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# *Evidence on the Costs of Intra-European Exchange Rate Variability*

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**Summary**

This paper finds that intra-European exchange rate variability has a statistically strong - and economically non-negligible - negative impact on (un)employment and investment for most EU member countries (including France and Germany). No similar effect was found for dollar variability. Robustness tests show that this result holds up in the presence of policy instruments (e.g. interest rates) and cyclical variables (e.g. GDP growth) that might have also an impact on exchange rate variability. A simple model of the 'option value of waiting' suggests that even short term spikes in volatility can have a strong impact on investment and employment.

*JEL-classifications*: E22, E24, F41

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## 1. Introduction: Why Care About Exchange Rate Variability?

Eliminating intra-European exchange rate variability is often portrayed as one major advantage of EMU (reducing it was already a goal of the creation of the EMS in 1979). But why should politicians and economists care about exchange rate variability? Up to now the answer has usually been that exchange rate variability discourages trade. Unfortunately, a large empirical literature on this issue has not been able to document a strong link between exchange rate variability and the volume of trade. What has not been considered so far is the possibility that exchange rate variability could have an impact on other real variables.

Our prior (and we presume the prior of many economists) was that there should be no link, especially no link between exchange rate variability and unemployment, but the results presented below are not consistent with this prior. The results reported below show that it is difficult to maintain the hypothesis that intra-European exchange rate variability does not have a significant impact on unemployment, job creation and investment.

At this point it is useful to make a digression to address the widely held prior that since exchange rate variability has little impact on trade it cannot have a strong impact on (un)employment. We would argue that the absence of a strong impact of exchange rate variability on the volume of trade does not imply that there should be no link between exchange rate variability and (un)employment and investment. This becomes clear once one asks the question: why would an increase in exchange rate volatility lead quickly to a lower volume (flow) of trade? The theoretical models that are used in this context start typically from the idea that in order to export one needs to sustain a sunk cost. This sunk cost is meant to represent the need to build up a distribution system in foreign markets and that this is really a sunk cost like in the bare bones model used here. But within Europe most firms already have a very elaborate distribution network in all member countries. A German automobile manufacturer will typically not have to build up a new distribution system in order to increase sales in other European countries. Hence we would argue that certainly for intra-European trade (the focus of our empirical work) market access costs cannot be the main reason why exchange rate volatility should affect trade.

Of course, an increase in volatility will lead firms to discount future profits from exports more heavily (as often assumed in the literature and also in the model used by us, see below). But this implies only that firms will invest less in export (or in general in trade-) oriented activities. This might depress future export (trade) volumes but firms will not necessarily export less in the short run just because exchange rate variability has increased. The long run response will be much more difficult to isolate in empirical

work because there are other long run trends (e.g. reduction in transport costs, shifts in tastes, etc.) and because variability changes so much over time. Trade volumes today might be a function of some average of the variability experienced over a number of years but this would be difficult to measure even with the annual data on volatility that is often used.

The recent experience with large exchange rate swings in Europe has once again shown that there is a lot of 'pricing to market' (Dornbusch, 1987, and Krugman, 1989; CEC (1995) documents the more recent European data) i.e. firms keep local prices fixed even in the face of large exchange rate changes. This implies that quantities react little to exchange rates, but profits by much more. Firms just keep producing and export more or less the same amount, but their domestic currency earnings become variable whereas their domestic cost remain stable. Exchange rate variability can thus certainly influence the variability of profits.

If firms react to an increase in exchange rate (and hence profit) variability in the first instance by reducing investment in trade related activities one would expect little impact on trade flows in the short run, but, potentially at least, a significant short run impact on investment (as we find) and on (un)employment because investment is an important component of demand. Moreover, in most continental European countries (and even in the UK until the 1980s) hiring workers represents also an investment in the sense that there are high costs to reversing this decision. This is an additional reason (independent of the demand effect) why exchange rate variability should affect (un)employment. Moreover, if labour is *de facto* a semi-fixed factor of production short run marginal costs of changing the volume of production must be very high. This fits well with the observed sluggishness of reaction of the volumes of trade to exchange rate changes mentioned above. (If consumers have adjustment costs in switching between products one could also explain why arbitrage across markets does not take place instantaneously and hence why local currency prices react so little to exchange rate changes.)

We would therefore argue that exchange rate variability should have little impact on production and export sales in the short run.[1] A change in the exchange rate that affects the profitability of exports will, of course, lead firms to look for ways to expand (or reduce) production in the short run. But this can be achieved by varying the utilization rate of the existing labor force, e.g. through over-time, or by putting employees on short time (e.g. Abraham and Houseman, 1993). However, firms will typically be reluctant to engage new labor (which involves a heavy sunk cost in most European countries) if the

[1] In a previous version of this paper we also investigated the impact of exchange rate variability on industrial production. We dropped this variable in the light of the arguments discussed here.

variability of the exchange rate is high so that the probability that this labor will not be used after all is also high. The model in the next section formalizes this idea.

Our emphasis is on intra-European exchange rates because only their variability could be suppressed by EMU. We therefore measured variability against the currencies of the 7 other original members of the ERM: Germany, Benelux, Denmark, France, Ireland, Italy, Netherlands. The ERM countries also represent the most likely early candidates for membership in EMU. A further reason why these initial ERM countries constitute a useful sample is that when the EMS was created, politicians used to emphasise the gains from exchange rate stability. However, we also tested whether the variability of the dollar exchange rate had a similar influence (and found in general negative results).

In this paper we consider the influence of this measure of intra-European exchange rate variability on two key labour market indicators as well as one other indicator linked to popular explanations of the impact of financial volatility on the real sector (Dixit, 1989, Aizenman and Marion, 1996, Ramey and Ramey, 1995). The three indicators of the real sector we used were: i) (changes in) unemployment, ii) manufacturing employment growth, iii) (growth of) investment.

The outline of the paper is as follows: section 2 presents a simple model of investment and uncertainty. It discusses a possible transmission channel that could account for a negative relationship between uncertainty and (un-) employment. Section 3 explains our measure of exchange rate variability. Section 4 then starts with the empirical results. Section 4a presents the results of some simple causality tests for all 12 EC members as of 1994. Section 4b checks whether these results are robust to some alternative explanations and to an alternative estimation procedure. It is tested empirically whether the results hold up in the presence of policy instruments (e.g. interest rates) and cyclical variables (e.g. GDP growth) that might have also an impact on exchange rate variability. Section 5 concludes.

## 2. Investment and Uncertainty: The Option Value of Waiting

### 2a. The Basic Model: No Risk Aversion

The following crude model is designed to illustrate the basic idea underlying the 'option value of waiting' à la Dixit (1989)[2]. The model does not pretend to be close to reality. It was designed to convey the basic idea in a simple way. Moreover, we wanted to present model that allows us to ask whether even a temporary, short run increase in uncertainty can have a strong impact on investment.

Consider a set-up in which there are three periods. During the first two periods (called zero and one) a single investment project can be undertaken that will bear fruit during the following periods. If this project is undertaken during period zero it yields a return during periods one and two. If it is undertaken during period one it yields a return only during period two.

The investment project starts with a unitary cost that is sunk and its return is uncertain because it depends on the exchange rate (e.g. because costs are in domestic currency but the price is determined by the exchange rate). The return to the investment in period one (i.e. if the set-up cost is undertaken during period zero) has a certain component, denoted by $r_1$, and a stochastic element, e, which is uniformly distributed between $+\sigma_1$ and $-\sigma_1$. An increase in $\sigma$ means an increase in uncertainty, or an increase in the mean preserving spread ($\sigma$ is the standard deviation). The return in period two has also a non-stochastic part, denoted by $r_2$, and it also depends on the exchange rate. The exchange rate is assumed to follow a random walk. The expected exchange rate for period two is therefore equal to the exchange rate realized during period one, denoted by $e_1$. But the uncertainty can persist, hence it is assumed that the exchange rate during period two is distributed uniformly around $e_1 + \sigma_2$ and $e_1 - \sigma_2$. As will become apparent soon the variability of the exchange rate during the second period has no influence on the result. The non-stochastic parts of the returns can differ for many reasons that are not essential to the model and the same applies to the variances.

The (unconditional) expected value of the return from the project, if it is undertaken in period zero, is therefore equal to:

(1) $E_0(I_0) = -1 + r_1 + r_2 > 0 \quad r_1, r_2 > 0.$

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[2] See also lecture two in Krugman (1989). We do not pretend to add substantially to the large literature on the real effects of uncertainty. The literature on the importance of uncertainty distinguishes between an output and an investment channel: Aizenman and Marion (1996), Bernanke (1983), Kulatilaka and Kogut (1996), Pindyck (1991) and Ramey and Ramey (1995).

For simplicity discounting issues and risk aversion are not taken into account in this sub-section so that all decisions can be based only on expected values (the same assumption is used also by Dixit, 1989). To make the problem non-trivial the expected return from investing must be non-negative.

If the firm waits until period one it keeps the option whether or not to invest. It will invest only if the exchange rate realised during period one (and hence expected for period two) is above a certain threshold level, or barrier, denoted by b. Given that an investment in period one yields a return only during period two, this barrier to make the investment just worthwhile is given by the condition that the expected period two return equals at least the set-up cost:

(2) $-1 + r_2 + b = 0$ or $b = 1 - r_2$.

The decision whether or not to wait will be based on the expected value of that strategy, which is given by:

(3) $E_0(I_1) = 0\,[(\sigma_1+b)/2\sigma_1] + [(\sigma_1-b)/2\sigma_1]\,[-1 + r_2 + (\sigma_1+b)/2]$.

where the first element is the probability that it will not be worthwhile to invest (in this case the return is zero). The second term represents the product of the probability that it will be worthwhile to invest (because the exchange rate is above the threshold) and the average expected value of the return under this outcome. Given condition (2) this can be rewritten as:

(4) $E_0(I_1) = (\sigma_1-b)\,[-b + (\sigma_1+b)/2] / 2\sigma_1$,

simplifying and collecting terms yields:

(5) $E_0(I_1) = (\sigma_1-b)^2 / 4\sigma_1$.

This is the key result since it implies that an increase in uncertainty increases the value of the waiting strategy. Formally this results from the fact that in this model $\sigma_1$ must exceed b (otherwise the exchange rate could never reach the threshold). Equation (5) is then an increasing function of $\sigma_1$. As $\sigma_1$ increases it becomes more likely that it is worthwhile to wait until more information is available about the expected return during period two. At that point the firm can avoid the losses that arise if the exchange rate is unfavourable by not investing. This option not to invest becomes more valuable with more uncertainty. The intuitive explanation is that waiting implies that the firm foregoes the expected return during period one, but it keeps the option not to invest, which is valuable if the exchange rate

turns out to be unfavourable. The higher the variance the higher the potential losses the firm can avoid and the higher the potential for a very favourable realization of the exchange rate, with consequently very high profits.

The difference between the two expected returns is equal to:

$$(6) \quad E_0(I_1) - E_0(I_0) = (\sigma_1 - b)^2 / 4\sigma_1 - (r_1 - b).$$

An increase in the expected return to period one ($r_1$) makes it obviously less likely that it will pay to wait.

An interesting special case is that of $b = 0$ (the non-stochastic component of the second period return equals the set-up cost; in this case the unconditional expectation of the overall return to the project (if undertaken immediately) is equal to $r_1$). In this case expression (6) collapses to:

$$(7) \quad E_0(I_1) - E_0(I_0) = \sigma_1/4 - r_1.$$

The standard deviation of the exchange rate (or rather of the impact of the exchange rate on the return) would have to be four times as large as the non-stochastic part of the return in period one to make waiting the better choice. Dixit (1989) found a strongly non-linear relationship between the incentive to wait and uncertainty. The linearity of expression (7) implies that the model does not replicate the conjecture that small variations in uncertainty can have large a large on impact the incentive to postpone investment decisions.[3]

An important implication of the model is that only the current, short term uncertainty $\sigma_1$ has an impact on the decision to wait. Future uncertainty, represented here by $\sigma_2$, does not enter in the decision under risk neutrality. If one takes a fixed period, e.g. one year, the likelihood that investment will be postponed to the end of that period depends only on the uncertainty during that period and not on future uncertainty. This implies that even short spikes in uncertainty can have a strong impact on investment.

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[3] An interesting aspect of this crude model is that it does not contain an important assumption of Dixit (1989), namely that the uncertainty is resolved at the end of the first period. In reality uncertainty is usually not resolved, but persists. In a model with an infinite horizon this could imply that the same decision represents itself every period in the same way. EMU constitutes an exception to the rule that uncertainty just continues in the sense that the start of EMU should definitely eliminate uncertainties about the economic environment. In this sense the start of EMU might boost investment.

This crude model has abstracted from risk aversion. However, we would argue that the basic conclusion that even a temporary increase in uncertainty can make a postponement of investment optimal does not change is robust because a prolonged period of high uncertainty means that expected returns beyond the next period would be discounted more heavily. The next sub-section proves this point formally.

### 2b. Risk Aversion

In this sub-section we present a variant of the model in which future returns are discounted and where the discount factors depend on variability to capture the idea that if there is risk aversion future returns are discounted more heavily if they are more variable.[4] The discount factor applied to period one returns is denoted by $A_1$ and the factor used to discount period two returns back to period one is denoted by $A_2$. The equations of the model have thus to be modified in the following way:

(1)' $E_0(I_0) = -1 + A_1r_1 + A_2r_2 > 0 \qquad r_1, r_2 > 0$ and $A_1, A_2 < 1$,

(2)' $-1 + (A_2r_2 + b) = 0$ or $b = A_2^{-1} - r_2$,

(3)' $E_0(I_1) = 0\ A_1A_2\ [(\sigma_1+b)/2\sigma_1] + [(\sigma_1-b)/2\sigma_1]\ A_1[-1 + A_2(r_2 + (\sigma_1+b)/2)]$,

(4)' $= (\sigma_1-b)\ A_1A_2[-b + (\sigma_1+b)/2] / 2\sigma_1$,

(5)' $E_0(I_1) = A_1A_2(\sigma_1-b)^2 / 4\sigma_1$, and

(6)' $\text{Diff} \equiv E_0(I_1) - E_0(I_0) = A_1A_2(\sigma_1-b)^2/4\sigma_1 - (-1 + A_1r_1 + A_1A_2r_2)$.

We introduce risk aversion in a crude way by just assuming that the two discount factors depend on the uncertainty for the two corresponding periods, i.e. $A_1 = A_1(\sigma_1)$ and $A_2 = A_2(\sigma_2)$ with both $A_1'$ and $A_2'$ negative (the discount rate goes up with uncertainty). The partial effects of a change in $\sigma_1$ is then given by:

$$(8)\ \frac{\partial \text{Diff}}{\partial \sigma_1} = A_1'\left[\frac{A_2(\sigma_1 - b)^2}{4\sigma_1} - (r_1 + A_2r_2)\right] + \frac{A_1A_2\left[\sigma_1 2(\sigma_1 - b) - (\sigma_1 - b)^2\right]}{4\sigma_1^2},$$

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[4] We are aware of the fact that the discount rate should really depend on the covariance of the risk with market risk. We ignore this aspect, which is appropriate if the market for risk is not efficient. See also Dixit (1989).

or, after simplifying the second term on the RHS:

$$(8)' \quad \frac{\partial \text{Diff}}{\partial \sigma_1} = A_1^{'}\left[\frac{A_2(\sigma_1 - b)^2}{4\sigma_1} - (r_1 + A_2 r_2)\right] + \frac{A_1 A_2(\sigma_1^2 - b^2)}{4\sigma_1^2}.$$

In the neighbourhood of the point where Diff = 0, i.e. where the firm is just indifferent between waiting and investing today this term in square brackets is equal to minus one. This implies that an increase in period one uncertainty will induce a firm that was indifferent to prefer waiting.

The partial effect of an increase in period two uncertainty is given by:

$$(9) \frac{\partial \text{Diff}}{\partial \sigma_2} = A_1 A_2^{'}\left[\frac{(\sigma_1 - b)^2 + 2(\sigma_1 - b)/A_2}{4\sigma_1} - r_2\right],$$

using the definition of b this can be simplified to:

$$(9)' \quad \frac{\partial \text{Diff}}{\partial \sigma_2} = A_1 A_2^{'}\left[(\sigma_1^2 - b^2) - 2(\sigma_1 + b)r_2\right]/4\sigma_1.$$

This expression can be positive or negative, even around the point Diff=0. It follows that an increase in period two uncertainty could either increase of diminish the incentive to wait. This implies that a simultaneous increase in $\sigma_1$ and $\sigma_2$ (i.e. a long run increase in uncertainty) could have actually a weaker impact on investment than a short run increase in uncertainty (an increase in only $\sigma_1$). This does not have to be the case, but it becomes more likely the higher the starting level of short run uncertainty, i.e. the higher $\sigma_1$.

For the special case b = 0 the two partial derivatives simplify considerably and the partial effects are given by:

$$(8)'' \quad d(\text{Diff}) = [(A_2(A_1'\sigma_1 + A_1)/4 - A_1'(r_1 + A_2 r_2)]\, d\sigma_1$$

$$= [A_2 A_1'(\sigma_1/4 - r_2) + A_1 A_2/4 - A_1' r_1]\, d\sigma_1 \quad \text{and}$$

$$(9)'' \quad d(\text{Diff}) = A_1 A_2' [(\sigma_1 - 2r_2)/4]\, d\sigma_2.$$

What is the intuition behind the result that the impact of second period uncertainty could be either positive or negative? An increase in period two uncertainty increases the discount rate applied to all period two returns. The present value of the difference between the expected return of the two options (invest today or tomorrow) therefore falls when this difference is positive to begin with. For a firm that is just indifferent it must be the case that the expected period two return under waiting ($\sigma_1/4$) is smaller than the expected period two return if investment takes place today ($r_2$) because under this strategy the firm would also reap the first period return. The intuition is that waiting postpones all revenues into the future, this becomes less attractive if the discount rate increases. Expression (8) contains additional terms because an in increase in period two uncertainty also affects b (i.e. the threshold exchange rate). This is why the sign of the partial effect depends on the difference between $\sigma_1$ and $2r_2$ (instead of the difference between $\sigma_1$ and $4r_2$). This result implies that it is possible that a temporary increase in uncertainty (an increase in $\sigma_1$ alone) has a stronger impact on investment than a persistent increase in uncertainty (i.e. an increase in $\sigma_1$ and $\sigma_2$).[5]

The slope of the function that links $A_2$ to second period risk has no influence on the *sign* of the partial effect of second period uncertainty on investment. This implies that the degree of risk aversion (and/or market imperfection) that implicitly determines the nature of the function $A_2(\sigma_2)$ has no bearing on the question of whether future uncertainty should increase or hinder investment today. The magnitude of the effect depends, however, clearly on $A_2'$.

A numerical example can illustrate the potential for even short run variability to influence investment decisions. Assume $A_2 r_2 = 1$. This implies that $b = 0$, so than one can use the simpler expression (9)". For a firm that is just indifferent between investing today or postponing, which implies that Diff = 0, one can obtain a simple expression since in this case:

(10) $A_1 A_2 \sigma_1 / 4 = A_1 r_1 + A_1 - 1.$

This expression can be viewed as a condition for $\sigma_1$ in terms of $A_1$ and $r_1$. Substituting out for the former in (9)", using b=0 and simplifying yields:

(11) $d(\text{Diff}) = A_1 A_2' [ (2A_1 r_1 + A_1 - 2) / 2 A_1 A_2 ] d\sigma_2.$

[5] Equation (9)" seems to suggest that $r_2$ needs to be large (i.e. if most of the return comes in period two, which could be defended under the assumption that the second period implicitly contains the entire future) so that an increase in period two uncertainty (an increase in $\sigma_2$) will increase the probability that postponing investment is the best choice. However, one has to keep in mind that under the maintained hypothesis of $b = 0$ $r_2$ is equal to $A_2^{-1}$ to keep the threshold exchange rate at zero. Hence, the present value of the second period return is fixed by assumption.

The expression in round brackets on the RHS can clearly be positive. For example if $A_1 r_1$ is also equal to one (one half of the revenues come from each period) an increase in $\sigma_2$ would always reduce Diff and hence be an incentive to invest now instead of waiting.

What does this little model show? We retain two conclusions: i) Even a temporary 'spike' in exchange rate variability can induce firms to wait with their investment. ii) The relationship between exchange rate variability and (un)employment should go partially via investment demand. A direct impact of exchange rate variability on employment can arise if one considers that the investment project (that is at the core of the simple model presented here) could also just stand for training a new shift in the use of existing machinery. Even if it were possible to fire these workers rapidly the investment in training would still be lost if the firm does not decide to export after all. The sunk cost aspect of hiring a new group of workers would be even stronger if they could then not be fired. In this interpretation the model would imply that an increase in uncertainty, even if only in the short run, could have a direct and immediate impact on employment, that is independent of the channel via investment demand.[6]

Our model is not detailed enough to have implications in terms of persistence. A simplistic interpretation in which the set-up cost consists just of the construction of a factory would imply that a short term increase in exchange rate uncertainty should increase unemployment in the short run, but should not have long run effects. However, it has often been argued that in Europe there is hysteresis; i.e. even temporary shocks can have permanent effects on unemployment. One channel through which hysteresis can arise is that the human capital of workers that have been fired depreciates rapidly so that they will not be able to find a new job at the old wage because they will have become less productive (see e.g. Blanchard and Diamond, 1994) If one interpretes the set-up cost as relating to human capital this view could also be compatible with the model presented here. Hence even in our set-up there could be strong hysteresis. However, some readers might have a strong prior that temporary shocks cannot have permanent effects. We do not want to take a stance on this issue here because it is not central to our analysis. Moreover, the results we present below are compatible with both views.

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[6] Though our model is mainly micro-founded, it could be aggregated to the macro-level along the lines of the Belke and Göcke (1994) model of micro- and macro-hysteresis in employment. In that model, a short-term increase in exchange rate uncertainty would lead to an increase in the width of the micro- and the macro-hysteresis loop and, thus, to significant real effects of short-term spikes in uncertainty.

### 3. The Operational Definition of Exchange Rate Variability

The variability of the currency of each country was measured by taking for each year the standard deviation of the 12 month-to-month changes in the logarithm of its nominal exchange rate against the currencies of the 7 ERM countries mentioned above. We used nominal exchange rates although one could argue that real exchange rates are more important for trade and other real variables. However, as is well known, over a monthly horizon real and nominal exchange rate changes are practically indistinguishable. The 7 standard deviations based on bilateral rates were then aggregated in one composite measure of exchange rate variability (denoted by "exv" below) weighing them by the weights of the countries in the ECU (which correspond approximately to their weights in terms of GDP). We preferred to aggregate the standard deviations instead of using the standard deviation of some average or effective exchange rate because there is extensive evidence that exporters price to market.[7] Dollar volatility was defined simply as the standard deviation of the 12 changes in the logarithm of the national exchange rate against the US dollar.

We use monthly exchange rates to calculate volatility instead of daily volatility because the required data were easier to obtain on a consistent basis for the entire sample period and all the countries we looked at. Another reason to prefer this measure over more short term alternatives (e.g. daily variability) was that we are convinced that while the latter might be important for financial actors it is less relevant for decisions whether to export or invest, which have a longer time horizon. The drawback of this decision was that we had to use annual data in order to have a meaningful measure of variability. We thus had only about 20-25 observations for each country, but this turned out to be sufficient.

In principle one could have used option prices to extract implicit forward looking volatilities, but options prices are generally available only for the US dollar and sometimes against the DM, and even then only for limited periods. Hence it would not have been possible to construct a measure of intra-European volatility on a consistent basis using option prices. We used actual exchange rate changes instead of only un-anticipated ones, but at the monthly horizon the anticipated change is usually close to zero given the small interest rate differentials in Europe.[8] Hence actual and un-anticipated changes

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[7] See Burgess and Knetter (1996) and Dornbusch (1987). For ERM members exchange rate variability was calculated only against the 6 remaining ERM partners, for non-ERM members variability was calculated against 7 currencies.

[8] For Europe an interest rate differential of 6% p.a. would already by large. This corresponds to an expected rate of depreciation of 0.5% per month., lower than the standard deviation actually observed.

should give the same results (see also Bundesbank, 1996, pp. 67 ff., Gros and Thygesen, 1992, p. 102, and Peeters, 1997, pp. 5 ff.).

The annex 1, Table 3 shows some of the descriptive statistics of exchange rate variability. The average for Germany was 0.64 (percent per month), with a peak of 1.5 and a low value of 0.25. For the UK variability is much higher, with a peak of 3.9 (again percent per month) and an average of 2.25.

Estimates of the standardized spectral density of the variability measures for some countries are finite or a kind of borderline at the zero frequency and the results of unit root tests -both from the Dickey-Fuller and the Phillips-Perron type are sometimes borderline. We therefore felt justified to use *both levels and changes* of our variability measure. As additional tests on the basis of necessarily modified critical values show that these tests indicate stationarity as soon as structural breaks are implemented in the test equations (Perron, 1989, Belke, 1996). Though it cannot take the place of a formal time series test, already a visual inspection of the variability series in the annex reveals that variability is much higher in the seventies than in the following period. Annex II shows the results of stationarity tests (McKinnon, 1991) and Phillips and Perron, 1988)) for exchange rate variability and all the other variables used below. We generally differenced the data until it was stationary. This led us to use the first difference in unemployment rates, the first difference in the index of manufacturing employment, and percentage changes in investment at constant prices.

In cases of doubt we always preferred taking differences since the disadvantages of differencing when it is not needed appear to us much less severe than those of failing to difference when it is appropriate. In the first case the worst outcome would be that the disturbances are moving average, but the estimators would still be consistent, whereas in the second case the usual properties of the OLS test statistics would be invalidated. Another reason for generally differencing was that this allows us to use the same approach for all countries. However, we generally repeated our test also in levels and found in most cases that the results were even stronger than the ones reported here for the first differences.

All series were taken from the Ameco data set of the EC Commission.

### 4a. Simple Tests: First Results

As a first step we present the results of some simple tests, i.e. we explained the three variables mentioned by their own past and lags of our measure of exchange rate variability. The results reported

below in tables 1 and 2 are thus standard causality tests on the annual data used throughout this paper.[9] The hypothesis tested was, as usual, that exchange rate variability does not have an influence on the four variables investigated here. For each country the coefficient estimate and its significance level is given. The expected sign of the (change in) exchange rate variability is positive for (the changes in) unemployment and negative for (the changes in) manufacturing employment) and investment (INV). The specification of the underlying equations was based on the usual diagnostics combined with the *Schwarz Bayesian Information Criterion (SCH)*. I.e. the regression which reveals the lowest SCH-value (given the same number of observations for the alternative specifications) and at the same time fulfills the usual diagnostic residual criteria is chosen (Banerjee et al., 1993, p. 286, Mills, 1990, p. 139, and Schwarz, 1978). The sample has been chosen to be 1973 to 1996 in order to exclude the Bretton Woods period of fixed exchange rates. Only significant entries are tabulated. The procedure was exactly the same for each country and we never intervened to excercise a discretionary judgement. To account for possible breaks in the (level) relations we add country specific dummies using the following criterion: dummies are added when they improve the SCH statistics and, at the same time, contribute to fulfil the criteria on the residuals. However, as numerous tests for robustness (which are available on request) showed, none of our results is due to the implementation of these dummies.

[9] We thus use VARs in first differences of the respective real variables. Since we classify all real variables as integrated of order one we feel justified to deviate from the usual specification of an Augmented Dickey-Fuller test (including a drift term) only by neglecting the (insignificant) lagged endogenous level variable. The significance of the coefficient estimates of the lags of the changes in the real variables and of the indicator of exchange rate variability can then be judged on the basis of the usual standard normal resp. the asymptotic values of the student-t-distribution. Cf. Haldrup (1990), p. 31 f.

*Table 1: Level of Exchange Rate Variability and the Real Sector (OLS)*

| Country | Changes in Unemployment | Changes in Manufacturing Employment | Changes in Investment |
|---|---|---|---|
| BE | (0) 0.52* | | |
| DK | (-1) 0.83** | | |
| ES | (-1) 0.28* | | |
| FR | (-1) 0.42** | (-1) -1.60*** | (-1) -4.97*** |
| | | | (-2) 5.71*** |
| GR | (0) 0.10** | n.a. | (-1) -2.07** |
| | (-1) -0.10** | | (-2) 1.74* |
| IR | (-2) 0.55*** | (-1) 1.14** | (0) 2.95* |
| IT | (-2) 0.16* | | |
| NL | (-1) 1.07*** | (-1) -1.57** | (-1) -3.40** |
| PO | (-1) 0.14** | (0) -0.81** | |
| UK | (-2) 0.43** | (0) -1.08* | (0) -2.66* |
| WD | (-1) 0.67** | (-1) -3.33*** | (0) -7.53*** |

The table summarises results from regressions on annual data (1973-1996); */**/*** indicates significance at a=0.1/0.05/0.01. Additional country-specific dummies were included when necessary. Lag order of exchange rate variability in brackets. n.a.: not available.

*Table 2: Change in Exchange Rate Variability and the Real Sector (OLS)*

| Country | Changes in Unemployment | Changes in Manufacturing Employment | Changes in Investment |
|---|---|---|---|
| BE | | | |
| DK | (-1) 0.73** | | |
| ES | | | |
| FR | (-1) 0.44*** | (-1) -0.84* | (-1) -5.93*** |
| GR | (-0) 0.10*** | | (-1) -1.91** |
| IR | (-2) 0.37* | (-1) 1.01* | |
| IT | | (0) -0.46* | (-2) -1.28* |
| NL | (-2) 0.94*** | (-2) -1.56*** | (-1) -2.76* |
| PO | (-1) 0.12** | (0) -0.82** | (-2) -1.56* |
| UK | | | (0) -1.66* |
| WD | (-1) 0.56** | (-1) -1.99** | (0) -6.67*** |
| | | | (-1) -6.69*** |

For notes see table 1.

The first column of table 1 contains a rather strong result: all 11 countries considered here show a statistically significant influence of exchange rate variability on employment. We were surprised to find that there are *more entries for unemployment* than for manufacturing employment as can be seen by comparing columns one and two. (This was not the case for changes in variability considered in table 2). One possible explanation for this might be that the transmission of exchange rate variability effects to the labour market does not primarily work via the export channel as argued above. Not surprisingly, there are fewer significant entries when we work with changes in exchange rate variability, but there is clear pattern across countries. Most countries show either no entry at all, or three or more. We were

surprised to find that Belgium, the most open economy in our sample, has few significant entries, but this country is often a borderline case, moreover, a lot of the trade that appears in Belgium statistics is really transit trade and does not affect the Belgian economy. The positive coefficient of IREXV with respect to changes in investment (wrong sign) in Table 1 becomes clearly insignificant if one takes into account that there have been de facto fixed exchange rates to the British pound until 1979 and corrects the sample for this (1980-1996).[10]

Regressions covering *the whole available* time span from 1960 to 1996 gave rather similar results. One justification for an inclusion of the Bretton Woods period might be that our indicator of exchange rate variability points to significant spikes of volatility during that period. But these were usually discrete devaluations during a period that was otherwise characterised by stable rates. Let us now turn to a more specific interpretation of the above results.

**i) Unemployment**

Since the unemployment rates of all countries in the sample have been found to be non-stationary, the analysis was performed using the changes in the unemployment rate, called "DUE". The nature of the results can be seen by looking at one specific result, e.g. that for Germany. The procedure based on the SCH criterion led to a simple OLS regression of "DWDUE" on its own past (two lags, DWDUE(-1) and DWDUE(-2)) and the measure of exchange rate variability during the previous year (EXV(-1)) over the period 1973-96, as shown in the annex.

Given that only one lag of exchange rate variability turned out to be important, one can directly use the t-statistic to check for the significance of the effect. The value of 2.44 is highly significant in the sense that the probability to find this effect if it does not exist in reality is much lower than the usual a=0.05. The point estimate implies that a reduction in the variability measure "DEEXV" by one percentage point reduces unemployment after one year by 0.67% (given a workforce of about 30 million this amounts to about 200 thousand unemployed less). One could thus argue that EMU, which would eliminate (intra-European) exchange rate variability, could reduce unemployment by about two thirds of one percentage point if the starting level is the value of about 0.8 (% per month) for "DEEXV" in 1995. Compared to the German unemployment rate of 9% reached in 1995, this is a small, but still non-negligible contribution. The effect would actually be somewhat stronger during the next period

[10] With respect to changes in unemployment/employment the significance level shrinks from 0.99 to 0.95/0.95 to 0.90.

given the high coefficient on the lag of the dependent variable. This pattern fits well with the observed increase in German unemployment in 1996 and 1997.

### ii) Employment

A similar story emerges when one does the same test on the rate of employment growth in manufacturing. (called "D(EMPLMANWD)", defined as the first difference in the index of employment manufacturing, i.e. roughly speaking percentage change in the number of employed persons). For Germany our automatic procedure led to the simple OLS regressions of this variable on its own past and on exchange rate variability during the previous years that is reported in the annex.

Exchange rate variability has a significant impact on the German labour market from this angle as well (the t-statistic on exv(-1) is -3.94, implying that the likelihood of obtaining this result by chance is less than one in 1000). The point estimate implies that eliminating the exchange rate variability of 1995, should lower, ceteris paribus, the rate of employment growth by about 2.6 percentage points (3.3*0.8); this would be equivalent to about 230 thousands of jobs in manufacturing lost.[11] This is very close to the impact on unemployment mentioned above, suggesting that most of the impact of exchange rate variability is in the tradables sector, as one would expect.

### iii) Investment

Again, the results are similar (across countries) in the sense that countries that show an impact of exchange rate variability on employment or unemployment also show one for (the growth rate of) investment. Somewhat surprisingly two large countries (F and WD) show the largest coefficient. The point estimates for the coefficients on exv of between 5 and 7 mean that the elimination of 1995 exchange rate variability should boost investment by between 4 to 5 % this would be equivalent to a demand shock of about 1 % of GDP. With an Okun coefficient of between 3 and 5 this effect would be equivalent to a fall in unemployment of between one third and one fifth of one percentage point, i.e. somewhat lower than the direct impact on unemployment calculated above.

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[11] The impact multiplier for manufacturing employment is nearly three times higher than that for the annual percentage change in the total occupied population. Given that manufacturing accounts for about a third of total employment this also suggests that most of the effect is in the tradable sector.

All in all the results of this section thus suggest that eliminating exchange rate variability could have substantial positive effects since it should reduce unemployment and increase employment in manufacturing and investment.[12]

### 4b. Robustness

The purpose of this section is to report the results of some tests for the robustness of the relationships found so far. As a first step, we try to take into account the three most plausible ways in which exchange rate variability could stand for some other variable. For each hypothesis we then implement the same procedure based on the SCH criterion explained above. We do this only *for the first difference* in exchange rate variability since some people might find the hysteresis argument explained above unlikely i.e. that a temporary change in the level of exchange rate variability might lead to a permanently higher level of the unemployment rate. However, the latter long-run characteristic would follow directly from our regression equations which include the change in the macroeconomic variables and the *level* of exchange rate variability.

#### 1. The Impact of Potential Shock-Absorbers: Real Exchange Rate, Monetary Policy and $-Exchange Rate-Variability

A first possible reason for the significant negative (positive) correlation of exchange rate variability with (un-) employment might be that this volatility just stands for misalignments of the real exchange rate. This aspect is often stressed for Germany (by German unions and industrialists). The basic argument is simple: the DM is strong when it is also variable. This argument cannot be made with reference to the other currencies that also show a relationship between variability and unemployment, but it needs to be addressed. To test this hypothesis we additionally implement REER in the regressions of Tab. 2 for (economy-wide) unemployment and manufacturing employment. (We did not repeat the procedure for investment since we found so far that there was a close correspondence of the results concerning these latter two indicators and the first two.) This leads to results shown in tables 3 (for unemployment) and 6 (for manufacturing employment). An unchanged positive (negative) sign of DEXV and of DREER is expected in both tables under the hypothesis that variability is not just a proxy for the level.

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[12] To convey a deeper impression of the order of magnitude of the regression results in Table 1 we give examples for West-Germany in Annex 1 (Tables A4-A7).

*Table 3: Change in Unemployment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability, and the Change in the Real Exchange Rate (OLS)*

| Country | Change in Unemployment | Change in intra-ERM Exchange Rate Variability | Change in Real Effective Exchange Rates |
|---|---|---|---|
| BE | (-1)*** | (0) 0.29 (↓) | (-1) 0.18 |
| DK | (-1)*** | (-1) 0.92*** (↑) | (-2) 0.07*** |
| ES | (-1)*** | (-1) 0.16 (↑) | (-1) 0.09* (-2) 0.07* |
| FR | (-1)*** (-2) | (-1) 0.44*** (→) | (0) 0.04** |
| GR | (-1)*** (-3)*** | (0) 0.11*** (→) | (0) -0.01 |
| IR | (-1)*** | (-2) 0.44* (↓) | (-2) -0.04 |
| IT | | (-1) -0.02 (↓) | (-1) -0.03** |
| NL | | (-2) 1.00*** (→) | (-3) 0.05* |
| PO | (-1)*** (-2)** | (-1) 0.12** (→) | (-1) -0.01 |
| UK | (-1)*** | (-2) 0.24* (↑) | (-1) 0.10*** |
| WD | (-1)*** (-2) | (-1) 0.51* | (-2) 0.00 |

Note: The table summarises results from regressions on annual data (1973-1996); */**/*** indicates significance at $\alpha$=0.1/0.05/0.01. ↑ (↓) means that the coefficient becomes more (less) significant than in the respective equation without the additional regressor, here: the real effective exchange rate. Additional country-specific dummies were included when necessary. Lags of respective variables are in brackets.

*Table 4: Change in Unemployment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and Monetary Policy (OLS)*

| Country | Change in Unemployment | Change in Intra-ERM Exchange Rate Variability | Monetary Policy (SPREAD) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.37* (↑) | (-1) -0.11 |
| DK | (-1)* | (-1) 0.68** (↓) | (-2) 0.06 |
| ES | (-1)*** (-2)*** | (0) 0.48* (↑) | (-2) 0.53** |
| FR | (-1)*** (-2) | (-1) 0.37** (↓) | (-1) -0.06 |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)*** | (-1) -0.33**(↑) | (-1) -0.12* |
| IT | (-1)* | (-1) -0.08 (↑) | (-1) -0.10* |
| NL | (-1)*** (-2)*** | (-2) 0.49*** (↓) | (-1) -0.18*** |
| PO | n.a. | n.a. | n.a. |
| UK | (-1)*** (-2)** | (-1) -0.24*(↑) | (-1) -0.07 |
| WD | (-1)* (-2)** | (-1) 0.60** (↑) | (-2) -0.15* |

For notes see table 3.

*Table 5: Change in Unemployment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Change in $-Exchange Rate Variability (OLS)*

| Country | Change in Unemployment | Change in Intra-ERM Exchange Rate Variability | Change in $ Exchange Rate Variability |
|---|---|---|---|
| BE | (-1)*** | (0) 0.39* (↑) | (0) -0.05 |
| DK | (-1)*** | (-1) 0.86*** (↑) | (-3) 0.24*** |
| ES | (-1)*** (-2)*** | (-1) 0.13 (↑) | (-3) -0.35*** |
| FR | (-1)*** (-2)* | (-1) 0.41*** (→) | (-2) 0.09* |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)*** | (-2) 0.35* (↓) | (0) 0.14 |
| IT | (-1) | (-1) -0.15* (↑) | (-1) 0.11 |
| NL | (-1)** | (-2) 0.62** (↓) | (-2) 0.16** |
| PO | (-1)*** (-2)* | (0) 0.02 (↓) | (-1) 0.14*** |
| UK | (-1)*** (-2)*** | (0) -0.20 (↑) | (0) 0.36** |
| WD | (-1)*** (-2)** | (-1) 0.74** (↑) | (0) 0.08 |

For notes see table 3.

*Table 6: Change in Employment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Change in the Real Exchange Rate (OLS)*

| Country | Change in Employment | Change in Intra-ERM Exchange Rate Variability | Change in the Real Exchange Rate |
|---|---|---|---|
| BE | (-1)*** | (-2) 0.69 (↓) | (0) -0.04 |
| DK | (-2)*** | (-1) -0.89* (↑) | (0) 0.15*** |
| ES | | (0) -0.97** (↑) | (0) 0.49*** |
| FR | (-1)*** | (-1) -0.76* (↑) | (0) -0.12** |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)** | (0) -1.02* (↑) | (-1) -0.22* (-2) -0.26** |
| IT | (-1)*** | (0) -0.76** (↑) | (0) -0.21** |
| NL | (-1)*** | (-2) -1.53*** (→) | (-1) -0.10 |
| PO | (-1)*** | (0) -0.67** (↓) | (-1) -0.12** |
| UK | (-1)*** | (-1) 0.11 (↓) | (-1) 0.16 |
| WD | (-1)*** (-2)*** | (-1) -2.90*** (↑) | (-1) -0.05 |

For notes see table 3.

*Table 7: Change in Employment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and Monetary Policy (OLS)*

| Country | Change in Employment | Change in Intra-ERM Exchange Rate Variability | Monetary Policy (SPREAD) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.43 (↓) | (-1) 0.20 |
| DK | (-2)*** | (-1) -0.63 (↓) | (-2) -0.24* |
| ES | (-1)** | (-1) -2.05** (↑) | (-2) 0.63 |
| FR | (-1)*** (-2) | (-1) -1.47** (↑) (-2) -0.97* | (-1) 0.44** |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)*** (-2) | (0) -1.00* (↓) | (-1) 0.24 |
| IT | (-1)*** | (0) -0.62** (↑) | (-2) -0.28 |
| NL | (-1)*** | (-2) -1.65*** (→) | (-1) 0.53*** |
| PO | n.a. | n.a. | n.a. |
| UK | (-1)*** | (0) -0.39 (↑) | (-1) 0.31 |
| WD | (-1)*** | (-1) -1.61* (-2) -2.61*** (↑) | (-1) 0.66*** |

For notes see table 3.

*Table 8: Change in Employment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and Change in $-Exchange Rate Variability (OLS)*

| Country | Change in Employment | Change in Intra-ERM Exchange Rate Variability | Change in $-Exchange Rate Variability |
|---|---|---|---|
| BE | (-1)*** | (-2) 1.01* (↑) | (-1) 0.17 |
| DK | (-2)*** | (-1) -1.31** (↑) | (-2) -0.13 |
| ES | (-1)*** | (-2) 0.63* (↑) | (0) -0.91*** |
| FR | (-1)*** (-2) | (-1) -1.06** (↑) | (-1) 0.20 |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)** | (0) -0.53 (↓) | (0) -0.56 |
| IT | (-1)* | (0) -0.57** (↑) | (-3) 0.14 |
| NL | (-1)*** | (-2) -2.99*** (→) | (0) 0.51*** |
| PO | (-1)*** | (0) -0.77*** (↑) | (-3) 0.50*** |
| UK | (-1)*** | (0) -0.36 (↑) | (-1) 0.29 |
| WD | (-1)*** (-2)*** | (-1) -3.08***(↑) | (-2) -0.24 |

For notes see table 3.

A second argument can be made for the case of Germany, namely that exchange rate variability could be increased by the difficulties EMS-countries had often in following increases of short-term interest rates by the Bundesbank. Again this effect could not really appear for other countries, but if it did manifest itself in Germany it could be the root cause of the impact of exchange rate variability on (un-)employment. If a restrictive national monetary policy leads to employment losses in the short-term, e.g. if there is no proportional wage restraint, this is exclusively assigned to exchange rate variability in tables 1 and 2. However, this problem of identification can be reduced by explicitly adding a variable that indicates the tightness of the national monetary policy to the equation. We used the *spread* (long minus short term interest rates) as the main indicator. Adding only the short term rate to the equation led to similar results. Again, this argument applies mainly to Germany, it should lead to a downward

bias for the weak currency countries. But we checked it nevertheless for all countries in the sample. The respective results for unemployment are shown in table 4. Here we expect an unchanged sign of DEXV and a negative sign of SPREAD (but this is secondary for us). Revised estimations for (manufacturing) employment can be found in table 7 where an unchanged negative sign of DEXV and positive sign of SPREAD makes sense from a theoretical point of view.

Finally, a third argument is that EMS-dollar (or DEM/$) exchange rate volatility (Table A2, Annex 1) influences labour markets in EMS-countries either directly or indirectly via its influence on intra-ERM-volatility. To test this alternative hypothesis the test equations in table 2 are augmented by the $-exchange rate variabilities D(EXVD). Results of the regressions that try to take this last argument into account are tabulated in tables 5 and 8 respectively. In this case we have some interest in the sign and significance of the additional variable. In contrast to tables 3,4 and 6,7 where we concentrate on any changes that might have occured with respect to the exchange rate variability measure.

The broad result that emerges from tables 3 to 8 is that the inclusion of additional variables does not really affect the role of exchange rate variability. There are about as many arrows pointing up (indicating that the inclusion of the control variable increases the significance of exchange rate variability) as there are arrows pointing down (indicating the opposite).

The results in tables 4 and 7 are corroborated by regressions using the change in the interest-rate spread (D(SPREAD)) instead of its level (SPREAD). This was motivated by the impression that the results of the unit root tests displayed in the annex in some cases appear to be borderline though intuition and priors from economic theory tell us that the long- and the short-term interest rate should be cointegrated. The supplementary results are available on request.[13]

We also find that the realisation of the Schwarz-criterion could in most of the cases not be decreased by the inclusion of the different robustness indicators. I.e., the latter do not statistically contribute to an increasing fit after correcting for the gain reached solely by an increasing number of regressors. Moreover, intra-ERM exchange rate variability stays as significant as before or even becomes more significant.[14] A well-known prior -the significance of the interest rate spread in forecasting equations for real activity- is empirically accepted in an impressive manner. The sign is in most cases conforming

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[13] In addition, we complementarily conducted estimations including the *lowest* number of dummies necessary to fulfil the usual residual diagnostics. While ignoring the SCH-criterion in this case, which in our case recommendates the implementation of more highly significant dummies, the results nearly stay the same and are also available from the authors on request.

[14] Note, however, that there are a few - which are accompanied by a change in sign. If the sign moves into the theoretically 'wrong' direction - cannot be interpeted as evidence for our hypothesis.

to economic theory. But despite the inclusion of the important indicator of the stance of monetary policy the coefficient on exchange rate variability stays significant (wherever it was from the start).

## 2. Symmetric Shocks and Common Business Cycles

We have so far estimated all equations independently for each country. However, the disturbance in the regression equation for one country could be correlated with the residual of an equation for some other country, i.e. in the case of symmetric shocks to real variables or 'common business cycles'. In this case, the seemingly unrelated regression SURE estimator is more efficient, because it explicitly takes account of the entire matrix of correlations of all of the equations.

The SURE estimator minimizes the determinant of the covariance matrix of the disturbances. Each iteration of SURE reestimates the parameters after transforming the equations to remove the correlation across the residuals. We take only one iteration since the asymptotic statistical properties of these SUREs are identical to iterating to convergence. Though the SURE method assumes nonstochastic regressors, the presence of lagged dependent variables creates no problem, if the residuals in each equation satisfy the classical assumptions. The reason is that in this case the asymptotic properties of the two-stage Aitken estimator are not affected (Kmenta, 1990, Pindyck, Rubinfeld, 1991, Zellner, 1962). The correct specification with respect to the residuals has been tested inter alia on the basis of the Breusch-Godfrey LM-Test for residual correlation (instead of the DW-test!) and could not be rejected for every regression.

*Tab. 1a: Level of Exchange Rate Variability and the Real Sector (SURE)*

| Country | Changes in Unemployment | Changes in Manufacturing Employment | Changes in Investment |
|---|---|---|---|
| BE | (0) 0.54*** | (0) 0.95** | |
| DK | (-1) 0.97*** | (-2) 1.09* | (-1) -5.71* |
| ES | (-1) 0.26*** | | (-2) 0.91* |
| FR | (-1) 0.41*** | (-1) -1.15*** | (-1) -5.49*** |
| | | | (-2) 5.16*** |
| GR | (0) 0.11*** | n.a. | (-1) -2.30*** |
| | (-1) -0.08*** | | (-2) 1.99*** |
| IR | (-2) 0.39*** | (-1) 1.05*** | (0) 2.48** |
| IT | | (-1) 0.56** | |
| NL | (-1) 1.07*** | (-1) -1.39*** | (-1) -2.36** |
| PO | (-1) 0.12*** | (0) -0.52* | |
| UK | (-2) 0.36*** | (0) -1.28*** | (0) -2.99*** |
| WD | (-1) 0.56*** | (-1) -3.21*** | (0) -8.21*** |

The table summarises results from seemingly unrelated regressions on annual data (1973-1996); */**/*** indicates significance at $\alpha$=0.1/0.05/0.01. Specification of the equations as in Tab. 1. Lag order of exchange rate variability in brackets. n.a.: not available.

*Tab. 2a: Change in Exchange Rate Variability and the Real Sector (SURE)*

| Country | Changes in Unemployment | Changes in Manufacturing Employment | Changes in Investment |
|---|---|---|---|
| BE | (0) 0.37*** | (-2) 0.94*** | (-1) -1.82* |
| DK | (-1) 0.87*** | | |
| ES | | (-2) 0.67** | (-2) -0.94** |
| FR | (-1) 0.26*** | (-1) -0.64** | (-1) -5.74*** |
| GR | (-0) 0.11*** | n.a. | (-1) -1.98*** |
| IR | (-2) 0.24** | (-1) 0.66* | |
| IT | (-1) -0.16** | (0) -0.41** | (-1) -0.70* |
| NL | (-2) 0.84*** | (-2) -1.46*** | (-2) -1.30*** (-1) -2.68** |
| PO | (-1) 0.11*** | (0) -0.64*** | (-2) -1.84*** |
| UK | | | (0) -1.08** |
| WD | (-1) 0.57*** | (-1) -1.80*** | (0) -6.20*** (-1) -6.61*** |

For notes see table 1.

As Tab. 1a and 2a reveal, using a SURE system instead of single equation OLS did affect the results. The gain in efficiency shows up in the fact that (compared to single equation OLS) there are now even *more* significant relationships. At the same time, the significance level increases noticeably on average with respect to all real variables. The model outlined in section 2 implies that even temporary spikes in exchange rate variability can have a strong impact on (un-) employment and investment. This impact might even be stronger in the case of a *temporary* increase in uncertainty than in cases of a persistent increase. But the prior of most readers is likely to be that only a permanent rather than a temporary change in exchange rate variability can permanently affect (un-) employment or investment. We will therefore focus our further interpretation on Tab. 2a.

In the case of investment all countries, except Denmark and Ireland, show a significant impact with the expected sign. Similarly, for the unemployment variable we find a significant relationship in 9 out of 11 countries. For employment we are able to identify 8 out of 10 countries in that respect. But this time there are a few (instead of one for Ireland in the OLS case) wrong signs for Belgium, Ireland and Spain. Seen on the whole, however, the results corroborate our findings shown in Tab. 1 and 2.[15] The

[15] We find significant results both for 'soft-currency' and 'hard-currency' countries. One initial interpretation of our results has been that they are spurious because tensions in foreign exchange markets tended to come during the ERM period when prolonged periods of tranquility (i.e. without realignments) led to large misalignments of real exchange rates because inflation did not converge. We do not agree with this interpretation, which should lead to opposite results for 'hard' and 'soft' currency countries. Moreover, we show below that including the level of the real exchange rate does not affect our results.

strong results for investment (all coefficients of the correct sign, most significant at the 0.05 level) confirms that at least part of the influence of exchange rate volatility comes via this channel.

### 3. Simultaneity of Regressors

One could object against the validity of the above results shown in Tab. 3-8 that since (un-) employment is regressed on real exchange rates, monetary policy and $-exchange rate variability, potential *simultaneity problems* arise. Besides the usual suspects already explained in section 4b, on the one hand, a change in exchange rate variability could influence (un-) employment. On the other hand, (un-) employment could at the same time have an impact on exchange rate variability. Unfortunately, all efforts to apply a TSLS-procedure (including various measures of export demand) were impeded by our inability to find a suitable instrument for exchange rate variability. None of the instruments we tried (inter alia current accounts, U.S. short- and long-term interest rates) did not work to get significant and plausible results. In other words, there is no reason to interpret the latter series as endogenous. Moreover, exchange rate variability in most cases does not influence real variables contemporaneously but *with a lag*. From this point of view, reverse causation is less plausible as mirrored at least for Germany, France, the Netherlands and Greece by the above Granger-causality tests. Table 9 shows the results of pairwise Granger causality tests.

*Table 9: Exchange Rate Variability and the Real Sector: Pairwise Granger-Causality Tests*

| EXV→DUE | EXV→D(EMPLMAN) | EXV→D(INV) |
|---|---|---|
| FR*, WD* | FR*, GR***, NL***, WD*** | FR***, GR*** |

Note: Table displays countries for which H0: D(real variable) does not cause EXV cannot be rejected but at the same time H0: EXV does not cause D(real variable) can be rejected. */**/*** indicates significance at a=0.1/0.05/0.01. Sample is 1973-1996, 2 lags in test equations.

| DEXV→DUE | DEXVD→(EMPLMAN) | DEXV→D(INV) |
|---|---|---|
| WD* | FR*, NL*, WD*** | FR***, GR***, PO** |

Note: Table displays countries for which H0: D(real variable) does not cause DEXV cannot be rejected but at the same time H0: DEXV does not cause D(real variable) can be rejected. */**/*** indicates significance at a=0.1/0.05/0.01.Sample is 1973-1996, 2 lags in test equations.

| DUE→EXV | D(EMPLMAN)→EXV | D(INV)→EXV |
|---|---|---|
| BE***, PO**, UK* | BE** | BE**, PO* |

Note: Table displays countries for which H0: D(real variable) does not cause EXV can be rejected but at the same time H0: EXV does not cause D(real variable) cannot be rejected. */**/*** indicates significance at a=0.1/0.05/0.01. Sample is 1973-1996, 2 lags in test equations.

| DUE→DEXV | D(EMPLMAN)→DEXV | D(INV)→DEXV |
|---|---|---|
| BE**, IT** | BE* | BE** |

Note: Table displays countries for which H0: D(real variable) does not cause DEXV can be rejected but at the same time H0: DEXV does not cause D(real variable) cannot be rejected. */**/*** indicates significance at a=0.1/0.05/0.01.Sample is 1973-1996, 2 lags in test equations.

The above results are completed and corroborated to a large part by pairwise causality-tests for the *whole* available sample 1960-1996. The results are available on request. Moreover, the results prove to be robust with respect to a change in the lag number in the test equations, e.g. only one lag. Following the results, *exogeneity* of exchange rate variability with respect to the real sector variables seems to be a minor problem for *France, Greece, the Netherlands and Germany*. However, with respect to Belgium and Portugal, the exogeneity assumption necessary for the validity of the estimates in tables 1 and 2, appears for the time being to be questionable.

We are sceptical in general about the possibility that exchange rate variability at our highy frequency is caused by slow moving variables such as labor market rigidities or unemployment. Indeed, all our attempts to use a two-stage procedure failed because we were not able to find satisfactory instruments for exchange rate variability. Most of the fundamentals in question, with the possible exception of monetary policy, are much less variable in the short run. A further argument validating our proceedings and our results is that of Canzoneri, Vallés and Viñals (1996) who show that intra-EU exchange rates reacted mainly to financial shocks rather than real fundamentals. Rose (1995) and Flood and Rose (1995) also emphasize that exchange rate volatility is apparently to a large extent noise (as opposed to being caused by fundamental variability). It does not make much sense to treat a noise series as endogenous. Finally, in an earlier version of this paper we were not able to reject the hypothesis of (weak) exogeneity of our proxy for intra-ERM exchange rate variability in a cointegration framework proposed by Belke and Göcke (1997) with respect to the West German labour market.

Moreover, variability is a key element of an asset price, i.e. the price of currency options. If it were possible to forecast variability one could forecast option prices. Could exchange rate variability be caused by shocks? This is also rather unlikely since it has been difficult in general to document any link between exchange rate volatility and fundamentals.[16] Furthermore, it is a priori unlikely that the kind of shock that requires a substantial exchange rate adjustment (a fall in export demand) occurs with a monthly frequency. We would therefore agree that 'relative velocity shifts, misguided national monetary

[16] Cfr. Canzoneri, Vallés and Viñals (1996), pp. 2 ff. and 11 ff., Gros (1996a), p. 14, Mélitz (1995), p. 496, and Rose (1994).

policy innovations, time varying risk premia and speculative currency attacks ... would go away once a monetary union is formed"[17].

However, one might argue that i.e. that the issue of reverse causation (from real variables to exchange rate variability) addressed in Tab. 9 appears to be less of a problem than the possibility that exchange rate volatility might itself be *affected by the additional regressors in Tables 3-8*. The literature on exchange rate volatility being caused by financial shocks provides support on the first count, but does not mean that these financial shocks could not have an impact on employment rather than exchange rate volatility itself. To check for robustness we therefore applied pairwise Granger-Causality tests to intra-ERM exchange rate volatility and the additional explanatory variables of Tables 3-8. Otherwise, the regression results presented might risk being spurious. That is, we checked the potential correlation of the change in intra-ERM exchange rate variability with the changes in the real effective exchange rate, the interest-rate spread and the change in the $-exchange rate variability.

But there is an additional reason why the role of missing variables should be studied in more detail. The results of the introductory regressions shown in Tab. 1 and 2 refer to bivariate VARs. However, it is well known in the literature that inference from such VARs is tricky, and that adding more variables can often dramatically change the results. This appears to be particularly important as the variables chosen are more or less cyclical, and *no additional* cyclical variables are included in the VARs. We therefore checked whether the results are robust to adding the *change in the short-term real interest rate* (e.g. as a potential shock-absorber) and the *growth in real GDP* to the VARs. For this purpose, we extended the pairwise Granger-causality tests to both time series. In addition, we used OLS and a SURE system to check whether the results of Tab. 1 and 2 (resp.1a, 2a) are robust to the inclusion of both variables.

We start with the extension of Granger-causality tests. Table 9a displays the results of pairwise tests (2 Lags, Sample 1973-1996) for the following pairs (11 tests each). The tables have to be interpreted along the lines already described for Tab. 9.

[17] Canzoneri, Vallés and Viñals (1996), p. 3.

*Table 9a: Exchange Rate Variability and Additional Regressors: Pairwise Granger-Causality Tests*

*Change in Intra-ERM Exchange Rate Variability and the Change in the Real Exchange Rate*

| DEXV→DREER | DREER→DEXV |
|---|---|
| ES*, UK borderline | PO***, UK borderline |

*Change in Intra-ERM Exchange Rate Variability and the Interest-Rate Spread*

| DEXV→SPREAD | SPREAD→DEXV |
|---|---|
| / | / |

*Change in Intra-ERM Exchange Rate Variability and the $-Exchange Rate-Variability*

| DEXV→DEXVD | DEXVD→DEXV |
|---|---|
| IR borderline, UK*** | / |

*Change in Intra-ERM Exchange Rate Variability and the Change in the Real Short-Term Interest-Rate*

| DEXV→D(INTSR) | D(INTSR)→DEXV |
|---|---|
| BE**, FR** | / |

*Change in Intra-ERM Exchange Rate Variability and the Growth in Real GDP*

| DEXV→DGDP | DGDP→DEXV |
|---|---|
| FR*, GR*,IT*, WD** | BE* |

Taken on the whole, Table A42 clearly conveys the impression that our regression results are not spurious. In only two cases (out of 55) is one forced to reject the hypothesis that one of the five chosen variables does not influence intra-ERM exchange rate variability. For Belgium the rejection is only marginal ($\alpha$=10%), for Portugal the extreme macroeconomic instability following the revolution might be one reason. Another mechanism that might have operated is that the exchange rate was kept constant for some time despite very high inflation rates. Strong capital controls

allowed the government to delay the necessary adjustment. Thus, the hypothesis that intra-ERM exchange rate variability represents a factor of uncertainty on its own, i.e. is to a certain extent (strongly) exogenous, is not rejected by the data for the broad majority of EU countries and five (!) different potentially variability driving variables. The evidence is only slightly different with respect to the null hypothesis that intra-ERM exchange rate variability does not influence one of the five variables considered here. The latter is rejected in only 4 out of 55 cases at the five percent level. Moreover, the fact that exchange rate variability also influences real GDP growth is compatible with our theoretical model, but we show below that there is also a direct channel through which exchange rate variability influences (un-) employment.

We continue by displaying the results from bivariate regressions (specified according to Tables 1 and 2, 1a and 2a respectively) augmented by the change in the real short-term interest rate. The results are summarised in the following tables 10, 10a to 11, 11a in the usual way.

*Table 10: Change in Unemployment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Change in Real Short-Term Interest Rate (OLS)*

| Country | Change in Unemployment | Change in Intra-ERM Exchange Rate Variability | Change in Real Short-Term Interest Rate (INTSR) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.34 (↑) | (-1) -0.03 |
| DK | (-1)** | (-1) 0.65** (↓) | (-1) 0.07 |
| ES | (-1)*** | (0) 0.55* (↑) | (-1) 0.12 |
| FR | (-1)*** | (-1) 0.30** (↓) | (-1) -0.07* |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)*** | (-2) -0.32*(→) | (-2) 0.06* |
| IT | (-1)* | (-1) -0.10* (↑) | (-1) 0.11** |
| NL | (-1)*** (-2)** | (-1) 0.53** (-2) 0.60** (↓) | (-2) 0.10* |
| PO | n.a. | n.a. | n.a. |
| UK | (-1)*** (-2)** | (-1) -0.21 (↑) | (0) -0.05 |
| WD | (-1)* (-2)** | (-1) 0.50** (↑) | (-2) 0.09* |

For notes see tables 2 and 3.

*Table 11: Change in Employment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Change in Real Short-Term Interest Rate (OLS)*

| Country | Change in Employment | Change in Intra-ERM Exchange Rate Variability | Change in Real Short-Term Interest Rate (INTSR) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.40 (↓) | (-1) -0.14 |
| DK | (-2)*** | (-1) -0.55 (↓) | (-1) -0.25** |
| ES | (-1)*** | (-2) 0.71 (→) | (0) 0.07 |
| FR | (-1)*** (-2)** | (-1) -2.11*** (↑)<br>(-2) -1.36*** | (-1) -0.31** |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)*** (-2)** | (0) -1.22** (↑) | (-1) -0.24** |
| IT | (-1)** | (0) -0.47 (→) | (-2) -0.05 |
| NL | (-1)*** | (-1) -1.04** (↓) | (0) 0.29***<br>(-2) -0.42*** |
| PO | n.a. | n.a. | n.a. |
| UK | (-1)*** | (-1) -0.44 (↑) | (-2) -0.33** |
| WD | (-1)*** | (-1) -3.03*** (-2) -2.97*** (↑) | (-2) -0.24* |

For notes see tables 2 and 3.

*Table 10a: Change in Unemployment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Change in Real Short-Term Interest Rate (SURE)*

| Country | Change in Unemployment | Change in Intra-ERM Exchange Rate Variability | Change in Real Short-Term Interest Rate (INTSR) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.47*** (↑) | (-1) -0.04 |
| DK | (-1)** | (-1) 0.74*** (→) | (-1) 0.04 |
| ES | (-1)*** | (0) 0.33* (↑) | (-1) 0.10* |
| FR | (-1)*** | (-1) 0.27*** (→) | (-1) -0.06* |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)*** | (-2) 0.31***(↑) | (-2) 0.07*** |
| IT | (-1)** | (-1) -0.13*** (↑) | (-1) 0.13*** |
| NL | (-1)*** (-2)*** | (-1) 0.55*** (-2) 0.64*** (→) | (-2) 0.10*** |
| PO | n.a. | n.a. | n.a. |
| UK | (-1)*** (-2)*** | (-1) -0.26*** (↑) | (0) -0.04* |
| WD | (-1)*** (-2)*** | (-1) 0.69*** (→) | (-2) 0.08** |

For notes see table 3. The results have been compared to Tab. 2a, first column, (original SURE regressions).

*Table 11a: Change in Employment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Change in Real Short-Term Interest Rate (SURE)*

| Country | Change in Employment | Change in Intra-ERM Exchange Rate Variability | Change in Real Short-Term Interest Rate (INTSR) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.03 (↓) | (-1) -0.18** |
| DK | (-2)*** | (-1) -0.82** (↑) | (-1) -0.28*** |
| ES | (-1)*** | (-2) 0.45 (↓) | (0) 0.10 |
| FR | (-1)*** (-2)*** | (-1) -1.65*** (↑) (-2) -0.69*** | (-1) -0.31*** |
| GR | n.a. | n.a. | n.a. |
| IR | (-1)*** (-2)** | (0) -0.91** (↑) | (-1) -0.15* |
| IT | (-1)*** | (0) -0.51** (↑) | (-2) -0.05 |
| NL | (-1)*** | (-1) -1.05*** (→) | (0) 0.29*** (-2) -0.42*** |
| PO | n.a. | n.a. | n.a. |
| UK | (-1)*** | (-1) -0.48 (↑) | (-2) -0.30*** |
| WD | (-1)*** | (-1) -3.67*** (-2) -3.64*** (↑) | (-2) -0.20** |

For notes see table 3. The results have been compared to Tab. 2a, second column, (original SURE regressions).

Above it was already mentioned that economists might be less sceptical about the link between intra-ERM exchange rate variability and (un-) employment and other real variables if they were robust to the introduction of the real short-term interest rate as a potential shock-absorber. This is indeed the case. As one can see from the Tables 10, 10a and 11, 11a the introduction of the real short-term interest rate does not substantially affect our results (many arrows point sideways, the ups and downs are on average at least balanced, in the case of SURE estimation the ups even exceed the downs). As expected, the real interest rate coefficient is often significant and with the right sign in both the OLS and the SURE estimations. In most cases it enters regression equations with at least one lag. If one takes the OLS-estimates as a basis, the coefficients estimates of intra-ERM variability in the unemployment equations appear to be a bit smaller in absolute values than before, though not loosing significance on average. The SURE-estimates, however, convey the impression that the inclusion of the real short-term interest rate in the unemployment equations leads to variability coefficient estimates which become even larger in absolute values. Hence, it is difficult to argue that exchange rate variability just stands for monetary policy. There exists definitely an independent effect of exchange rate variability on employment.

We finish our robustness tests by displaying the results from bivariate regressions (specified again according to Tables 1 and 2, 1a and 2a respectively) augmented by the growth in real GDP.[18]

[18] Corresponding regressions for levels of exchange rate variability *and* the growth in real GDP in (un-) employment equations can be found in Annex 3.

*Table 12: Change in Unemployment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Growth in Real GDP (OLS)*

| Country | Change in Unemployment | Change in Intra-ERM Exchange Rate Variability | Growth in Real GDP (DGDP) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.47** (↑) | (0) -0.24*** |
| DK | (-1)*** | (0) 0.39** (→) | (0) -0.57*** |
| ES | (-1)** | (-1) 0.31** (↑) | (0) -0.48*** |
| FR | (-1)*** | (-1) 0.20* (↓) | (0) -0.19*** |
| GR | (-1)*** (-3)** | (0) 0.09*** (→) | (0) -0.04* |
| IR | (-1)*** | (-2) 0.40** (↑) | (0) -0.17* |
| IT | (-1)** | (-1) 0.07 (→) | (0) -0.09** (-1) -0.08** |
| NL | (-1)** | (-2) 0.63*** (→) | (0) -0.23** |
| PO | (-1)*** | (-1) 0.12** (→) | (-1) -0.08*** |
| UK | (-1)*** | (0) 0.48*** (↑) | (0) -0.38*** |
| WD | (-1)*** | (0) 0.50*** (-1) 0.33** (↑) | (0) -0.26*** |

For notes see tables 2 and 3.

*Table 13: Change in Employment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Growth in Real GDP (OLS)*

| Country | Change in Employment | Change in Intra-ERM Exchange Rate Variability | Growth in Real GDP (DGDP) |
|---|---|---|---|
| BE | (-1)*** | (-1) 0.29 (→) | (0) 0.55*** |
| DK | (-1)*** | (0) -1.35** (-1) -1.51** (↑) | (0) 1.07*** |
| ES | (-1) | (0) -0.24 (→) | (0) 1.51*** |
| FR | (-1)*** | (-1) -0.04 (↓) | (0) 0.73*** |
| GR | | n.a. | |
| IR | (-1)*** | (-1) 1.01** (→) | (0) 0.88*** |
| IT | (-1)*** | (0) -0.38** (↑) | (0) 0.68*** |
| NL | (-1)*** | (-1) -0.73* (-2) -1.16*** (→) | (0) 0.64*** |
| PO | (-1) | (0) 0.01 (↓) | (0) 0.57*** |
| UK | (-1) | (0) 0.22 (→) | (-1) 0.88*** |
| WD | (-1)*** | (-1) -1.78**(-2) -1.35** (→) | (0) 0.63*** |

For notes see tables 2 and 3.

*Table 12a: Change in Unemployment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Growth in Real GDP (SURE)*

| Country | Change in Unemployment | Change in Intra-ERM Exchange Rate Variability | Growth in Real GDP (DGDP) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.31** (↓) | (0) -0.20*** |
| DK | (-1)*** | (0) 0.39*** (→) | (0) -0.56*** |
| ES | (-1)*** | (-1) 0.30*** (↑) | (0) -0.39*** |
| FR | (-1)*** | (-1) 0.24*** (→) | (0) -0.14*** |
| GR | (-1)*** (-3)*** | (0) 0.08*** (→) | (0) -0.04** |
| IR | (-1)*** | (-2) 0.52*** (↑) | (0) -0.16** |
| IT | (-1)*** | (-1) 0.06* (↓) | (0) -0.07*** (-1) -0.08*** |
| NL | (-1)*** | (-2) 0.55*** (→) | (0) -0.22*** |
| PO | (-1)*** | (-1) 0.13*** (→) | (-1) -0.07*** |
| UK | (-1)*** | (0) 0.40*** (↑) | (0) -0.35*** |
| WD | (-1)*** | (0) 0.44*** (-1) 0.35*** (→) | (0) -0.24*** |

For notes see table 3. The results have been compared to Tab. 2a, first column, (original SURE regressions).

*Table 13a: Change in Employment as a Function of Its Own History, the Change in Intra-ERM Exchange Rate Variability and the Growth in Real GDP (SURE)*

| Country | Change in Employment | Change in Intra-ERM Exchange Rate Variability | Growth in Real GDP (DGDP) |
|---|---|---|---|
| BE | (-1)*** | (-1) 0.19 (↓) | (0) 0.44*** |
| DK | (-1)*** | (0) -1.58*** (-1) -1.59*** (↑) | (0) 0.98*** |
| ES | (-1)** | (0) -0.53** (→) | (0) 1.51*** |
| FR | (-1)*** | (-1) -0.09 (↓) | (0) 0.73*** |
| GR | | n.a. | |
| IR | (-1)*** | (-1) 0.90*** (↑) | (0) 0.74*** |
| IT | (-1)*** | (0) -0.33*** (↑) | (0) 0.67*** |
| NL | (-1)*** | (-1) -0.63** (-2) -1.08*** (→) | (0) 0.61*** |
| PO | (-1)*** | (0) -0.00 (↓) | (0) 0.55*** |
| UK | (-1) | (0) 0.26 (→) | (-1) 0.82*** |
| WD | (-1)*** (-2)*** | (-1) -2.23*** (-2) -1.60*** (→) | (0) 0.55*** |

For notes see table 3. The results have been compared to Tab. 2a, second column, (original SURE regressions).

As one can see from the tables 12, 12a and 13, 13a the introduction of the growth in real GDP does not substantially affect our results (many arrows again point sideways, the ups and downs are on average at least balanced, in the case of unemployment the ups even exceed the downs independent of the estimation method chosen). As expected, the growth in real GDP coefficient is often highly significant, with the right sign in both the OLS and the SURE estimations and enters throughout as a contemporary variable. If one takes the estimated unemployment equations as a basis, five highly significant new entries with the expected sign of the variability coefficient estimate can be registered. With respect to employment, the patterns of Tab. 2, 2a are reproduced independent of the estimation method. We therefore conclude that adding the cyclical variable 'growth in real GDP' does not change

the results of the bivariate VARs summarised in Tab. 1, 1a and 2, 2a at all. On the contrary, the evidence in favour of a negative impact of intra-ERM exchange rate variability on real variables even becomes more impressive.

We have attempted in this section to see whether the results from the simple tests are robust. We have used five control variables here and have found that their presence does not diminish the strength of the results. In previous work we already checked out the nominal short-term interest rate as another potential control variable but, again with the results unaffected. We therefore believe that it is difficult to argue that the relationship between exchange rate variability and the real variables we used here is spurious.

## 5. Conclusions and Implications for the EMU Debate

Our main policy conclusions is that (whatever its cost) EMU should bring substantial benefits by suppressing exchange rate variability in Europe. Intra-European exchange rate variability has a statistically significant (and economically small, but non-negligible) negative impact on employment, and investment for a number of countries. We would argue that this result is due to the fact that all employment and investment decisions have some degree of irreversibility. They are discouraged by exchange rate variability as shown in a simple model. Our model of the 'option value of waiting' also suggests that temporary short run increases in variability could have a stronger impact on investment than permanent ones.

Could the gains from suppressing exchange rate variability that are suggested by our results be lost if the volatility re-appears elsewhere, for example in a higher dollar variability or higher interest rate variability? Formally we could argue that dollar volatility did in most cases not have a significant impact in our estimations. But the more important argument is that it is simply at present not possible to show whether dollar variability will go up or down with EMU. The same holds for other financial variables. Recent research (see e.g. Rose, 1995) shows that official action can reduce exchange rate variability even holding constant the variability of fundamentals such as interest rates and money.

We realize that our results are preliminary, not least because the questions posed in this paper have not been posed in this way in the literature so far. The limited number of observations we have, given the annual data we use, are a further reason to be cautious. But we are encouraged by the extent to which the results have been able to withstand the numerous robustness tests we conducted. Moreover, our results are consistent across countries in the sense that most of the countries that are affected by

exchange rate variability show this in more than one variable. We consider the biggest challenge for future research to identifying the details of the transmission channel.

The simple argument that exchange rate variability is just an expression of general uncertainty, and that it is this general uncertainty that drives unemployment and investment, is not compatible with the observation that the variability of the dollar rate does not have the same impact. General uncertainty, especially if it is uncertainty about the country concerned, should also be reflected in the dollar rate, not only intra-European rates. The fact that the measure of intra-European exchange rate variability remains significant even when the dollar variability is introduced suggests that there is an *independent component* of intra-European variability that has effects on its own. This part of our results fits nicely with the finding that only for intra-European relations does one find an impact of exchange rate variability on trade (de Grauwe, 1987, and Sapir and Sekkat, 1995). However, we would argue that one should actually expect that exchange rate variability should have a stronger impact on investment and employment than on current production and exports, because the latter can be adjusted with the existing labor through variations in over time. Irreversibility of set-up costs is thus not an important consideration for production that can be sold within weeks or days, but it is a crucial aspect for decisions of a more long run character, e.g. to invest or hire additional workers.

It will never be possible to establish beyond any doubt that exchange variability does not stand for some other macroeconomic variable, such as the level of the exchange rate, the interest rate, etc. We have tried to take some of the more obvious possibilities into account here and found that they did not affect the results. These results can certainly be disputed on technical grounds, e.g. that the level and variability are related. But our main counter-argument would anyway be that this argument presumably differs from country to country. For Germany one could argue that the DM is variable when it is strong and the Bundesbank follows a high interest rate policy. But what about France or Italy? Would the argument not be the other way round: the lira (or the Franc) are variable when they are weak? If this type of argument were true the bias should be in opposite directions and could thus not explain why one finds as strong effect both for hard currency countries (Germany and Netherlands) as well as weak currency countries (France, Italy, Greece).[19]

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[19] Our results corroborate findings by Aizenman and Marion (1996) who find a significant negative relationship between private investment shares in GDP and the volatility of the real exchange rate (measured as the standard deviation from the average change in the effective real rate at annual frequency) for a cross section of 43 developing countries. Their result is also robust to the inclusion of measures of nominal variability, such as money supply or fiscal policy variability. Thus, one could conclude that in their context that exchange rate variability has an impact even if one does not assume that it is mainly noise, but dependent e.g. on money supply variability.

We found consistently that Germany (followed by the Netherlands and France) showed the strongest impact of exchange rate variability. In a previous version of this paper we therefore investigated the long term determinants of employment more deeply for Germany and confirmed the importance of exchange rate variability in a cointegration framework. This approach could be followed only for one country since replicating it for many others would simply have taken too much space. We leave this task for future research.

We readily admit that some aspects of the results remain unsatisfactory. For example, one would expect that more open countries show a stronger impact of exchange rate variability. But this was only partially confirmed by the data. We found a significant impact for such relatively open economies as France, Germany and the Netherlands. But Belgium, which is the most open economy in the EU, did sometimes not show significant effects. Moreover, one would have expected that the impact of exchange rate variability on manufacturing employment (or industrial production) is much stronger than that on economy-wide variables such as unemployment and investment. We found that this is true in terms of the magnitude of the coefficient, but not in terms of the statistical significance levels. Finally we argue that the absence of a relationship between exchange rate variability and trade in general should not be taken as a reason not to expect that exchange rate variability has an impact on investment and (un)employment.

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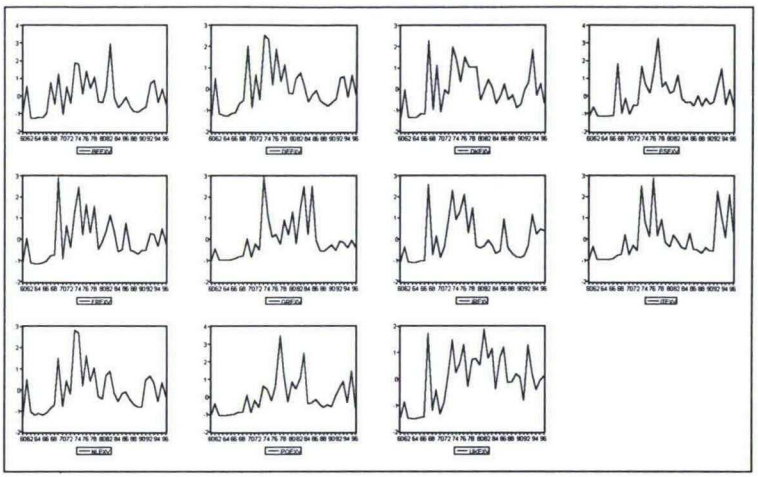
## Variable List

| | |
|---|---|
| DEXPECU | Annual percentage change of EXPECU |
| DGDP | Growth in real GDP (1990 prices) |
| EMPLMAN | Employment in manufacturing (index) |
| EXVD | Nominal exchange rate variability against the dollar |
| EXV | Nominal exchange rate variability against 8 ERM-currencies |
| INTL | Nominal long-term interest rate |
| INTS | Nominal short-term interest rate |
| INTSR | Real short-term interest rate |
| INV | Gross fixed capital formation at 1990 prices; total economy (annual percentage change) |
| REER | Real effective exchange rates relative to 19 industrial countries (1991=100, double export weights, unit labor costs)), increasing index means appreciation of the respective currency |
| SPREAD | National interest rate spread INTL-INTS |
| UE | Unemployment rate |

*Data Sources*: AMECO (European Commission), IFS (IMF), Own Calculations.

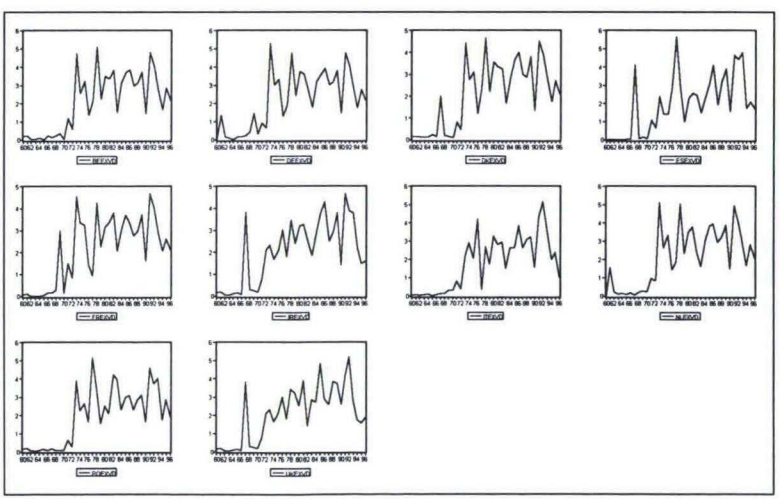
# Annex 1

*Table A1: Nominal Exchange Rate Variability Against 8 ERM-Currencies*



Note: ERM-8: Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands. Variability is defined as the weighted sum of the standard deviation of changes in the logarithm of monthly nominal bilateral exchange rates (times 100). The weights are the implicit ECU-weights derived from average exchange rates 1991. Source: International Financial Statistics, line ae (end-of-month). Graphs normalised.

*Table A2: Nominal Exchange Rate Variability Against the U.S. Dollar*



Note: Variability is defined as the weighted sum of the standard deviation of changes in the logarithm of monthly nominal bilateral exchange rates (times 100). Source: International Financial Statistics, line ae (end-of-month). Graphs normalised.

*Tab. A3: Descriptive Statistics for Intra-ERM Exchange Rate Variability*

| | BEEXV | DKEXV | ESEXV | FREXV | GREXV | IREXV | ITEXV | NLEXV | POEXV | UKEXV | DEEXV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.787596 | 0.957454 | 2.091333 | 0.896429 | 1.900642 | 1.408037 | 1.505544 | 0.804408 | 1.715911 | 2.352340 | 0.645337 |
| Median | 0.649626 | 0.894095 | 1.843393 | 0.869825 | 1.296258 | 1.028147 | 1.195995 | 0.696428 | 1.524981 | 2.257695 | 0.563568 |
| Maximum | 2.023138 | 1.815541 | 5.947405 | 2.198053 | 5.278085 | 3.484468 | 4.132445 | 1.970566 | 5.070540 | 3.954668 | 1.497734 |
| Minimum | 0.270393 | 0.371100 | 0.818696 | 0.332848 | 0.619997 | 0.333125 | 0.428436 | 0.300466 | 0.571339 | 0.891895 | 0.241871 |
| Std. Dev. | 0.456608 | 0.428987 | 1.234343 | 0.500747 | 1.388259 | 0.933998 | 1.109829 | 0.455278 | 1.127546 | 0.783050 | 0.350895 |
| Skewness | 1.035779 | 0.546071 | 1.365281 | 0.940869 | 1.230795 | 0.761952 | 1.159115 | 1.224526 | 1.351321 | 0.162931 | 1.088649 |
| Kurtosis | 3.284891 | 2.100952 | 4.773663 | 3.008445 | 3.227298 | 2.421739 | 3.022414 | 3.836871 | 4.472233 | 2.117689 | 3.282794 |
| Jarque-Bera | 4.372511 | 2.001061 | 10.60185 | 3.541010 | 6.111085 | 2.656672 | 5.374695 | 6.698211 | 9.471741 | 0.884659 | 4.820600 |
| Probability | 0.112337 | 0.367684 | 0.004987 | 0.170247 | 0.047097 | 0.264918 | 0.068061 | 0.035116 | 0.008775 | 0.642538 | 0.089788 |
| Observations | 24 (1973-1996) | | | | | | | | | | |

*Table A4: Level of Exchange Rate Variability and Unemployment: The Example of Germany*

LS // Dependent Variable is DWDUE
Sample(adjusted): 1973 1995
Included observations: 23 after adjusting endpoints

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.319862 | 0.192228 | -1.663976 | 0.1156 |
| DWDUE(-1) | 0.761554 | 0.164811 | 4.620761 | 0.0003 |
| DWDUE(-2) | -0.356944 | 0.158014 | -2.258937 | 0.0382 |
| D76 | -0.869841 | 0.468632 | -1.856126 | 0.0819 |
| D81 | 1.073565 | 0.444235 | 2.416659 | 0.0280 |
| D93 | 0.882932 | 0.457309 | 1.930710 | 0.0714 |
| DEEXV(-1) | 0.665476 | 0.273084 | 2.436893 | 0.0269 |

| | | | |
|---|---|---|---|
| R-squared | 0.775977 | Mean dependent var | 0.269565 |
| Adjusted R-squared | 0.691968 | S.D. dependent var | 0.761240 |
| S.E. of regression | 0.422493 | Akaike info criterion | -1.477375 |
| Sum squared resid | 2.856005 | Schwarz criterion | -1.131789 |
| Log likelihood | -8.645778 | F-statistic | 9.236855 |
| Durbin-Watson stat | 2.348591 | Prob(F-statistic) | 0.000183 |

*Table A5: Level of Exchange Rate Variability and Employment: The Example of Germany*

LS // Dependent Variable is D(EMPLMANWD)
Sample(adjusted): 1973 1995
Included observations: 23 after adjusting endpoints

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 1.461095 | 0.586011 | 2.493290 | 0.0226 |
| D(EMPLMANWD(-1)) | 0.661213 | 0.141830 | 4.662009 | 0.0002 |
| D(EMPLMANWD(-2)) | -0.521174 | 0.153804 | -3.388556 | 0.0033 |
| D93 | -3.016011 | 1.466073 | -2.057204 | 0.0545 |
| DEEXV(-1) | -3.329661 | 0.845206 | -3.939467 | 0.0010 |

| | | | |
|---|---|---|---|
| R-squared | 0.757855 | Mean dependent var | -1.018242 |
| Adjusted R-squared | 0.704045 | S.D. dependent var | 2.505285 |
| S.E. of regression | 1.362919 | Akaike info criterion | 0.808918 |
| Sum squared resid | 33.43587 | Schwarz criterion | 1.055764 |
| Log likelihood | -36.93814 | F-statistic | 14.08390 |
| Durbin-Watson stat | 1.960315 | Prob(F-statistic) | 0.000022 |

*Table A6: Level of Exchange Rate Variability and Investment: The Example of Germany*

LS // Dependent Variable is D(INVWD)
Sample: 1973 1996
Included observations: 24

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 4.775256 | 1.749972 | 2.728762 | 0.0143 |
| D(INVWD(-1)) | -0.294764 | 0.160692 | -1.834338 | 0.0842 |
| D(INVWD(-2)) | -0.362985 | 0.161967 | -2.241109 | 0.0387 |
| D76 | 11.53283 | 4.477342 | 2.575820 | 0.0196 |
| D81 | -6.842052 | 3.970563 | -1.723194 | 0.1030 |
| D93 | -11.22209 | 4.023640 | -2.789038 | 0.0126 |
| DEEXV | -7.528570 | 2.536816 | -2.967724 | 0.0086 |

| | | | |
|---|---|---|---|
| R-squared | 0.632530 | Mean dependent var | -0.183333 |
| Adjusted R-squared | 0.502835 | S.D. dependent var | 5.359240 |
| S.E. of regression | 3.778797 | Akaike info criterion | 2.897304 |
| Sum squared resid | 242.7482 | Schwarz criterion | 3.240903 |
| Log likelihood | -61.82217 | F-statistic | 4.877049 |
| Durbin-Watson stat | 1.995906 | Prob(F-statistic) | 0.004541 |

## Annex 2

## Tests for Integration

Note: ADF: empirical value of the ADF-test statistics; PP: empirical value of the Phillips-Perron test statistics; */**/***: stationarity indicated for $\alpha$=0,10/0,05/0,01; N/C/C,T: neither constant nor trend/constante/constant and Trend in the test equation; sample: max. 1973-1996. Two lagged differences (ADF) resp. two 'truncation lags' (PP) proved to be sufficient to gain the desired properties of the residuals. /: cannot be calculated. n.a.: non available.

*Table A1: UE*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **BEUE** | 0.34 | -1.81 | -1.74 | 0.32 | -1.90 | -1.70 |
| **DKUE** | -0.10 | -2.53 | -2.01 | -0.22 | -2.49 | -1.75 |
| **ESUE** | 0.79 | -1.29 | -1.70 | 0.73 | -1.22 | -1.68 |
| **FRUE** | 1.12 | -1.11 | -1.92 | 1.54 | -1.17 | -1.66 |
| **GRUE** | 1.10 | -0.69 | -2.16 | 0.96 | -0.70 | -2.33 |
| **IRUE** | 0.32 | -1.43 | -1.09 | 0.32 | -1.56 | -1.24 |
| **ITUE** | 1.89 | 0.23 | -4.19** | 1.92 | -0.10 | -2.80 |
| **NLUE** | 0.03 | -2.13 | -1.71 | 0.03 | -2.20 | -1.76 |
| **POUE** | -0.06 | -2.50 | -2.35 | -0.05 | -2.11 | -1.95 |
| **UKUE** | 0.29 | -1.50 | -1.15 | -0.06 | -1.64 | -1.46 |
| **WDUE** | 0.37 | -1.95 | -1.89 | 0.24 | -1.84 | -2.05 |

*Table A2: DUE*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **DBEUE** | -2.64** | -2.83* | -2.89 | -2.30** | -2.40 | -2.43 |
| **DDKUE** | -3.30*** | -3.37** | -3.78** | -3.11*** | -3.09** | -3.38* |
| **DESUE** | -2.56** | -3.21** | -3.17 | -2.06** | -2.33 | -2.29 |
| **DFRUE** | -2.19** | -3.01** | -2.99 | -2.81*** | -3.45** | -3.42* |
| **DGRUE** | -3.17*** | -3.64** | -3.40* | -2.60** | -2.92** | -2.70 |
| **DIRUE** | -3.14*** | -3.20** | -3.35* | -2.71*** | -2.67* | -2.70 |
| **DITUE** | -3.37*** | -4.03*** | -4.11** | -3.47*** | -3.70** | -3.70** |
| **DNLUE** | -3.25*** | -3.28** | -3.49* | -3.76*** | -3.75*** | -3.84** |
| **DPOUE** | -2.62** | -2.67* | -2.96 | -2.78*** | -2.79* | -2.77 |
| **DUKUE** | -3.78*** | -3.88*** | -3.99** | -2.60** | -2.57 | -2.55 |
| **DWDUE** | -3.39*** | -3.67** | -3.80** | -2.40** | -2.51 | -2.54 |

*Table A3: EMPLMAN*

| Series | ADF(N) | ADF(C) | ADF(C,T) | PP(N) | PP(C) | PP(C,T) |
|---|---|---|---|---|---|---|
| **EMPLMANBE** | -2.17** | -1.69 | -1.07 | -3.68*** | -1.97 | -0.80 |
| **EMPLMANDK** | -1.10 | -2.68* | -2.44 | -0.80 | -2.25 | -2.07 |
| **EMPLMANES** | -0.54 | -1.78 | -2.23 | -1.18 | -2.22 | -2.28 |
| **EMPLMANFR** | -2.20** | 0.10 | -3.79** | -3.33*** | 0.44 | -3.55* |
| **EMPLMANGR** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| **EMPLMANIR** | 0.80 | -1.58 | -1.58 | 0.78 | -1.59 | -1.55 |
| **EMPLMANIT** | -0.68 | -0.67 | -3.50* | -0.89 | -0.39 | -2.68 |
| **EMPLMANNL** | -1.73* | -1.68 | -1.26 | -2.28** | -1.97 | -1.58 |
| **EMPLMANPO** | -1.01 | -2.00 | -4.26** | -0.58 | -1.21 | -2.22 |
| **EMPLMANUK** | -2.76*** | -1.31 | -1.55 | -2.97*** | -0.86 | -1.82 |
| **EMPLMANWD** | -1.56 | -1.43 | -2.14 | -1.49 | -1.48 | -2.13 |

*Table A4: DEMPLMAN*

| Series | ADF(N) | ADF(C) | ADF(C,T) | PP(N) | PP(C) | PP(C,T) |
|---|---|---|---|---|---|---|
| **DEMPLMANBE** | -1.77* | -2.57 | -2.94 | -2.15** | -3.07** | -3.30* |
| **DEMPLMANDK** | -3.52*** | -3.65** | -3.72** | -3.08*** | -3.07** | -3.06 |
| **DEMPLMANES** | -2.26** | -2.20 | -2.11 | -2.34** | -2.24 | -2.02 |
| **DEMPLMANFR** | -1.94* | -3.06** | -2.96 | -1.77* | -2.82* | -2.40 |
| **DEMPLMANGR** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| **DEMPLMANIR** | -2.55** | -2.66* | -2.65 | -2.65** | -2.77* | -2.70 |
| **DEMPLMANIT** | -2.30** | -2.35 | -2.69 | -2.92*** | -2.95* | -3.32* |
| **DEMPLMANNL** | -2.51** | -2.94* | -3.17 | -2.22** | -2.43 | -2.54 |
| **DEMPLMANPO** | -1.89* | -2.03 | -1.90 | -2.46** | -2.45 | -2.61 |
| **DEMPLMANUK** | -2.14** | -3.38** | -3.46* | -2.42** | -3.00** | -2.94 |
| **DEMPLMANWD** | -3.42*** | -3.81*** | -3.72** | -2.26** | -2.42 | -2.33 |

*Table A5: SPREAD*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **SPREADBE** | -2.77*** | -2.93* | -2.76 | -3.40*** | -3.46** | -3.58* |
| **SPREADDK** | -1.04 | -1.64 | -2.90 | -1.21 | -2.23 | -3.16 |
| **SPREADES** | -2.03** | -2.22 | -2.41 | -3.55*** | -3.45** | -3.67* |
| **SPREADFR** | -2.64** | -3.19** | -3.05 | -3.12*** | -3.57** | -3.41* |
| **SPREADGR** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| **SPREADIR** | -3.27*** | -3.38** | -3.51* | -2.62** | -2.65* | -2.49 |
| **SPREADIT** | -3.50*** | -3.45** | -3.60** | 4.86*** | -4.79*** | -5.08*** |
| **SPREADNL** | -2.20** | -3.29** | -2.94 | -2.67*** | -3.58** | -3.36* |
| **SPREADPO** | / | / | / | / | / | / |
| **SPREADUK** | -2.66*** | -2.65* | -2.61 | -2.27** | -2.25 | -2.11 |
| **SPREADWD** | -1.80* | -2.51 | -2.34 | -2.59** | -2.95* | -2.87 |

*Tab. A6: INV*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **INVBE** | -2.37** | -2.63 | -2.57 | -3.55*** | -3.74*** | -3.67** |
| **INVDK** | -3.09*** | -3.02** | -2.94 | -3.90*** | -3.81*** | -3.77** |
| **INVES** | -2.79*** | -2.92* | -2.87 | -2.54** | -2.59 | -2.47 |
| **INVFR** | -2.72*** | -2.93* | -2.81 | -2.86*** | -2.94* | -2.83 |
| **INVGR** | -4.27*** | -4.33*** | -4.16** | -4.60*** | -4.52*** | -4.60*** |
| **INVIR** | -2.33** | -2.66* | -2.52 | -3.40*** | -3.62** | -3.49* |
| **INVIT** | -2.64** | -3.00** | -2.96 | -3.10*** | -3.30** | -3.18 |
| **INVNL** | -2.49** | -2.78* | -2.86 | -3.17*** | -3.31** | -3.32* |
| **INVPO** | -3.30*** | -3.88*** | -3.75** | -3.00*** | -3.07** | -3.00 |
| **INVUK** | -2.53** | -2.87* | -2.82 | -2.82*** | -2.96* | -2.89 |
| **INVWD** | -3.04*** | -3.07** | -3.03 | -2.94*** | -2.87* | -2.84 |

*Tab. A7: DINV*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **DINVBE** | -3.51*** | -3.43** | -3.35* | -8.20*** | -8.02*** | -7.85*** |
| **DINVDK** | -5.01*** | -4.89*** | -4.84*** | -8.59*** | -8.33*** | -8.36*** |
| **DINVES** | -4.46*** | -4.35*** | -4.30** | -5.27*** | -5.13*** | -5.16*** |
| **DINVFR** | -3.96*** | -3.89*** | -3.84** | -5.84*** | -5.72*** | -5.64*** |
| **DINVGR** | -5.38*** | -5.26*** | -5.28*** | -8.53*** | -8.22*** | -8.25*** |
| **DINVIR** | -5.28*** | -5.16*** | -5.11*** | -10.58*** | -10.27*** | -11.01*** |
| **DINVIT** | -5.90*** | -5.76*** | -5.64*** | -76.59*** | -43.99*** | / |
| **DINVNL** | -5.01*** | -4.90*** | -4.74*** | -7.44*** | -7.28*** | -7.03*** |
| **DINVPO** | -4.79*** | -4.70*** | -4.68*** | -4.36*** | -4.23*** | -4.17** |
| **DINVUK** | -4.71*** | -4.61*** | -4.50*** | -6.43*** | -6.22*** | -6.00*** |
| **DINVWD** | -4.89*** | -4.79*** | -4.66*** | -7.60*** | -7.16*** | -6.87*** |

*Table A8: REER*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **BEREER** | -0.37 | -2.24 | -2.57 | -0.12 | -1.82 | -1.96 |
| **DEREER** | -0.17 | -1.56 | -1.70 | -0.19 | -1.56 | -1.61 |
| **DKREER** | 0.07 | -2.09 | -2.50 | 0.07 | -2.01 | -2.33 |
| **ESREER** | 0.01 | -2.97* | -2.91 | 0.02 | -2.48 | -2.38 |
| **FRREER** | -0.33 | -1.16 | -2.02 | -0.33 | -1.51 | -2.37 |
| **GRREER** | -0.03 | -2.51 | -2.29 | 0.12 | -2.53 | -2.33 |
| **IRREER** | -1.10 | -1.36 | -1.64 | -1.22 | -1.44 | -1.76 |
| **ITREER** | -0.38 | -2.18 | -3.04 | -0.43 | -1.96 | -2.27 |
| **NLREER** | -0.43 | -1.14 | -2.35 | -0.39 | -1.17 | -2.27 |
| **POREER** | -0.08 | -1.15 | -0.92 | -0.17 | -1.74 | -1.64 |
| **UKREER** | -0.24 | -2.33 | -2.78 | -0.31 | -2.19 | -2.35 |

*Table A9: DREER*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **DBEREER** | -2.59** | -2.51 | -2.45 | -2.51** | -2.44 | -2.39 |
| **DDEREER** | -4.27*** | -4.17*** | -4.10** | -4.57*** | -4.42*** | -4.55*** |
| **DDKREER** | -3.11*** | -3.05** | -2.99 | -3.74*** | -3.67** | -3.60** |
| **DESREER** | -3.03*** | -2.97** | -2.92 | -3.76*** | -3.69** | -3.62** |
| **DFRREER** | -4.26*** | -4.18*** | -4.08** | -5.94*** | -5.82*** | -5.66*** |
| **DGRREER** | -3.90*** | -3.75*** | -3.85** | -5.26*** | -5.11*** | -5.16*** |
| **DIRREER** | -3.49*** | -3.65** | -3.58* | -4.43*** | -4.55*** | -4.44*** |
| **DITREER** | -2.82*** | -2.77* | -2.67 | -4.03*** | -3.96*** | -3.86** |
| **DNLREER** | -3.30*** | -3.25** | -3.19 | -3.38*** | -3.29** | -3.20 |
| **DPOREER** | -5.37*** | -5.24*** | -5.22*** | -2.53** | -2.47 | -2.41 |
| **DUKREER** | -3.95*** | -3.86*** | -3.77** | -3.32*** | -3.23** | -3.13 |

*Table A10: EXV*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **BEEXV** | -0.79 | -2.49 | -3.63** | -1.07 | -3.74*** | -4.52*** |
| **DKEXV** | -0.68 | -2.28 | -3.22* | -0.80 | -3.47** | -4.36** |
| **ESEXV** | -0.75 | -2.41 | -3.23* | -1.13 | -3.86*** | -4.60*** |
| **FREXV** | -0.65 | -2.04 | -3.62** | -1.23 | -4.18*** | -5.38*** |
| **GREXV** | -0.90 | -2.34 | -3.40* | -1.77 | -4.38*** | -5.26*** |
| **IREXV** | -0.82 | -1.81 | -2.07 | -1.15 | -2.74* | -3.23* |
| **ITEXV** | -0.24 | -1.79 | -1.82 | -1.64 | -4.63*** | -4.62*** |
| **NLEXV** | -0.76 | -2.11 | -3.58* | -0.84 | -3.24** | -4.45*** |
| **POEXV** | -0.72 | -2.42 | -2.71 | -1.30 | -3.93*** | -4.23** |
| **UKEXV** | -0.32 | -2.91* | -4.14** | / | -5.03*** | -6.97*** |
| **DEEXV** | -0.58 | -1.84 | -3.11 | -0.89 | -3.75*** | -4.92*** |

*Table A11: DEXV*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **DBEEXV** | -5.04*** | -4.93*** | -4.86*** | -15.93*** | -15.52*** | -13.60*** |
| **DDKEXV** | -4.40*** | -4.29*** | -4.30** | -9.07*** | -8.86*** | -8.39*** |
| **DESEXV** | -5.11*** | -5.00*** | -5.07*** | -14.28*** | -13.73*** | -13.68*** |
| **DFREXV** | -5.06*** | -4.94*** | -4.85*** | -15.15*** | -14.68*** | -13.64*** |
| **DGREXV** | -4.95*** | -4.84*** | -4.87*** | -10.98*** | -10.67*** | -10.35*** |
| **DIREXV** | -4.68*** | -4.56*** | -4.42*** | -9.27*** | -9.03*** | -9.21*** |
| **DITEXV** | -6.79*** | -6.71*** | -6.55*** | -24.97*** | -23.75*** | -21.68*** |
| **DNLEXV** | -4.80*** | -4.69*** | -4.62*** | -10.79*** | -10.54*** | -9.52*** |
| **DPOEXV** | -5.82*** | -5.69*** | -5.68*** | / | / | / |
| **DUKEXV** | -6.33*** | -6.19*** | -6.33*** | / | / | / |
| **DDEEXV** | -5.07*** | -4.96*** | -4.88*** | -11.41*** | -11.05*** | -10.28*** |

*Table A12: EXVD*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **BEEXVD** | -0.37 | -5.50*** | -5.02*** | -0.80 | -8.78*** | -8.34*** |
| **DKEXVD** | -0.39 | -5.64*** | -5.13*** | -0.71 | -7.99*** | -7.58*** |
| **ESEXVD** | -0.75 | -2.40 | -3.23 | -1.13 | -3.86*** | -4.60*** |
| **FREXVD** | -0.42 | -5.33*** | -5.06*** | -0.62 | -6.39*** | -6.09*** |
| **GREXVD** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| **IREXVD** | -0.48 | -2.53 | -1.98 | -0.74 | -4.03*** | -3.92** |
| **ITEXVD** | -0.65 | -3.40** | -3.00 | -1.13 | -4.96*** | -4.81*** |
| **NLEXVD** | -0.43 | -5.41*** | -4.97*** | -0.77 | -7.24*** | -6.92*** |
| **POEXVD** | -0.44 | -5.12*** | -4.74*** | -0.86 | -7.75*** | -7.32*** |
| **UKEXVD** | -0.42 | -2.36 | -1.69 | -0.53 | -3.75*** | -3.65** |
| **DEEXVD** | -0.45 | -6.15*** | -5.69*** | -0.77 | -7.16*** | -6.89*** |

*Table A13: DEXVD*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **DBEEXVD** | -5.30*** | -5.22*** | -5.49*** | / | / | / |
| **DDKEXVD** | -5.08*** | -5.00*** | 5.31*** | -18.60*** | -17.71*** | -50.62*** |
| **DESEXVD** | -5.11*** | -5.00*** | -5.07*** | -14.28*** | -13.73*** | -13.68*** |
| **DFREXVD** | -4.92*** | -4.83*** | -5.02*** | -16.07*** | -15.27*** | -18.71*** |
| **DGREXVD** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| **DIREXVD** | -5.00*** | -4.87*** | -5.19*** | -10.79*** | -10.50*** | -13.71*** |
| **DITEXVD** | -4.30*** | -4.21*** | -4.53*** | -9.49*** | -9.29*** | -10.44*** |
| **DNLEXVD** | -5.32*** | -5.22*** | -5.46*** | -22.00*** | -20.42*** | -41.15*** |
| **DPOEXVD** | -4.90*** | -4.83*** | -5.12*** | -14.94*** | -14.72*** | -24.70*** |
| **DUKEXVD** | -5.55*** | -5.42*** | -5.76*** | -21.37*** | -20.69*** | / |
| **DDEEXVD** | -5.00*** | -4.92*** | -5.15*** | -14.15*** | -13.46*** | -15.68*** |

*Table A14: DGDP*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **DGDPBE** | -1.74* | -2.95* | -2.89 | -2.88*** | -5.27*** | -5.23*** |
| **DGDPDK** | -2.29** | -4.59*** | -4.43*** | -2.62** | -4.68*** | 4.58*** |
| **DGDPES** | -2.23** | -3.11** | -2.77 | -2.29** | -2.92* | -2.54 |
| **DGDPFR** | -1.57 | -3.07** | -3.13 | -1.72* | -3.64** | -3.67** |
| **DGDPGR** | -2.74*** | -3.93*** | -4.67*** | -3.46*** | -5.01*** | -6.02*** |
| **DGDPIR** | -0.91 | -3.03** | -2.96 | -1.16 | -4.14*** | -4.07** |
| **DGDPIT** | -1.55 | -3.58** | -4.37*** | -1.92* | -4.34*** | -4.95*** |
| **DGDPNL** | -1.37 | -2.78* | -2.68 | -1.54 | -3.48** | -3.39* |
| **DGDPPO** | -2.47** | -3.97*** | -4.04** | -2.49** | -3.98*** | -3.61** |
| **DGDPUK** | -2.31** | -3.72*** | -3.63** | -2.21** | -3.16** | -3.06 |
| **DGDPWD** | -1.99** | -3.90*** | -3.83** | -2.04** | -3.50*** | -3.38* |

*Table A15: DINTSR*

| *Series* | *ADF(N)* | *ADF(C)* | *ADF(C,T)* | *PP(N)* | *PP(C)* | *PP(C,T)* |
|---|---|---|---|---|---|---|
| **DINTSRBE** | -3.72*** | -3.66** | -3.83** | -5.84*** | -5.75*** | -6.08*** |
| **DINTSRDK** | -3.09*** | -3.04** | -3.25* | -5.28*** | -5.20*** | -5.46*** |
| **DINTSRES** | -3.24*** | -3.17** | -4.00** | -7.35*** | -7.54*** | -16.66*** |
| **DINTSRFR** | -5.76*** | -5.73*** | -5.63*** | -7.54*** | -7.71*** | -7.92*** |
| **DINTSRGR** | | | | n.a. | | |
| **DINTSRIR** | -5.32*** | -5.29*** | -5.26*** | -11.56*** | -12.65*** | -13.51*** |
| **DINTSRIT** | -3.85*** | -3.84*** | -3.73** | -6.10*** | -6.10*** | -5.96*** |
| **DINTSRNL** | -5.06*** | -5.12*** | -5.92*** | -6.35*** | -6.39*** | -7.91*** |
| **DINTSRPO** | -4.39*** | -4.37*** | -4.39*** | -7.58*** | -7.88*** | -7.84*** |
| **DINTSRUK** | -5.33*** | -5.25*** | -5.14*** | -8.61*** | -8.50*** | -8.21*** |
| **DINTSRWD** | -5.06*** | -4.96*** | -4.93*** | -5.87*** | -5.66*** | -5.48*** |

# Annex 3

*Change in Unemployment as a Function of Its Own History, the Level of Intra-ERM Exchange Rate Variability and the Growth in Real GDP (OLS)*

| Country | Change in Unemployment | Level of Intra-ERM Exchange Rate Variability | Growth in Real GDP (DGDP) |
|---|---|---|---|
| BE | (-1)*** | (0) 0.47* (→) | (0) -0.26*** |
| DK | (-1)*** | (0) 0.43** (→) | (0) -0.55*** |
| ES | (-1)** | (0) 0.48** (↑) | (0) -0.45*** |
| FR | (-1)*** | (-1) 0.32*** (↑) | (0) -0.21*** |
| GR | (-1)*** (-3)** | (0) 0.08* (↓) | (0) -0.03 |
| IR | (-1)*** | (-2) 0.46** (↓) | (0) -0.18** |
| IT | (-1) | (-1) 0.15** (↑) | (0) -0.07** (-1) -0.09*** |
| NL | | (-1) 0.64*** (-2) 0.74*** (→) | (0) -0.18** |
| PO | (-1)*** | (0) 0.19** (→) | (-1) -0.10*** |
| UK | (-1)*** | (0) 0.54*** (↑) | (0) -0.24*** (-1) -0.12** |
| WD | (-1)*** (-2)** | (0) 0.38** (→) | (0) -0.23*** |

For notes see tables 1 and 3.

*Change in Employment as a Function of Its Own History, the Level of Intra-ERM Exchange Rate Variability and the Growth in Real GDP (OLS)*

| Country | Change in Employment | Level of Intra-ERM Exchange Rate Variability | Growth in Real GDP (DGDP) |
|---|---|---|---|
| BE | (-1)*** | (-2) -0.12 (→) | (0) 0.52*** |
| DK | (-1)*** | (0) -1.54** (↑) | (0) 1.13*** |
| ES | (-1) | (0) -0.71 (→) | (0) 1.35*** |
| FR | (-1)*** | (-1) -0.70** (↓) | (0) 0.68*** |
| GR | | n.a. | |
| IR | (-1)*** | (-1) 1.03** (→) | (0) 0.78*** |
| IT | (-1)*** | (0) -0.38* (↑) | (0) 0.67*** |
| NL | (-1)*** | (-1) -0.83* (↓) | (0) 0.66*** |
| PO | (-1) | (0) 0.40 (↓) | (0) 0.66*** |
| UK | (-1) | (-1) -0.95* (→) | (-1) 0.95*** |
| WD | (-1)*** (-2)*** | (-1) -3.13*** (→) | (0) 0.39*** |

For notes see tables 1 and 3.

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