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MEASURING THE CORRELATION OF SHOCKS BETWEEN THE EU-15 AND THE NEW MEMBER COUNTRIES

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Working Paper

No. 31 January 2006

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ABSTRACT

This paper considers the question of the symmetry of inflation, exchange rate changes and GDP shocks between the EU15 and the new member countries. It applies a relatively new technique, the orthogonal GARCH model, which allows us to calculate a complete time varying correlation matrix for these countries. We can then examine the way the conditional correlation of shocks between the EU15 and the new member countries has been evolving over time. Our results suggest that the shocks which hit the EU are not symmetrical with those affecting the majority of new member countries. In addition, most of the new member countries seem to exhibit relatively low correlation with EU15.

Keywords: Business cycle, GARCH
JEL Classification: E32, C22

Acknowledgements: The authors wish to thank Heather Gibson and the participants at the Euro Area Business Cycle Network (EABCN) Workshop on Business Cycle and Acceding Countries, Vienna 23/24 April 2004, for discussions and helpful comments on a previous version of this paper. Financial Support from ESRC grant No L138250122 is gratefully acknowledged from the first author. The views expressed in this paper are those of the authors and not those of the Bank of Greece.

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1. Introduction

Recent years have seen considerable interest in the optimal currency area literature for obvious reasons, given developments in Europe with Monetary Union (EMU). Following the seminal early work of Mundell (1961) and McKinnon (1963), a small selection of the vast recent literature would include Alesina and Barro (2002), Artis (2002), Buiter (1999), Frankel and Rose (1997), McCallum (1999), McKinnon (1994) and Rogoff (2001). One theme common to this literature is that a key criterion for the success of a monetary union is that the shocks which hit the economies, should be reasonably common and well correlated. Artis (2002, Table 2), for example, assesses the appropriateness of various countries joining a monetary union based on a number of criteria including the symmetry of shocks and concludes that on this criteria the UK should not join EMU.

The purpose of this paper is to examine the question of the correlation of inflation, exchange rate changes and output shocks between the new member countries (that is, Estonia, Latvia, Cyprus, Lithuania, Malta, Hungary, Poland, Slovak Republic, Slovenia, Czech Republic) and the older members of the European Union (EU15). The new member countries have similar features as most of them were former communist countries, during the last decade they placed a lot of effort into adjusting their economies towards a market based structure, while the main focus of their macroeconomic policies was to stabilize their economies through structural reforms. Furthermore, today their ultimate economic goal is to join EMU as full members and adopt the euro. Therefore, high estimated correlation of economic aggregates between the new member countries and the EU15 might suggest convergence of the new member countries towards the EU15.

A key aspect of this analysis however is that conventional correlations measure something which is true on average over a particular historical period but which may not be true of the future. A more appropriate measure is a conditional correlation based on a good time series model of the series under examination. In effect a system GARCH model would allow us to properly examine the changing conditional correlation in the shocks affecting these countries. System GARCH however is difficult to apply to even fairly small systems of equations as the number of parameters quickly expands as the number of variables in the system increases. Here we propose to use a relatively new model, the orthogonal GARCH model to calculate the conditional covariance matrix of shocks and to examine the pattern of developments in these correlations from the early 1990s to the early 2000s.

This last measure of correlation seems to be more appropriate to estimate the relationship between the EU15 and the new member countries since it takes into account all the potential changes through time. Contrary, the simple correlation coefficient is not sufficient to describe the complete dependence structure between two variables. The simple correlation coefficient has a major drawback, as it is an average estimate during the estimation period which is not capable of taking into account regime changes. Therefore, in the estimation of the relationship between the EU15 and the new member countries the simple correlation coefficient cannot distinguish between the early transition period and the later, during which presumably the new member countries enter a period of greater integration, and cannot capture the potential effect of the structural reforms. Hence, it is possible that the simple correlation could be misleading since low correlation does not necessarily imply low interdependence through time.

The choice of the conditional correlation coefficient is justified from the empirical results which suggest that the correlation coefficient of inflation, exchange rate changes and output shocks between the new member countries and the EU15 is time varying throughout the estimation period. In particular, the empirical analysis indicates that there are weak links through time between the new member countries and the EU15, while they become stronger in the more recent periods. Therefore, utilizing the estimates of the simple correlation coefficients would not reflect the latest efforts of the new member countries to converge towards the EU15 and would lead to misleading results.

The plan of the paper is as follows, Section 2 outlines the basic problem of system GARCH estimation and the usefulness of the orthogonal GARCH model. Section 3 then applies this model to the series for inflation, exchange rate changes and real GDP growth for all the new member countries with the EU15 and presents the empirical results. Section 4 then draws some conclusions.

2. System GARCH

The standard univariate GARCH model is now well known but this model suffers from the obvious drawback that it can only be used to produce a measure of the conditional variance of a process. If we are interested in understanding the complete conditional distribution of a group of variables then we need to extend the basic GARCH framework to a multivariate context so that we may consider complete conditional covariance matrices. A number of studies have already used this extension and a number of alternative specifications exist in the literature (Kraft and Engle (1982); Bollerslev, Engle and Wooldridge (1988); Hall, Miles and Taylor (1990); Hall and Miles (1992); Engle and Kroner (1995)).

Essentially we are interested in building a model of a complete conditional covariance structure of a set of variables. So consider a set of n variables, Y, that may be generated by the following VAR process:

$$A(L)Y_t = e_t$$

This varies from a conventional VAR model as we assume that:

$$E(e_t) = 0 \quad and \quad E(e_t e'_t) = \Omega_t$$

So that the covariance matrix is time varying. We then make the standard ARCH assumption that this covariance matrix follows an autoregressive structure. Estimation of such a model is, in principle, quite straightforward as the log likelihood is proportional to the following expression:

$$l = \sum_{t=1}^{T} \ln|\Omega_t| + e'_t \Omega_t^{-1} e_t \qquad (1)$$

and so standard maximum likelihood (or quasi maximum likelihood) procedures may be applied. The only real difficulty comes in the parameterization of the process generating Ω_t; the natural extension of the standard GARCH formulation very quickly begins to generate huge numbers of parameters. If we define the VECH operator in the usual way as a stacked vector of the lower triangle of a symmetric matrix then we can represent the standard generalization of the univariate GARCH model as:

$$VECH(\Omega_t) = C + A(L)VECH(e_t e_t') + B(L)VECH(\Omega_{t-1}) \qquad (2)$$

where C is an (N(N+1)/2) vector and A_i and B_i are (N(N+1)/2)x(N(N+1)/2) matrices. This general formulation rapidly produces huge numbers of parameters as N rises (for just 1 lag in A and B and a 5 variable system we generate 465 parameters to be estimated) so for anything beyond the simplest system this will almost certainly be intractable. A second problem with this model is that without fairly complex restrictions on the system the conditional covariance matrix cannot be guaranteed to be positive semi-definite. So much of the literature in this area has focused on trying to find a parameterization which is both flexible enough to be useful and yet is also reasonably tractable.

One of the most popular formulations was first proposed by Baba, Engle, Kraft and Kroner, sometimes referred to as the BEKK (see Engle and Kroner (1993)) representation, this takes the following form

$$\Omega_t = C'C + \sum_{i=1}^{q} A'_i \, e_{t-i} e'_{t-i} \, A_i + \sum_{j=1}^{p} B'_j \, \Omega_{t-j} B_{t-j} \qquad (3)$$

This formulation almost surely guarantees positive semi-definiteness of the covariance matrix and reduces the number of parameters considerably. However even this model can give rise to a very large number of parameters and further simplifications are often applied in terms of making A and B symmetric or diagonal.

A recent generalisation of the orthogonal GARCH model has been put forward by Van der Weide (2002). This model essentially allows for the possibility that the data may exhibit weak dependence and in this circumstance the identification of the loading matrix may become problematic. The so called GO-GARCH model, however, is estimated by a joint maximum likelihood procedure which involves estimating the parameters of all the univariate GARCH models along with m(m-1)/2 rotation parameters which define the mapping from the orthogonal factors to the observed data (where m is the number of variables under consideration). For a model involving say 12 variables this would therefore still involve maximising a likelihood which is a function of over 110 parameters and thus remains quite intractable.

Orthogonal GARCH

An alternative approach to getting around the problem of intractability which can be applied, potentially to a system of any size, rests on the use of principal components and is sometimes referred to as orthogonal GARCH. This technique is first mentioned by Ding (1994) in his PhD thesis and he ascribes it to Ron Kahn who suggested it to him in a conversation. Consider a set of n stochastic variables X, which have a covariance structure V. Principal components then produces a set of n variables (P), which contain all the variation of X but are also orthogonal to each other. The standard principal component representation can be written as follows:

$$X_i = \mu_i + \sum_{j=1}^{n} \omega_{ij} p_j \quad \text{i=1…n} \tag{4}$$

so if all n principal components are used each x_i can be exactly reproduced by weighting the principal components together with the correct loading weights. Now by simply taking the variance of both sides of this equation we can see that:

$$VAR(X) = V = W(VAR(P))W' = W\Psi W' \tag{5}$$

The advantage of this is of course that, as the principal components are orthogonal, Ψ will be a diagonal matrix with zeros on all non-diagonal elements. From applying principal components we know W; we then simply have to derive a set of univariate GARCH models to each principal component to derive estimates of the conditional variance at each point in time and apply the above formulae to derive an estimate of the complete covariance matrix V. The conditional variance may be obtained from any chosen procedure (GARCH, EGARCH or even an EWMA model of the squared errors).

There are, however, two further issues here:

i) as the principal components are ordered by their explanatory power we may often find that a subset of them produces a very high degree of explanatory power. It may then only be deemed necessary to use the first k principal components. It has even been suggested that this helps to remove noise from the system as the minor principal components may be reflecting pure random movements. This can easily be done but it introduces an error term into the principal components representation above and the resulting covariance matrix may no longer be positive definite.

ii) Equation (5) above is true exactly for the whole period for which the principal components are calculated but it does not necessarily hold at each point in the sample. So it is really only delivering an approximation. It may then be useful to apply the procedure to a moving window of observations so that the W matrix also effectively becomes time varying.

Yhap (2003) has conducted an extensive Monte Carlo study of the properties of the orthogonal GARCH model and one of his findings is that the model performs well for samples of less than 500 observations but that its ability to accurately track conditional covariance's deteriorates substantially as the sample increases beyond this number of observations.

3. Orthogonal GARCH estimation for European shocks

In this section we undertake three experiments to calculate the complete conditional correlation matrix for CPI inflation, exchange rates against the US dollar and real GDP for the EU15 and the new member countries (that is Estonia, Latvia, Cyprus, Lithuania, Malta, Hungary, Poland, Slovak Republic, Slovenia, Czech Republic). The data we are using are monthly not seasonally adjusted for the consumer price index (CPI) and the exchange rate from January 1993 until October 2002 (for the CPI) and December 2002 (for exchange rates); for real gross domestic product (GDP) quarterly seasonally adjusted data are used, starting in the first quarter of 1995 until the last quarter of 2002. The source of the data is *International Financial Statistics* (IFS) for the new member countries and the European Central Bank for the EU15. Inflation and GDP growth are estimated as the first difference of the logs of CPI and GDP.

Inflation

We begin by presenting the simple correlation matrix of inflation over the full period (Table 1). For reasons of space we concentrate only on the correlation with the

European Union as the most relevant information although the full correlation matrix was calculated in each case.

Table 1	
Inflation Rate Simple Correlation Coefficients	
	EU15
EU15	1.0000
Estonia	0.5811
Latvia	0.6135
Cyprus	0.0250
Lithuania	0.3025
Malta	0.1299
Hungary	0.4186
Poland	0.6813
Slovak Republic	0.3177
Slovenia	0.5120
Czech Republic	0.2596

The simple correlation coefficient between the EU15 and all the new member countries is relatively low. The highest value appears for Poland and Latvia, but even this is not very high at 0.68 and 0.61. This of course reflects a simple average over the past. When we are considering the possibility of these countries joining a monetary union, the relevant correlation is that which exists today rather than the average over the past. We therefore now turn to the orthogonal GARCH model.

We begin by deriving the principal components for these series. The first principal component explains almost 40% of the variation in the data, the second 14%, the third 9%, the fourth 6% and the final one (eleventh) just 2%. Univariate GARCH models were then estimated for each of the components; we found a third order autoregression was adequate to capture the time series properties of each component and a GARCH(1,1) specification was an adequate description of the conditional volatility.

We will not report each of these models in detail as they have only limited interest. Finally, using equation 5 and the principal component loading matrix we construct the full conditional covariance and conditional correlation matrix.

The full sets of 10 conditional correlations against the European Union are presented in Figures 1-4. Three main conclusions can be drawn from the empirical analysis. First, there is a considerable variation in the correlation both between countries and over time. Therefore it is necessary to calculate a true conditional correlation for each country rather than a simple average. Second, the true conditional correlation is very low through time for Cyprus and Malta (Figure 2). Third, the calculated conditional correlation is higher for the other countries compared to Cyprus and Malta but with high variation and perhaps most significantly no strong upward trend. There is a suggestion for almost all the countries of a rise in the correlation from 2001. But this is still very small and it is probably too early to base any decisions on this, possibly, emerging trend.

GDP

We now turn to the GDP results. Again we begin by presenting the simple correlation matrix for the growth rate in real GDP for eight of the new member countries (Table 2). The correlation coefficient is relatively high for Poland, Estonia and Hungary and rather low for Lithuania, Slovenia and Czech Republic while in two cases, Latvia and the Slovak Republic, it is actually negative.

Following the same procedure we again begin by calculating the principal components of these series. The first principal component now explains 26% of the variation, the second 20%, the third 13%, the fourth 12% and the final one 2%. So there is clearly relatively more diversity in growth rates than inflation rates over the whole period. Following the same procedure outlined above we estimate univariate GARCH models for each component and construct the conditional correlation matrix. The resulting correlations are shown in Figures 5-7.

Table 2	
GDP Simple Correlation Coefficients	
	EU15
EU15	1.0000
Estonia	0.3251
Latvia	-0.0141
Lithuania	0.0847
Hungary	0.2383
Poland	0.4571
Slovak Republic	-0.0675
Slovenia	0.1455
Czech Republic	0.1564

All of these Figures show relatively low correlations, the highest is Poland at around 0.4, which has remained fairly stable since 1998, but there is little sign of an increase in this correlation over the period. All the other countries have correlations, which are between ± 0.2. The only apparent systematic trend change is in Slovenia and the Czech Republic where there does seem to be a consistent rise in the correlation from 2000 onwards. This may indicate the beginning of a convergence process. The higher correlations observed during this period for Slovenia and the Czech Republic might be attributed to the efforts by these countries to liberalize their markets and restore macroeconomic stability. In contrast, the weak correlation observed for Slovakia and Latvia may be due to the limited restructuring of their production base and rather small intra-industry trade with other EU countries which leads to less synchronization.

Exchange rates

During the estimation period the new member countries experience different exchange rate regimes. The exchange rate regime range from free floats in Poland, managed floats in Czech Republic, pegs with fluctuations in Hungary and Cyprus, hard pegs in Latvia to currency boards in Estonia. This regime diversity has changed through the estimation period since the new member countries follow different monetary policies and exchange rate strategies aiming eventually to adopt the euro. The overall estimation period is characterized by three different intervals. In the first interval, until 1994, the main focus of the economic policy was to stabilize the economy. The second interval, until 2000, is regarded as the transition period and is characterized by a greater economic and financial orientation toward the euro area. Finally, during the last interval from 2001 onwards the new member countries followed policies aiming of facilitating the adoption of the euro.

Table 3	
Exchange Rate Simple Correlation Coefficients	
	EU15
EU15	1.0000
Estonia	0.9161
Latvia	0.4859
Cyprus	0.9064
Lithuania	-0.0514
Malta	0.4881
Hungary	0.6648
Poland	0.4556
Slovak Republic	0.7373
Slovenia	0.8589
Czech Republic	0.7084

Table 3 shows the simple correlation matrix for the exchange rate changes for each country. The simple correlation coefficient between the EU15 and all the new member countries is positive for all countries except Lithuania, which is effectively zero. The highest correlation appears for Estonia and Cyprus. However, as expected, the simple correlation coefficients cannot capture the changes in the exchange rate regime during the estimation period.

As in the previous cases, next we derive the principal components for these series. The first principal component explains 60% of the variation in the data, the second 11.5%, the third 7%, the fourth 6% and the final one (eleventh) just 0.6%. So in this case there is clearly much less diversity in exchange rates changes than GDP growth rates and inflation rates over the whole period. Following the same procedure outlined above we estimate univariate GARCH models for each component and construct the conditional correlation matrix. The resulting correlations are shown in Figures 8-11.

From the empirical analysis we notice that first, there is strong positive correlation between the EU15 and Cyprus, Estonia and Slovenia and weak correlation with some other countries such as Lithuania. This finding reflects Estonia's currency board arrangement with a peg initially to DM and since 1999 to euro and Cyprus' peg to ECU until the end of 1998 and since 1999 to euro. Second, in other countries such as Malta, Hungary and Poland, the correlation coefficients through time are high but lower than the corresponding estimates for Cyprus and Estonia. This reflects Hungary's peg to euro and US dollar, Poland's peg to a basket of European currency and US dollar and Malta's peg to a basket of currencies where the euro/ECU had a large weight. Third, in Czech Republic and Slovak Republic the degree of correlation is relatively high and quite similar in magnitude. From the beginning of 1993 both countries peg their currency to DM and US dollar. Starting May 1997 Czech Republic has floating exchange rate with interventions from the Central Bank. Since January 1999 Slovak Republic has managing exchange rate. Fourth, in other countries such as Lithuania the correlation coefficient appears to be considerably lower. This reflects Lithuania's peg to the US dollar via a currency board arrangement.[1]

Finally, in all cases there is high variation in the conditional correlation but almost uniformly there is no sign of an upward trend. So although some economies exhibit quite high degrees of correlation with the euro there is no sign of increasing convergence. This empirical finding indicates that the new member countries have to intense their efforts to catch-up with the euro area. To be sure in some cases the high degree of correlation (0.9)

[1] For more details on exchange rate arrangements in new member countries see Gbson and Tsakalotos (2004).

throughout the period is evidence of a high degree of convergence and higher correlation seems very difficult to be succeeded without actually adopting the euro but even in these cases high variation without an upward trend exist which are clear signs of weak convergence. Therefore, we can conclude that, although the preparatory period started in 2001, at the end of 2002 most of new member countries still had to catch-up with the euro area.

The prospects are for all the new member countries to join EMU as full members. Hence all the new member countries have to join the ERM II mechanism for a minimum of two years and adjust their exchange rate strategies in line with the ERM II requirements. In the period following 2002, most of the new member countries, except Poland, Hungary, the Czech Republic and Slovak Republic, have subsequently joined ERM II and hence further convergence is expected in the coming years.

In addition, it is perhaps worth noting that almost all the currencies show a sharp downward spike in the correlations at the beginning of 2001, this is caused by some erratic movements in the Euro during its foundation period that were not mirrored in the other currencies. This illustrates the ability of this technique to quickly capture changes in the correlation structure.

4. Conclusion

We have applied a sophisticated technique to calculate a GARCH based conditional correlation matrix for shocks to inflation, real GDP growth and exchange rate changes for the new member countries (Estonia, Latvia, Cyprus, Lithuania, Malta, Hungary, Poland, Slovak Republic, Slovenia, Czech Republic) with the EU15. In most of the cases, with the exception of Poland, we find weak links between the new member countries and the EU15 and the absence of trends in the conditional correlations. These empirical results suggest that by the end of our period (2002), most of the new member countries were in a different economic position compared to the European Union countries. Based on this element of the optimal currency area criteria therefore it would seem that, at least at 2002 the new member countries were not yet ready to take part in a currency union. However, in some cases the last two years (2001 to 2002), the conditional correlation of real GDP growth has increased or shows a tendency to increase, reflecting the successful efforts of many new member countries towards market restructuring, financial liberalization, macroeconomic stability and orientation of their trade towards EU countries.

The advantage of this technique however is its ability to detect changes in the correlation structure very rapidly. This ability is monitor in a systematic way in the estimation of the degree of correlation of the exchange rate changes between the euro and the currencies of the new member countries since its magnitude is in accordance with the exchange rate arrangements in new member countries. It is therefore desirable to revisit this analysis on a regular basis to see if and when more systematic signs of convergence emerge.

References

Alesina A. and Barro R.J. (2002) "Curency Unions", Quarterly Journal of Economics, 117, 409-436

Artis M.J.(2002) "Reflections on the Optimal Currency Area (OCA) Criteria in the Light of EMU", Osterreichische Nationalbank Working paper No 69.

Bollerslev T. Engle R.F. and Wooldridge J.M. (1988) "A Capital Asset Pricing Model with Time Varying Covariances", Journal of Political Economy, 96 116-131

Buiter W. (1999) "Optimal Currency Areas: Why does the Exchange Rate Regime Matter? (with an application to UK membership of EMU)", Sixth Royal Bank of Scotland lecture at the Scottish Economic Society annual conference.

Ding Z. (1994) "Time Series Analysis of Speculative returns", PhD thesis UCSD

Engle R.F. and Kroner K.F. (1995) "Multivariate Simultaneous Generalized ARCH", Econometric Theory, 11(1) 122-50

Frankel J. and Rose A. (1997) "Is EMU more Justifiable Ex-Post than Ex-Anti?", European Economic Review, 41, 753-760

Gibson. H. D. and Tsakalotos E. (2004) "Capital Flows and Speculative Attacks in Prospective EU Member States", Economics of Transition, Vol. 12, pp.559-586.

Hall S.G. Miles D.K. and Taylor M.P. (1990) "A Multivariate GARCH in Mean Estimation of the Capital Asset Pricing Model", in Economic Modelling at the Bank of England, edited by K. Patterson and S.G.B. Henry, Chapman and Hall, London.

Hall S.G. and Miles D.K. (1992) "An Empirical Study of Recent Trends in World Bond Markets", Oxford Economic Papers, 44, 599-625

Kraft D.F and Engle R.F. (1982) "Autoregressive Conditional Heteroskedasticity in Multiple Time Series", UCSD manuscript

McCallum B. T. (1999) "Theoretical Issues Pertaining to Monetary Unions" NBER working paper No 7393.

McKinnon R.I. (1963) "Optimum Currency Areas", American Economic Review, 53, 717-725.

McKinnon R.I. (1994) "A Common Monetary Standard or a Common Currency for Europe Fiscal Lessons from the United States", Scottish Journal of Political Economy, 41, 337-357.

Mundell R.A. (1961) “A Theory of Optimal Currency Areas”, American Economic Review, 51, 657-665

Rogoff K. (2001) “On why not a Global Currency”, American Economic Review, 91, 243-247.

Van der Weide R.(2002) “GO-GARCH: A Multivariate Generalized Orthogonal GARCH Model”, Journal of Applied Econometrics , 17, 549-564.

Yhap B (2003) “The Analysis of Principal Component GARCH models in Value-at-Risk calculations” London University PhD thesis

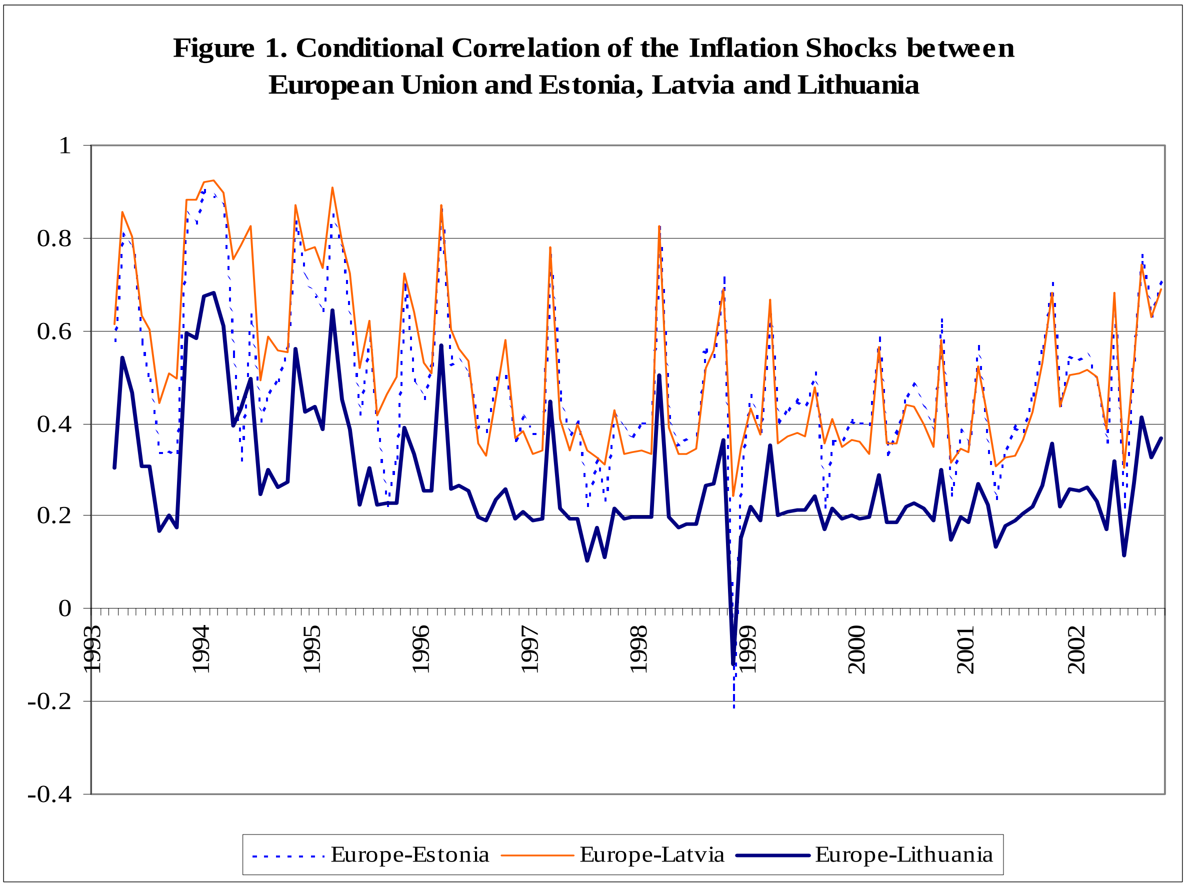


Figure 1. Conditional Correlation of the Inflation Shocks between
European Union and Estonia, Latvia and Lithuania
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Europe-Estonia
Europe-Latvia
Europe-Lithuania

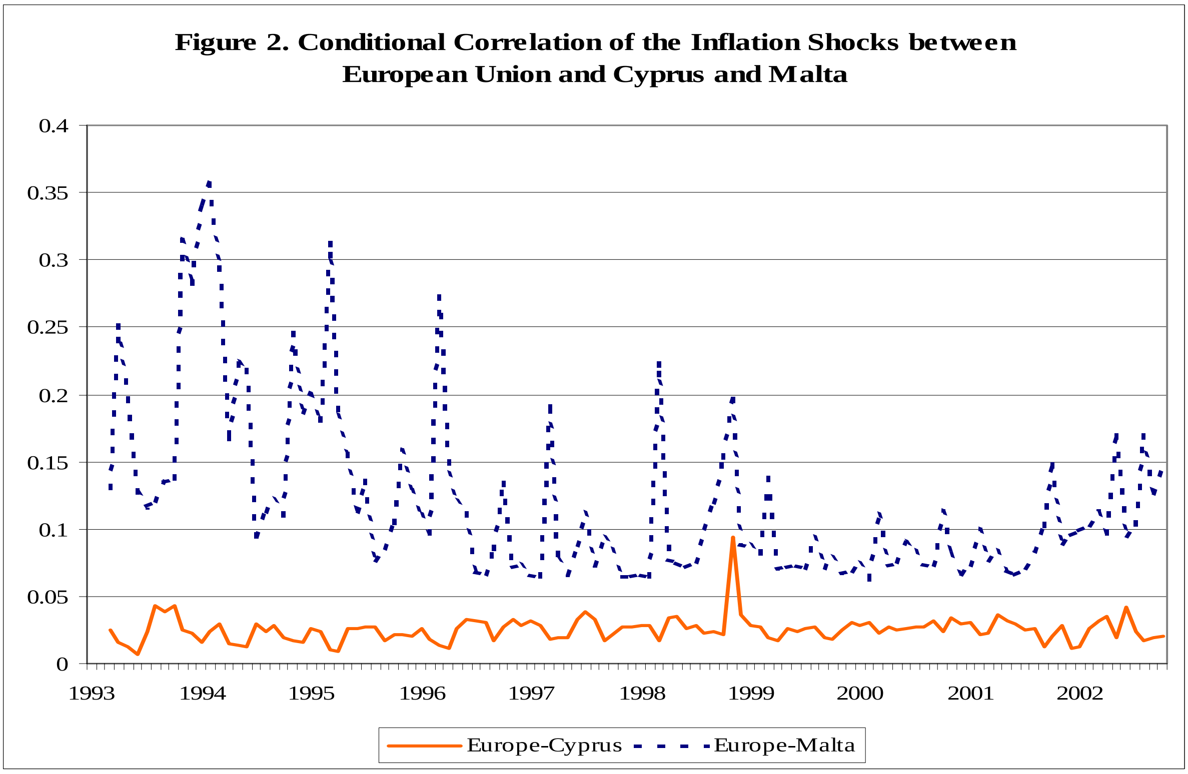


Figure 2. Conditional Correlation of the Inflation Shocks between
European Union and Cyprus and Malta
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Europe-Cyprus
Europe-Malta

Figure 3. Conditional Correlation of the Inflation Shocks between European Union and Poland, Hungary, and Slovenia

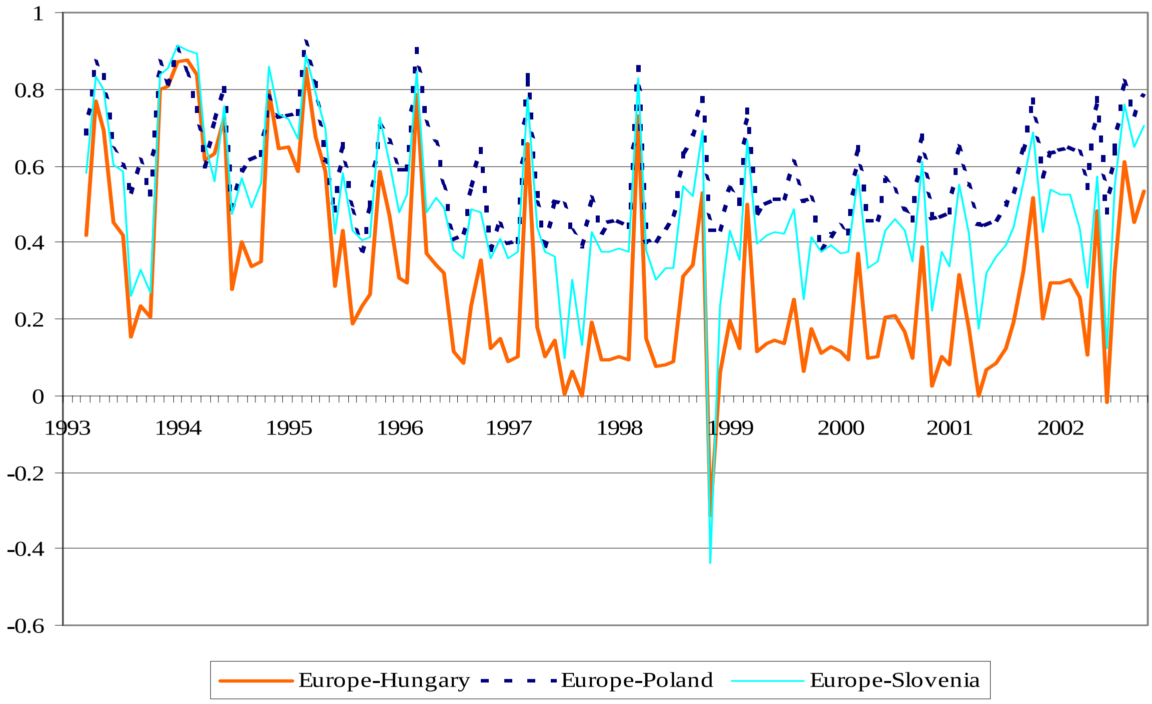


Figure 4. Conditional Correlation of the Inflation Shocks between European Union and Slovakia and Czeck Republic

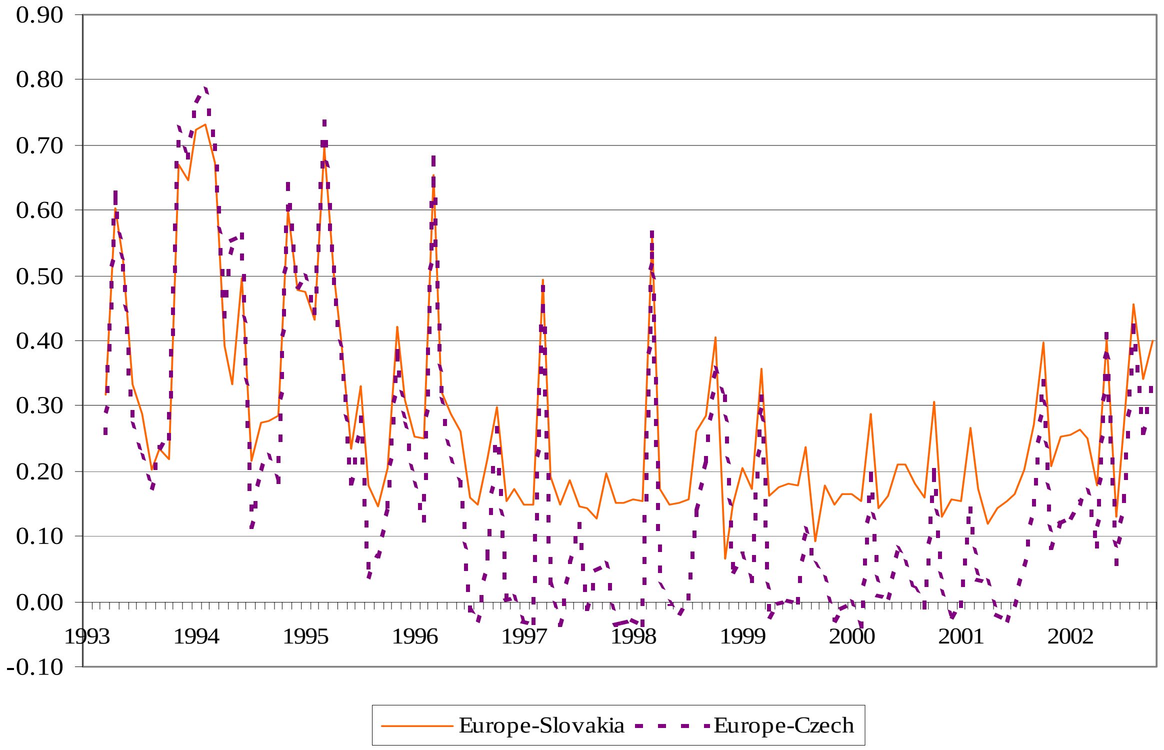


Figure 5. Conditional Correlation of GDP Shocks between European Union and Estonia, Latvia and Lithuania

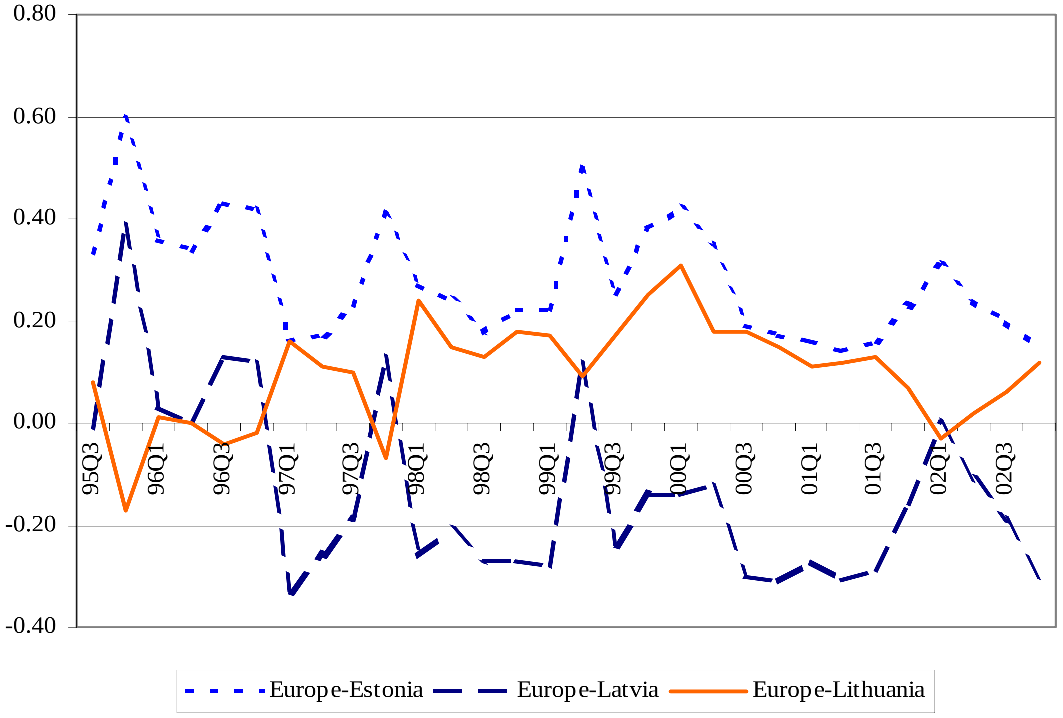


Figure 6. Conditional Correlation of GDP Shocks between European Union and Slovakia, Slovenia and Czech Republic

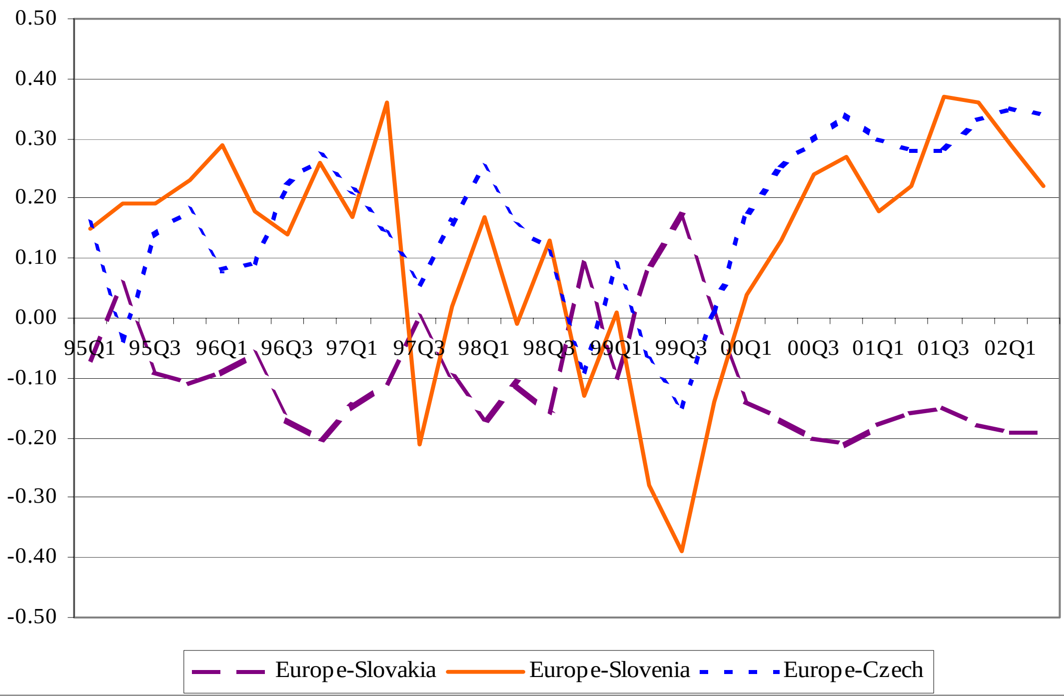


Figure 7. Conditional Correlation of GDP Shocks between European Union and Poland and Hungary

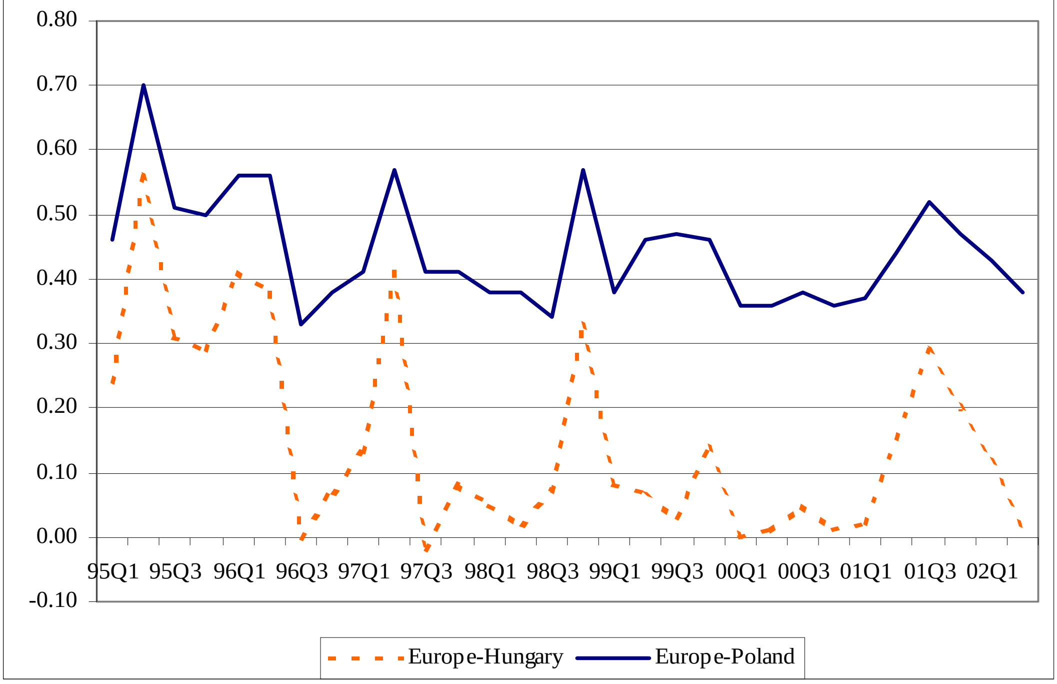


Figure 8. Conditional Correlation of the Exchange rate Shocks between European Union and Estonia, Latvia and Lithuania

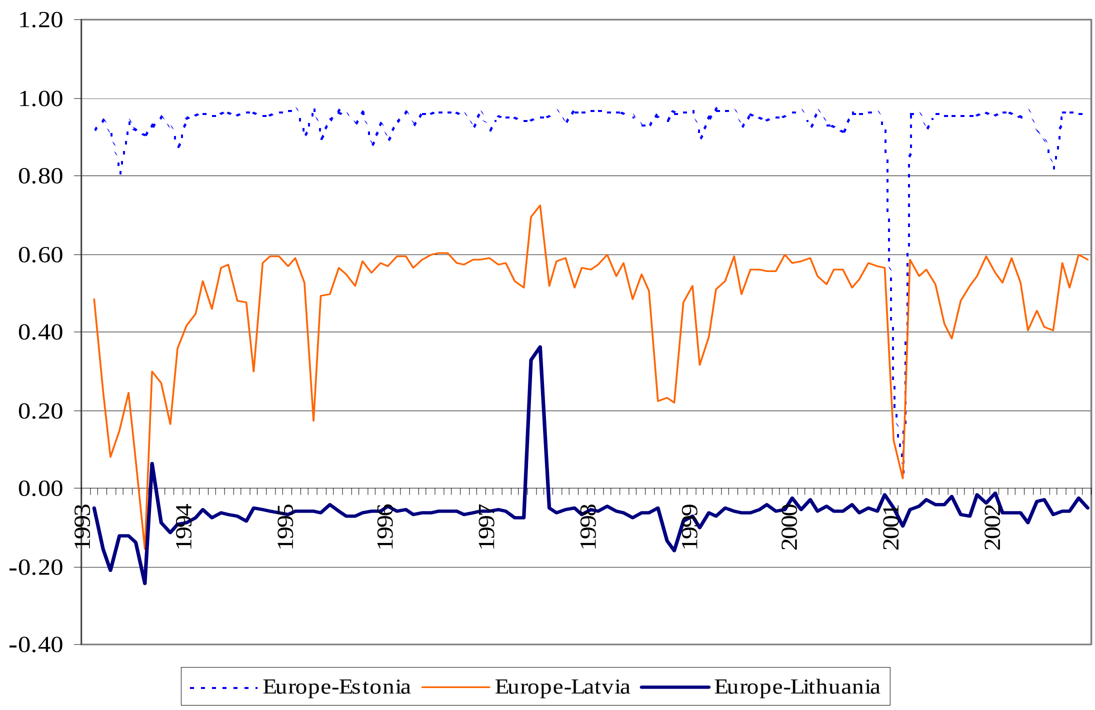


Figure 9. Conditional Correlation of the Exchange Rate Shocks between European Union and Cyprus and Malta

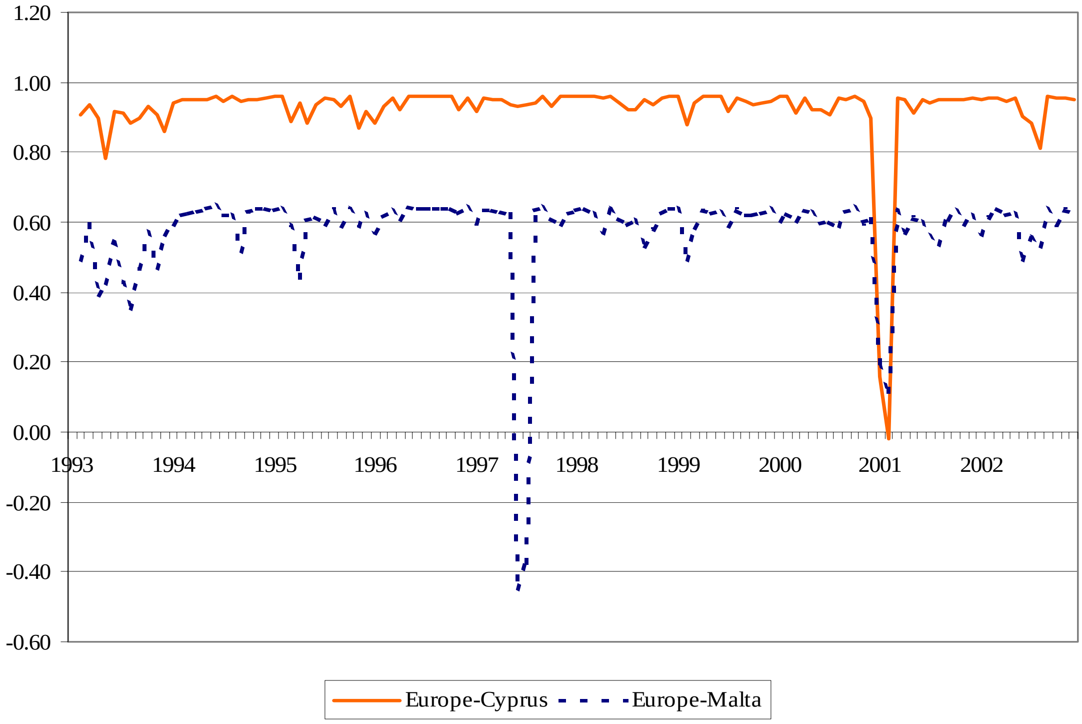
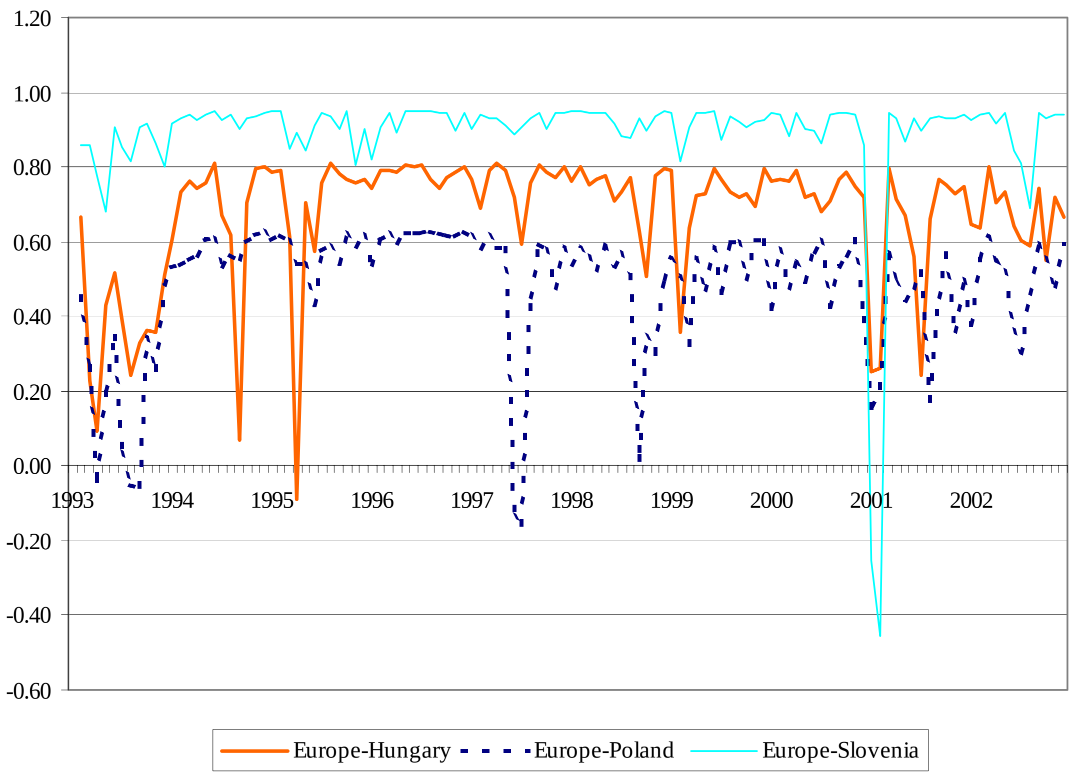


Figure 10. Conditional Correlation of the Exchange Rate Shocks between European Union and Poland, Hungary, and Slovenia



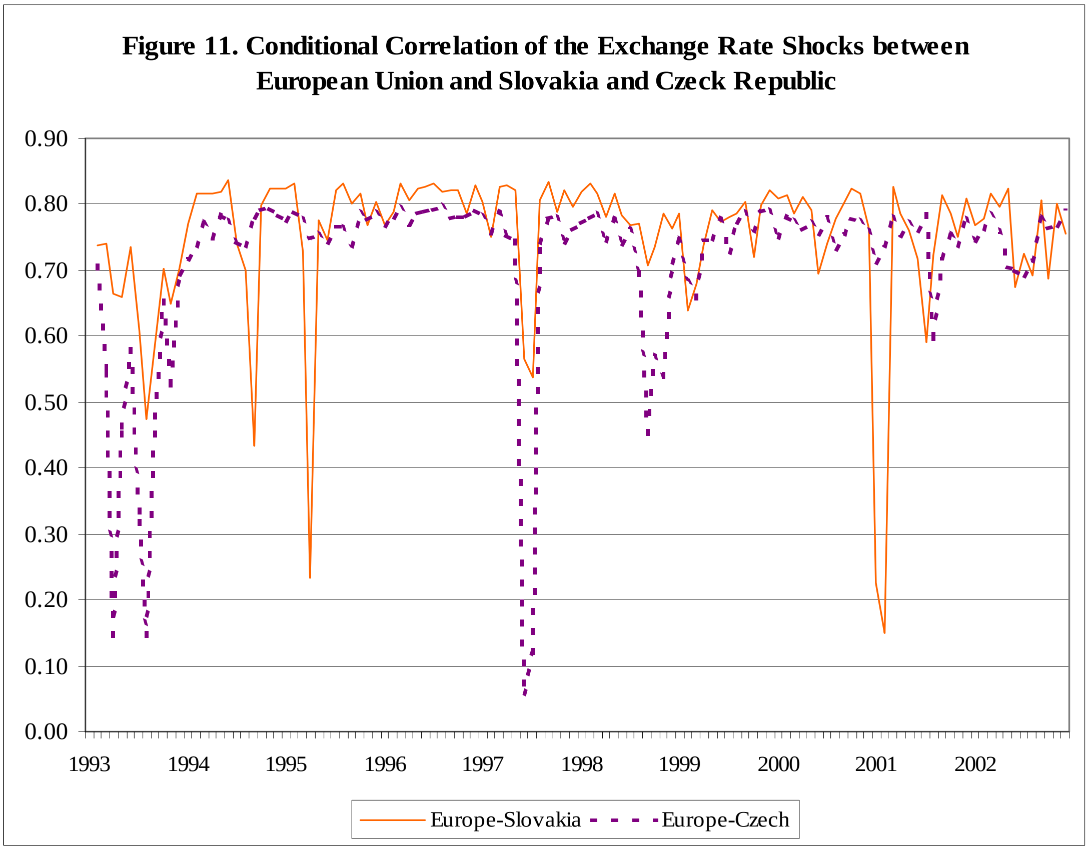


Figure 11. Conditional Correlation of the Exchange Rate Shocks between European Union and Slovakia and Czeck Republic
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Europe-Slovakia
Europe-Czech

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