*, as long as some A-good is made in both regions. This condition – the so-called non-full-specialisation (NFS) condition – requires that no region has enough M-firms to absorb all its labour force. This, in turn, requires the M-sector entry cost to be sufficiently high. This is assumed to hold henceforth. Walras's Law permits us to ignore the A-sector market-clearing condition. We take A as the numeraire, so w=w*=p_A=1.

C-sector short-run results

Utility optimisation implies that the inverse demand function for a typical C-variety is linear, namely p_C(j)=a-C_C(j) where C_C(j) is the total consumption/sales of variety-j in a particular market and p_C(j) is the corresponding price. When it comes to local sales (i.e. non-export sales), firms face no risk and so price at marginal cost; the price of such goods is just a_C in both nations, given w=w*= 1. The resulting consumption/supply is given by plugging this price into the demand function.

When exporting the goods, however, perfect competition does not mean marginal-cost pricing due to the presence of exchange rate uncertainty. Instead, firms supply the good up to the point where all are indifferent to supplying it and this drives the price down to the risk-adjusted marginal cost. More specifically, firms supply each variety up to the point where U from (2) is zero. Modelling atomistic C-sectors firms as producing 1 unit of C each, the per-firm profit from exporting is

(3) $\pi_C = (p_C - s a_C \tau_C)$

[1] There is an extensive industrial organization literature on justifying this assumption, see Asplund (2002).

where 's' is the spot rate (Partner currency price of Home currency), and $\tau_C \geq 1$ is the ad valorem tariff equivalent of all trade barriers, both natural and man-made (more on this below). The variance of π_C is $\sigma^2(a_C\tau_C)^2$, where σ^2 is the variance of the exchange rate, so the value of the objective function, U, is $(p_C - s^e a_C\tau_C) - \alpha\sigma^2(a_C\tau_C)^2$. Perfect competition drives U to zero and this requires that the price of each variety is $p_C = a_C\tau_C(1+\alpha\sigma^2 a_C\tau_C)$. Here we think of $a_C\tau_C(1+\alpha\sigma^2 a_C\tau_C)$ as the risk-augmented marginal cost. Using this price in the demand function, the volume of exports per variety will be:

(4) $$q_C = a - a_C\tau_C(1+\alpha a_C\tau\sigma^2)$$

where we have normalised $s^e=1$ to reduce clutter in the expressions.

M-sector short-run results

Each M-sector firm produces a differentiated good and all of these enter preferences symmetrically in the sense that the demand function in a particular market for each variety is identical and equal to:

(5) $$p(i) = a - q(i)$$

where a>0. Firms play Cournot market by market, which, as usual, is tantamount to assuming that markets are segmented; in other words, firms can engage in third degree price discrimination. Since each variety is distinct, each firm is a monopoly for its variety in each market.

The D-type firm's problem

Consider D-type firms, i.e. the M-sector firms that sell only in their local market. These firms face no uncertainty since their costs and revenue are in the same currency. Consequently, maximisation of (2) is tantamount to profit maximisation. Using the well-known fact that operating profit of a monopolist facing linear demand is its optimal sales squared, a typical D-firm's pure profit is:

(6) $$\Pi = \left(\frac{a - m(\chi)}{2}\right)^2 - F$$

An exporting (E-type) firm's problem

Home firms that export face exchange rate risk directly since the level of the exchange rate affects their marginal cost of selling to Home. In particular, their operating profit is:

(7) $$\pi \equiv (p - sm_\chi\tau)q$$

where p is the price, q is per-firm export, m is the marginal cost, 's' is the spot rate (Partner currency price of Home currency), and $\tau \geq 1$ is the ad valorum tariff equivalent of all trade barriers, both natural and man-made (more on this below).

Note that Home firms' marginal costs are converted into Partner currency units, so, at this stage of the game, the per-period operating profit is defined in Foreign currency units.

In expected value terms, π is $(p-s^e m_\chi \tau)q$, the superscript 'e' denotes the expectation of s. The variance of this is $\sigma^2(m_\chi \tau q)^2$, where σ^2 is the variance of the spot rate 's'. A typical exporting firm's problem is to choose its sales to the Partner market, q, to maximise:

(8) $$V = \max_q (p - s^e \tau m_\chi) q - \alpha\sigma^2 (\tau m_\chi q)^2$$

If a firm has entered the Partner market, the solution to its exporting problem is:

(9) $$q = \frac{(a - s^e \tau m_\chi)}{2(1+\alpha\tau^2 m_\chi{}^2 \sigma^2)}$$

With our mean-variance objective function, (2), the risk adjusted operating profit is the square of optimal sales times $(1-\alpha(\tau m_\chi)^2\sigma^2)$. To see this, note that the first order condition for export sales is $p-ms^e-q-2m^2\sigma^2 q$, where all variables are evaluated at equilibrium. Thus the pay off function, $U=(p-ms^e)q-\alpha m^2\sigma^2 q^2$, evaluates to $q^2(1-\alpha(\tau m_\chi)^2\sigma^2)$. Given this, plugging the optimal export level from (9) back into the objective function, (8), the risk adjusted reward to exporting for a firm with marginal cost i is:

(10) $$U = \frac{(a - \tau m_\chi)^2}{4(1+\alpha\tau^2 m_\chi{}^2 \sigma^2)}$$

Recall that we normalised $s^e=1$ to reduce clutter in the expressions.

4.1.3 Long-run equilibrium: Free entry

Having worked out the optimal actions and pay-offs for the second and third stages, we turn to the first stage market-entry decision, i.e. the decision of whether to export at all.

The objective of Home firms is to maximise risk-adjusted profit denominated in Home currency. This means that we must translate both the operating profit and the fixed entry costs – both of which have hereto been denominated in Partner currency units – into Home currency units when considering the entry decision, i.e. Home firms care about $s^e(U-F)-\sigma_2 var(U-F)$. From (10) we see that the variance of U-F is zero, so the entry criteria is just $s^e(U-F)$. It is obvious that this is positive, if and only if (U-F) is positive. In short, currency of denomination has no impact on the entry decision.

Using (6) and (10), we see that the minimum class-sizes for D-types and E-types are defined by the cut-off levels of marginal cost, namely:

(11) $$m_D = a - 2\sqrt{F}, \qquad m_E = \frac{a - 2\sqrt{F(1+\alpha\sigma^2(a^2-4F)}}{\tau(1-\alpha\sigma^2 4F)}$$

where m_D and m_E are the minimum viable class-size for D-types and E-types, respectively. By inspection, we see that there is a range of firms with marginal cost between m_D and m_E who will sell in the local market without exporting.

The expression for optimal export sales makes it clear that firms with high marginal costs will sell less. This will also be true of their Home market sales, regardless of whether they export. In particular, firms get bigger (in terms of home market sales) as their marginal cost m_χ falls.

4.2. ***The volume of trade***

Having determined the cut-off m_E, we know which class sizes will be exporting and how much a typical firm in each size class will sell. This, however, is not sufficient for determining the overall volume of exports. We also need the distribution of firms across size classes.

A well-known fact in the empirical industrial organisation literature is that the size distribution of firms is skewed heavily towards small firms. Indeed, the actual distribution is usually approximated with a Pareto distribution (see Cabral and Mata 2001 for recent findings and a history of the literature). In other words, the number of firms per size class is:

(12) $$n[size] = B(size)^{-\rho}$$

where size is measured in a variety of ways (number of employees, sales, assets, etc.), ρ measures the skewness of the distribution, and B is a constant.

As it turns out, calculations are simplified by taking a very specific measure of size. That is, we measure firm-size by the number of units they would export with zero volatility. This is certainly not the only measure of size one could think of, but it simplifies calculations and we argue below that other measures would lead to qualitatively equivalent results.

The volume of Home exports in M-sectors is the number of firms in each size class times the export sales per firm integrated over all exporting size classes. That is, the volume of trade is:

(13) $$VT_M = \int_0^{m_E} \frac{(a - m\tau)^{1-\rho}}{4(1+\alpha\tau^2 m^2\sigma^2)} dm; \qquad VT_M\Big|_{\rho=1} = \frac{\arctan(\tau m_E\sqrt{\alpha\sigma^2})}{\tau\sqrt{\alpha\sigma^2}}$$

This integral cannot be solved for general values of ρ, but it is easily solved for ρ=1 or 2; the solution for ρ=1 is shown as the second expression.

Trade including C-sector varieties

The total volume of Home exports includes trade in C-sector varieties. Taking the fixed number of C-sector varieties as n_C, the export per variety equation (4) implies that C-sector exports are:

(14) $$VT_C = n_C\left(a - a_C\tau_C(1+\alpha a_C\tau\sigma^2)\right)$$

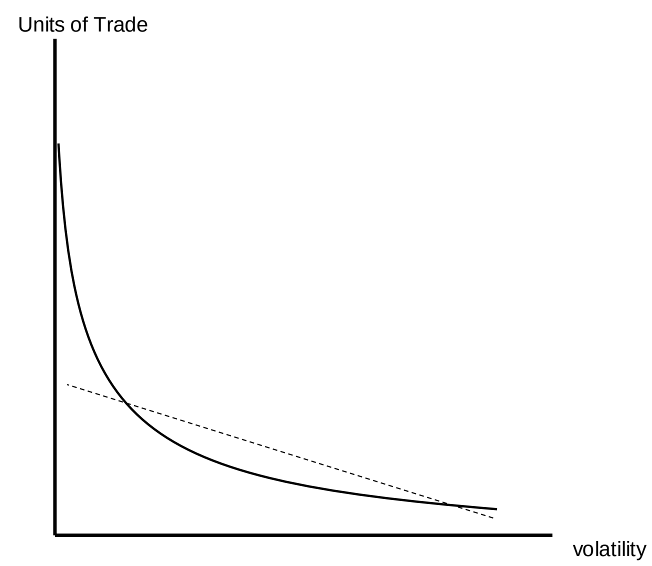
4.3. ***Demonstrating the stylised facts***

Having designed the model to reflect the key features of the empirical literature, it should not be a surprise that the model does indeed account for these; we turn now to showing that it does.

4.3.1 Trade impact of exchange rate volatility

There are two points to demonstrate: that higher volatility reduces the trade volume, and that the volatility-trade relationship is convex. The first explains the observed negative trade-volatility link. The second explains why the monetary union dummy is significant even after controlling for volatility. To see this, suppose the true relationship between volatility and trade is convex, as illustrated by the solid curve in Figure 5. An empirical model that assumed a linear link between volatility and trade (as illustrated by the dashed line), but also allowed a dummy for monetary union (i.e. zero volatility), would estimate the dummy to be positive and significant. Importantly, if the link were sufficiently convex, then adding a finite number of higher order volatility terms to the regression would not be enough. There would still be room for a significant currency dummy.

Figure 5: Convexity of the volume-volatility link



As it turns out, we can show that $dVT/d\sigma^2<0$ allowing for a general ρ using an indirect analysis; Figure 6 facilitates the analysis. The volume of trade is the integral of the density weighted export per firm from m=0 to the cut-off m, m_E. The solid curve in the diagram shows the weighted export curve for a given σ^2, and the cut-off m_E that corresponds to it. The volume of trade for this σ^2 is the area under the curve up to m_E, namely area A.

As inspection of (10) shows, a reduction in volatility raises the exports per firm regardless of size class (as measured by m). The higher weighted export curve is shown as the dashed curve in the diagram. The lower volatility also raises the maximum cost at which firms find exporting interesting, i.e. it raises m_E to m_E'. The new integral, which is the new volume of trade, is large than the old volume by the areas B and C. This formally demonstrates that the volume-volatility link is negative.

By inspection of (13), the M-sector trade volume is diminishing in the level of trade barriers τ and we have just shows that it is diminishing in σ^2. Inspection of (14) shows that C-sector exports are also diminished by volatility and trade costs. Thus we write:

Result 1:

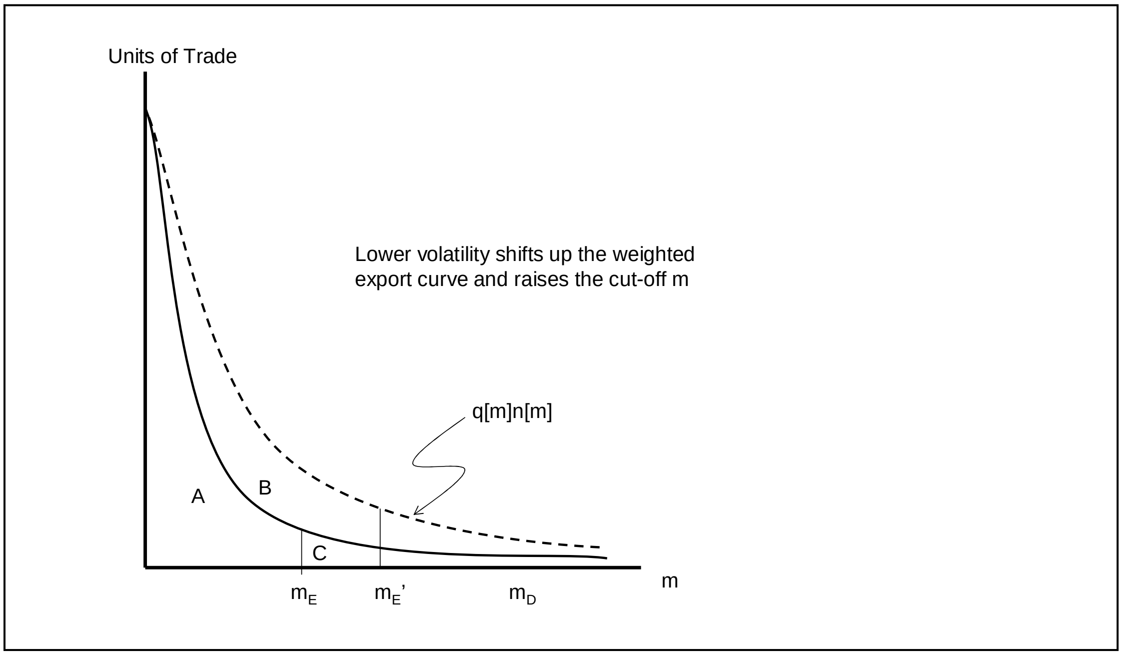
The volume of trade declines as exchange rate volatility and as trade-barriers rise.

While the impact of volatility on trade is clear, it is useful to decompose effects. The elimination of exchange rate uncertainty, i.e. setting $\sigma^2=0$, will affect exports in two ways. First, the level of exports per exporting firm will increase. This is seen immediately by inspection of the optimal sales level (9). Second, the number of Partner firms exporting to the Home market will increase. This can be seen by inspection of (11) because a reduction in σ^2 reduces the minimum class-size that is required to make exporting profitable.

Result 2:

> ***A reduction in exchange rate volatility raises both the sales per exporting firm and raises the number of firms exporting.***

Figure 6: Deriving the slope of the volume-volatility link



4.3.2 Convexity of the trade-volatility link

We turn next to the shape of the trade-volatility link, considering C-sector exports and then M-sector exports.

Linearity of the C-sector trade-volatility link

Inspection of (14) reveals that the volume of trade in linear is the exchange rate variance.

The importance of this linearity is clear. In a model that controls for the trade-volatility link assuming a linear relationship would find a significant, negative effect of volatility on trade in C-sector trade but no Rose effect, i.e. the dummy for monetary union would not be significant.

Convexity of M-sector trade-volatility link

The expression for M-sector exports, (13), shows that the trade-volatility link is not a simple one in this ICIR sector. Even when we take ρ=1, the expression is difficult to manipulate. The deep reason for this is clear enough. As we showed in Figure 6, a reduction in volatility increases the cut-off m_E and shifts up the export by size-class curve, but the shift is greater for small firms. To sign the second derivative of the σ^2 on the term VT (volatility) involves working out whether these shifts are larger when σ^2 is higher.

There is an easy part of this task and a hard part. The easy part is showing that the upward shift in the weighted export-per class-size curve is greater when volatility is lower. The reason in that the impact on volatility is greater on smaller firms and there are more small firms in operation when volatility is low. The hard part is to see whether the increase in VT due to the volatility-induced rise in m_E will also be larger when the initial level of σ^2 is smaller. We have been unable to show that VT is convex in σ^2 for the general case, but it is simple to do when evaluating the $d^2VT/d(\sigma^2)^2$ at σ^2=0. That is:

$$\text{(15)} \qquad \lim it_{\sigma^2 \to 0} \frac{d^2 VT}{d(\sigma^2)^2} = \frac{\alpha^2 (4a^2 + 9a\sqrt{F} + 6F)(a - 2\sqrt{F})^3}{10\tau} > 0$$

We can establish the sign since we know that $(a-2(F)^{1/2})=m_D>0$.

For more general cases, we rely on numerical analysis. For the simple case where ρ=1, the relationship between trade and volatility is convex for a wide range of parameters.[2] This leads to:

Result 3:

> ***In ICIR industries, the marginal increase in trade as volatility fall gets progressively larger as volatility approaches zero, i.e. the volume-volatility link is convex. In perfectly competitive industries, the trade-volatility link is linear.***

Importantly, this is one source of the pure Rose effect, i.e. the impact of monetary union on trade when controlling for the linear impact of volatility.

There are two sources of the convexity. First, a reduction in volatility affects the sales of small firms more than that of large firms, and there are more small firms exporting when the volatility is initially low. Second, each reduction in volatility brings more firms into the exporting business. Given the distribution of firms is so heavily skewed to small firms, a reduction in volatility brings more exporters into the market when the initial level of volatility is low.

4.3.3 Interaction effect between trade costs and the volume-volatility link

Another stylised result from the empirical literature concerns the interaction between the size of the trade effect of monetary union and trade costs. In particular, the empirical findings suggested that the Rose effect was larger for nations that initially had lower bilateral trade costs.

To show that this is indeed a feature of our model, we first formulate the Rose effect. In general terms, we define the Rose effect as the change in the volume of trade when volatility falls from some positive level to zero, in other words

$$RE = VT\big|_{\sigma^2=0} - VT$$

where RE stands for the Rose effect. In the ρ=1 case, the expression for VT with σ^2=1 is simply $(a-2(F)^{1/2})/\tau$. Using this and the definition of VT from (13), we have:

[2] Indeed, we have yet to find parameters where this is not true, although we cannot prove convexity.

$$(16) \qquad RE = \frac{a - 2\sqrt{F}}{\tau} \quad - \quad \frac{\arctan(\tau m_E \sqrt{\alpha\sigma^2})}{\tau\sqrt{\alpha\sigma^2}}$$

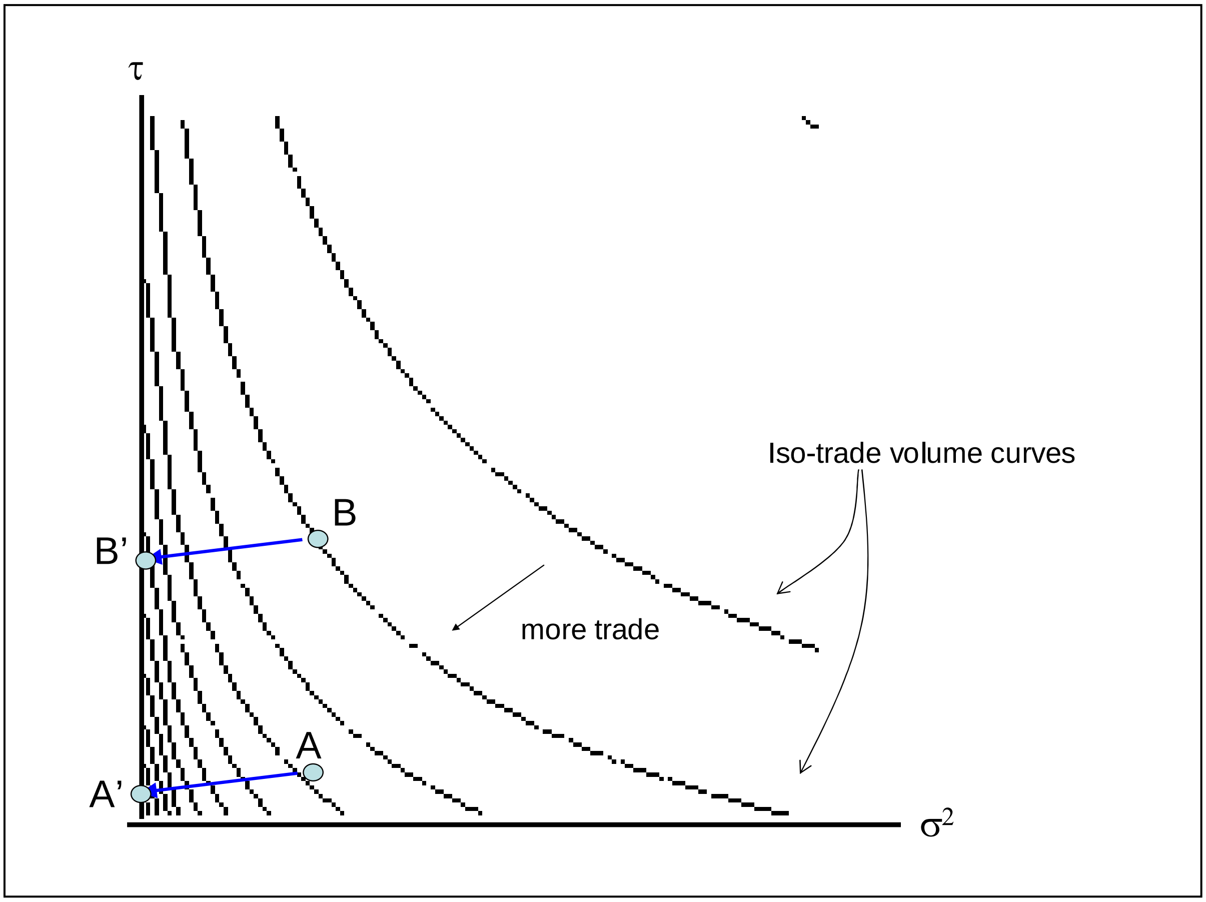
where m_E is given by (11).

Noting that τ enters denominator of m_E in a multiplicative fashion, we see that τ cancels out of the argument of the arctan function, so RE equals $1/\tau$ times a term that is constant with respect to τ. Given this, it is obvious that the size of the Rose effect rises as trade barriers fall. Moreover, the relationship is hyperbolic – the increase in the Rose effect with each marginal reduction of τ is larger as τ falls. This allows us to write:

Result 4:

> ***The increase in trade that results from a reduction of volatility to zero gets progressively larger as trade costs come down. In other words, the Rose effect should be larger among nations that start with lower trade barriers.***

Figure 7: Trade volume against trade costs and volatility



In our discussion of the empirical results, we noted that some of the nations that started with very low bilateral volatility and very low trade costs seemed to have larger Rose effects than nations with high pre-euro volatility and high trade costs. To make sense of this, it helps to have a map of the level of M-sector exports in τ-σ^2 space like Figure 7 (which was plotted for α=1, F=1, and a=10).

The diagram, which shows the iso-VT curves, indicates the relative importance of volatility reduction and trade costs. For example, the DM bloc nations may have started out at point A, with low volatility and trade costs, while more peripheral nations, like Portugal, started with higher trade costs and higher volatility. The monetary union would take volatility to zero in both cases, but trade would increase more from point A to A' than it would from B to B' because the A arrow crosses more iso-VT lines that the B arrow. This is due to the interaction between trade costs and volatility reduction.

4.3.4 The impact of risk aversion and financial market development

Although the existing empirical work has not explored the connection between the size of the Rose effect and the extent of risk aversion, we can do this easily in the model. To be concrete, we study the impact of raising the degree of risk aversion on the expression for RE in (16).

Given that our measure of risk aversion, α, always enters the expression for VT together with σ2, it is clear that our demonstration in Result 1 applies to α. This allows us to write:

Result 5:

> ***The trade-reducing effect of volatility is larger when firms act in a more risk averse manner. Equating risk aversion with financial market imperfection, this suggests a positive correlation between the size of the Rose effect and the backwardness of a nation's financial markets.***

4.3.5 Transaction cost reduction of monetary union and currency union

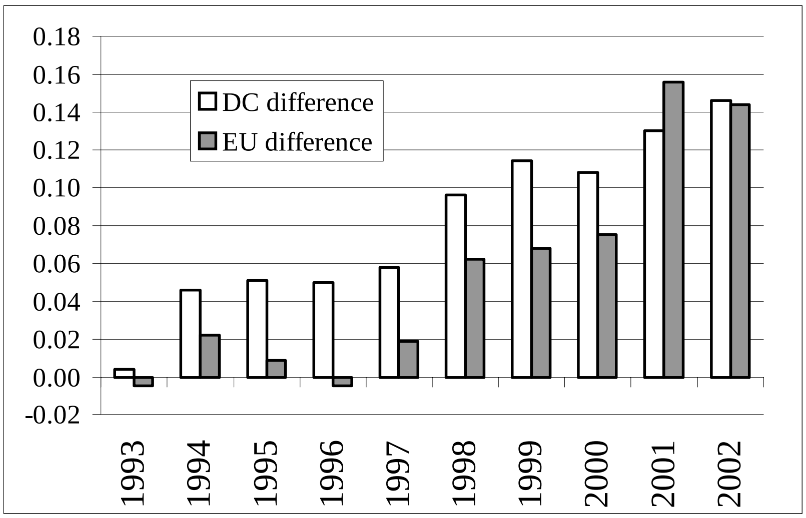
Two facts suggest that formation of the monetary union in 1999 and the currency union in 2001 had an impact on transaction costs in addition to their impact on volatility. First, trade between the Eurozone and non-euro nations jumped up in 1999 even though the bilateral volatility between these nations did not go to zero. Second, the intra-Eurozone dummy jumps up again in 2001 when the monetary union became a currency union. Importantly, the difference between the intra-euro dummy and the euro-non-euro dummy becomes greater in 2001, suggesting that the elimination of the need to exchange currencies as part of exporting had a favourable effect (see Figure 8).

Why would monetary and currency union lower transaction costs?

The classic optimal currency area reasoning applies to currency unions, not monetary unions. While it is obvious that adopting a common currency eliminates some of the costs involved in trade, the impact of adopting a common monetary policy without a common money is less clear.

One approach is to focus on the cost of exchanging currencies, measuring this as the bid-ask spread in the relevant foreign exchange market. The thinking here is that monetary union led to changes that lowered the bid-ask spread both between Eurozone nations and between Eurozone nations and others. For example, Hartmann (1999) shows the bid-ask spread is positively related to unpredictable trading volume, and more directly, Naranjo and Nimalendran (2000) find the bid-ask spread increases with unexpected government intervention. To the extent that the Euro eliminated the need for European Central banks to intervene in their currency markets, all speculation became stabilising speculation (so the bilateral rates enforced themselves). The elimination of risk among euro-legacy currencies may also have stimulated competition in the forex market, especially for small currencies such as the Belgian franc. Here we note that Huang and Masulis (1999) found the deutsche mark spread to diminish as dealer competition rose. Contrary evidence, however, can be found in Hau, Killeen, and Moore (2002). These authors find that the euro spreads increased (compared to DM-dollar spreads) in 1999.

Figure 8: Intra- and extra-Eurozone Rose dummies, DC and EU samples



Source: MSO (2003).
Note: DC sample includes 22 developed nations, EU sample includes only EU members.

Could a currency union reduce transaction costs for trading partners that are not part of the monetary union? The evidence in Figure 8 certainly suggests this, so we explore economic channels that might produce this result.

Begin with a mental picture of the foreign exchange market for most euro-legacy currencies. With the sole exception of the DM and the French franc, the euro-legacy currencies were quite unimportant on the foreign exchange market. For example, the most recent Bank of International Settlement's 3-yearly survey of the forex market showed that none of the euro-legacy currencies other than the French franc and the deutschemark were traded in any significant amounts (the 1998 survey lists currencies down to those that represented two-tenths of one percent of the market). With such low levels of trade, it seems likely that adoption of the euro radically increased the amount of relevant competition. Before the euro, only a few banks would trade Belgian francs, so exporting to Belgium was particularly expensive. After the euro, exporting to Belgium involved a forex transaction in the second largest currency in the world. For this and other related reasons, it seems plausible that the introduction of the euro in 2001 lowered transaction costs even for non-Eurozone nations.

Taking it as given that lower transactions costs did fall for all Eurozone nations, we note that this would tend to stimulate trade between the Eurozone and all nations. Specifically, our model predicts that the trade-enhancing effect of lower transaction costs is greater when volatility is lower. This is, in fact, just a restatement of Result 4. This allows us to write:

Result 6:

> ***Assuming that formation of the monetary union and, separately, formation of the currency union lowered transaction costs, we should observe an increase in all trade with Eurozone nations both in 1999 and 2001. However, the size of the effect should be larger between Eurozone nations since a given transaction cost reduction will have a larger trade-boosting effect when bilateral volatility is low.***

Our model was designed to match the basic facts in the existing literature, but it can be used to formulate more precise, empirically testable hypotheses.

5. NEW, EMPIRICALLY TESTABLE HYPOTHESES

The most obvious hypothesis concerns the nature of the volatility-trade link. Our model's main explanation of the Rose effect is the convexity of the volatility-trade link (see Figure 5). Specifically

<u>Hypothesis 1:</u>

> ***The relationship between bilateral exchange rate volatility and the volume of imports of a Eurozone nation should be convex, at least for ICIR goods.***

Our model explained the geographic variation of the Rose effect as the natural outcome of an interaction of the trade-altering effects of bilateral trade costs and bilateral exchange rate volatility. Thus:

<u>Hypothesis 2:</u>

> ***The interaction term involving distance (as a proxy for trade costs) and volatility should enter the gravity equation positively, i.e. higher trade costs make volatility's trade impact less negative.***

A related prediction involves the impact of the transaction cost reduction that accompanied formation of the currency union in 2001.

<u>Hypothesis 3:</u>

> ***To the extent that currency union reduced trade costs, the Rose effect should increase in 2001; the model predicts that if this trade boosts occurs, it should be greater for intra-Eurozone trade relationships than it is for Eurozone nations' trade with other nations.***

Finally, although it is not a prediction of the model, it is interesting to explore the sources of the non-volatility related trade increase in 1999. Our conjectures above suggested the change in the market thickness for many euro-legacy currencies was an important element. If this is indeed the case, we should see a larger boost bilateral trade between small Eurozone nations and other nations than we do for large euroland members such as Germany. The idea here is formation of the monetary union involved much more substantial changes for low-volume currencies, like the Dutch guilder, than it did for high volume currencies like the deutschmark and the franc. Thus:

<u>Hypothesis 4:</u>

The dummy on Eurozone nation's trade with other nations should rise more for small euroland nations than it does for France and, especially, Germany.

6. EMPIRICAL TESTS OF THE NEW HYPOTHESES

To test Hypothesis 1, we introduce volatility in the benchmark specification of the gravity model in MSO. Our chosen measure of volatility is the moving average over the previous 5 years of the annual variance of the weekly effective exchange rate returns. Volatility appears to have a negative and significant effect even when we control for EMU. This is a very crude check on the convexity of the trade-volatility relationship, but our results are consistent with convexity of the trade-volatility link.

Table 2: The Euro's trade impact in a gravity model with volatility

	(1)	(2)
emu2	**0.054**	**0.031**
	(0.013)***	(0.017)**
volatility		**-0.013**
		(0.004)***
Real GDP	1.145	1.110
	(0.059)***	(0.043)***
Free Trade Agreement	-0.005	0.016
	(0.021)	(0.019)
EU	0.043	0.046
	(0.021)**	(-0.022)**
EU Trend	0.001	0.000
	(0.001)	(0.001)
Real exchange rate country 1	-0.158	-0.212
	(0.044)***	(0.042)***
Real exchange rate country 2	-0.270	-0.194
	(0.057)***	(0.049)***
Observations	2541	2541
Adj R-squared	0.9952	0.9954
Country Pair Dummies	yes	yes
Year Dummies	yes	yes

Note: (1) is MSO benchmark specification, (2) adds volatility to the MSO benchmark

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

A more direct test of the convexity is to introduce higher order volatility terms. We note, however, that the convexity predicted by our model cannot be fully captured by a finite order polynomial. The results are shown in Table 3. The first column reproduces MSO's preferred specification. The second and third columns add, respectively, our volatility measures and the square of the same. Volatility in levels has the expected negative sign and the volatility squared has the expected positive sign, however, when we include both, neither is statistically different from zero and both are negative. We note that this may be a problem of homoroskedascity between a variable and its square.

In conclusion, the data does not strongly confirm or deny the existence of a convex relationship between volatility and trade. We plan to conduct further tests on this hypothesis in future drafts.

Table 3: Testing for convexity with quadratic volatility terms in the DC sample.

	(1)	(2)	(3)	(4)
emu2	**0.054**	**0.031**	**0.032**	**0.031**
	(0.013)***	(0.017)**	(0.017)**	(0.017)**
volatility		**-0.013**		**-0.016**
		(0.004)***		(0.022)
volatility 2nd derivative			**0.001**	**-0.001**
			(0.01)***	(0.01)
Real GDP	1.145	1.110	1.116	1.108
	(0.059)***	(0.043)***	(0.043)***	(0.045)***
Free Trade Agreement	-0.005	0.016	0.014	0.016
	(0.021)	(0.019)	(0.019)	(0.019)
EU	0.043	0.046	0.047	0.046
	(0.021)**	(-0.022)**	(-0.022)**	(-((-0.022)**
EU Trend	0.001	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Real exchange rate country 1	-0.158	-0.212	-0.217	-0.211
	(0.044)***	(0.042)***	(0.042)***	(0.043)***
Real exchange rate country 2	-0.270	-0.194	-0.196	-0.193
	(0.057)***	(0.049)***	(0.049)***	(0.049)***
Observations	2541	2541	2541	2541
Adj R-squared	0.9952	0.9954	0.9954	0.9954
Country Pair Dummies	yes	yes	yes	yes
Year Dummies	yes	yes	yes	yes

Note: (1) is MSO benchmark specification, (2) to (4) add volatility to the MSO benchmark
Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

To test Hypothesis 2, we introduction and interaction term between trade costs and our volatility measure. Our model predicts that this should be positive since higher trade costs make the impact of volatility less negative. As the findings in Table 4 show, the hypothesis in confirmed. The interaction term is positive and significant at the 1% level in both samples used by MSO. In all cans the standard gravity model variables remain significant and sensible.

It is interesting to note that the size of the Rose effect actually increases once one corrects for the trade cost-volatility link.

Hypothesis 3 concerns the impact of monetary union and currency union on intra-Eurozone trade and Eurozone nations' trade with other non-members. The hypothesis is that both monetary union and currency union should boost both types of trade, but the boost should be greater for trade within the Eurozone. To test this, we re-do the MSO basic

regression allowing for year-by-year Rose dummies (intra and extra-Eurozone), but we also control for volatility as our model suggests. Our findings, shown graphically in Table 4: Testing for interaction between trade costs and volatility

, confirm the basic effect. In future drafts, when we have another year of data, we will test more directly for an independent effect of the currency union.

	DC sample		EU sample	
	(1)	(2)	(3)	(4)
emu2	**0.033**		**0.064**	
	(0.017)**		(0.014)***	
volatility	**-0.092**	**-0.092**	**-0.159**	**-0.157**
	(0.034)**	(0.034)**	(0.029)***	(0.030)***
volatility*distance	**0.011**	**0.011**	**0.021**	**0.021**
	(0.005)**	(0.005)**	(0.004)***	(0.004)***
Real GDP	1.127	1.142	1.068	1.112
	(0.044)***	(0.043)***	(0.050)***	(0.050)***
Free Trade Agreement	0.014	0.016		
	(0.019)	(0.019)		
EU	0.043	0.043		
	(0.021)**	(0.021)**		
EU Trend	0.000	0.000		
	(0.001)	(0.001)		
Real exchange rate country 1	-0.221	-0.200	-0.159	-0.077
	(0.042)***	(0.041)***	(0.057)***	(0.055)***
Real exchange rate country 2	-0.213	-0.212	0.468	0.462
	(0.050)***	(0.050)***	(0.084)***	(0.085)***
Observations	2541	2541	858	858
Adj R-squared	0.9263	0.9954	0.997	0.996
Country Pair Dummies	yes	yes	yes	yes
Year Dummies	yes	yes	yes	yes

Note: (1) and (2) estimate the volatility-distance interaction in the DC sample while (3) and (4) in the EU
*Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%*

Table 4: Testing for interaction between trade costs and volatility

Market thickness and small currencies

Generally speaking, it seems that the Rose effect is bigger for core countries and among these participation in the monetary and currency union tends to favour small countries with a large share of their trade being intra-EMU. It favours Germany more than smaller EMU core countries. A possible explanation could be that the share of German extra-EMU trade denominated in Euros is larger than the share Germany used to denominate in DM before, i.e. greater international role of the Euro as currency of denomination for transactions that it was the case for DM.

Financial markets

Hypothesis of higher Rose effect in countries with less developed financial markets is not confirmed using first-pass techniques. In particular, Figure 9: Intra-Eurozone (EMU2) and Extra-Eurozone (EMU1) Rose effect

presents scatter plots of our estimates of the Rose effect against three measures of financial market development. The graphs present no evidence for the expected negative relationship and mild evidence for positive relationship. This however is a rather crude test, in particular, the hypothesis suggests that we should include an interaction term between the Rose dummy and a proxy for financial market sophistication. Additionally, since changes in the transaction costs are conjectured to stem from forex market changes, a more relevant proxy would be related to each members' forex market prior to the euro. We plan to under take these more nuanced tests in future work.

Figure 9: Intra-Eurozone (EMU2) and Extra-Eurozone (EMU1) Rose effect

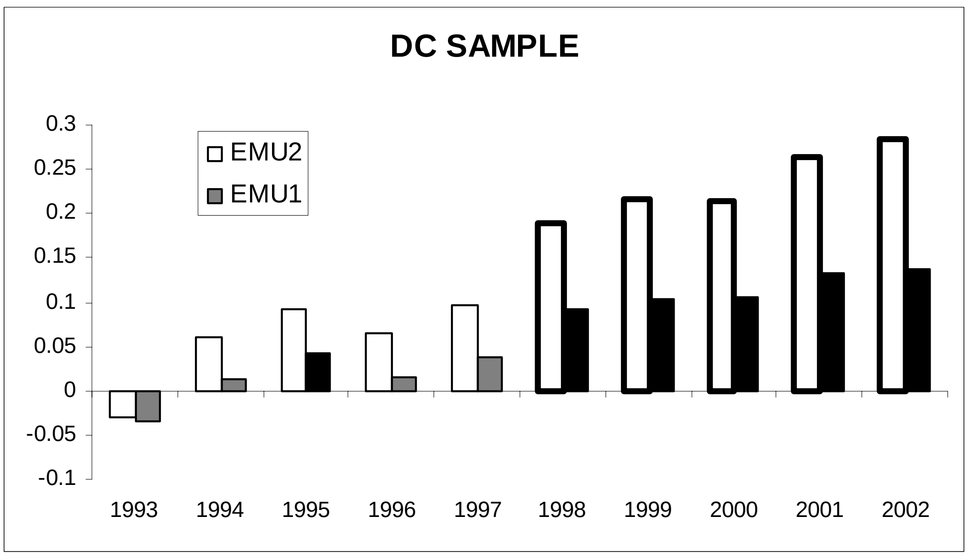
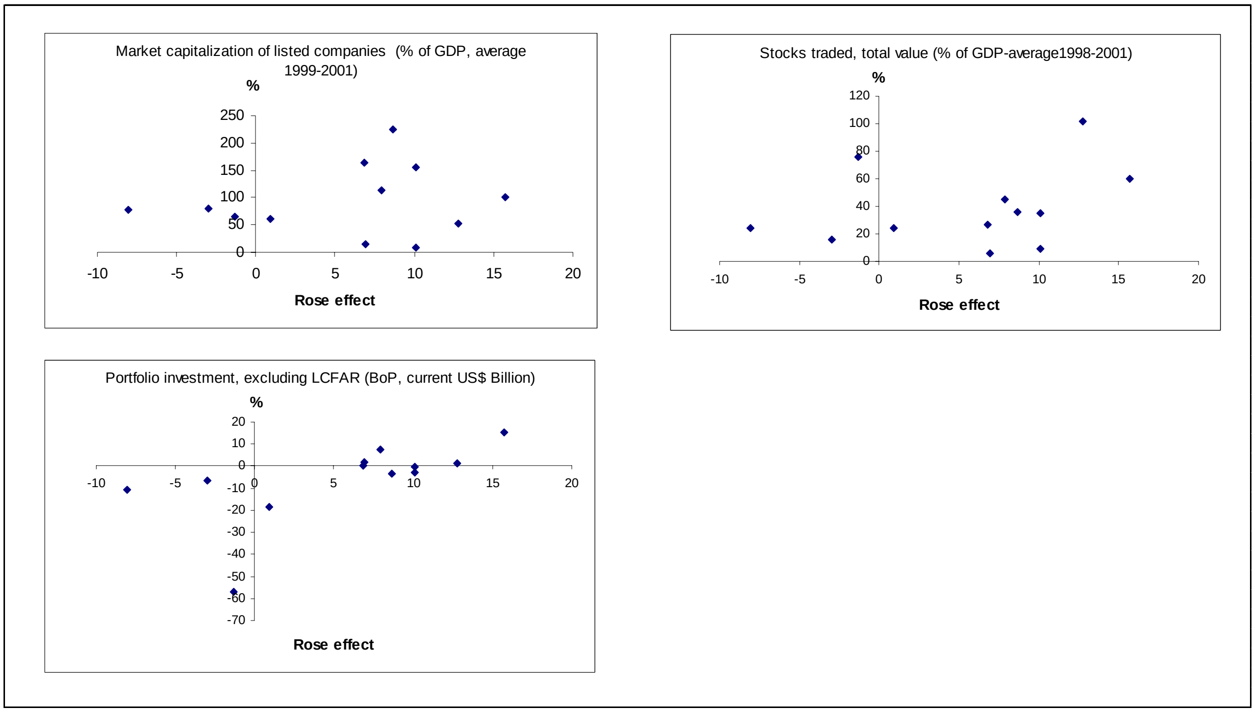


Figure 10: Financial market develop and the size of the Rose effect by nation



7. CONCLUSIONS

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