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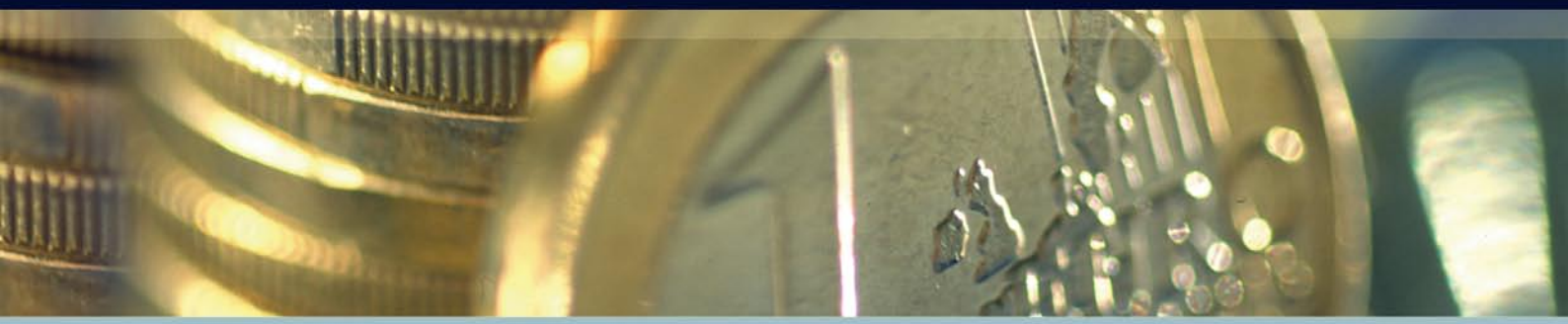

The impact of the euro on international stability and volatility

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In May 2008, it will be ten years since the final decision to move to the third and final stage of Economic and Monetary Union (EMU), and the decision on which countries would be the first to introduce the euro. To mark this anniversary, the Commission is undertaking a strategic review of EMU. This paper constitutes part of the research that was either conducted or financed by the Commission as source material for the review.

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The Impact of the Euro on International Stability and Volatility[1]

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Abstract:

We investigate the impact of EMU on macroeconomic volatility. The volatilities of inflation and nominal interest rates have declined, as has, more importantly, the volatility of real consumption growth. Since global volatility has fallen for reasons unrelated to EMU (the great moderation), we focus on the volatilities of bilateral differences in growth rates (or changes). Pairs of EMU countries have experienced the greatest fall in consumption volatility, followed by pairs in which one country is an EMU member. We demonstrate that these findings are closely linked to changes in consumption risk sharing. Overall, EMU has made a difference.

Key words: EMU, macroeconomic volatility, euro
JEL classification: E42, F41

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1 Introduction

The establishment of the euro in 1999 was seen by many as perhaps the greatest monetary experiment of all time. While of course currency unification had occurred in the past (as had currency separations), the monetary and financial system have come to play a much greater role for the smooth functioning of the economy, making the introduction of a new currency in an economy as large and as sophisticated as that of the euro area a truly major undertaking.

With almost a decade having passed, it is an opportune time to assess what the implication of the euro for economic welfare might have been. In this chapter we investigate the impact on the euro on macroeconomic volatility, broadly defined. The key question we study is straightforward: has the establishment of the euro reduced volatility of macroeconomic aggregates? In addressing this issue it is essential to note that the *absolute* level of volatility may have changed for reasons unrelated to EMU. Thus, our focus is on investigating whether EMU members have experienced a decline in volatility *relative* to each other and to other countries, in a way we discuss further below.

To preview the results, we find that macroeconomic stability has increased since the inception of EMU. The effect on nominal stability – the volatility of short and long interest rates and of inflation – has been particularly large, but there has also been an increase in the stability of real variables. Much of this decline in volatility has occured between EMU members but also, though to a somewhat lesser extent, between EMU and non-members. Though our

results do not directly allow us to conclude that outsiders' macroeconomies have become more stable as an immediate consequence of EMU they do – to the least – suggest that there is an important international dimension to the creation of the euro in the sense that the euro area has become a pole of stability in the global economy.

The most important real effect of the euro that we identify is that consumption has become much smoother, a result that we find deserves special emphasis for two reasons. First, consumption and its volatility directly impact on welfare since – unlike output or income – consumption enters households' utility functions.

Secondly, while consumption volatility could have decreased for a number of reasons, notably better and more synchronized macroeconomic policies, in particular monetary policy, the very pattern of the decline in volatility is informative by itself: the fact that – among real variables – we see increased smoothness mainly in consumption and less so in output or equity returns suggests that the decline in consumption volatility may to a large extent be due to better risk sharing, plausibly brought about through a widening and deepening of financial markets following the inception of EMU. Indeed, we argue that the creation of EMU has been pivotal for the rise in international risk sharing, which has been documented by an emerging literature (e.g., Sorensen, Wu, Yosha and Zu (2007), Artis and Hoffmann (2007a,b and 2008): EMU is associated with more risk sharing not only among its members but also of EMU countries with non-members, whereas risk sharing among non-member countries does not seem to have increased very much.

The rest of the chapter is structured as follows. We set the scene by

documenting a global decline in macroeconomic volatility in the next section. Since this global decline could have a multitude of causes that are unrelated to the inception of the euro, we focus the discussion on what we call relative volatility – or specifically: the volatility of relative variables – in Section three. Section four lays out our framework for identfiying the internal and international dimension of the impact of EMU on volatility, showing that patterns in relative volatility are indeed closely related to the inception of EMU. Section five then focuses on the decline in consumption volatility, singling out improved risk sharing as its main source. Section six summarizes and concludes.

2 Trends in global volatility

As a first step, we develop some stylized facts with respect to what we call *real* and *nominal* volatility. Real variability is captured by the standard deviations of real GDP growth, real consumption growth and stock market returns as a proxy of the real return to capital. We measure nominal volatility through the standard deviations of changes in short and long interest rates and inflation. All data are quarterly, obtained from the IMF's international financial statistics. There are 25 countries in our sample: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

The reason we limit our sample to industrialised economies is that many

emerging market economies have experienced bouts of volatility over our sample period (e.g. the Asian and Russian crises of the late 1990s) for reasons that are unrelated to the creation of the euro. Including such economies into our analysis of the impact of EMU on global volatility might distort our results.

It is well known that volatility declined across the world starting in the mid 1980s, a phenomenon referred to as the "great moderation" (McConnell and Queres-Piros (2000), Kose, Otrok, and Whiteman (2003), Bordo and Helbling (2004), Stock and Watson (2005)). To avoid having our results be unduly affected by this event, we use data starting in 1990 and ending in 2006/7. We break this sample in two subperiods – the ten years before the inception of the euro in January 1999 and the years since. Our sample ends in the fourth quarter of 2006.

Figure 1 provides Artis-Stockman-type cross-plots of these standard deviations for the variables discussed above, for the two subperiods. The top row is for a set of real variables (GDP and consumption growth, stock market returns), the lower row of panels focuses on nominal variables (short and long interest rates and inflation). Points below the the 45-degree line indicate that volatility was higher before the establishment of EMU. The figure shows that there is some evidence that the volatility of real GDP growth has generally declined. The volatility of real consumption growth has fallen markedly for all but one of the countries considered. Stock market volatity does not appear to have systematically changed.

Turning to the nominal variables, we see that volatility has declined in almost all countries, reflecting the increased focus by central banks on achiev-

ing and maintaining low and stable inflation.

3 Global vs. country-specific volatility

The decline in volatility that is apparent from Figure 1 seems to affect EMU and non-EMU countries alike. This suggests that there must be a common, possibly global, factor playing a role. Such a common factor may be unrelated to EMU and may be due to a decline in the volatility of global shocks, lower volatility in financial markets due to financial innovation or increased liquidity etc. In what follows, we therefore condition on any factor that may have affected all countries by focussing on the volatilities of bilateral differences between consumption and output growth, levels of interest rates etc. For brevity but with some abuse of language, we refer to the volatility of relative variables as *relative* or as *country-pair specific* volatility throughout the paper. This focus on relative volatilities does not preclude us from identifying international effects of EMU as we discuss below. Our setup only assumes that the effect of EMU is greater on some industrialised countries than it is on others – a presumption that we deem uncontroversial since only a subset of all industrialised countries in our sample are EMU members.

In fact, looking at relative volatilities directly allows us to study a particularly interesting aspect of the variation in the data. To understand this, note that our data set comprises n countries and therefore $n(n-1)/2$ independent country pairs. By comparing the results for pairs of EMU members, pairs with one EMU member, and pairs with no EMU members can we get at the important issue of the relative impact of EMU on members and non-

members.

Figure 2 provides cross-plots of idiosyncratic volatility measures for the two subperiods. Again, the top row is for a set of real variables and the lower row of panels focuses on nominal variables. The figure also allows us to distinguish whether a particular country pair involves one EMU Country (dots), two EMU countries (circles) or none at all (x's)

For the nominal variables, there is a generalised decline in idiosyncratic volatility, as is evidenced by the fact that most of the points fall below the 45 degree line. While this effect is apparent for intra-EMU country pairings, it is also seems to be important for pairs that involve only one EMU country.

>From Figure 2, a general decline in idiosyncratic volatility is less readily apparent for real variables. In particular, the period since the creation of EMU does not appear to be characterised by systematically less volatile GDP growth or stock market return differentials. This is in contrast to the findings for absolute volatility in the previous section and suggests that the continued great moderation in stock markets and in real GDP growth is indeed largely due to a moderation in the volatility of global factors and not so much due to a diminuishing role of country-specific influences. This finding is in line with those reported in Panetta et al. (2006) and Gerlach et al. (2006).

Among the real variables, a general decline in relative volatility is clearest for consumption. This is noteworthy because theory holds that consumption enters directly into the utility function of agents and consumption volatility has therefore an important impact on economic welfare. By contrast, theory has less to say about the importance of a decline in the volatility of output or income.

Furthermore, economic theory would predict that financial integration directly affects idiosyncratic volatility of consumption through better risk sharing. The effect of financial globalization on consumption risk sharing has generally been quite hard to capture empirically (see the survey in Kose et al. (2007)). However, a recent literature has made some progress along these lines (Artis and Hoffmann (2007a, b, 2008) and Sørensen Wu, Yosha and Zu (2007)), showing that consumption risk sharing has indeed increased with the internationalisation of the external investment position of most industrialised economies. Our results are compatible with these findings.

Finally, the theoretical case for a decline in the relative volatility of consumption is much more clear-cut than it is for output or stock market volatility: Other things being equal, one would expect financial integration to lead to lower relative volatility of consumption. Conversely, while economic integration might also increase the symmetry of output fluctuations, the theoretical case for economic integration to increase the importance of idiosyncratic influences on output growth can equally well be made. For instance, economic integration may allow regions and countries to exploit patterns of comparative advantage. To the extent that supply shocks are sector specific, this could actually lead to increased asymmetry. This point was prominently suggested by Krugman (1993) and the results in Kalemli-Ozcan, Sørensen and Yosha (2001) provide strong support for its empirical relevance. In the same mould, Heathcote and Perri (2004) suggest that output growth in the U.S. has actually become less synchronized with the rest of the world as financial integration has advanced.

For all these reasons, the decline in the volatility of consumption is sig-

nificant and we explore further its implications below.

4 Internal and international effects of EMU on volatility

4.1 EMU and volatility levels

What is the role of EMU in determining volatility? We investigate this question in Tables 1 and 2. For the two sub-periods, these tables provide regressions of relative volatility on a dummy that takes the value of unity if country in the pair is an EMU member (the "international" dummy) and a dummy that takes the value of unity if both countries are EMU members (the "EMU" dummy). To see how these regressions may shed light on the issues at hand, suppose that EMU has reduced the importance of country-specific shocks. If so, one would expect the volatility of EMU pairs to have fallen quite a bit relative to pairs not involving EMU members. Similarly, the elimination of idiosyncratic policies within EMU could have lowered the volatility of pairs involving only one EMU country, though we would expect this to have declined somewhat less. While it is beyond the scope of this paper to offer a full taxonomy of the structural causes of the decline in volatility, we provide a further interpretation of our findings related to these two dummies below.

Since third factors, in particular globalization, could have affected the observed patterns of macroeconomic volatility, in our regressions, we also use a range of control variables that capture trade and financial openness,

financial deepening as well as the exposure of countries to terms of trade shocks.

Specifically, we use the sum of exports and imports divided by GDP as a measure of trade openness and the sum of assets and liabilities as measure of financial openness. We use the volatility of the terms of trade to control for the size of external shocks. To capture the exposure of an economy to such shocks, we further include a measure of trade concentration in natural resource or primary sectors and a measure of trade diversification (see Gerlach (1999)).[1]

As is apparent from Table 1, pairs of countries that later joined EMU had consistently lower relative nominal volatility as well as a lower volatility of real GDP already in the period *before* 1999. This reflects the considerable convergence that been achieved by the EMU candidates before monetary union. Almost the same is true for the "mixed" pairs, though, as one would expect, the point estimate of the effect of volatility is about that for the EMU pairs.

Table 2 reports the results for the EMU period. Interestingly, there is no longer a significant effect of EMU on nominal volatility – be it among member or vis-à-vis outsiders. This again can be read as an indication that the bulk of nominal convergence that EMU has fostered took place already in the run-up to 1999. Conversely, Table 2 clearly shows that after 1999, EMU has had a pronounced effect on the relative volatility of real variables. While

[1]Note that we do not have data on bilateral country characteristics, such as financial and trade flows or capital account openess. We generate such country-pair-specific characteristics as simple arithmetic means of the respective country-specific variables.

country pairs involving EMU members continue to display lower relative GDP volatility, the relative volatility of stock market returns has increased significnatly. Most importantly, EMU is now associated with significantly lower volatility of relative consumption growth rates. All of these effects, again, pertain to both the international and the internal dimension of EMU, with the impact on mixed country pairs being somewhat smaller but still large and significant.

As shown by Tables 1 and 2, in both sub-periods the signs of the control variables – to the extent that they are significant – are generally as expected. Trade openness is associated with higher volatility of GDP and consumption growth as is the presence of capital controls, while financial openness is negatively related to volatility. This is an important finding since it suggests that international financial trade depresses volatility, an effect that we will return to further below. There is no robust effect across subperiods of the control variables on nominal volatility or on stock market returns.

One notable aspect of these results is that we consistently find the volatility of the terms of trade to be associated with *lower* relative volatility of GDP and consumption growth. If the terms of trade were a truly exogenous source of shocks, we would expect a positive sign: higher terms of trade volatility should be associated with higher consumption and GDP volatility. The fact that we find a negative sign suggest that the terms of trade and the real exchange rate could by themselves act as shock absorber rather than as a source of shocks. This interpretation is supported by the recent findings of other researchers (see European Commission (2007)).

4.2 EMU and the decline in global volatility

While our results suggest that EMU have had a significant effect on the level of relative volatiliy for both member and non-member pairs of countries, the findings reported in Tables 1 and 2 are not directly informative about what role EMU may have played in explaining the decline in macroeconomic volatility over time. We turn to this issue next.

To this end, we provide in Table 3 regressions of the change in volatility between the two subperiods on the EMU and international dummies along with the controls used in the previous sections.[2] As an additional conditioning variable, for each of our three real and nominal variables, we also include the respective lagged (i.e. pre-EMU) volatility into the regression. This is motivated by Figure 2 which would suggest that – in spite of the general decline in relative volatility – the level of volatility in the period before EMU remains an important determinant of volatility also in the period after 1999.

For each of our three nominal and real variables, we run the regression:

$$\sigma^{ij}_{EMU} - \sigma^{ij}_{PRE} = \alpha_1 \sigma^{ij}_{PRE} + \alpha_2 Inter_{ij} + \alpha_3 EMU_{ij} + \boldsymbol{\gamma}' \mathbf{Z}^{ij}_{PRE} + \varepsilon^{ij}$$

where ij denotes the pair of countries i and j, σ is the relative variability of the respective nominal or real variable, $Inter$ and EMU are our international dimension and EMU dummies respectively that take the value of one if one

[2]It would appear that one way to obtain insight into the decline in volatility over time is to look at a version of the regressions in Table 1 or 2 where the regressors and the dependent variable have been differenced across subperiods. This is, however, not practically feasible, because the regressors do not change at all (EMU membership status) or almost not (e.g. relative measures of trade openness change very little).

($Inter$) or both (EMU) countries in pair ij are EMU members and zero otherwise. The subscripts PRE and EMU, denote variables from the pre-EMU and EMU periods respectively. The vector $\mathbf{Z}^{ij}$ stacks the trade and financial openness controls.

The results in Table 3 show a highly significant and negative estimate of α_1 for all variables except output growth. This effect is particularly pronounced for the three nominal variables, for which the estimate of α_1 is close to negative unity. This confirms the impression from Figure 2 that relative volatility has fallen almost across the board but that this decline has been far more drastic for nominal variables.

In addition, those country pairs that involve at least one EMU country, have generally experienced even more drastic declines in volatility. Among the nominal variables, this is true for both inflation and long interest rates. Among the real variables, EMU has had a strong effect on the decline in relative GDP and consumption growth volatility. Again, for all variables, the intra-EMU effect is stronger than it is vis-à-vis outsiders (by about a factor of two), but still the international dimension is highly significant and sizeable.

The order of magnitude of the impact of EMU on the volatility of GDP and consumption is worth noting: EMU membership reduces the relative volatility of GDP growth by 2 percentage points vis-a-vis other members and by still one percentage point vis-a-vis outsiders. The effect on relative consumption volatility appears even slightly higher.

4.3 Interpreting the international dimension of EMU

The results in the previous tables suggest that the decline in relative volatility, already apparent from Figure 2 is particularly pronounced among EMU members. In addition, we have identified an important international dimension of EMU in the sense that relative volatility also declines more than average if only one of the two countries i or j is an EMU member (though not quite as much as for intra-EMU pairings). To understand these results better, let x^i denote one of the real and nominal variables that we considered in our analysis so far. Assume that x^i is determined by three factors: a global factor that affects all countries in the same way, a European factor that we also allow to affect all countries but to potentially different degrees, and a purely country-specific factor. Then for two countries i and j we can write

$$\begin{aligned} x_t^i &= g_t + \alpha_i f_t + s_t^i \\ x_t^j &= g_t + \alpha_j f_t + s_t^j \end{aligned}$$

where g_t is the global factor, f_t is the European factor and s_t is the country-specific influence. The factor loadings α_i and α_j capture the exposure of the respective economy to the European factor. Assuming that f_t and s_t are uncorrelated, it is easy to see that the country-pair specific or relative variance is

$$var(x_t^i - x_t^j) = (\alpha_i - \alpha_j)^2 var(f_t) + var(s_t^i - s_t^j)$$

Note first, that the idiosyncratic variance is independent of the global

factor, which is one reason why we focus on relative variances. Secondly, note that the European factor affects the relative variance to the extent that the exposure of the two economies to Europe-wide shocks differs. To capture the idea that exposure to the European factor is more similar among pairs of EMU members than between "mixed" pairs or non-EMU pairs of countries, we assume that the squared difference between the factor loadings $(\alpha_i - \alpha_j)^2$ is generally smaller if both country i and j are EMU members than if only one of the countries is an EMU member.

Then the pattern we observe in the data is compatible with the following explanations: first, $(\alpha_i - \alpha_j)^2$ has declined for all country pairs, but it has declined by more for intra EMU-pairs than for pairs involving only one or no EMU country. Secondly, the purely idiosyncratic variances have declined, possibly due to the elimination of disturbances related to poor fiscal and monetary policy. Third, $var(f_t)$ could have declined. We do not distinguish between these explanations since there is no reason to believe that they are mutually exclusive.

Before proceeding, we note that the pattern we observe in the data cannot be explained by a decline in $var(f_t)$ alone, because – under the plausible assumption that the factor loadings, α_i, for EMU countries are on average more similar than those of non-EMU countries – we would expect such a decline to have led to a larger decline in relative volatilities among outsiders than among EMU-members. Furthermore, we emphasise that the decline in $var(x_t^i - x_t^j)$ can have occurred without the absolute level of $var(x_t^i)$ and $var(x_t^j)$ changing„ which would reflect an increase in the correlation between the two variables.

5 The decline in consumption volatility

Our findings highlight that EMU has been associated with a decline in relative consumption volatility – both in as far as intra-EMU volatility as well as the international dimension are concerned. At a theoretical level, we could think of this decline in two ways. First, it may reflect a decline in the volatility of other macroeconomic variables. For instance, more synchronized fiscal policy stances as well as the creation of a single monetary policy itself – and the removal of speculative attacks as a source of occasional episodes of sharp interest rate increases – could all have had an direct impact on the volatility of output, interest rates and inflation and this in turn could have affected consumption volatility.

Secondly, consumption may have become more insulated against idiosyncratic macroeconomic shocks due to better international risk sharing: the deepening and widening of financial markets that resulted from EMU may have allowed households to insure better against fluctuations in their consumption (perhaps as a consequence of financial institutions having become able to offer a wider range of financial products). According to our results from the previous sections, the volatility of consumption has fallen by somewhat *more* than that of output which would indeed suggest that better consumption risk sharing is a potentially important factor in the decline of consumption volatility.[3]

To study to what extent consumption has become better insulated against

[3]This interpretation is also supported by empirical results in Bekaert et al. (2006) who show that consumption volatility tends to fall by more than output volatility after financial liberalizations.

business cycle volatility, we turn to a by now well-established literature (Asdrubali, Sørensen and Yosha (1996), Sørensen and Yosha (1998), Crucini (1999), Becker and Hoffmann (2006)) which measures risk sharing through panel regressions the form:

$$\widetilde{c}_t^{ij} = \alpha + \beta \widetilde{gdp}_t^{ij} + \mu^{ij} + \tau_t + const + \xi_t^{ij} \tag{1}$$

Here, $\widetilde{x}_t^{ij}$ denotes the difference $x^i - x^j$ for countries i and j and c and gdp denote the logarithm of real consumption and GDP respectively. We capture time specific fixed effects through τ_t and country-pair specific fixed effects through μ^{ij}. Finally, ξ_t^{ij} is the residual and *const* the regression constant.[4]

Estimates of β are typically between zero and one, which allows us to interpret the coefficient as a measure of risk sharing. Specifically, β tells us the fraction of country-specific volatility in business cycles (i.e. in $\widetilde{gdp}_t^{ij}$) that remains uninsured and that systematically spills over into volatility in consumption. A value of β near zero would thererfore imply almost perfect risk sharing, whereas a value near one would indicate no risk sharing. If risk sharing has indeed increased, we would expect that β has fallen over time.

We present the results from regressions of the form (1) in Panel A of

[4]In the literature, such regressions have often been estimated in first differences of the idiosyncratic variables. However, Artis and Hoffmann (2008) caution against this practice by showing that in an environment in which the variability of business cycles may also be declining over time, the coefficient of the differenced regression will fail to pick up improvements in international risk sharing. Since a continuded decline in output variability forms the backdrop for our analysis here, we follow Becker and Hoffmann (2006) and Artis and Hoffmann (2006, 2007) and estimate these regressions in relative (log) levels, a procedure that is less sensitive to changes in the volatility of business cycles by putting more emphasis on the identification of longer-term trends in risk sharing. To facilitate the identification of these trends further, for this part of our analysis, we also use annual data from the Penn World tables, release 6.2. (Heston, Summers and Aten (2006)). This data ranges till 2004.

Table 7. As is apparent, risk sharing has indeed increased globally since the inception of EMU. The coefficient β has fallen from about **0.6** to roughly **0.5**, suggesting that around **50** percent of all idiosyncratic risk was shared among the countries in our sample, up from **40** percent in the decade before EMU – a sizeable increase by about one quarter. There are by now a number of papers that document a statistically significant link between consumption risk sharing and financial globalization (Artis and Hoffmann (2007 a, b, 2008) and Sørensen, Wu, Yosha and Zhu (2007)) and that show that consumption risk sharing has indeed increased over the last decade. The results in Panel A are compatible with these findings. The question we ask here is what role EMU has played in this global increase in international risk sharing. In order to address this question, we let β vary across country pairs. Specifically, we posit the linear relation:

$$\beta_{ij} = \beta_0 + \beta_1 Inter_{ij} + \beta_2 EMU_{ij} \tag{2}$$

where $Inter$ and EMU are again our international and EMU dummies respectively. A negative value of β_1 (β_2) would then imply that a country pair shares more risk if it involves one (two) EMU members. The coefficient β_0 tells us how much risk sharing a country pair outside the EMU would achieve, whereas $\beta_0 + \beta_1$ ($\beta_0 + \beta_2$) indicates the amount of risk shared by country pairs involving one (two) EMU countries. Once these coefficients have been estimated, we can then also ask what accounts for the rise in risk sharing. If it is a global phenomenon, then β_0 should have decreased. If it due to better risk sharing between EMU and non-EMU members, then β_1 should have

decreased, whereas if international risk sharing has just increased because of better intra-EMU risk sharing, we should find that β_2 has fallen.

To estimate the coefficients β_0, β_1 and β_2 we use (1) and (2) which gives us two interaction terms between $\widetilde{gdp_t}^{ij}$ and $Inter_{ij}$ and EMU_{ij} respectively, so that the regression we estimate becomes:

$$\widetilde{c}_t^{ij} = \alpha + \beta_0 \widetilde{gdp_t}^{ij} + \beta_1 \left(Inter_{ij} \times \widetilde{gdp_t}^{ij} \right) + \beta_2 \left(EMU_{ij} \times \widetilde{gdp_t}^{ij} \right) + \mu^{ij} + \tau_t + \varepsilon_t^{ij}$$

Panel B of Table (6) provides the estimates. The first column gives the results for the pre-EMU period, 1990-98, the second for the period since the beginning of EMU.

The results in Table (6) confirm our conjecture that the creation of EMU plays an important role for international consumption risk sharing: β_2 is significant in the regressions for both subperiods, indicating that EMU members (or – in the pre-EMU period: candidates that were eventually to become EMU members) share significantly more risk with each other than does the average non-EMU country pair in our sample.

There is, again, also an important international dimension to the results. The international dummy (β_1) is significantly negative in the second period: since the inception of the euro, outsiders share risk with countries inside EMU more effectively than among themselves. Again, this effect is of the same order of magnitude as the effect of bilateral EMU membership, though generally somewhat weaker: the coefficient β_1 is significantly negative but smaller in absolute value than β_2.

Panel C summarizes our results by providing the net extent of risk sharing for non-EMU members (β_0) and along the international ($\beta_0+\beta_1$) and internal ($\beta_0+\beta_2$) dimensions respectively. This synopsis helps illustrate the pivotal role that the creation of EMU seems to have played in the international rise in risk sharing. In fact, non-EMU members share somewhat *less* risk among themselves than before 1999, as evidenced by the fact that β_0 increases from 0.67 to 0.79. But this seems to be more than substituted for by the significant increase in risk sharing between outsiders and EMU members. The sum $\beta_0+\beta_1$ decreases from 0.63 to 0.53. Interestingly, the level of risk sharing achieved between members – which was already much higher than among the other two country-pair groups in the period before 1999 – seems to have increased only marginally.[5] Therefore, it seems that better risk sharing of EMU members with outsiders (the international dimension) accounts for most of the global increase in risk sharing that we see from the results in panel A and that others have documented before.

6 Conclusions

To our knowledge, this chapter constitutes the first systematic exploration of the effect of EMU on the stability and volatility of key macroeconomic variables both within the euro area and internationally. We have documented that, since the inception of the euro, industrialised economies have seen a considerable decline in the volatility of both key nominal and – to a some-

[5]This finding is compatible with Artis and Hoffmann (2007b) who show that EMU *is* associated with better risk sharing among its members but that much of this increase already occured before the inception of the euro.

what smaller extent – also real macroeconomic indicators, including inflation, interest rates, GDP, stock markets and, most notably, consumption. While the global decline in volatility is also likely to be due to a more stable international macreconomic environment, we condition on the impact of global factors by focussing on the role that EMU has played in moderating idiosyncratic volatility among its members and relative to non-members. We find that EMU has hugely increased not only the stability of EMU members relative to each other but also relative to non-members.

While EMU seems to have particularly strongly affected the volatility of nominal variables, such as inflation or interest rates, on the real side, our results concerning the volatility of consumption stand out as particularly important. Not only is the decline in the volatility of consumption more marked and more clearly associated with EMU than it is for other real aggregates. We also find evidence to suggest that this decline is clearly associated with better risk sharing through a widening and deepening of financial markets and that EMU has been pivotal in the recent increase of consumption risk sharing that we and others have documented.

References

[1] Artis, Michael J. and Mathias Hoffmann (2007a). 'The Home Bias and Capital Income Flows between Countries and Regions' Institute for Empirical Research in Economics working paper no 316, March 2007. *http://ssrn.com/abstract=976341.*

[2] Artis, Michael J. and Mathias Hoffmann (2007b). 'Declining Home Bias and the Increase in International Risk Sharing: Lessons from European Integration' to appear in Lars Jonung, Christoph Walkner and Max Watson (eds.) *Building the Financial Foundations of the Euro: Experiences and Challenges.* Available for download at *http://www.iew.uzh.ch/home/hoffmann/*

[3] Artis, Michael J. and Mathias Hoffmann (2008). 'Financial Globalization, International Business Cycles and Consumption Risk Sharing' forthcoming in the *Scandinavian Journal of Economics.* An almost identical working paper version is downloadable at *http://papers.ssrn.com/abstract=1069601.*

[4] Asdrubali, P., Sørensen, P. E. and Yosha, O. (1996). 'Channels of interstate risk sharing: United States 1963-90.' *Quarterly Journal of Economics*, vol. 111, pp.1081-1110.

[5] Becker, Sascha O. and Mathias Hoffmann (2006). 'Intra- and International Risk-Sharing in the Short Run and the Long Run', *European Economic Review*, vol. 50, pp.777–806.

[6] Bekaert, Geert, Campbell R. Harvey and Christian T. Lundblad, 'Growth Volatility and Equity Market Liberalization', *Journal of International Money and Finance*, 25(3), 370-403.

[7] Bordo, Michael D. and Thomas F. Helbling (2004). 'Have National Business Cycles Become More Synchronized?' in Siebert, H. and R. Langhammer (eds.) *Macroeconomic Policies in the World Economy* Springer Verlag (Berlin and Heidelberg).

[8] Crucini, Mario (1999). 'On international and national dimensions of risk sharing', *The Review of Economics and Statistics*, February 1999, 81(1): 73-84.

[9] European Commission (2007). 'The Impact of the euro on world stability' draft chapter for the *European Economy Review 2008* dated Oct 18th 2007.

[10] Gerlach, Stefan, Ramaswamy, Srichander and Michela Scatigna (2006). "150 years of financial market volatility" *BIS Quarterly Review*, September 2006, 77-91.

[11] Gerlach, Stefan (1999). 'Who targets inflation explicitly?' *European Economic Review*, 1999, 43, 1257-1277.

[12] Heathcote Jonathan and Fabrizio Perri (2004) 'Financial Globalization and Real Regionalization', *Journal of Economic Theory* , vol. 119(1) , 207-243.

[13] Heston, Alan, Summers Robert and Bettina Aten, *Penn World Table Version 6.2*, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006. *http://pwt.econ.upenn.edu/php_site/pwt_index.php*

[14] Kalemli-Ozcan, Sebnem, Sørensen, Bent and Oved Yosha (2001). 'Economic Integration, Industrial Specialization, and the Asymmetry of Macroeconomic Fluctuations' *Journal of International Economics*, 55.

[15] Kose, M. Ayhan. , Cristopher Otrok, and Charles. H. Whiteman (2003). 'International Business Cycles: World, Region, and Country-Specific Factors.' *American Economic Review* 93 (4): 1216–1239.

[16] Kose, M. Ayhan. , Cristopher Otrok, and Charles. H. Whiteman (2004). 'Understanding the Evolution of World Business Cycles', paper presented at the Summer at CEU workshop, Budapest June 2004.

[17] Kose, Ayhan M., Prasad, Eswar and Marco E. Terronoes (2007). 'How Does Financial Globalization Affect Risk Sharing? Patterns and Channels', IZA discussion paper 2903.

[18] Krugman, Paul (1993). 'Lesson of Massachusetts for EMU.' In: Giavazzi, F., Torres, F. (Eds.), *The Transition to Economic and Monetary Union in Europe*. Cambridge University Press, New York, pp. 241–261.

[19] McConnell, Margret M. and Gabriel Queres-Piros (2000). 'Output Fluctuations in the United States: What has changed since the early 1980s?', *American Economic Review*, vol 90., no 5, 1464-76.

[20] Panetta, Fabio, Angelini, Paolo, Grande, Giuseppe, Levy, Aviram, Perli, Roberto, Yesin, Pinar, Gerlach, Stefan, Ramaswamy, Srichander, and Michela Scatigna (2006). 'The recent behaviour of financial market volatility', BIS Papers no 29.

[21] Sørensen, B. E. and Yosha, O. (1998). 'International risk sharing and European Monetary Unification.' *Journal of International Economics*, vol. 45, pp. 211-38.

[22] Sørensen, B. E. and Yosha, O., Wu, Y.-T. and Zu Y. (2007). 'Home Bias and International Risk Sharing: Twin Puzzles Separated at Birth', *Journal of International Money and Finance*.

[23] Stock, James H. and Mark W. Watson (2005). 'Understanding Changes in International Business Cycle Dynamics', *Journal of the European Economic Association*, vol. 3, issue 4 (September).

Table 1: Pre-EMU volatility and the international and internal dimensions

	GDP	Consumption	SMI	Inflation	Long Interest	Short Interest
International Dummy	**-0.019**	0.009	-0.005	**-0.01**	-0.004	**-0.024**
	(-3.3)	(1.6)	(-0.3)	(-3.9)	(-1.8)	(-7.4)
EMU Dummy	**-0.039**	0.014	-0.017	**-0.022**	**-0.01**	**-0.053**
	(-3.8)	(1.4)	(-0.5)	(-4.4)	(-2.3)	(-8.9)
Trade Concentration	0.017	0.032	-0.014	**-0.026**	-0.008	0.009
	(0.7)	(1.3)	(-0.2)	(-2.1)	(-0.8)	(0.6)
Trade Diversification	-0.009	**0.09**	-0.055	0.017	**0.019**	-0.022
	(-0.04)	(3.9)	(-0.8)	(1.5)	(2.0)	(-1.6)
Trade Openess	**0.045**	**0.048**	**-0.16**	0.008	**-0.032**	0.002
	(4.5)	(4.9)	(-5.2)	(1.6)	(-7.9)	(0.3)
Financial Openess	**-0.007**	**-0.015**	**0.015**	0	**0.004**	0.001
	(-3.1)	(-6.8)	(2.3)	(-0.0)	(3.8)	(0.6)
Capital Account Restr.	**0.047**	**0.027**	**-0.078**	**0.027**	-0.007	**0.029**
	(4.8)	(2.8)	(-2.6)	(5.5)	(-1.9)	(5.0)
Relative Income	**0.001**	**0.002**	-0.001	**0**	**-0.001**	**-0.001**
	(2.0)	(6.9)	(-0.5)	(-2.9)	(-7.4)	(-5.2)
M2/GDP	0.006	**-0.008**	**0.037**	**0.003**	**0.009**	**0.006**
	(1.7)	(-2.4)	(3.8)	(2.0)	(6.5)	(2.9)
ToT Volatility	**-0.56**	**-0.82**	**1**	**-0.23**	-0.049	**-0.31**
	(-4.2)	(-6.4)	(2.6)	(-3.6)	(-0.9)	(-4.0)
Constant	-0.024	**-0.091**	**0.2**	0.016	**0.05**	**0.082**
	(-1.2)	(-4.7)	(3.3)	(1.6)	(6.1)	(6.9)
Adj.R^2	0.55	0.68	0.25	0.47	0.72	0.61
No of Obs.	91	91	91	91	91	91

Note: for each variable indicated in the column headings, country-pair standard deviations for the pre-EMU (1990-1998) period are regressed on EMU (international/internal dimension) dummies and a set of controls. OLS regressions. Bold coefficients are significant at 5% level.

Table 2: EMU-period volatility and the international and internal dimensions

	GDP	Consumption	SMI	Inflation	Long Interest	Short Interest
International Dummy	**-0.04**	**-0.031**	**0.067**	0.001	-0.001	0
	(-5.2)	(-6.4)	(4.7)	(0.)7	(-0.9)	(0.2)
EMU Dummy	**-0.077**	**-0.063**	**0.13**	0.001	-0.002	-0.001
	(-5.5)	(-7.1)	(5.2)	(0.5)	(-1.6)	(-0.3)
Trade Concentration	**0.074**	**0.12**	-0.059	-0.004	**-0.006**	-0.01
	(2.2)	(5.6)	(-1.0)	(-0.9)	(-2.3)	(-0.9)
Trade Diversification	**0.039**	0.021	**0.3**	-0.002	0.003	**0.024**
	(2)	(1.7)	(8.4)	(-0.7)	(1.8)	(3.7)
Trade Openess	**0.023**	**0.017**	0.013	0	0	-0.001
	(5.3)	(6.1)	(1.7)	(0.6)	(-0.2)	(-0.5)
Financial Openess	**-0.003**	**-0.003**	**-0.012**	0	**0**	**-0.001**
	(-3.3)	(-4.5)	(-6.5)	(1.4)	(-4.8)	(-4.1)
Capital Account Restr.	**0.032**	**0.031**	-0.005	-0.001	**-0.005**	**-0.021**
	(2.7)	(4.1)	(-0.2)	(-0.7)	(-5.3)	(-5.1)
Relative Income	0	0	**0.003**	0	**0**	0
	(-1.4)	(-0.71)	(6.1)	(-0.1)	(3.9)	(0.6)
M2/GDP	**0.015**	**0.013**	**-0.018**	0	0	0
	(4.3)	(6.1)	(-2.8)	(-0.4)	(1.4)	(-0.1)
ToT Volatility	**-0.23**	**-0.2**	**-0.43**	**0.03**	**0.018**	0.008
	(-3.7)	(-5.1)	(-3.8)	(3.9)	(3.8)	(0.4)
Constant	-0.022	**-0.036**	**-0.15**	**0.007**	0.002	0.012
	(-1.0)	(-2.5)	(-3.6)	(2.6)	(0.9)	(1.6)
Adj. R^2	0.41	0.66	0.4	0.27	0.68	0.48
No of Obs.	136	136	136	136	136	136

Note: for each variable indicated in the column headings, country-pair standard deviations for the EMU (1999-2006) period are regressed on EMU (international/internal dimension) dummies and a set of controls. OLS regressions. Bold coefficients are significant at 5% level.

Table 3: EMU and the Decline in Volatility

	GDP	Consumption	SMI	Inflation	Long Interest	Short Interest
International Dummy	**-0.009**	**-0.011**	0.001	**-0.004**	**-0.002**	-0.0006
	(-2.41)	(-4.55)	(0.21)	(-3.83)	(-2.91)	(-0.37)
EMU Dummy	**-0.022**	**-0.026**	0.002	**-0.008**	**-0.004**	-0.005
	(-3.17)	(-5.71)	(0.13)	(-4.52)	(-3.95)	(-1.26)
σ^{pre}	0.092	**-0.166**	**-0.276**	**-1.038**	**-1.007**	**-0.85**
	(1.29)	(-3.29)	(-6.21)	(-28.43)	(-37.19)	(-17.93)
Trade Concentration	**-0.048**	-0.013	-0.028	0.002	**0.013**	**0.044**
	(-2.93)	(-1.18)	(-0.91)	(0.41)	(5.23)	(6.98)
Trade Diversification	**0.044**	0.011	0.031	**-0.010**	**-0.009**	**-0.016**
	(2.87)	(0.97)	(1.06)	(-2.69)	(-3.69)	(-2.62)
Trade Openness	**-0.014**	**-0.015**	**0.083**	**0.007**	-0.002	-0.003
	(-1.99)	(-2.94)	(5.95)	(4.30)	(-1.41)	(-1.35)
Financial Openness	-0.0007	0.002	**-0.011**	-0.0003	-0.0001	0.0001
	(-0.47)	(1.25)	(-4.05)	(-0.95)	(-0.54)	(0.32)
Capital Account Restr.	-0.004	**-0.013**	**0.034**	**0.008**	-0.002	-0.004
	(-0.63)	(-2.80)	(2.79)	(4.1)	(-1.65)	(-1.61)
Relative Income	-0.0001	**-0.0005**	**0.0009**	-0.0005	0.0004	0.0004
	(-0.57)	(-3.1)	(2.74)	(-1.16)	(1.24)	(0.55)
M2/GDP	0.0007	**0.008**	**-0.019**	**0.001**	**0.0009**	-0.0001
	(0.33)	(5.2)	(-4.47)	(2.37)	(2.21)	(-0.14)
ToT Volatility	**-0.338**	-0.040	**-0.529**	**0.050**	**0.067**	**0.079**
	(-3.61)	(-0.57)	(-3.19)	(2.19)	(5.06)	(2.19)
Constant	0.020	**0.023**	-0.038	0.005	**0.005**	0.008
	(1.57)	(2.33)	(-1.47)	(1.57)	(2.01)	(1.31)
Adj.R^2	0.51	0.61	0.66	0.94	0.99	0.91
No of Obs.	91	91	91	91	91	91

Note: For each variable given in the column heading, we regress the differences in the country-pair specific standard deviations between the pre-EMU and EMU-periods. on the EMU (international/internal dimension) dummies. In addition, the regressions also include our set of controls, including the lagged (i.e. pre-EMU period) volatility σ^{pre} of the respective variable. OLS regressions. Bold coefficients are significant at 5% level.

Table 4: EMU and International Consumption Risk Sharing

	Panel A	
	pre-EMU period (1990-98)	EMU period (1999-2004)
β	**0.60** (48.90)	**0.52** (55.20)
Adj.R^2	0.50	0.67
No of Obs.	2277	1518
	Panel B	
β_0	**0.67** (26.34)	**0.79** (23.09)
β_1	**-0.04** (-1.35)	**-0.26** (-7.22)
β_2	**-0.22** (-6.09)	**-0.35** (-9.23)
Adj.R^2	0.51	0.69
No of Obs.	2277	1518
	Panel C: Risk sharing by country pair group	
EMU Outsiders	**0.67**	**0.79**
EMU & Non EMU	**0.63**	**0.53***
IntraEMU	**0.45***	**0.44***

Notes: For both the pre-EMU and the EMU periods, the table reports panel regressions of the form

$$\widetilde{c}_t^{ij} = \alpha + \beta_0 \widetilde{gdp}_t^{ij} + \mu_{ij} + \tau_t + const + \varepsilon_t^{ij}$$

in panel A and

$$\widetilde{c}_t^{ij} = \alpha + \beta_0 \widetilde{gdp}_t^{ij} + \beta_1 \left(Intra_{ij} \times \widetilde{gdp}_t^{ij} \right) + \beta_2 \left(Extra_{ij} \times \widetilde{gdp}_t^{ij} \right) + \mu_{ij} + \tau_t + const + \varepsilon_t^{ij}$$

in panel B, where $\widetilde{x}_t^{ij} = x_t^i - x_t^j$ and x stands for the logarithms of consumption (c) and GDP in turn. t-statistics in parentheses, coefficients significant at the 5% level are in bold. Panel C reports the fraction of unshared risk among the respective country pair groups, i.e. β_0 for outsiders, $\beta_0 + \beta_1$ for risk sharing between EMU and non-EMU and $\beta_0 + \beta_2$ for risk sharing among EMU countries. An asterisk in panel C signals if risk sharing in the respective country-pair group is significantly different (at the 5% level) from the risk sharing achieved among non-EMU members.

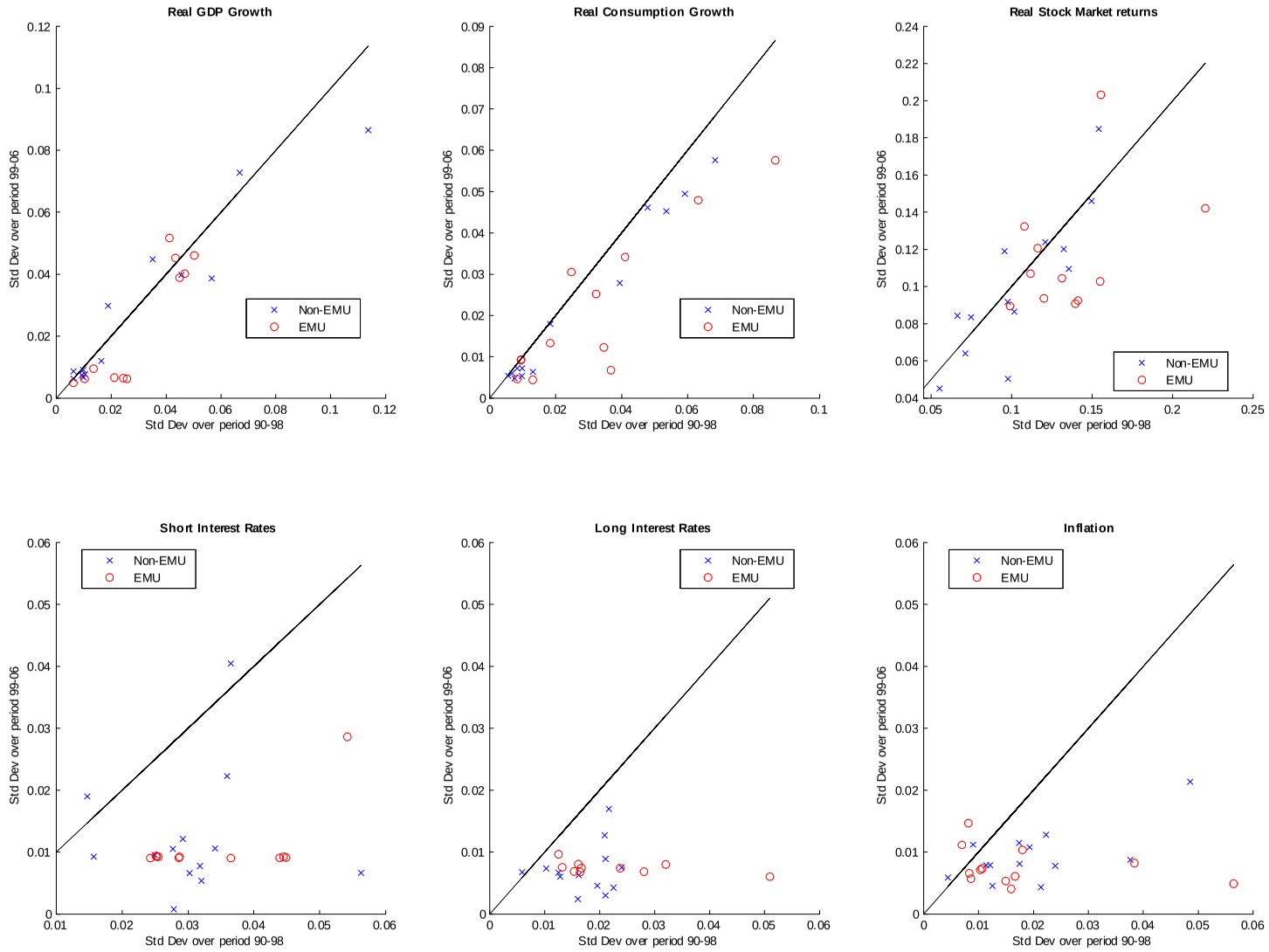

Figure 1: Cross-plots of volatilities in the pre-EMU (1990-98) and EMU (1999-2006) periods. For country i these are the standard deviations of x^i where x stands for the growth rate of output, consumption and the stock market index for the real variables and changes in interest rates and inflation for the nominal variables. Points below the line (45 degree) indicate lower volatility in the EMU period than before.

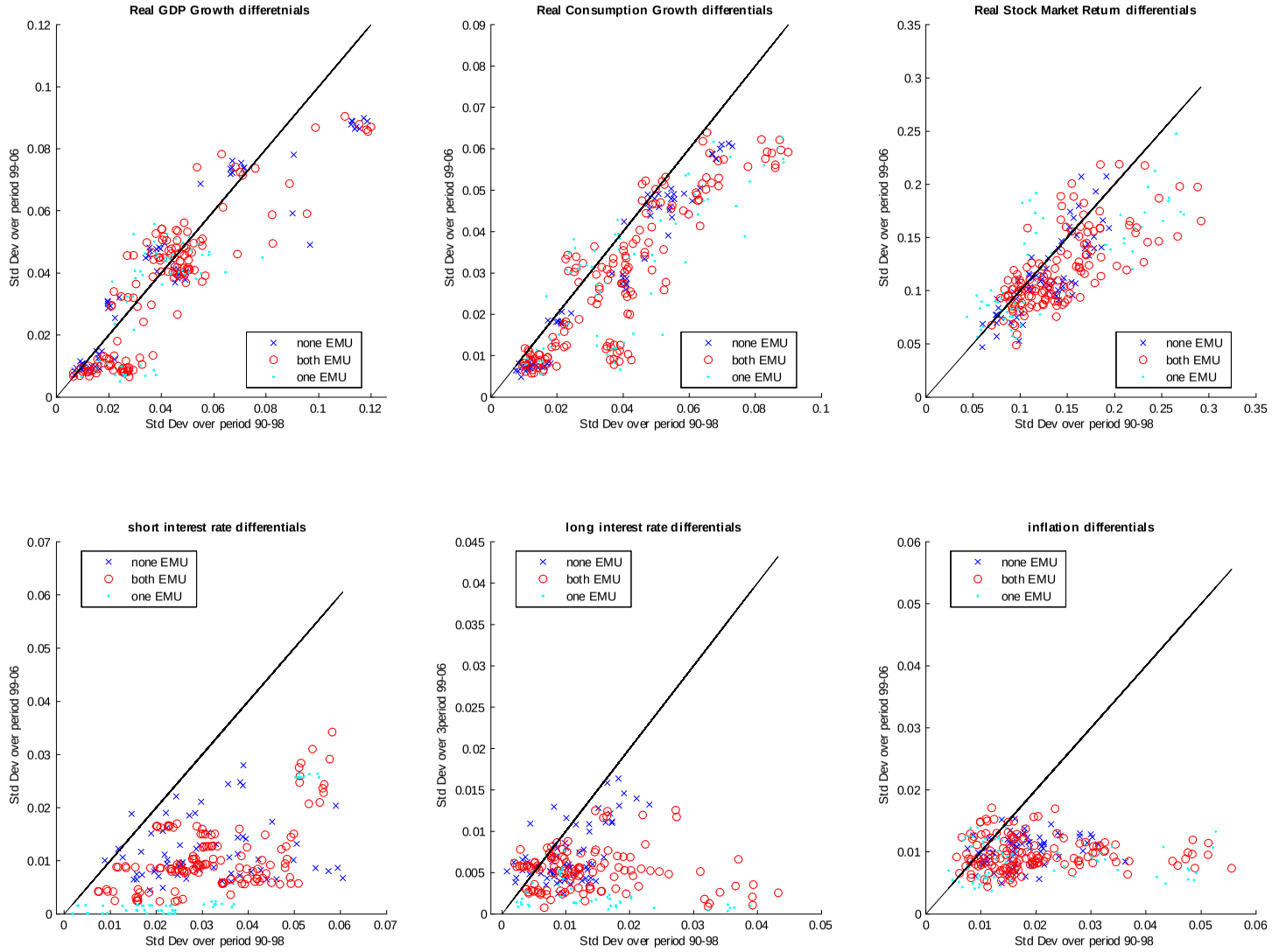

Figure 2: Cross-plots of country-pair specific volatilities in the pre-EMU (1990-98) and EMU (1999-2006) periods. For a country pair $i\ j$, these are the standard deviations of $x^i - x^j$ where x stands for the growth rate of output, consumption and the stock market index for the real variables and changes in interest rates and inflation for the nominal variables. Points below the line (45 degree) indicate lower volatility in the EMU period than before.