Monetary Integration in the ex-Soviet Union: a "Union of Four"?*

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Abstract: The governments of 4 ex-Soviet countries recently discussed forming a currency union. We examine the economic feasibility of this union. Using conventional techniques, we find the arrangement is likely to founder on the lack of structural symmetry, the asymmetric pattern of shocks and the lack of market flexibility among the potential participants. Moreover, the union would be a unilateral one. It would therefore require an exceptionally strong political commitment to survive. Nevertheless there are some subtleties in the timing and pattern of mutual dependency between Russia and Kazakhstan (and to a much lesser extent, Belarus) which might allow a currency union with less strain. Otherwise, the black market will inevitably have to provide the necessary market flexibility.

Keywords: Structural symmetry, Unilateral currency unions, market flexibility.
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1. Introduction: the Story Opens

In 2003, Russia and some of the former Soviet republics revisited the possibility of creating a currency union and common economic area between them. Whether this was to be a prelude to, or vehicle for, recreating the Commonwealth of Independent States (CIS) of earlier years was not made explicit. Nevertheless, an agreement to create a common economic area was signed in September. It envisioned that a single market would be completed, and a single currency introduced, within 5 - 7 years.[1]

The Russian government justified this initiative on four grounds: the common experience of 70 years in the Soviet Union; the 30 years of successful economic integration in Europe; the fact that this "Union of Four" would allow a substantial degree of multi-speed and multilateral integration; and the fact that only a subset of the ex-Soviet economies – Russia, Belarus, Ukraine and Kazakhstan – would be involved. Nevertheless considerable differences in the degree of economic development remain. Russia is the most financially (if not economically) developed of the four, and clearly dominates in size. She also has the most diversified economy. This puts her in the familiar position of not being very concerned whether this union is formed or not – unless creating such a union would enhance her weight in international affairs, or unless poor financial management in one of the partners should damage her own stability. In short, the partners are likely to need Russia, and access to Russian markets, more than Russia needs them.

For the other three, the position is quite different. Individually they are less than one third Russia's size by population; less than 15% by GDP, and only half as rich in GDP per head. Even collectively, they only amount to 30% of Russia's GDP (see Table 1). They are equally a poor match in other performance indicators. Inflation is clearly lower in Kazakhstan and Ukraine than in Russia, whereas it is much higher in Belarus. The official unemployment figures are uninformative; but Russia is running a large fiscal

[1] For a general discussion of these issues, but without the econometric and statistical feasibility that underlies the present study, see Alimova and Idrisov (1995), Evistigneev (1997), and Valovaya and Konstantinov (1998). In fact, even at this stage, no formal evaluation of this currency union appears to have been made.

surplus without much exposure to foreign debt, while Kazakhstan and Ukraine are running small deficits and have significant foreign debt. And there are marked differences in the growth rates.

Table 1: National Incomes (2002)

	BELARUS	KAZAKHSTAN	RUSSIA	UKRAINE
Population (million)	10.0	16.7	144.8	48
GDP (bn US-$)	185	105	1350	218
GDP per capita (US-$)	8200	6300	9300	4500
% below poverty line	22	25	25	29
Growth in %	4.2	9.5	4.2	4.1
Inflation in %	42.8	6.0	15.0	-1.2
U/E in %	2.1	8.8	7.9	3.8
External debt (bn US-$)	0.8	6.6	0.5	14.2
Fiscal deficit (bn US-$)	0.1	1.0	-8.0	1.0

Even more significant differences appear in industrial structures and trade patterns (table 2). It appears that the Belarus economy is focused on heavy industry (machinery, metals, chemicals, equipment, textiles), while Kazakhstan is a primary commodity producer (oil, gas, phosphates, metals, bauxite, and some agricultural machinery) and Ukraine is specialized in agriculture (her agricultural sector is twice the size of that in the potential

Table 2: Products and Trade Deficits

	BELARUS	**KAZAKHSTAN**	**RUSSIA**	**UKRAINE**
Products	Metals, machine tools, transport equipments, chemicals, fertilizers, textiles	Coal, gas, iron, phosphates, metals, bauxite, agricultural, machinery	Complete range, mining/extractive, chemicals, manufactures, transport, communications, machinery, durables, food	Chemicals, food, coal, machinery, transport equipment
Trade Deficit	$ 1bn	-$0.4bn (surplus)	-$46bn (surplus)	$0bn

partners, though coal, chemicals and machinery have a role as well).

This pattern of specialization is no doubt a legacy of the Soviet economic system. But it may have profound implications for the ability of this "union of four" to operate a currency union successfully. It contrasts with Russia's own industrial structure, which shows a diversified economy with a full range of goods, but with an agricultural sector half the size of the others and services up to 50% larger. The result of this is a trade pattern which is even more asymmetric between Russia and her partners. Russia has a trade surplus of 3.5% of GDP, while the others are roughly in balance (see Table 2). Russia is similarly by far the largest trading partner of the other three taking between 30% and 50% of their trade. By contrast, the other three are responsible for 8% or less of Russia's trade individually or 20% collectively (see figures 5-9 in Appendix C). And, whereas Russia does not have very extensive financial markets, they are certainly more extensive than those in Belarus, Kazakhstan or Ukraine. Such imbalances virtually guarantee that a currency union formed between these four economies would be a

unilateral monetary union[2]. That is important because the conditions for a successful unilateral union are much more difficult to fulfill, if only because the dependent partners have no influence on the monetary policies or the union of the fiscal policies of its largest member. The union's policies are likely to be less suitable for the partner economies than if they had been chosen jointly. Consequently symmetry in shocks and transmissions will become more important than ever in order that different policies are not demanded in different places.[3] Conversely, to the extent that the partner economies remain different in structure, policy and market flexibility will be at a premium so that the partner economies can adjust to cover the residual differences with the lead economy.

With the differences in structure and trade patterns noted above, one must ask if – in the light of the traditional optimal currency area (OCA) criteria – a currency union between these four partners is likely to be successful. In the absence of strong symmetries and mutual dependence, it will require a great deal from factor mobility, policy flexibility and the symmetric transmission of shocks to output and inflation to make such a union durable and advantageous. The contribution of this paper is to assess whether those conditions are, or might become, satisfied by enough for Russian currency union to make economic sense[4]. The traditional test is to examine the symmetry – both in size and in sign – of demand, supply, and monetary shocks on prizes and output (see Bayoumi and Eichengreen 1993, 1996; Demertzis et al. 1998). And as that is evidently a condition for a viable currency union, according to the analysis of optimal currency areas, that is the test we adopt here. However, for the cases where it is not well satisfied, we also pay some attention to the necessary conditions of wage flexibility or labour mobility; and to the possibility that a common currency would itself induce the symmetry that we need.

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[2] The crucial differences between a unilateral and a multilateral monetary union were shown, all too clearly, by the collapse of the Argentine currency board in 2001: see Anthony and Hughes Hallett (2001). For earlier analyses of monetary integration among the ex-Soviet economies, see Alimova and Idriso (1995), or Valovaya and Konstantinov (1998). These studies focus on the difficulties for a common monetary policy, and the capacity for accumulating debt when there are different structures and shocks, but do not provide any specific assessment for those four economies.

[3] One can already see the crucial importance of this distinction between unilateral and multilateral monetary unions in the fact that Russia and Belarus are currently negotiating an "interstate bank" to conduct monetary policy for the two of them. But the negotiations are making little progress because Belarus is unable to exert any real influence on the policies of the Russian Central Bank. Belarus is nonetheless trying to insist on an equal weight in decision making, while Russia is not prepared to delegate any of its policy making powers to other parties (Belarus, or other regions of Russia): see Tereshenko, 2002.

[4] We do not examine the political motives here.

2 Criteria for a Common Currency

2.1 The Optimal Currency Area Criteria

The economics literature has focused on four conditions that need to be satisfied within a currency union:

a) the extent of trade (openness) between participants;
b) the degree of similarity in economic structures, and in the shocks and preferences;
c) the degree of factor (capital or labour) mobility – or flexibility in labour costs;
d) the existence of a system of fiscal transfers to compensate for the absence of sufficient factor mobility or wage/price flexibility[5].

The stronger the linkage between the economies under any of these criteria, the more suitable a single currency between them.

In this group of ex-Soviet economies conditions (a), (c) and (d) are clearly not satisfied. In figures 5 to 9, in appendix C, we saw that although the smaller three trade with Russia, Russian trades rather little with them and they trade very little among themselves. Thus, although these economies are open, they are not open to each other. Second, although significant capital mobility may exist in the region, official and unofficial labour mobility is rather limited. Table 3 shows that the migration flows in 1998 were less than ¼% of the labour forces in each case (except for the Kazakhstan to Russia figure which is closer to 2%). Thus, unless unrecorded flows plus wage/price flexibility in the black market step in significantly, condition (c) will not be satisfied. Third, there are no fiscal flows at present, and none planned for the future.

[5] Mundell (1961), McKinnon (1963). A fifth criterion, industrial diversification (Kenen, 1969), could not be expected to play a role in economies as small and undiversified as Belarus, Kazakhstan and Ukraine – although it might apply to Russia. The implications of a lack of industrial diversification in small national economies more generally is discussed in Armstrong and Read (1998).

Table 3: Migration (Interregional) in '000, 1998

To / From	**Belarus**	**Kazakhstan**	**Russia**	**Ukraine**
Belarus		0.4	13.8	1.7
Kazakhstan	5.2		209.9	4.6
Russia	19.9	26.7		58.0
Ukraine	5.6	1.5	14.9	

In that case, the economic argument for an economic currency union must rest on the similarity of shocks and structures. But table 1 and figures 5 to 9 show little structural similarity. Consequently, it is the symmetry of the shocks as transmitted to prices and output that we must examine. That we do in the next two sections. But before we do that, we must consider two other possible justifications for a common currency.

2.2 Fiscal and Monetary Discipline

If some countries have found it difficult to pursue credible and disciplined financial policies in the past, and fear that this may be a problem in the future, then, by entering a currency union with those who have been successful in the past, they may be "constrained" to enjoy the credibility and discipline of those who have been successful. In other words, by becoming a member of such a union, they could import the discipline of those who have achieved it (de Grauwe 1997; Giavazzi and Pagano 1988).

However, it is not obvious that any of these four countries have achieved credibility, discipline or unanimity in their monetary policies – inflation varies from 42% to -1% in table 1. And more significantly, the argument works in reverse. Forming a currency union without some external anchor, may mean that the more disciplined countries import the expansionary tendencies of those less disciplined. In particular, the largest economy in this group (Russia) is one of the less disciplined, with an inflation rate of 15% and only a small fiscal to GDP surplus to offset it. To deal with this criticism, there would have to be some radical changes in the monetary (if not fiscal) sector. If there are none, not only will there be no improvement in the performance of the union. There

will be no incentive for the more disciplined to join, and therefore no point in forming the union.

2.3 Creating the Conditions for an Optimal Currency Area

The second reason for creating a currency union is that adopting a single currency may, in itself, hasten the process of economic integration between the group of four and, in fact, induce the relevant conditions for a common currency endogenously. This is because a single currency would induce more trade between the participants as countries take advantage of the single market, lower transaction costs and the absence of exchange rate uncertainty between them. Then, as trade increases, the divergence between economies decreases – or so the argument goes[6]. Countries become more similar and face fewer asymmetric shocks or asymmetric transmissions.

How likely is this scenario for our group of four? The evidence is not favourable because the pattern of trade needed to create this convergence is largely absent. In fact, to get this convergence process, countries are going to have to create a great deal of intra-industry trade: that is the only basis for expecting the endogenous emergence of the optimal currency area criteria (Frankel and Rose, 1998). But such intra-industry trade would only be found in the trade of manufactures in relatively developed and diversified industries. It is not found in the smaller, specialized economies like Belarus, Kazakhstan or even Ukraine. Moreover, if this course were followed, the prime advantages of creating a single market – that is, increased output at lower prices through the ability to exploit scale economies and comparative advantage – would be lost in many of those industries. Consequently, there may be little incentive to go down this inter-industry trade path. Similarly, the evidence from the Central African franc zone shows how difficult it is to make optimal currency area criteria emerge in small, underdeveloped and undiversified economies (Boughton, 1993). Thus unless there are radical changes in economic structure, it seems unlikely that this kind of intra-industry trade would develop in this group of four. In that case the hope must be that sufficient symmetry in shocks and transmissions exists to allow the gains from price stability and policy discipline to appear. We examine that question next.

[6] Frankel and Rose (1998).

3 Theory: A Formal Model of Currency Unions

3.1 Lessons from Europe

A number of recent papers have reviewed these conditions and the extent to which they are satisfied in Europe[7]. They almost all conclude that the EU economies are sufficiently open to trade among themselves and that capital is highly mobile. Likewise they nearly all argue that labour is largely immobile for linguistic and cultural reasons, as well as because of the personal and social costs of migration. The fact that labor is immobile in the long term, and that wage and non-wage labour costs are not flexible in the short term, means that asymmetric shocks could lead to persistent disequilibria under a common currency. Indeed even symmetric shocks will generate persistent disequilibria if the degree of labor mobility, wage and price flexibility, varies between countries. If these are difficulties in the EU, it is not clear that conditions would be any better satisfied further East.

By contrast, product diversification would make countries appear more symmetric since, by mutual canceling, industry and country specific shocks would become rather small; or it would make the time profile of the transmission mechanisms become more similar because shocks would be absorbed more easily. Conversely regional specialization would imply asymmetric transmission mechanisms and disturbances that were more persistent.[8] The trend to regional specialization has been documented as a feature of the monetary unions formed in the last century (Italy, Germany, the United States), and would be a natural consequence of the opportunities for exploiting the scale economies and the wider range of comparative advantages in a single market with significant rigidities (de Grauwe and Vanhaverbeke, 1993; Krugman, 1993; Puga, 1999; Krugman and Venables, 1996). Calculations by Bayoumi and Eichengreen (1996) show

[7] Masson and Taylor (1993), and Tavlas (1993) provide general surveys. Eichengreen (1992), Bean (1994) de Grauwe and Vanhaverbeke (1993), and Bayoumi and Eichengreen (1993) review the work on the nature of the underlying shocks and factor mobility.

[8] Some argue that supply shocks tend to be sector specific and demand shocks country specific; but if countries enjoy different specialization patterns, then both types of shock will appear country specific.

that, in a period when regional specialization in the United States had been mildly declining, it has been increasing in the EU. Again the question arises, why would this group of four, with their fragmented markets, be different from the rest of the EU?

3.2 A Formal Model

To test whether membership of a currency union is justified, we adapt a model of analysed by Bayoumi (1994). In this model, each region has the same production structure but produces its own goods with a fixed amount of labour:

$$Y_i = L_i^{\alpha} e^{\varepsilon_i} \tag{3.1}$$

where Y_i is the output region i, L_i the labour input of region i, ε_i is a disturbance with mean zero and independent of the exchange rate regime. The capital stock has been normalized at 1. In a competitive market, labour will be employed up to the point where real wages equal the marginal product of labour in the common currency. To incorporate wage stickiness we assume that full employment wages hold when there is full employment[9]. If there is excess demand for labour, then wages will rise; but if there is excess supply , then wages will remain at this level and unemployment results. Each region can choose its own exchange rate regime, and those regions in the same regime will avoid the transactions cost τ on the transactions across borders. Finally on the demand side, utility levels are given by the Cobb-Douglas function:

$$U_j = \sum_{i=1}^{N} \beta_{ji} \log C_{ji} - \phi \tag{3.2}$$

where C_{ji} is the consumption of good I in region j, β_{ji} is the proportion of region j's income spent on good produced in region i, and ϕ is a constant.

[9] This feature follows from the common observation that real wages are the main adjustment mechanism in the United States, whereas outside the United States it is usually changes in the employment (Blanchard and Katz, 1992).

When regions j and k decide to form a currency union, the algebra in Appendix A shows that the utilities gained by being in the currency union are:

$$\Delta U_j = \beta_{jk}\tau - \beta_{jk}\alpha(\varepsilon_j - \varepsilon_k)/(2(1-\alpha)) + \sum_j \beta_{ji}\Delta v_{ji}$$

$$\Delta U_k = \beta_{kj}\tau - \beta_{kk}\alpha(\varepsilon_j - \varepsilon_k)/(2(1-\alpha)) + \sum_j \beta_{ki}\Delta v_{ki} \qquad (3.3)$$

while the loss to the region 1 (say) staying outside the union is:

$$\Delta U_1 = -\beta_{1k}\alpha(\varepsilon_j - \varepsilon_k)/(2(1-\alpha)) + \Sigma\beta_{1i}\Delta v_{1i} \qquad (3.4)$$

where Δv_{ji} is the increase in region j's demand for goods produced in region i *as a result of joining the currency union*; that is the trade creation and the trade diversion effects of the common currency itself. But in this paper, all the countries investigated were members of the Soviet Union, Comecon and the CIS for many years and therefore members of a single market. Hence it is difficult to believe that there would be any additional systematic shocks to demand in the union countries beyond those already reflected in τ. We can therefore ignore the Δv_{ji} terms, or treat them as small.

Having said that, notice that $\beta_{jk}\tau > 0$ and $\beta_{kj}\tau > 0$. So there are always gains in terms of lower transactions costs within the union. The remaining terms (3.3) and (3.4) show the costs, or loss in welfare, due to having sticky real wages in the union which make macroeconomic adjustment more difficult and more costly. Here we have taken region j to be the high demand country and hence $\varepsilon_j > \varepsilon_k$. This implies higher wages in j, and an adjustment problem to remove unemployment in region k where wages are sticky. But equally we could have treated region j as the country with excessive wages, and region k as that with full employment. Either way the costs of adjustment are positive in (3.3); and the resulting disequilibria effects spill over to other members, causing their welfare to deteriorate.

The cost-benefit ratio for the union therefore depends on the demand elasticities (β_{ji}), the transactions costs (τ), the elasticity of the demand for labour (α), and

the similarity or dissimilarity of the shocks in different regions. But nonmembers will be worse off because adjustment difficulties in the union spill over to cause disequilibria outside, without any trade or currency benefits created to compensate. Hence rigidities in the core impose costs on the periphery, but the periphery countries will impose no such costs on the core. However, since the shocks are symmetrically distributed around zero, there will be times when $\varepsilon_j < \varepsilon_k$, and times when $\varepsilon_k > \varepsilon_j$, with a probability of one half of either event occurring. That means the ex ante expected benefit in joining a currency union is:

$$E(\Delta U_j) = \beta_{jk}\tau - \gamma(\beta_{jj} + \beta_{jk})\phi(0)\sqrt{\sigma_j^2 - 2\rho\sigma_j\sigma_k + \sigma_k^2} \qquad (3.5)$$

And for the nonmembers:

$$E(\Delta U_j) = -\gamma(\beta_{1j} + \beta_{1k})\phi(0)\sqrt{\sigma_j^2 - 2\rho\sigma_j\sigma_k + \sigma_k^2} \qquad (3.6)$$

where $\phi(0)$ is the density function of a standard jointly normal distribution of random variables and $\gamma = \alpha/(2(1-\alpha))$. [10] Thus the expected costs of monetary union are minimised for members and nonmembers alike *if* $\rho \to 1$; but *only if* $\sigma_j \cong \sigma_k$ as well. Hence a necessary condition for low costs is a high positive correlation between the shocks in regions j and k; but the necessary and sufficient condition is high correlations *and* stocks of similar size.

[10] The periphery might impose other costs on the core however, for example if it indulged in *systematic* competitive devaluations designed to offset output losses forced on it by the core's adjustment difficulties, or to offset an inherently lower average rate of growth (Martin 1995). But that would just come out in a higher probability of larger ε_k values and hence of $\varepsilon_k > \varepsilon_j$ rather than $\varepsilon_k < \varepsilon_j$. That in turn would simply lead to a probability weighted average of β_{jj} and β_{jk} replacing $(\beta_{jj}+\beta_{jk})\phi(0)$ in (3.5), and of β_{ij} β_{1k} for $(\beta_{ij}+\beta_{1k})\phi(0)$ in (3.6). That would increase the costs in (3.5) and reduce them in (3.6), but *not* remove them either entirely. Our analysis is unaffected, although the cost-benefit calculus will be less favourable to the core members.

3.3 Introducing Market Flexibility

a) Labour mobility: All this analysis has been conducted assuming no labour mobility. However, suppose instead that a proportion δ ($0<\delta<1$) of the number remaining unemployed in a depressed region is able to migrate to a full employment region. Appendix A shows that the costs of forming a currency union shrink by a factor $(1-\delta)$ for both parties. The welfare costs will still vary with ρ, σ_j and σ_k, but vanish entirely if $\delta \rightarrow 1$. Hence full mobility will offset the costs of a monetary union for both members and nonmembers.

b) Wage flexibility: A similar outcome can be achieved if wages and nonwage costs are flexible downwards in region k. Suppose wages fall sufficiently to reemploy the δX employees, who might otherwise have migrated to region j. Again we show in Appendix A that the costs of forming a monetary union with asymmetric shocks are reduced. Indeed the mechanism remains the same; the costs depend on ρ, σ_j and σ_k, and will vanish if $\delta \rightarrow 1$. Hence fully flexible wages restore full employment in region k and remove the costs of belonging to a currency union.

c) Product diversification: There are three possibilities here. Diversification might mean that industrial structures are so diverse that individual industry shocks would either be negligible; or would affect every country in exactly the same way, diversity being extensive enough to leave everyone with broadly similar structures. That is the case where $\sigma_j \cong \sigma_k \cong 0$; or $\sigma_j \cong \sigma_k$ and $\rho \rightarrow 1$, respectively. If diversification in the former sense is not perfect, shocks hitting each economy will result in disturbances that are "shrunk" by a factor $(1-\delta)$ – where $\delta=0$ implies no diversification, but $0<\delta<1$ otherwise. In that case $(1-\delta)\sigma_j$ replaces σ_j etc, and we get reduced costs again.

d) Symmetric structures:[11] The alternative explanation is that industries are sufficiently differentiated in their cost structures that a country specific shock has different impacts

[11] There is an extensive literature on the sources of, and consequences of, asymmetric structures between (or within) partners in a common currency area: see Hughes Hallett and Piscitelli (2002), Hughes Hallett (2003) and references therein. We have emphasized differences in wage flexibility here, and differences in

on different marginal productivity conditions. Some labour would then migrate to the higher returns; from industry k to industry j within countries. If no wage flexibility is involved, this would merely reproduce equation (A.11) where ε_j and ε_k refer to the different impacts of the same national shock. In that case, (3.5) and (3.6) then represent the costs to industry j of being in or out of the union; and $\delta \rightarrow 1$ would mean greater symmetry of industrial structures.

Summary: The costs of forming a monetary union are therefore reduced by increasing market flexibility ($0<\delta<1$). They are reduced for each member of the union because flexibility and mobility reduce the impact of adjustment costs. Indeed, in the extreme case of $\delta=1$, there is no adjustment costs at all. This implies that:

- The success or failure of a monetary union will ultimately depend on the flexibility and performance of the labour (factor) markets.
- The design and quality of monetary and fiscal policies are a secondary issue in the sense that they have to compensate for whatever lack of wages or mobility of labour may exist.
- But given imperfect mobility or flexibility in the labour or capital markets, a test of whether a monetary union is beneficial can only be concluded in terms of the symmetry of shocks in the member countries.

4 Practice : Estimating Demand and Supply Shocks

4.1 The Long Run Effect of Shocks

This paper uses long-un restrictions on a simple vector autoregressive (VAR) model to identify the fundamental demand, supply and monetary shocks that drive output, prices and competitiveness in each country studied. That allows us to calculate the

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the stickiness with which prices can adjust. They are perhaps the most important. But asymmetries can also arise from differences in trade patterns (Anthony and Hughes Hallett 2000), differences in industrial structures, differences in the interest and income elasticities of the demand for money, or differences in asset holdings (Hughes Hallett and Piscitelli 2002). All but the last could also be important here.

correlations between the underlying disturbances in the model discussed in section 3. Unfortunately that model did not distinguish the origin of the shocks: ε_i and v_{ji} just represent the combined effects of the underlying demand, supply and monetary shocks. We therefore decompose those disturbances into their underlying components by imposing long-run restrictions on the estimated short-run dynamics of output, prices, and real exchange rates. This is a technique pioneered by Blanchard and Quah (1989) and employed extensively by Bayoumi and Eichengreen (1992, 1993) and many others.

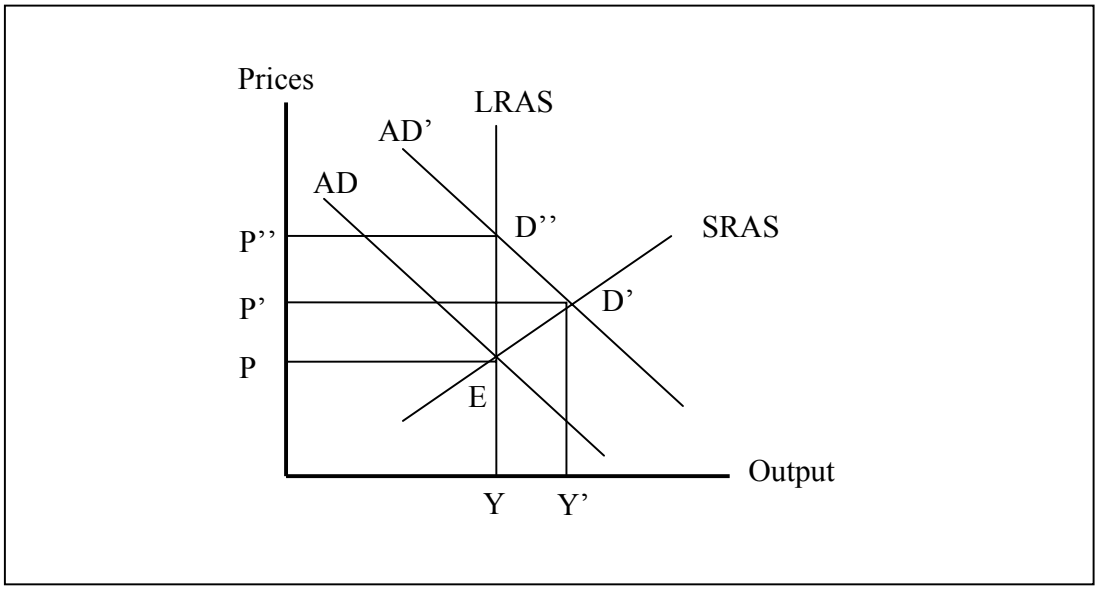

Figure 1: The Effects of a Positive Demand Shock

Our starting point is the aggregate demand and supply diagram displayed in Figure 1, where aggregate demand is represented by the downward sloping curve AD, and short-run aggregate supply by the upward sloping curve SRAS. The long-run aggregate supply curve (LRAS) will be vertical for "classical" reasons.

Figure 1 now shows the effect of a demand shock. The AD curve shifts from AD to AD', moving the equilibrium position from E to D'. This raises both output and prices, but as the aggregate supply curve becomes more vertical over time, the economy gradually moves from its short term equilibrium at D' to its new long-run equilibrium at D''. That restores the old (natural) level of output. The response to a permanent demand shock is therefore a rise in prices to P''. Long-run output does not change. This result is

independent of the slopes of the aggregate demand and supply curves, except in so far as a steeper (i.e. more price elastic) demand curve means larger price rises. Differences in transmission mechanisms will not influence the choice of policy – only the question of how hard it should be used. Hence, given sufficient symmetry in demand shocks, monetary union will entail few long-run costs if demand shocks dominate.

For the effect of a supply shock, we have figure 2. As a result of positive supply shock, both LRAS and the SRAS curves shift outwards. In the short-run this raises output and reduces prices, shifting the equilibrium form E to S'. As the supply curve becomes increasingly vertical over time, at the new capacity level, the economy moves from S' to S''. This implies a further fall in prices and an additional increase in output.

Positive supply shocks therefore result in an increase in output and a decrease in prices. In this case however, transmission mechanisms do matter. If the demand and supply curves are relatively steep and long-run supply is still elastic, then most of the adjustments will be made through prices. The situation is then much the same as for demand shocks: differences in transmission mechanisms will not influence the choice of policy. And membership of a disciplined currency union will entail few costs if supply shocks predominate.

If however the demand and supply curves are flatter and/or long-run supply is price inelastic, then most of the adjustment will be made through output. In that case, a currency union with independent monetary policy could be expensive, in terms of output fluctuations, unless fiscal and supply side policies can easily be used to stabilize output. In this case, if countries vary in their transmission mechanisms (principally through their demand and supply elasticities), then the costs of monetary policy could be very different in different places -- and the preferred regime will also vary.

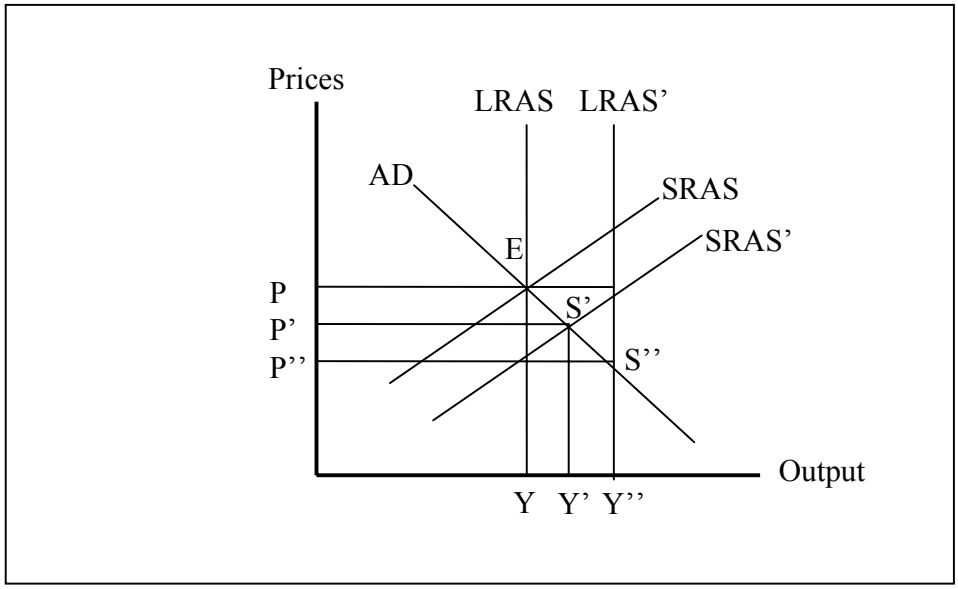

Figure 2: The Effects of a Positive Supply Shock

Now we move to the impact of supply and demand shocks on *relative* prices. Figures 3 and 4 apply (Bayoumi and Thomas, 1995). A demand shock will move the economy from D to D' in figure 3 causing a rise in domestic output and the relative price of domestic goods. Domestic incomes therefore rise, causing a second movement from D' to D''; that is a further rise in domestic output and a further loss in domestic competitiveness. Had the disturbance been a supply shock, however, the economy would move from E to E' in figure 3, causing relative prices to fall and domestic outputs to rise. Higher domestic incomes will then expand demand, moving the economy to E'' with a rise in relative prices and a second increase in output. The net change in competitiveness may be a positive or negative, but zero only if demand and supply curves have equal slopes and the price elasticity of domestic demand is unity. Hence output changes will be large, but competitiveness changes small. It is possible therefore that a monetary union with little provision for output stabilisation would prove expensive for those whom output stability is a priority. And it would become more of a problem if prices were sticky. If the currency union contains nothing to make markets (and relative prices) more flexible, while the strength and importance of the social insurance in non-wage costs make them less flexible, then transmission mechanisms do matter. Similarly, if the supply and demand curves become flat the output fluctuations will be larger.

Finally we have to consider monetary shocks, since if they vary over countries then it will be more difficult to operate a single monetary policy successfully. That would pose problems for those whose monetary shocks were large or uncorrelated with the union average. The impact of such shocks is standard. The vertical supply curve Figure 6 corresponds to the natural level of output and shows that a positive monetary shock would ultimately increase prices but not output. A conventional vertical long-run Phillips curve justifies this.

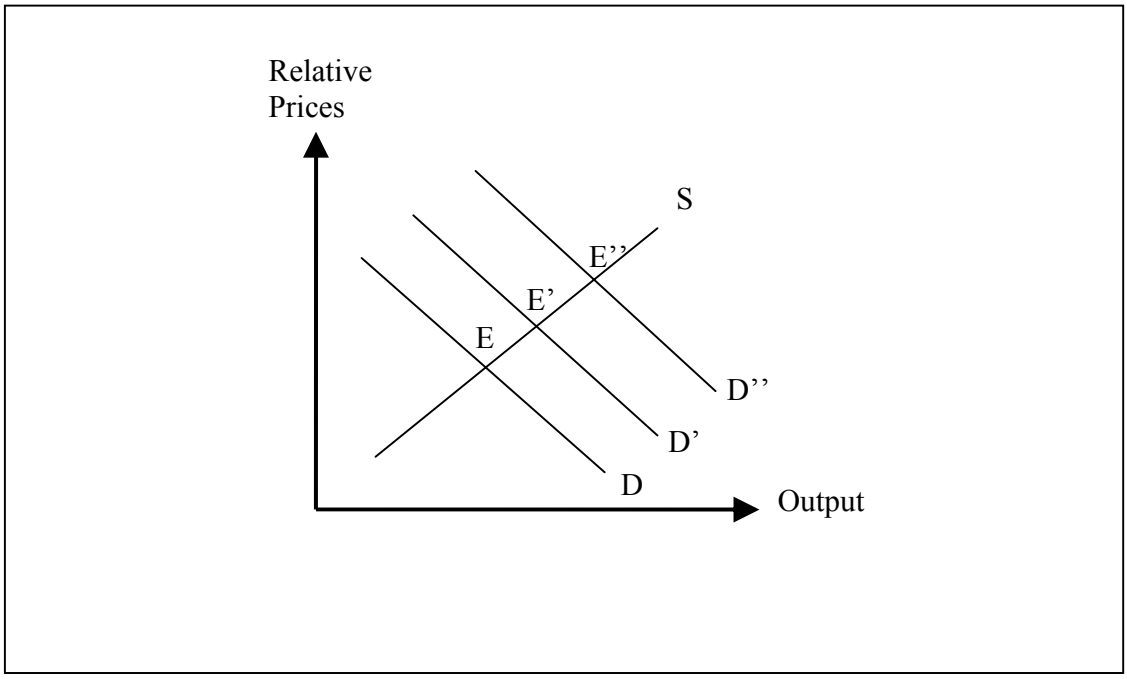

Figure 3: Effect of Demand Shock on Relative Prices

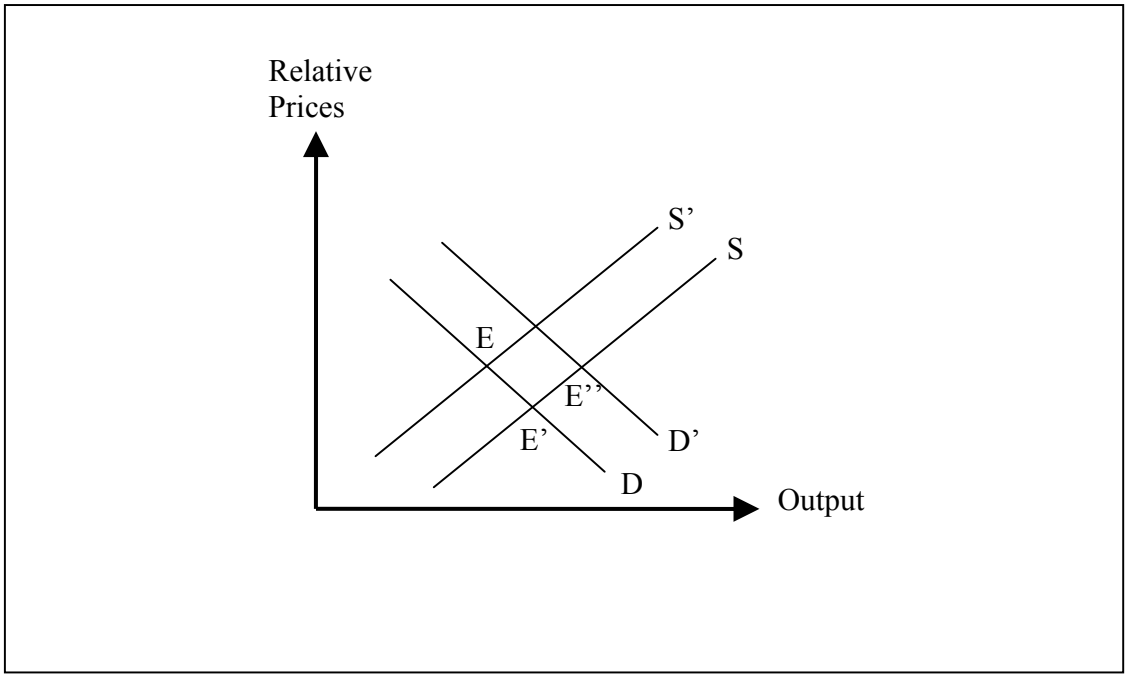

Figure 4: Effect of supply shock on relative prices

However monetary shocks will have no impact on exchange rates. If nominal exchange rates are flexible than any increase in relative prices, such as in Figure 3, will be countered by a depression in the nominal exchange rate triggered by the current account deficit or the expected loss in asset values. The opposite would happen for a fall in relative prices. Clarida and Galli (1994) have an open economy macro model to show this explicitly. Alternatively, if nominal exchange rates are fixed, then an increase in relative prices will imply a loss of competitiveness and a loss of exports and outputs. If nominal exchange rates cannot adjust, then deflation is necessary; and, as Driffil and Miller (1992, 1993) demonstrate formally, not just until domestic inflation stops. Prices have to be deflated beyond the point of zero inflation, until relative prices fall back to their original level. If this is not done, there would be a permanent loss of output and competitiveness. Hence the restriction that monetary policy should not affect relative prices and competitiveness in the long-run is independent of the exchange rate regime.

4.2 Short Run Considerations

A currency union is a long-run proposition, but may nevertheless entail short run costs. For example if demand shocks are important and the aggregate demand and supply curves are flat, output will fluctuate a lot in the short-run. Countries sensitive to output changes will find that unsatisfactory and prefer stabilisation on the real side. On the other hand, if supply shocks dominate, the short-run costs will be lower than the long-run costs; and in all cases, monetary policy will be less active in the short-run than the long-run.

However there is another issue. The analysis above suggests that a currency union with a common but independent central bank will be preferable if demand or monetary shocks dominate. But there is also the possibility that countries may decide to join the union, not because their structures and shocks are highly correlated with the rest of the union, but because policy actions have made them that way. In other words, unless we control explicitly for (monetary) policy shocks, countries may get misallocated.

4.3 How to Estimate These Shocks

Our point of departure here is Sims' (1980) vector autoregressive (VAR) methodology. This represents a convenient way of estimating relationships among jointly endogenous variables without imposing *a priori* restrictions on the coefficients of a model. We start with

$$A(L)x_t = e_t \qquad (0.1)$$

where $A(L) = I + A_1 L + A_2 l^2 + ... + A_k L^k$; L is the lag operator; and e_t has an independent multivariable normal distribution with mean zero and covariance matrix $\Sigma = E(e_t e_t^{'})$.
It is shown in Appendix B that this process has a moving average representation of the form

$$x_t = D(L)\varepsilon_\rho \qquad (0.2)$$

In our case, the vector x_t consists of the log of the real output (y_t), the inflation rate (π_t), the relative prices (r_t). The variables have to be stationary. In our case they were integrated of order 1 (test results available from the authors). We therefore take first differences to ensure stationarity. That means the following model has been estimated.[12]

$$A(L)\Delta x_t = e_t \tag{0.3}$$

The analysis in the previous section suggests that we identify D(L) on the basis of three structural relationships:

1. The three components of ε_t should be orthogonal, i.e., unrelated to each other.
2. One of the components of ε_t has no long-run effect on one of the variables in Δx_t. We identify that as the demand or expenditure shock, ε_d, having no long-run effect on output.
3. One of the components of ε_t has no long-run effect on two of the variables in Δx_t. We identify that a monetary shock, ε_m, having no long-run effect on output or relative prices.

These three restrictions imply equation (4.2) will become:

$$\begin{aligned}
\Delta y_t &= d_{11}(L)\varepsilon_{st} + d_{12}(L)\varepsilon_{dt} + d_{a3}(L)\varepsilon_{mt} \\
\Delta r_t &= d_{21}(L)\varepsilon_{st} + d_{22}(L)\varepsilon_{dt} + d_{23}(L)\varepsilon_{mt} \\
\Delta \pi_t &= d_{31}(L)\varepsilon_{st} + d_{32}(L)\varepsilon_{dt} + d_{33}(L)\varepsilon_{mt}
\end{aligned} \tag{0.4}$$

[12] The stationarity of Δx_t implies that all the roots of $|A(L)|$ are of modulus greater than one. A(L) is therefore invertible. In addition, while a Choleski decomposition will give unrestricted triangular decomposition for D(L), we prefer structural assumptions to identify D(L).

where $d_{12}(1) = d_{13}(1) + d_{23}(1) = 0$, plus $d_{11}(1) > 0$, $d_{22}(1) > 0$, $d_{32}(1) < 0$, and $d_{33}(1) > 0$ describe the long run values of the impulse parameters, and the first component of ε_t is a supply shock. Finally $d_{21}(1)$ is of uncertain sign.

The first zero restriction is that used by Bayoumi and Eichengreen (1994) to identify demand shocks; the other two are added by ourselves to identify the monetary shocks. This makes D(1) triangular. However, triangularity is just a convenient simplification that follows form the model put forward above. It is not a necessary requirement. Indeed it may well be that output in open economies will in fact be a function of both demand and supply shocks. In that case the ability to identify those two shocks separately will be lost. However given nine unknowns in equation (4.4) and six numerical values from the variance-covariance matrix Σ, any three equality restrictions would do. In this case we would need one extra restriction to replace $d_{12}(1) = 0$. In a small economy, one possibility would be $d_{22}(1) = d_{32}(1)$, so that demand shocks cause the same change in domestic prices and relative prices, with foreign prices unaffected. In principle the same kind of assumption can be made for the short-run impact of shocks, so long as the duration of the effects of demand, supply, or monetary disturbances on output (say) is different. We have not pursued any of these alternatives for lack of suitable decomposition algorithm in these cases.

4.4 Data

For this paper we used quarterly data starting in 1994Q1 until 2003Q1. The origin of this data is the Central Banks of Belarus, Kazakhstan, Russia, and Ukraine, respectively[13]. The series are not seasonally adjusted. The GDP series is the real GDP for all countries.

[13] We are grateful to the above mentioned Central Banks for their kind support in providing the data.

4.5 The VAR Structure

In implementing our error decomposition, an important practical issue is the length of the lag to be used in the underlying VAR equations. We selected the shortest lag length such that adding extra lags adds nothing to the explanatory power (information content) of the model.[14] The extra correlation analysis that follows is then conducted on shocks calculated from the VAR with optimal lag length for the county in question. Those lags appear in Table 4.

Table 4: Optimal Lag Lengths in Equation (4.3)

Russia	2	Ukraine	2
Belarus	2	Kazakhstan	4

The significance level of the correlation coefficients in the tables which follow can be assessed by calculating Fisher's transformation:

$$z = 0.5 \ln[(1+\rho)/(1-\rho)] \qquad (0.5)$$

which is approximately normally distributed, with mean zero and standard deviation $\sigma = (n-3)^{-½}$ where n = sample size. The critical values are provided at the end of each table and the hypothesis examined is H_0: $\rho=0$ against the alternative H_1: $\rho>0$.

4.6 Correlations between Countries: A Multilateral Monetary Union?

Table 5 displays our main results: the contemporaneous correlations of each countries supply, demand and monetary shocks with Russia within the Union of Four.

[14] The information criteria used are the Schwarz criterion (S), the Hannan-Quinn criterion (HQ) and the Akaike information interior (AIC). See Schwarz (1978), Hannan and Quinn (1979) and Enders (1995) respectively. Englund, Vredin, and Warne (1994) note that the Schwarz and Hannan-Quinn criteria are consistent in the presence of unit roots, but the Akaike information is not. Consequently, where there was disagreement between the criteria, we took longer lag indicated by the Schwarz or Hannan-Quinn criteria on the argument that too many lags might yield inefficient estimates in the VAR equations, but too few would introduce misspecification biases.

Table 5: The Contemporaneous Correlation of Supply, Demand and Monetary Shocks within the Union of Four

(a)	SUPPLY	DEMAND	MONETARY
Correlations with Russia			
Belarus	-0.161	+0.165	-0.165
Ukraine	+0.161	-0.155	+0.251
Kazakhstan	+0.034	-0.034	+0.033
(b)			
Correlations in the "Periphery"			
Belarus - Ukraine	-0.690	-0.005	-0.010
Belarus - Kazakhstan	+0.003	+0.008	-0.003
Ukraine - Kazakhstan	-0.102	-0.162	-0.249

NB: Critical values for a significant value at the 5% (10%) levels are 0.328 (0.279).

Table 6: The Unilateral Monetary Union Option

(a) Supply Shocks			
Russia (t) – Belarus (t+j)	-0.514 (j=2)	-0.366 (j=6)	+0.412 (j=7)
Russia (t) – Ukraine (t+j)	-0.337 (j= -8)	+0.295 (j=4)	-0.271 (j=5)
Russia (t) – Kazakhstan (t+j)	+0.279 (j= -3)	+0.380 (j= -1)	
(b) Demand Shocks			
Russia (t) – Belarus (t+j)	+0.512 (j=2)	+0.368 (j=6)	-0.408 (j=7)
Russia (t) – Ukraine (t+j)	-0.322 (j= -1)		
Russia (t)- Kazakhstan (t+j)	+0.306 (j=3)		
(c) Monetary Shocks			
Russia (t) – Belarus (t+j)	-0.512 (j=2)	-0.367 (j=6)	+0.408 (j=7)
Russia (t) – Ukraine (t+j)	+0.280 (j= -1)	-0.278 (j=2)	
Russia (t) – Kazakhstan (t+j)	+0.354 (j=3)	+0.303 (j= -3)	

NB: (a) No other values with $j<0$.
(b) Critical values for a significant value at the 5% (10%) levels are 0.328 (0.279).
Non-contemporaneous Correlations with Russia: where j is measured in quarters

Contemporaneous correlations would be the conventional yardstick for judging the wisdom (feasibility) of creating a multilateral monetary union between these four countries.[15] But in this case there are few which show any significant correlations. Belarus and Ukraine show no significant correlations with Russia. What is problematic, furthermore, is that each country is showing some *negative* correlations – on the supply side in Belarus, and on the demand side in Ukraine and Kazakhstan. Although these correlations are not significant, they do go the wrong way. Similarly for the monetary shocks: Ukraine shows a marginal correlation with Russia, but Belarus and Kazakhstan none. There is no systematic grouping here.

The correlations among the three 'periphery' countries show even less coherence. Belarus, Ukraine and Kazakhstan show negative and insignificant correlations, except on the supply side where one correlation is strongly negative.

4.7 Non-contemporaneous Correlations: a Case for a Unilateral Monetary Union with Russia?

If we look at the non-contemporaneous correlations displayed in table 6, we find a rather different picture. Here there are some significant correlations, but also negative correlations as often as positive ones. There appear to be strong differences between Russia and Belarus on the supply side (and in the monetary shocks), with Belarus disturbances lagging Russian disturbances by up to eighteen months. But for intervals greater than eighteen months, the Russian and Belarusian disturbances become positively and significantly related. That is exactly what one would expect if Belarus were the smaller and "follower" economy in terms of production. But on the demand side, Russia and Belarus show a significant positive relationship out to eighteen months (and negative after that). That suggests Belarus could form a multilateral union with Russia – that is adopt the Rouble – provided that it is understood that Belarus's performance in output and employment will lag that in Russia, meaning that the impact of monetary policy changes will come too early and that there is likely to be a rise in short term output

[15] Bayoumi and Eichengreen (1993,1996,1997); Demertzis et al (1998); Kontolemis and Samiei (2001)

volatility as a result. Similarly the negative correlations on the demand side at seven quarters suggest that the inflation performance may eventually prove fragile.

The relationship between Russia and Ukraine shows no such clear pattern. There are no correlations which are more than marginally significant; and even then the signals alternate. It would appear that Ukraine could not adopt the Rouble without considerable cost to performance.

Finally the correlations between Russia and Kazakhstan are positive on the supply side, with Kazakhstan leading Russia by 9 months, and also positive on the demand side with Russia leading by 9 months. This would be the natural consequence of Kazakhstan being the supplier of energy and raw materials to Russian industry, but a consumer of Russian output. That suggests Kazakhstan may actually be closer to being able to sustain a common monetary policy with Russia than the others, since any changes that come too late for influencing supply conditions will be compensated by coming too early for any changes in demand. In fact, that is already reflected in the near symmetric lead-lag pattern of correlations in monetary disturbances: Kazakhstan shows positive correlations at equal leads and lags suggests a (partially) coincident cycle, although not one necessarily driven by exactly the same shocks at each peak. That shows a mutual inter-dependence in monetary conditions from this supply side-demand side linkage.

5 The Costs of a Union: are they Big or Small?

Section 3 showed that, for the costs of forming or joining a monetary union to be small, the within group correlations must approach unity *and* the shocks must have approximately equal variances. From Table 5 it can be seen that the first condition is violated in either the supply or demand shocks in every case.

For the second condition, we have set out the standard deviations of the shocks in Table 7. To test the equality of the variances of the errors from different VAR equations, we can use the Wald test (Hamilton 1994, p301):

$$\frac{n(\hat{\sigma}_i^2 - \hat{\sigma}_j^2)^2}{2\hat{\sigma}_i^4 - 4(\hat{\rho}\hat{\sigma}_i\hat{\sigma}_j)^2 + 2\hat{\sigma}_j^4} \qquad (0.1)$$

which is distributed asymptotically as $x^2_{(1)}$. This test will have critical values of 3.8 and 6.6 at the five percent and one percent significance levels. But applying such a test to Table 7 shows that every variance is significantly different form its counterpart in the partner economies at the one percent level, with the exception of the Russian and Belarusian monetary shocks. The shocks are mainly supply shocks in Russia, monetary disturbances in Belarus, and demand shocks in Ukraine and Kazakhstan – with most of the uncertainty being contributed by the latter.

Table 7: The Standard Deviations of Shocks

	SUPPLY	DEMAND	MONETARY
Russia	1.375	0.281	0.110
Belarus	0.009	0.032	0.122
Ukraine	5.903	119.5	38.63
Kazakhstan	458.26	392721.40	15.397

Given this evidence, the costs of a monetary union between the Union of Four will certainly not be small – not even within the core. Can we say anything more about the costs? Notice that if $\rho \approx ½$ and $\sigma_j \neq \sigma_k$, then the last term of (5.1) becomes σ_j. In that case the cost becomes $\gamma(\beta_{jj}+\beta_{jk})\phi(0)\sigma_j$, which is just one standard error away from zero, the minimum cost under exactly symmetric shocks or no disturbances at all. But we have $\rho < ½$ and $\sigma_j \neq \sigma_k$ for every shock and each country. Hence the costs for each country will be *more than* one standard deviation larger than the adjustment costs that that country would have faced in a floating regime. A currency union will not come cheap.

6. Conclusions

The lessons to be learnt from this paper are four:

a) **A Policy Conclusion**. A currency union between Russia, Belarus, Ukraine and Kazakhstan in likely to be expensive in increased instability and lost performance. It is also likely to become more of a unilateral monetary union, than a multilateral one. That means the burden of that instability will be borne largely by the three smaller economies. Given that the economics are against it, is the political will to create such a union going to be strong enough?

b) **The distribution of costs**. Given that table 7 shows supply shocks dominating in Russia, demand shocks in Ukraine and Kazakhstan, and monetary shocks in Belarus, section 4's analysis modifies that conclusion by suggesting that the costs may be rather lower for Russia (where supply and demand will be relatively price inelastic); and possibly less serious for Ukraine and Kazakhstan in the long term. But they may be more serious for Belarus; and they will be more serious in the short to medium term for Ukraine and Kazakhstan where supply and demand will be relatively price elastic.

c) **A Methodological Contribution.** The non-contemporaneous correlations of table 6 are a new twist in a familiar form of analysis. They show that there are statistically significant symmetries within this group of economies: principally between Russia and Kazakhstan on the supply side, and Russia and Belarus on the demand side. Lesser correlations exist between Russia and Ukraine, and there is some monetary interdependence between Russia and Kazakhstan. These correlations would have been missed in the traditional form of this analysis. Moreover the pattern of leads and lags between these correlations reveals the form of the economic links. The lead of Kazakhstan over Russia on the supply side reflects the position of the former as supplier of energy and materials to Russian industry. The lead of Russia over Belarus on the demand side follows from the latter's inputs of specialist and high tech equipment into Russian manufactures – though the mix of signs for Belarus and Ukraine suggests they are out of cycle with Russia. Both appear out of cycle with Russian monetary conditions

too, whereas Russia and Kazakhstan show some mutual dependence. Moreover, the extent of the leads and lags for Belarus and Ukraine vs. Russia (more than 6-9 months) means that there would inevitable disagreements about the size and timing of monetary policy changes within the union. For them, the case for a single currency is weak; it is slightly stronger in Kazakhstan.

d) **Market performance**. If a lack of market flexibility, whether in terms of mobility or wage/price responsibility, is the main obstacle, then – ironically given that these economies are supposed to be in transition to market economies – the extension of black market activities may be the biggest factor working towards the possibility of a currency union. It fact black market activities may be a necessary compliment. Conversely, if a single currency were established, those activities would almost certainly increase out of necessity. The danger is, to the extent that this does not happen, governments will be tempted (in their own interest) to use fiscal policies to stabilize their economies and provide the impetus for growth. In the absence of a system of fiscal federalism, that is likely to lead to a steady accumulation of debt in the smaller economies as governments try to compensate for the mismatch of common currency area conditions.

Appendix A
The model of currency union used in the main text.

In Bayoumi's (1994) model, each region has the same production structure but produces its own goods with a fixed amount of labour:

$$Y_i = L_i^{\alpha} e^{\varepsilon_i} \tag{A.1}$$

where Y_i is the output region of i, L_i the labour input region i, ε_i is a disturbance with mean zero and independent of exchange rate regime. The capital stock is normalised at 1. In logs:

$$y_i = \alpha l_i + \varepsilon_i \tag{A.2}$$

In a competitive market, labour is employed up to the point where real wages equal the marginal product of labour in terms of a common currency:

$$w_i - p_i + e_i = \log\alpha - (1-\alpha) l_i + \varepsilon_i \tag{A.3}$$

where e_i= the (log of the) bilateral exchange rate with region 1. The level of wages and prices are W_i and P_i with their log counterparts in (A.3). To incorporate wage stickiness, we assume that full employment wages $\overline{w} = \log(\alpha)$ will hold when there is full employment (L_i=1) and no shocks (ε_i=0), and when the exchange rate is at its parity value (E_i=1). Then. if there is excess demand for labour when W_i=α, wages will be raised until the demand falls to L_i=1. But if there is excess supply at W_i=α, then wages will remain at this level and unemployment results.

Now each region is free to choose its own exchange rate regime. If regions I and j form a currency union then their exchange rate ratio, E_i / E_j, is fixed at unity and they have common currency. If they choose separate currencies then E_i / E_j may vary, but there is a transactions cost between the two currencies. This cost implies that, in value terms, goods exported form region I "shrink" by a factor (1-T_i) when they arrive at region j. For simplicity, let T_i=T for all regions.

Finally on the demand side, if production is owned locally, region i's income will be P_iY_i. Utility levels are given by the Cobb-Douglas function:

$$U_j = \sum_{i=1}^{N} \beta_{ji} \log C_{ji} - \phi \tag{A.4}$$

where C_{ji} is the consumption of good i in region j and $\phi = \sum_j \beta_{ji}$ is constant. The β_{ji} parameters are subject to the normalisations $\sum_i \beta_{ji} = 1, \sum_j \beta_{ji} = 1$. Since β_{ji} is the

proportion of region j's income spent on goods produced in region I, these restrictions ensure total income is spent and that aggregate demand exhausts income spent on each good (before payment of transactions costs T_j).

Under these conditions the demand for good i from region j is:

$$Y_{ji} = (\beta_{ji} P_j Y_j / P_j) e^{v_{ji}} \tag{A.5}$$

where v_{ji} is another normally distributed disturbance with zero mean arising on the demand side. Note that production in region i will be *expected* to equal unity in the absence of shocks (y_i=0 in (A.2) at full employment). Now let prices be normalised such that P_i=1, so that $E(P_i,Y_i)$=1 where E denotes expectations. That means all other national incomes are also unity in expectation; if P_1Y_1=1, since then:

$$Y_i + \sum_j Y_{ji} = (\sum \beta_{ji} e^{v_{ji}} / P_j) \tag{A.6}$$

which implies P_iEY_i=1. But P_1Y_1=1, so P_iEY_i=1 for i=2 … N. Hence, in the long-run, output in each region will be independent of the exchange rate, but in the short-run actual output will depend on relative prices. Thus if region j and region i do not form a currency union, the equilibrium consumption of good I in region j will be:

$$C = (\beta_{ji}(1 - T_j) / P_j) e^{v_{ji}} \tag{A.7}$$

where the production of good i is given by (A.6) and, for simplicity, T_j=T. Taking logs:

$$c_{ji} = \log \beta_{ji} + \log(1 - T) + d_{ji} \tag{A.8}$$

where $d_{ji} = v_{ji} + \varepsilon_i$ is a composite disturbance term, since full employment with equilibrium wages and exchange rates implies y_i=-p_i=ε_i. Each region's utility level is therefore:

$$U_j = \sum_j \beta_{ji} d_{ji} - \sum_{i \neq j} \beta_{ji} \tau \tag{A.9}$$

where τ=log(1-T).

Now suppose region j and region k decide to form a currency union. Equations (A.6) to (A.9) hold with k replacing j and T_k=0. The external exchange rate will be the mean of the free float exchange rates, which, under the normalisation of E_j=E_k=1 vs.that in region 1, implies e_{jk}=e_j-e_k=(ε_j+ε_k)/2 and $\bar{e}_{jk} = 0$. Suppose wages adjust to provide full employment in the high demand region (region j say) but are sticky downwards in the other region. Then:

$$y_j = \varepsilon_j, \qquad w_j = \log(\overline{w}) + (\varepsilon_j - \varepsilon_k)/2 \tag{A.10}$$

using (A.3) and the results above for e_j and p_j, where $\overline{w}$ is the log equilibrium real wage with no shocks and $E_j=1$. Substituting back into (A.3), using (A.2) for y_k, yields:

$$y_j = \varepsilon_j - \alpha(\varepsilon_j - \varepsilon_k)/(2(1-\alpha)), \qquad w_k = \log(\overline{w}) \tag{A.11}$$

for region k. Now evaluating the differences between (A.9) and the utilities generated by equation (A.10) and (A.11), we find the utilities gained by being in the currency union are:

$$\Delta U_j = \beta_{jk}\tau - \beta_{jk}\alpha(\varepsilon_j - \varepsilon_k)/(2(1-\alpha)) + \sum_i \beta_{ji}\Delta v_{ji} \tag{A.12}$$
$$\Delta U_k = \beta_{kj}\tau - \beta_{kk}\alpha(\varepsilon_j - \varepsilon_k)/(2(1-\alpha)) + \sum_i \beta_{ki}\Delta v_{ki}$$

while the loss in region 1 (say) staying outside the union is:

$$\Delta U_1 = -\beta_{1k}\alpha(\varepsilon_j - \varepsilon_k)/(2(1-\alpha)) + \sum \beta_{1i}\Delta v_{1i} \tag{A.13}$$

where Δv_{ji} is the increasing region j's demand for goods produced in region i *as a result of joining the currency union*; that is the trade creation and trade diversion efforts of the single currency itself.

Since the shocks are symmetrically distributed around zero, with $\varepsilon_j<\varepsilon_k$ with the probability of one-half and $\varepsilon_j>\varepsilon_k$ with probability one-half, and the *ex ante* expected benefit in a currency union is:

$$\begin{aligned} E(\Delta U_j) &= \beta_{j\kappa}\tau - \beta_{jj}\gamma E(\varepsilon_j - \varepsilon_\kappa \,|\, \varepsilon_j < \varepsilon_\kappa)\Pi(\varepsilon_j < \varepsilon_\kappa) \\ &\quad - \beta_{jk}\gamma E(\varepsilon_k - \varepsilon_j \,|\, \varepsilon_j > \varepsilon_k)P(\varepsilon_j > \varepsilon_k) \\ &= \beta_{jk}\tau - \gamma(\beta_{jj} + \beta_{jk})\phi(0)\sqrt{\sigma_j^2 - 2\rho\sigma_j\sigma_k + \sigma_k^2} \end{aligned} \tag{A.14}$$

For the non-members, the expected welfare costs are:

$$E(\Delta U_1) = -\gamma(\beta_{1j} + \beta_{1k})\phi(0)\sqrt{\sigma_j^2 - 2\rho\sigma_j\sigma_k + \sigma_k^2} \tag{A.15}$$

where $\phi(0)$ is the density function of a standard jointly normal distribution of random variables and $\gamma = \alpha/(2(1-\alpha))$.

Introducing Market Flexibility

Labour mobility. All this analysis has been conducted assuming no labour mobility. However, suppose instead that a proportion δ of the number remaining unemployed (X) in a depressed region migrates to a full employment region. If the latter had had full

employment of 1, then a migration equilibrium implies employment of 1-δX and 1+δX respectively. If X is small, $\log(1 \pm \delta X) \cong \pm \delta X$ and (A.10) and (A.11) become:

$$y_i = \varepsilon_j + \gamma\delta(\varepsilon_j - \varepsilon_k), \qquad w_j = \log(\overline{w}) + (1-\delta)(\varepsilon_j - \varepsilon_k)/2 \tag{A.19}$$
$$y_k = \varepsilon_k - \gamma\delta(\varepsilon_j - \varepsilon_k), \qquad w_k = \log(\overline{w})$$

respectively, where region j is the excess demand region $(\varepsilon_j > \varepsilon_k)$. Aggregate output has simply been reallocated between members of the union. Hence, repeating the steps to (A.14), we get the ex ante expected welfare benefit from being in the currency union:

$$E(\Delta U_j) = \beta_{jk}\tau - \gamma(1-\delta)(\beta_{1j} - \beta_{1k})\phi(0)\sqrt{\sigma_j^2 - 2\rho\sigma_j\sigma_k\sigma_k^2} \tag{A.20}$$

and the cost of being left outside:

$$E(\Delta U_1) = -\gamma(1-\delta)(\beta_{1j} + \beta_{1k})\phi(0)\sqrt{\sigma_j^2 - 2\rho\sigma_j\sigma_k + \sigma_k^2} \tag{A.21}$$

under the usual symmetric distributions assumption. Hence the costs of forming a currency union have fallen for both insiders and outsiders $(0 < \delta < 1)$, but the interpretation is exactly the same. Comparison with (A.14) and (A.15) shows that the costs still vary with ρ, σ_j and σ_k, but will vanish if $\delta \to 1$. Hence full mobility will offset the costs of a monetary union for both insiders and outsiders.

Wage Flexibility. A similar kind of outcome can be achieved if wages and nonwage costs are flexible downwards in region k. Suppose wages fall sufficiently to reemploy the δX employees, who might otherwise have migrated to region j. That leaves employment of 1 and (1-(1-δ)X) in regions j and k respectively. Evidently region j is unaffected:

$$y_j = \varepsilon_j \qquad w_j = \log(\overline{w}) + (\varepsilon_j - \varepsilon_k)/2 \tag{A.22}$$

But region k will now achieve:

$$y_k = \varepsilon_k - \gamma(1-\delta)(\varepsilon_j - \varepsilon_k), \qquad w_k = \log(\overline{w}) - \delta(\varepsilon_j - \varepsilon_k)/2 \tag{A.23}$$

These expressions are now identical to equations (A.10) and (A.11), except for the fact that γ(1-δ) has been substituted for γ in equation (A.11) and w_k has fallen by $\delta(\varepsilon_j - \varepsilon_k)/2$. Consequently the costs of forming a monetary union, and the costs for outsiders, are reduced. But the interpretation remains the same; and the costs depend on ρ, σ_j and σ_k, and will vanish if $\delta \to 1$. Hence fully flexible wages restore full employment in region k and remove the costs of a currency union.

Appendix B: The VAR System Underlying Our Estimates

We start with the process:

$$A(L)x_t = e_t \tag{B.1}$$

The process has a moving average representation of the form:

$$x_t = C(L)e_t = \sum_{i=0}^{\infty} C_i L^i e_p \qquad C(L) = A(L)^{-1} \tag{B.2}$$

and the matrices C_i represent the impulse response function of the shocks to the elements of x_t. Since Σ is a positive definite matrix, there exists an orthogonal matrix P such that $P\Sigma P^1=I$. Hence we can compute the orthogonalised innovations, $\varepsilon_t=Pe_t$, as follows. Write equation (B.2) in the form:

$$x_t = \sum_{i=0}^{\infty} C_i P^{-1} P e_{t-i} = \sum_{i=0}^{\infty} D_i \varepsilon_{t-i} \tag{B.3}$$

where $D(L)=A(L)^{-1}P^{-1}$. But (B.2) and $P\Sigma P^1=I$ imply $C(L)\ \Sigma C(L)^1=D(L)D(L)^1$. Hence estimates of $C(L)=A(L)^{-1}$ and $\Sigma=E(ee^1)$ from (B.1) allow us to derive estimates of D(L) by a Choleski decomposition or otherwise. Finally $P=D(L)^{-1}A(L)$ will allow us to construct the orthogonalised residuals ε_t themselves.

Appendix C: Trade and Industrial Structures in the Four

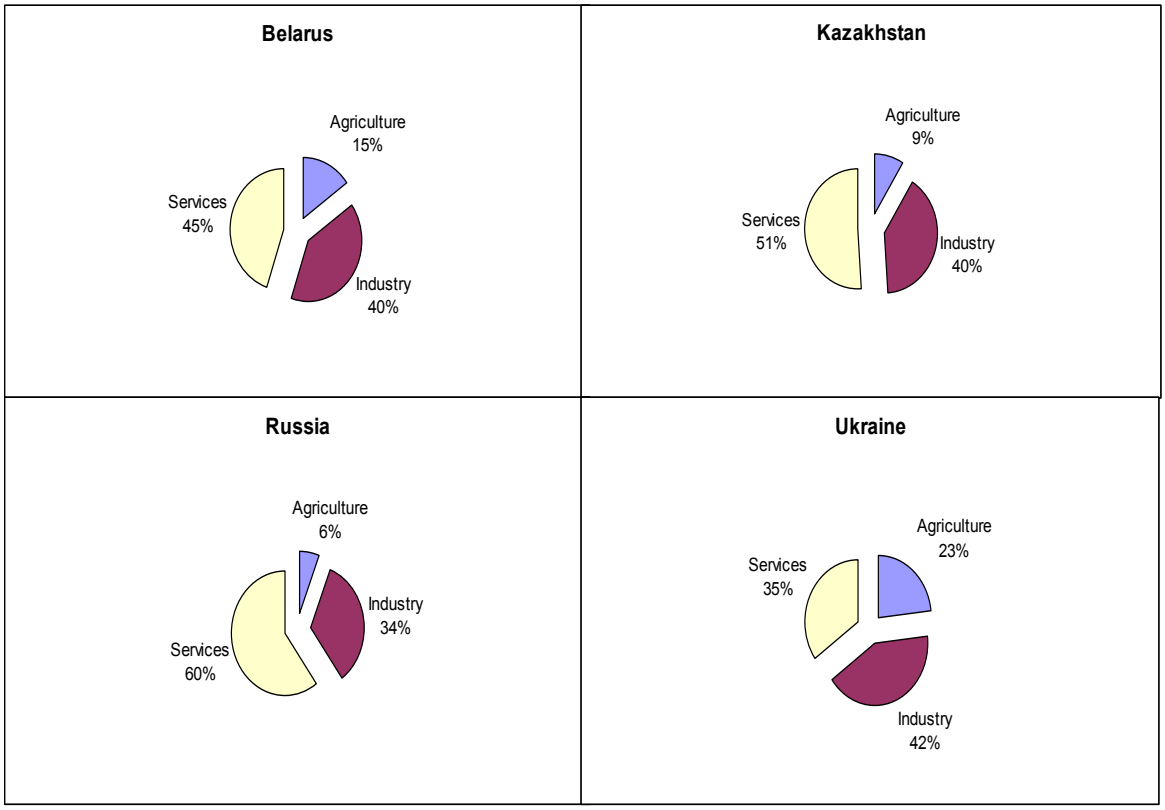

Figure 5: Industrial Structure of Belarus, Kazakhstan, Russia, and Ukraine

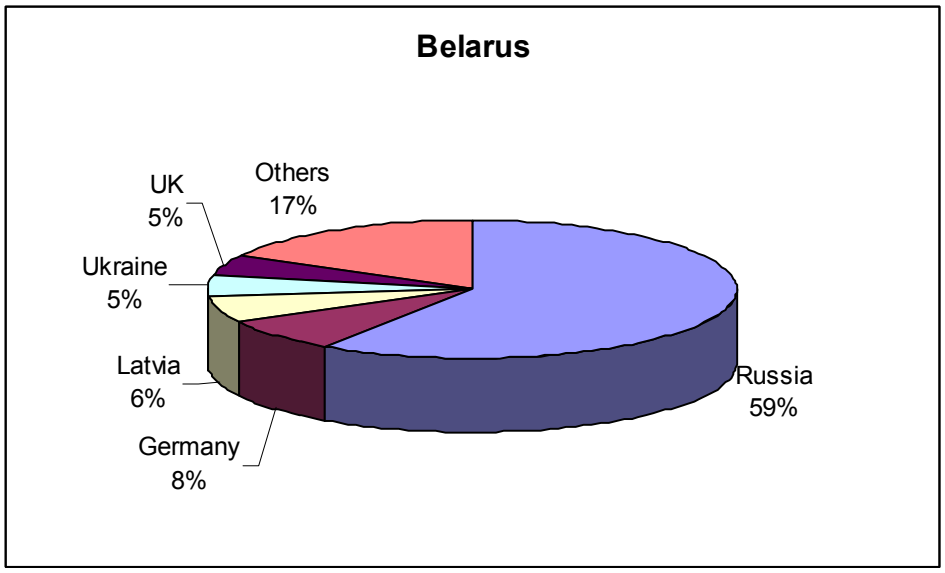

Figure 6: Trade Partners of Belarus

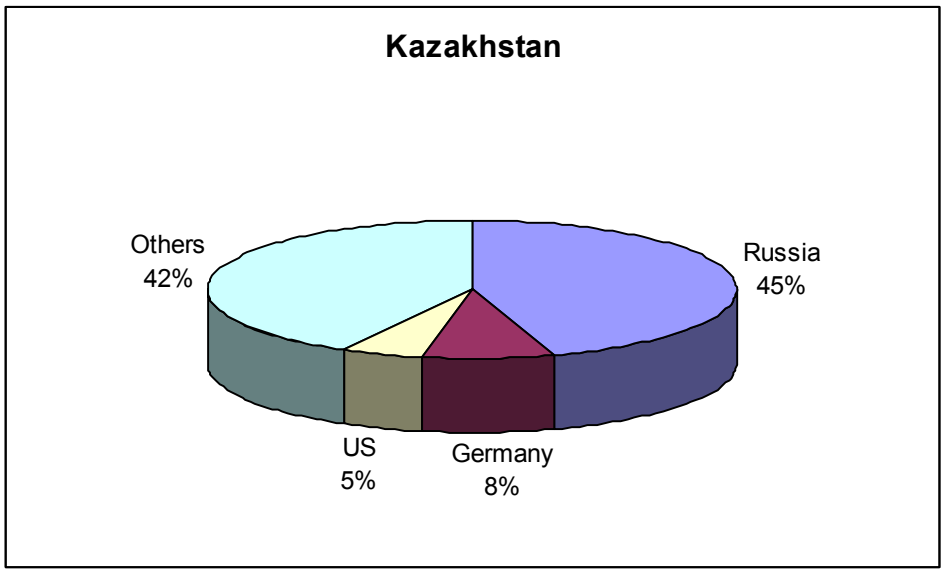

Figure 7: Trade Partners of Kazakhstan

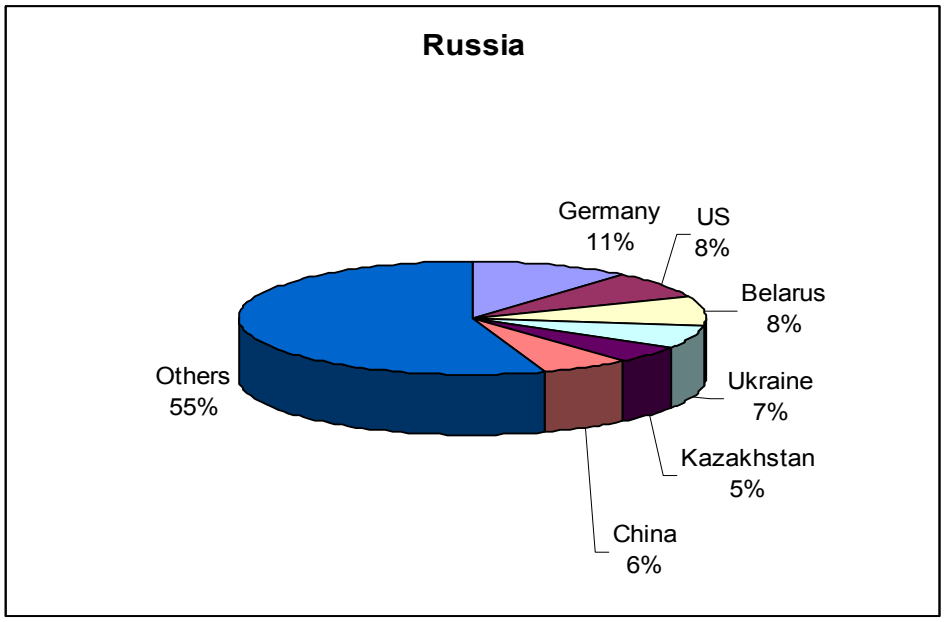

Figure 8: Trade Partners of Russia

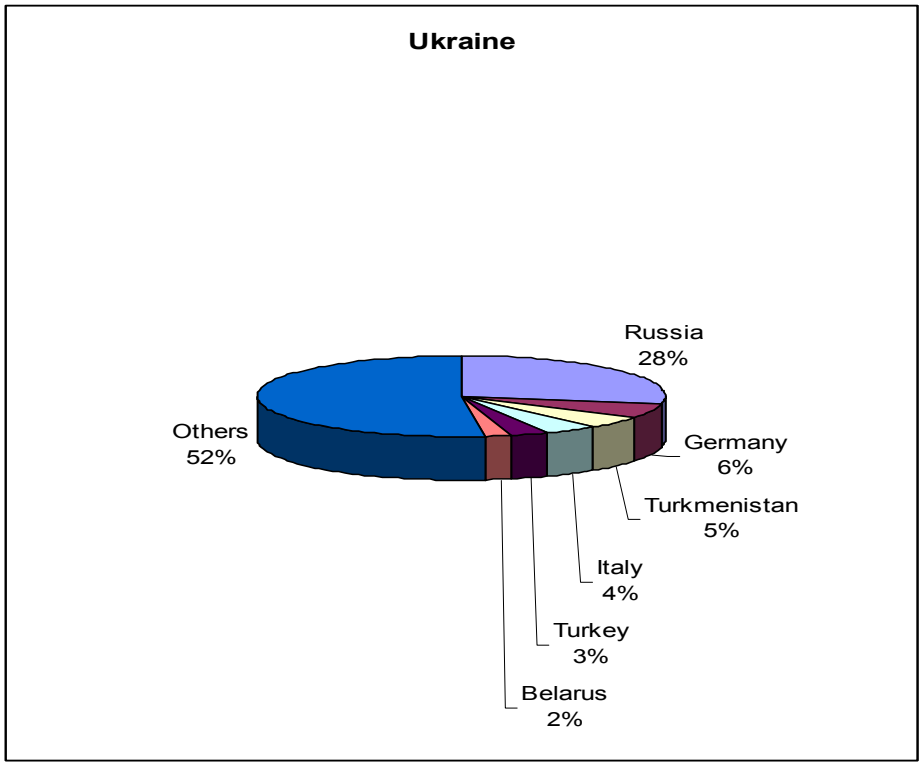

Figure 9: Trade Partners of Ukraine

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