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Better off without the Euro?

A Structural VAR Assessment of European Monetary Policy

Jan Philipp Fritsche* and Patrick Christian Harms‡

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Abstract

Modern OCA theory has developed different conclusions on when forming a currency union is beneficial. An important pragmatic question in this context is: Did delegating monetary policy to the ECB increase stress in the individual euro area countries? An SVAR analysis reveals that monetary stress has declined more in the euro area than in the euro areas' doppelganger. The synthetic doppelganger is composed of other OECD countries. This result is independent of the identification strategy (sign restrictions/heteroskedasticity/Cholesky). The results can be rationalized by more formalized central banking and the euro becoming a dominant currency.

JEL Classification Codes: C32, E42, E52, F45
Keywords: Economic and Monetary Union, ECB, euro area, structural vector autoregressions, monetary policy stress, sign restrictions, heteroskedasticity, dominant currency

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1 Introduction

Did delegating monetary policy to the supra-national level increase monetary stress in the individual countries? Economic theory yields contradicting answers to this question. Twenty years after the introduction of the euro, this study assesses the performance of monetary policy from the perspective of the founding members of the European Monetary Union (EMU) in an empirical framework. We measure *monetary policy stress* as the variance of identified monetary shocks. The monetary shocks are deviations from stabilizing and rule-based policy from the individual countries' perspective.

The '*Impossible Trinity*' – rooted in the seminal work of Mundell (1963) and Fleming (1962) – dictates that you cannot have stabilizing monetary policy, a fixed exchange rate, and capital mobility at the same time. Following this reasoning the euro has often been characterized as a currency that impedes stabilizing monetary policy at the national level. This conclusion is premature. Before the introduction of the euro, the European Exchange Rate Mechanism coordinated exchange rates among European countries and restricted monetary autonomy at the national level. Moreover, the presence of monetary spillovers (Iacoviello and Navarro, 2019) and the dominant role of the US dollar (Gopinath et al., 2020) are empirically well documented de facto limits for the monetary autonomy of small open economies. Consequently, choosing a free-floating regime instead of the euro, might have come at the risk of being dominated by a global reserve currency.

Stabilizing monetary policy requires an independent central bank. Today, the ECB is considered the most independent central bank worldwide (Nergiz Dincer and Eichengreen, 2014). Chari et al. (2019) show how delegating the monetary competence to a supranational institution can have beneficial welfare effects by strengthening the central bank's commitment to its mandate, even if the economies have heterogeneous macroeconomic shocks.

After all, there is no consensus about which of the positive and negative effects is dominant. Evidence on the performance of the ECB relative to international benchmarks is still scarce. This study aims to close this gap. We measure monetary policy stress as the variance of monetary shocks, which are

defined as deviations from stabilizing policy rules. This benchmark definition of good policy as rule-based policy allows us to compare the pre-EMU sample with the post-EMU sample. Put simply, we conduct the thought experiment that since the ECB took over, it conducted monetary policy for all countries individually. This allows us to compare the performance of the national central banks prior to the introduction of the common currency with the ECB's performance thereafter.

Conceptually, our empirical approach measuring monetary stress and evaluating policy rules is related to Clarida et al. (1998), Sturm and Wollmershäuser (2008), and Quint (2016). While those studies look at reduced form residuals from single equation estimates, we identify structural shocks and use a synthetic control method to obtain a benchmark for the euro area. While there is a general trend of decreasing stress from monetary policy over time, it is more pronounced in the euro area than in the synthetic doppelganger country. This result holds even after conducting several robustness checks. In addition, we rationalize our results with regressions inspired by the dominant currency paradigm for all the countries. We find that prior to the introduction of the euro most countries' monetary policy stress was related to U.S. dollar and D-Mark fluctuations. Countries had to adjust their monetary policy according to exchange rate fluctuations, which caused monetary stress. This result vanishes for all euro area members following the introduction of the euro.

Our results are highly policy relevant for three main reasons. First, they allow to render the frequently used term 'one size fits none' as misleading.[1] Proponents of this view seem to over-emphasize the costs of giving up individual currencies while ignoring important favorable developments. Second, our results confirm that joining the EMU and abandoning the European Monetary System (EMS) was beneficial for most of the member countries and the average euro area country. Third, our results provide some evidence that leaving the euro or choosing an independent currency in the first place might (have) come at the cost of being dominated by the D-Mark or the U.S.

[1] This or a similar reasoning is for example used in Berger and De Haan (2002), Enderlein (2005), Enderlein et al. (2013), Sapir et al. (2015) and Wyplosz (2016).

dollar.

The remainder of this paper is structured as follows: Section 2 explains the chosen empirical approach, section 3 presents the results for the average euro area country and the individual countries as well as how monetary stress may be related to exchange rate fluctuations. In section 4, we show that our results are robust when we change the country sample and the time sample, employ various specifications of the doppelganger or a welfare-based measure. Section 5 provides possible interpretations of the results and section 6 concludes.

2 Empirical Approach

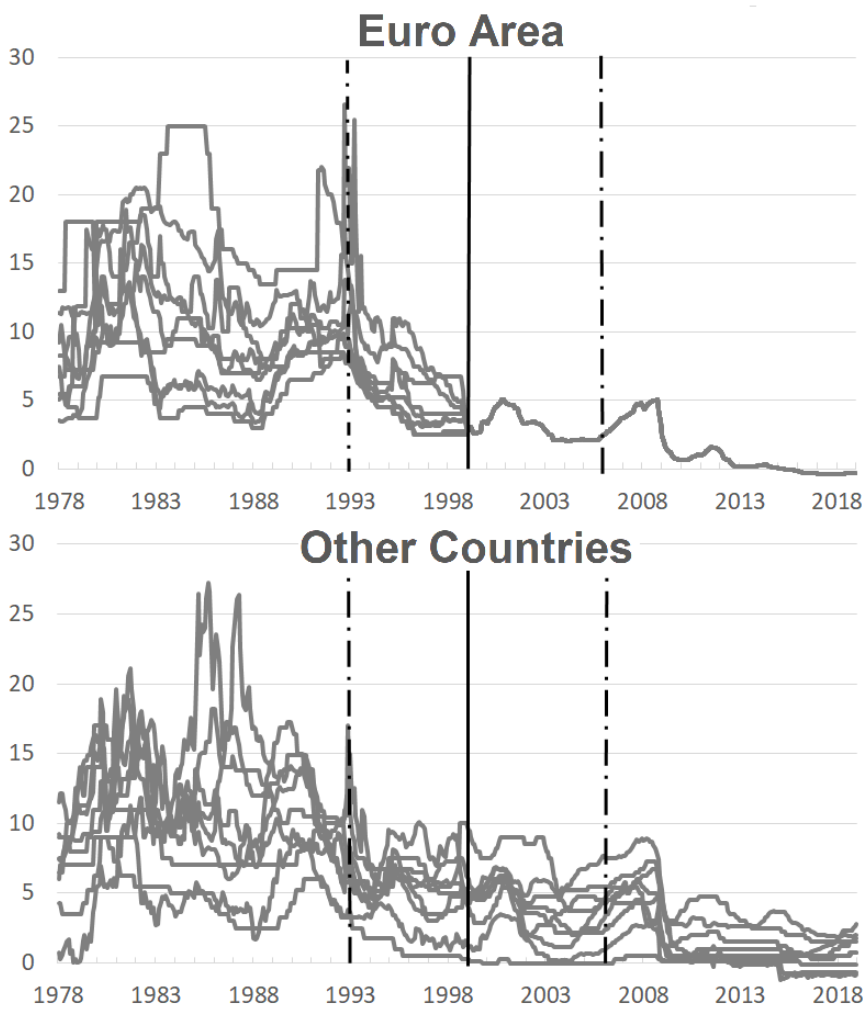
The empirical approach in this paper tackles the question from two different methodological perspectives: First, and in line with the literature, single equation Taylor (1993)-rules are estimated and the level of monetary policy stress is calculated in a similar way to the original reference Clarida et al. (1998). Second, the factor of improvement of the monetary policy stress is discussed for the euro area and the other countries on the basis of structural residuals. The reason we add results based on identified structural vector autoregressions (SVAR) is that the measured deviations from the estimated rules - strictly speaking - are reduced form residuals. In fact, this type of stress estimate may capture demand and supply shocks instead of genuine monetary disturbances.

In the SVAR exercise, the identifying assumptions make sure that the residuals can be labeled as deviations from rule based stabilizing interest rate policy. Those results are provided for 10 euro area countries and 8 non-euro but OECD countries and are summarized using synthetic control method (SCM) doppelgangers as proposed by Abadie and Gardeazabal (2003).[2]

The research question whether individual countries would have been better off without adopting the euro from a monetary policy perspective

[2]We use all founding members of the EMU except Luxembourg, which previously was part of a currency union with Belgium. In section 4, we include Luxembourg, Greece and three additional OECD-countries, which we kept out of the sample due to data quality or availability.

Figure 1: Time series of interest rates i_t



Notes: Interest rates for euro area countries (top panel) and non-euro OECD countries (lower panel), the solid line is 1999, the date of the introduction of the common currency, the dashed lines represent the sample modifications applied in the robustness exercise.

drives our conceptual framework. The outstanding feature in figure 1 is at the heart of the empirical investigation: while the two panels of monetary policy target interest rates are similar for the time before 1999 (solid vertical line), the euro area countries have started to only use one policy rate for all countries afterwards.[3] By comparing the factor of change of deviations from estimated policy rules before 1999 and after we try to measure the effect of this particular structural break. This *unification* of policy rate setting can be seen as a treatment, which only euro area countries received, while the other country group is untreated.[4]

Monetary policy stress describes deviations from a policy that is stabilizing from the perspective of a prototypical closed economy. This implies that - for instance - the stability of the foreign exchange rate as a goal for monetary policy is excluded right away. The rationale for this choice is twofold: first, there is no counterpart in the ECB's policy function to the goal of exchange rate stabilization that many of the individual members followed before the monetary unification. Second there is no compelling theoretical case for combining macroeconomic with exchange rate stabilization. In fact there is a consensus view that the stabilization of the domestic economy is the primary goal of monetary policy.[5] Thus being *better off* refers to receiving relatively more domestic macroeconomic stabilization and nothing else.

2.1 Single Equation Taylor Rules

In this first part of the empirical analysis, the equation

$$i_t = r_t^n + E_t[\pi_{t+k}] + \phi_\pi(E_t[\pi_{t+k}] - \pi^*) + \phi_y y_t^{gap} + \epsilon_{t,MP} \tag{1}$$

is estimated, from which the measure of stress $\epsilon_{t,MP}$ can be derived. Since $\epsilon_{t,MP}$ by definition has $E[\epsilon_{t,MP}] = 0$, its square is used as the preferred stress

[3] This is where the term 'one size fits all/none' [(Issing, 2001), (Enderlein, 2005)] comes from.

[4] Here, the suspicion of 'one size fits none' would be that heterogeneous policy rates would be preferable over unified monetary policy if the business cycles and price setting dynamics are heterogeneous as well.

[5] For a theoretical discussion in the framework of equilibrium models see Gali and Monacelli (2005) and Faia and Monacelli (2008).

measure throughout the text:

$$Stress_t = \epsilon^2_{t,MP}. \tag{2}$$

Equation 1 is estimated using standard least squares separately for 1980-1998 (before the euro was introduced) and after (1999-2018). The sample of countries follows from table 1, where the euro area sample consists of Germany, Belgium, Spain, France and Italy mainly due to data availability. In the estimation logic, we follow Clarida et al. (1998): For the euro area countries who joined in 1999, we used the estimated Bundesbank rule as the policy rule for the pre-euro sample and the estimated ECB rule afterwards.[6] For all other countries, national policy rules were estimated for the whole sample.[7] The equations were estimated for all available countries separately and estimates for r^N_t and $E_t[\pi_{t+k}]$ were plugged in for the constant to derive the stress level.[8] In calculating $\epsilon_{t,MP}$ for the euro area countries, we follow Quint (2016) instead of Sturm and Wollmershäuser (2008) and use the difference between the observed interest rate series from the rule-implied country-specific interest rate.[9] The results in table 1 reflect this approach: The factor in the table

Table 1: Ratios of Taylor rule stress estimates

	Euro Area (weighted)	**US**	**UK**	**CA**
Factor	1.89	1.28	0.80	3.31

Notes: Results based on single equation Taylor rule estimates. The reported factor is $[\frac{\Sigma^{T_1}_{i=t_1}\epsilon^2_{t,MP}/T_1}{\Sigma^{T_2}_{i=t_2}\epsilon^2_{t,MP}/T_2}]$

[6] Due to the dominant role the Bundesbank played in the EMS.

[7] For all data sources please find a precise list in the data appendix A

[8] r^N_t is taken from Holston et al. (2017) and extended with own estimates for the single euro area countries and $E_t[\pi_{t+k}]$ are backward-looking annual averages of the inflation rate before 1990 and *Ifo World Economic Survey*-data thereafter due to availability.

[9] So that $\epsilon_{t,MP} = i^j_t - i^{*,j}_t$. Sturm and Wollmershäuser (2008) calculate the stress level as the difference between the euro area wide rule-implied rate and the country-specific interest rate implied by the same rule or $i^{*,EA}_t - i^{*,j}_t$. Quint (2016)'s approach can be extended to the sample before the euro was introduced.

reflects the stress level before the euro was introduced over the stress level afterwards so that values larger than one point toward an improvement, while values smaller than one imply a worsening. Based on those results using a similar methodology as Quint (2016) and Sturm and Wollmershäuser (2008) one would argue that the level of weighted monetary policy stress has decreased since the introduction of the euro. This is also true for the US - to a lesser extent - and for Canada - to a larger extent. According to this measure, only the stress level of the UK has, in fact, increased after 1999 compared to before.

The results from the single-equation analysis are broadly in line with the results in Quint (2016), which already led to the conclusion that, compared to other *federations*, euro area countries are not subject to a large level of monetary stress. However, we do not want to stop the analysis here: The residual term $\epsilon_{t,MP}$ does not have a structural interpretation, which makes it hard to defend the interpretation as *monetary stress*. Due to the method and data availability, our sample of euro area countries is insufficient. Further, while the US, UK, and Canada appear to be sensible economies for comparison, the choice appears somewhat arbitrary. In the following analysis, we tackle these two issues by first basing our results on structural VAR models and second by broadening our country and time sample.

2.2 SVAR analysis

Consider the SVAR(p) model

$$y_t = c + B_1 y_{t-1} + ... + B_p y_{t-p} + B_0 s_t \tag{3}$$

and its reduced-form

$$y_t = c + B_1 y_{t-1} + ... + B_p y_{t-p} + r_t, \tag{4}$$

where $y_t = [\tilde{y}_t, \tilde{p}_t, \tilde{i}_t]'$ is the vector of endogenous variables consisting of the output-gap, detrended prices and detrended interest rates. The difference between the two expressions is the *structure* on B_0 and the fact that Σ_r is of

full rank so that the r_ts are correlated across equations while Σ_s is diagonal so that the s_ts are orthogonal. While there is no general agreement on the right way to identify structural models related to monetary policy, sign restrictions and identification via heteroskedasticity are often used as alternatives to the Cholesky-ordering. We base our results on all three methods to ensure that the identification does not drive our results qualitatively. When disentangling the effects of QE from conventional policy or when the researchers are interested in obtaining a precise estimate of the impact of unanticipated policy changes, high frequency instruments have merged as a prominent way to identify SVARs. Because those instruments are not available for all the countries, we cannot identify our SVARs in that fashion. As our research question is not centered around unanticipated shocks and the related effects of monetary stimulus for the economy this is not a major drawback. We are interested in capturing deviations from rules that aim to stabilize the economy. For example, contractionary policy with the purpose of supporting a Foreign Exchange (FX) intervention is something that we want to capture as a deviation from macroeconomic stabilization.[10] Hence, we label the shock as a monetary stress shock. This study deliberately estimates a rule that ignores the fact that the national central banks in the EMS had to set interest rates in such a way that the exchange rate remained stable. This is needed to examine the ability of monetary policy to stabilize prices and real economic developments before and after the introduction of the euro. The error term will exactly capture the fact that national banks had to deviate from a stabilizing rule in order to keep exchange rates within the corridor. Equally, the fact that the ECB sets interest rates for the euro area as a whole is also ignored. The rules are estimated in such a way that they only contain two factors, inflation and output of the domestic economy, which are justified from a theoretical perspective (Clarida et al., 2001; Taylor, 1993; Kydland and Prescott, 1977).[11] Our approach to measuring monetary

[10] Since the macroeconomic trilemma dictates that a central bank can either pursue macroeconomic stabilization or stabilization of exchange rates once there are free capital markets (Obstfeld et al., 2005).

[11] Of course, interest rates are an endogenous variable in the VAR and, thus, its lagged values are also included in the reduced-form estimation. While this may be seen as

policy's ability to stabilize, enables us to compare the systems. In order to make a fair comparison, we must treat all countries equally. This is a delicate undertaking because of the heterogeneity of central bank statutes around the world. We follow the argument of Taylor (1993) that rules of central banks will eventually not be algebraically describable but some combination of inflation and output is a good approximation of most of the rules.[12] We allow for a structural break at the introduction of the euro,[13] which takes different forms depending on the model and identification we use.
The SVAR analysis in this paper is based on three different ways to obtain the structural form of the VAR, which are described in the following.

2.2.1 Sign Restrictions

At least since Canova and De Nicolo (2002) and Uhlig (2005) sign restrictions are a well established method to identify SVARs. This type of identification results in a whole set of admissible models and does not yield a consistent point estimate. We follow this general idea with a few modifications: Since we are interested in the variance estimates attached to each model we impose[14] $diag(B_0) = [1, 1, 1]$, so that Σ_s is not the identity matrix but carries the variance estimates of the different shocks on its diagonal. The sign patterns used for identification are summarized in the matrix

$$B_0 = \begin{pmatrix} 1 & ? & - \\ ? & 1 & ? \\ + & + & 1 \end{pmatrix}, \tag{5}$$

implying that the immediate response of the interest rate to output and inflation innovations is positive and that output indeed falls as a response

a deviation from stability oriented monetary policy, Woodford (2003) emphasizes the importance of monetary policy's history-dependence, which provides a clear rationale for interest rate smoothing.

[12] Every central bank will retain a bit of leeway in order to be able to respond to particular situations with a certain degree of flexibility. For the general public and for policy makers, it is more important to understand this general approximation than the exact formula.

[13] The first observation of the second part of the sample is always January 1999.

[14] After the identification has taken place.

to a monetary policy shock.[15] Since the set identification results must be further summarized, the median value of the set of variance estimates is used as a measure of stress.[16] When we use sign restrictions, we estimate and identify the SVAR for the period 1980-1998 and for 1999-2018, separately.

2.2.2 Identification using Heteroskedasticity

The approach of Rigobon (2003) uses the changes in the variances of the variables to identify monetary policy shocks. As we specifically want to study the changes in variances of structural innovations, this identification approach is particularly well suited to identify a monetary policy stress shock. We use the following SVAR model and estimate it using a Feasible Generalized Least Squares (FGLS) for the whole sample:

$$y_t = c_z + B_{z1} y_{t-1} + ... + B_{zp} y_{t-p} + B_0 \Lambda_z^{1/2} s_t, \tag{6}$$

with structural errors $s_t \sim N(0, I)$ and the normalization of the structural impact matrix $diag(B_0) = I$. We allow the reduced form parameters $B_{z1} \dots B_{zp}$ to vary across the regimes $z = 1, 2$ – i.e. pre- and post-euro introduction. Furthermore, as we are interested in studying the variances of the same kind of shock across the regimes, we leave the B_0^{-1} matrix constant across time but let the standard deviation of the shocks, denoted by the diagonal matrix $\Lambda_z^{1/2}$, vary across the two regimes z of interest. The reduced form covariance matrices can be written as

$$\Sigma_{u1} = \; B_0 \; \Lambda_1^{1/2} \Lambda_1^{1/2\prime} B_0' \tag{7}$$

for the first state and as

$$\Sigma_{u2} = \; B_0 \; \Lambda_2^{1/2} \Lambda_2^{1/2\prime} B_0' \tag{8}$$

[15] Practically, we used an algorithm close to the original Canova and De Nicolo (2002) approach, which is based on Given's rotations across the space of orthogonal matrices. This results in a different number of admissible models for every application and specification of the step size of the rotations.

[16] Typically, the distributions of this parameter estimate may be interpreted as versions of the χ^2 distribution.

for the second state. Having a total number of 12 structural parameters in B_0, $\Lambda_1^{1/2}$ and $\Lambda_2^{1/2}$ our system is exactly identified with the 12 degrees of freedom in the two reduced form covariance matrices. Because the identification is purely driven by data and not by economic assumptions, the identified and orthogonal shocks do not have an inherent economic label. However, for our purpose, we can derive an adequate labeling. We use the forecast error variance decomposition (FEVD) to determine the shock, which is responsible for most of the variance of the interest rate. As this shock is the main driver of the uncertainty in the interest rate, it can easily be interpreted as a monetary policy stress shock. This comes close to a Cholesky ordering, where the zero restrictions enforce the same assumption on the monetary shock.

2.2.3 Identification using timing restrictions

By using zero restrictions, it is assumed that only the interest rate reacts to the monetary shock contemporaneously and that the other variables need time to factor in monetary developments; therefore, the shock always explains 100 percent of the on impact FEVD. In addition it is assumed that because of price rigidity inflation does not react to demand shocks contemporaneously. The following zero restrictions identify our system and allow us to estimate a diagonal covariance Σ_s matrix of the structural shocks for the pre- and post-euro sample separately.[17]

$$B_0 = \begin{pmatrix} 1 & 0 & 0 \\ ? & 1 & 0 \\ ? & ? & 1 \end{pmatrix} \tag{9}$$

2.3 Data

Frequency of the data is monthly, for the construction of the output-gap and the detrended price level - based on the price deflator - the Chow and

[17] To be consistent with the notation in the literature we re-order the vector of endogenous variables to $y_t = [\tilde{p}_t, \tilde{y}_t, \tilde{i}_t]'$.

Lin (1971) interpolation technique was used.[18] All time series are expressed as deviations from flexible trends as proposed by Hamilton (2017). The sample of euro area countries includes Germany (DE), Belgium (BE), Spain (ES), Finland (FI), France (FR), Ireland (IE), Italy (IT), the Netherlands (NL), Austria (AT), Portugal (PT). The set of non-euro OECD countries is Australia (AU), Canada (CA), Denmark (DK), Japan (JP), Norway (NO), Switzerland (CH), United Kingdom (UK), and the United States (US).[19] Our baseline sample covers 1980m12-2018m12.

2.4 Synthetic control and the weighting scheme

Finding a way to summarize the euro area results is simple: The ECB targets prices and supports economic activity for the currency union as a whole and does not apply a specific weighting scheme to the countries. Hence, nominal GDP weights are the most obvious choice. We chose to apply the weights based on the levels of nominal GDP from the period of the sample split, which is 1999.

For the control countries, the research question requires a more sophisticated approach since there is no obvious counterpart to the nominal GDP weights. SCM is found to be useful in macroeconomic applications (Born et al., 2019a,b). The idea is to construct a *doppelganger* of the unit under treatment and to then measure the effect of an intervention by comparing the unit of interest to the doppelganger after the intervention. In the case of this application, the variable of interest is monetary policy stress. It is common practice to add different measures to the pool of variables, which may further describe outstanding features of the unit under treatment. In this application,

[18] Industrial production was used to construct monthly GDP series and the CPI was used to construct monthly deflator series. For further information on the data sources please consult the data appendix.

[19] In section 4 we exclude the period after the effective lower bound as well as the pre-Volcker period. There we also discuss results including Greece (GR), Luxembourg (LU), Sweden (SE), Mexico (MX), and New Zealand (NZ). Other OECD cannot be included due to either data-limitations and/or the fact that they adopted the euro only several years after 1999.

six additional covariates are chosen[20]: the country size, measured by nominal GDP itself, the level of central bank independence,[21] and the level of economic development, measured as GDP per capita. We also try to control for macroeconomic performance prior to the introduction of the euro by using averages of GDP growth, inflation, and the interest rate from the beginning of the sample until 1998.[22] Since the monetary stress series stem from a monthly model and this part of the analysis does not have a particular interest in the monthly timing of these shocks, the SVAR variance estimate for the first part of the sample - representing pre-euro stress - is used as variable number 7. Thus, these variables describe the matrix X_0 - which corresponds to the non-EMU countries and the vector x_1 represents the euro area in equation 10.

$$\min_{w}(x_1 - X_0 w)' V (x_1 - X_0 w) \tag{10}$$

subject to

$$\sum\nolimits_{n=0}^{N} w_n = 1, w_n \geq 0. \tag{11}$$

Equation 10 reminds of a weighted least squares problem, with V being the weighting matrix. The idea of the method is to minimize the *square* distance between a set of average euro area characteristics (x_1) and a weighted counterpart of non-euro area countries ($X_0 \times w$) with respect to the *optimal* set of weights summarized by w subject to the obvious restriction that the sum of w's elements w_n is one and that all weights are non-negative. Since the elements in x_1 and X_0 are not of the same unit of measurement, the choice of V is crucial in this respect. Without prior knowledge of potential off-diagonal elements, we restrict V to be diagonal. Its diagonal elements are chosen to be $1/\hat{\sigma}_c$ of the variables, where $\hat{\sigma}_c$ is the standard deviation.

[20] In section 4 we construct the doppelganger with several more parsimonious specifications to ensure that our results remain robust.

[21] The Central Bank independence index from Garriga (2016) is based on a de jure measure of independence. The history of the index goes further back than the Nergiz Dincer and Eichengreen (2014) measure and is therefore our preferred measure.

[22] We try to match pre-sample averages instead of time series in order to circumvent any autocorrelation in the matching equation. This is also consistent with the reporting of our results, where we also focus on the pre-to-post change in the variance of the stress shock. Collapsing time series data to averages works well in SCM, when the number of states is small (Bertrand et al., 2004).

3 Results

This section consists of four parts: First, we display the results for all individual countries, where it turns out that all countries in the baseline sample were able to reduce the stress stemming from monetary policy. Second, we compare an average euro area country with non-euro area countries weighted according to the SCM method. The results show that the euro area average outperforms this synthetic doppelganger country across identification methods. Third, we repeat the matching for all euro area countries individually and find that most, but not all, countries separately outperform their individual doppelganger. Fourth, we provide evidence that the level of monetary policy stress before the introduction of the euro was related to FX fluctuations, which is no longer true after 1999. While this result uniformly holds for all euro area countries, this is not true for the non-euro area countries in our sample.

3.1 Single Country Results

The results from the SVAR analysis are presented in tables 2 and 3. For all countries, the ratio of the variance for the first - pre-euro - and the second - post-introduction - part of the sample ($\frac{\tilde{\sigma}^2_{1,MP}}{\tilde{\sigma}^2_{2,MP}}$, where MP implies that this is the identified monetary component of the shocks) are reported. Again, the factor in the table reflects the stress level before the euro was introduced over the stress level afterwards so that values larger than one point toward an improvement, while values smaller than one imply a worsening.

The first important note is that the countries exhibit a high degree of heterogeneity across all the measures. The reported factor of improvement in the level of stress stemming from monetary policy takes on very low values in countries like Finland, Austria, Norway and the US. These countries tend to have a high level of economic development and an advanced level of macroeconomic stability. At the other hand of the spectrum, we find countries such as Portugal and Italy or Japan. However, it seems to be generally unproductive to draw deeper conclusions from this type of results to answer the research question.

First, as the sample consists of 18 countries with 3 different results across

Table 2: **Factor of improvement** of monetary stress for the individual euro area countries

	DE	**BE**	**ES**	**FI**	**FR**	**IE**	**IT**	**NL**	**AT**	**PT**
SR	10.1	21.2	26.1	3.4	24.1	21.2	45.2	29.5	4.0	127.3
IH	13.9	20.6	20.7	5.9	20.5	21.5	34.7	14.2	3.4	238.4
Cholesky	16.1	24.3	25.3	5.0	24.1	18.8	42.7	17.1	4.2	113.7

Notes: The table displays the ratio of the post-euro to pre-euro monetary stress $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for a sample of 10 euro area countries. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH) and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

Table 3: **Factor of improvement** of monetary stress for the individual non-euro area countries

	AU	**CA**	**DK**	**JP**	**NO**	**CH**	**UK**	**US**
SR	24.9	11.6	12.8	36.1	6.9	13.5	16.9	6.2
IH	19.1	15.1	9.2	27.2	7.7	7.9	19.8	7.5
Cholesky	21.3	15.7	8.1	34.3	6.9	8.0	18.3	7.1

Notes: The table displays the ratio of the post-euro to pre-euro monetary stress $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for a sample of 8 non-euro area countries. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH) and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

identification methods, the flow of information is large. Second, the research question is on the euro area's performance compared to the pre-euro phase. Hence, the results are further summarized in the following. On the other hand, when discussing the summarized results the individual countries are helpful to identify potential drivers in the weighting scheme and to point out potential biases in this regard.

3.2 The average euro area country

Table 11 in the appendix shows that the weights to replicate the average euro area country in the SCM exercise are predominantly distributed across 6 countries: The UK, which across specifications receives the highest weight, Switzerland, Norway, Canada, Japan, and - to a lesser extent - the US. Australia and Denmark, on the other hand, receive 0 weight across specifications.[23]

The SCM seems to do a good job at replicating the pre-euro average for almost all metrics as tables 13 and 12 in the appendix show: Total GDP and GDP per capita are matched perfectly and similarly accurate are the estimates for the average interest and GDP growth rate. Where the method consistently fails is the central bank independence index: On average, euro area central banks seem to have been more independent than the non-euro sample. For the interpretation, this should not be a problem since - if anything - the bias in the results would go in favor of the non-euro doppelganger as lower independence, thus, leaves more room for improvement.

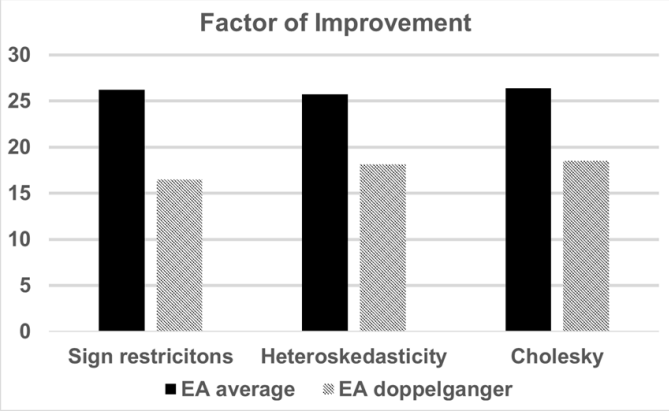
After the discussions of the individual country results and the empirical implementation of the SCM, we apply the resulting weights to summarize the above results.

For the important question whether the level of monetary policy stress has been reduced in the euro area, the results in figure 2 are consistent across

[23]For Australia this is because of a very high estimate for the pre-1999 level of monetary stress and for Denmark it is likely due to the combination of very low average inflation, interest rates, the small country size, and high GDP per capita.

identification methods.[24] While the change factor of the monetary policy stress measure takes on a value of about 25.7 - 26.4 for the average euro area country, its doppelganger country estimate ranges from 16.5 to 18.5 so that even the lowest weighted estimate for the euro area is still strongly above the value for the control country. Thus, for both country groups, we find a strong reduction in the level of stress stemming from monetary policy. Of course, this could be due to a general tendency around the industrialized world toward better central banking.[25] The doppelganger is constructed precisely to control for this type of trend.

Figure 2: Factor of improvement of monetary stress for the average euro area country and its doppelganger



Notes:The figure displays the post-euro to pre-euro ratio of the monetary stress measure $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for the euro area (EA) average and its doppelganger after applying the SCM country weights w_i to the individual country factor of improvement as in the tables 3 and 2. The identification assumptions are sign restrictions, identification using heteroskedasticity, and zero restrictions (Cholesky), following the recursive ordering described in equation 9. The values are displayed in table 14 in the appendix

From this section, we conclude that the euro area has experienced a

[24]The exact numbers are displayed in table 14 in the appendix. In section 4 we refer to results for a changing country and time sample. The result that the euro area outperforms its doppelganger does not depend on those choices.

[25]Svensson (2010) documents the historical convergence toward inflation targeting and Garriga (2016) and Dincer and Eichengreen (2013)'s indices clearly show an upward trend around the world, implying more independent and transparent central banks.

stronger improvement of the fit of monetary policy than the weighted control countries. Interestingly, across sample specifications, the euro area's factor of improvement is about 40 to 50% larger than in the doppelganger country.

3.3 Doppelganger results from the single country perspective

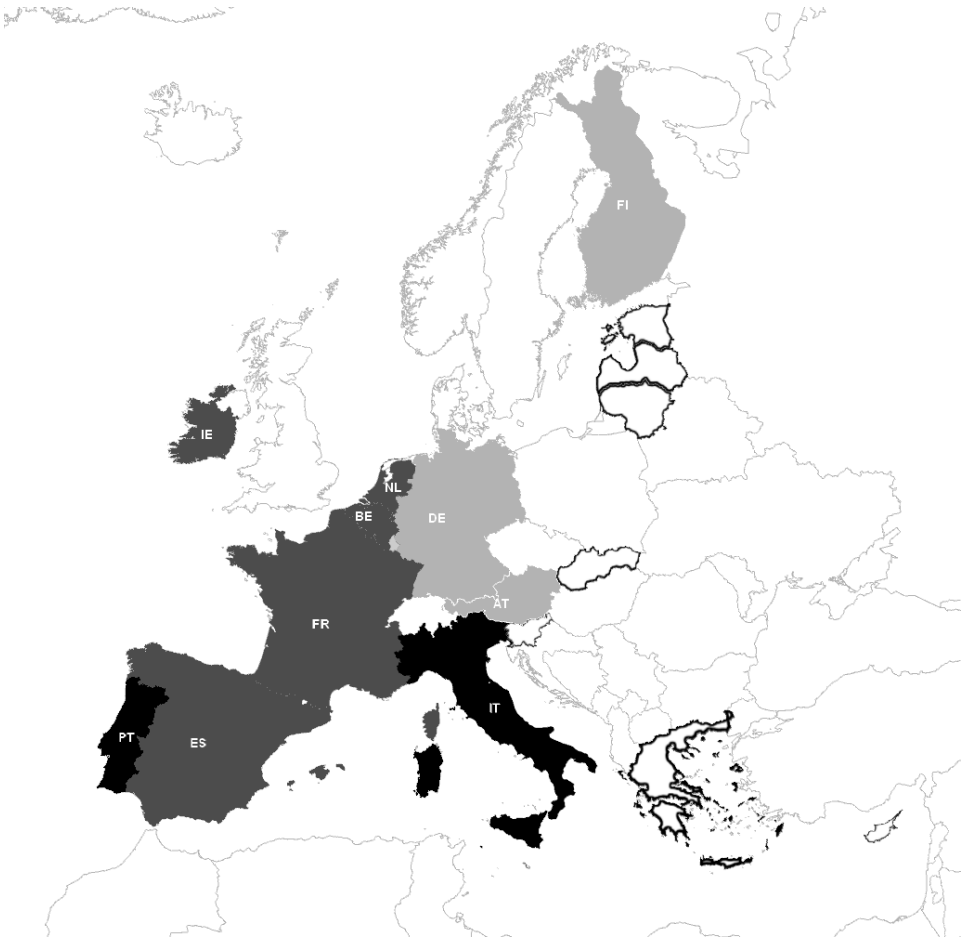
While the results of the last section already provide an answer to the research question, the analysis is extended with another formulation of the problem. In particular, while the 'one size fits none' reasoning may not hold for the average country, it may very well hold for individual countries. Further, it appears of particular interest to identify those countries that drive the positive result for the average euro area. Thus, in this section, we un-do the euro area weighting and perform the same analysis from the perspective of every individual country. This allows us to compare every single country to its own *doppelganger*. For this exercise we use the same set of variables to construct the weighting matrix as in the last section. Figure 3 and table 15 in the appendix show the results.

A general remark is required for the results in this section. While the SCM method worked well for the purpose of replicating the average euro area country, its performance is weaker for each individual country.[26] However, there is one takeaway from this set of results: there is a small group of countries that, across identification methods, exhibits a lower factor of improvement than its doppelganger: Austria, Finland, and Germany. All other countries outperform their doppelganger. Table 15 in the appendix shows that this margin is already large for the Netherlands and Spain. Italy and Portugal double the performance of their doppelganger. Belgium, France, and Ireland still outperform their SCM counterparts, but by smaller margins. Thus, the group that did not perform better than its individual doppelganger only includes northern or core countries of the euro area.[27] These results hold

[26] Note that it is generally easier to match any mean observation compared to individual observations that are not located at the center of a given distribution.

[27] Here, the qualification is particularly important since for Germany - for instance - the SCM method performed poorly for important measures such as the level of central bank

Figure 3: Doppelganger results from the single country perspective.



Notes: The figure displays the improvements from a single country perspective relative to their doppelganger. While the countries in light grey improve but are outperformed by their doppelganger, the countries in dark grey and black outperform their respective doppelganger. The countries in black even outperform their doppelganger by more than 100 percent on average, across different identification assumptions. Moreover, the stability of these results across the three identification assumptions holds for every single county. The results are displayed in table 15 in the appendix. The countries with thick boarders are those that adopted the euro after 1999.

true across all three identification assumptions.

independence.

3.4 Exchange Rate Fluctuations and Monetary Stress

In this section, we examine the relationship between monetary stress and exchange rates. Figures 5, 6, and 7, in the appendix, show time-varying coefficients for the relationship between country-level monetary stress and the exchange rate between national currencies and the D-Mark, national currencies, the euro, and the U.S. dollar. Formally, we employ a Kalman-Filter as in 12 and 13.[28]

$$\omega_t^{MON-POL} = \beta_t \Delta E_t + v_t \tag{12}$$

$$\beta_t = \beta_{t-1} + \eta_t. \tag{13}$$

Figure 5 presents the time-varying relationship between national currencies and the D-Mark prior to the introduction of the euro. In all cases - except for Austria and the Netherlands - they are significantly different from zero for extended periods of time.[30] This result implies that monetary policy prior to 1999 reacted to D-Mark movements in a way that is unrelated to national price and output stabilization. Figure 6 repeats the exercise for all euro area countries, but now with the nominal U.S. dollar exchange rate. Extending the sample to the time period after 1999 shows that while the U.S. dollar has had an impact on most countries' monetary policy before 1999, no such effect is found after 1999.[31] This result implies that since the ECB conducts monetary policy, the dollar's influence on monetary policy stress is no longer observed and statistically insignificant in all countries. Thus, we can conclude that the joint currency provided some additional freedom from

[28] Equation 12 is the observation equation and 13 is the state equation. The time-varying parameter β_t links the observed monetary policy shock $\omega_t^{MON-POL}$ to the exchange rate,[29] which we express as the first difference of the log, since nominal exchange rates are known to be very likely integrated of order one (Meese and Rogoff, 1983). Additionally, equation 13 shows that we assume that the process for generating the time-varying parameter follows β_t a random-walk.

[30] The fact that one cannot show a relationship between Austrian and Dutch monetary policy to the D-Mark exchange rate is due to the very strong relationship to the D-Mark, showing almost no variance in the nominal exchange rates.

[31] Note that for the countries that lost the competition against their individual doppelganger, the impact of the dollar is relatively small: In Germany, the effect decays after the reunification, when most of the international influence was lost, for Austria and Finland the effects are insignificant and small throughout the whole sample.

external influences following the introduction of the euro. Figure 7 shows that this is not the case when the exercise for the U.S. dollar is repeated for the non-euro area countries. At least in Australia, Norway, and Switzerland there is an influence of the dollar exchange rate on national monetary policy even after 1999.[32] Interestingly, an influence from the dollar on monetary policy is also observed for the UK. This section shows that the euro and the centralization of monetary policy free many countries from their obligations to take exchange rates into account when conducting monetary policy. The fact that this result holds for all euro area members, but not for all other countries, is evidence that this is a genuine advantage of joining the common European currency.

4 Robustness

4.1 Sample Adjustments

The baseline sample covers two major economic crises, which are particularly important for the analysis. First, the global financial crisis led to a global decrease in policy rates, in many cases very close to the effective lower bounds. Second, in 1992 the EMS experienced a major crisis[33], which caused Italy and the UK leave the EMS. Moreover, the EMS crisis triggered some reforms of the EMS and its member states. Thus, in a first robustness exercise, the sample only covers 1993m1-2006m12 to exclude both incidents. This period has the additional advantage of a broad consensus about the goals of monetary policy and that Taylor (1993)-type inflation targeting was broadly established. The results are reported in tables 16-18 of the appendix E.1. While the per country results are more heterogeneous and most countries even experience a decrease in one of the three identified models, the average euro area country still outperforms its doppelganger by a 55-86 percent margin. For the short time sample, data is also available for Greece (GR), Luxembourg

[32] While Switzerland has publicly announced exchange rate targets in the recent past, Bergsten and Gagnon (2017) count Norway as one of the most prominent currency manipulators globally.

[33] Often referred to as *Black Wednesday*; see also the appendix F.

(LU), Sweden (SE), Mexico (MX) and New Zealand (NZ). Tables 19 and 20 in appendix E.2 report the results of the analysis with the increased country sample from 1993-2006. The euro area outperforms its doppelganger with an even greater margin. As Portugal is the only country that outperforms the average euro area by an order of magnitude, we make sure that this does not drive the results and exclude it in the calculation of the average euro area country in table 21 in appendix E.3. From this section we conclude that it is not a specific choice of the country sample, the time sample or a potential statistical outlier that drives the results.

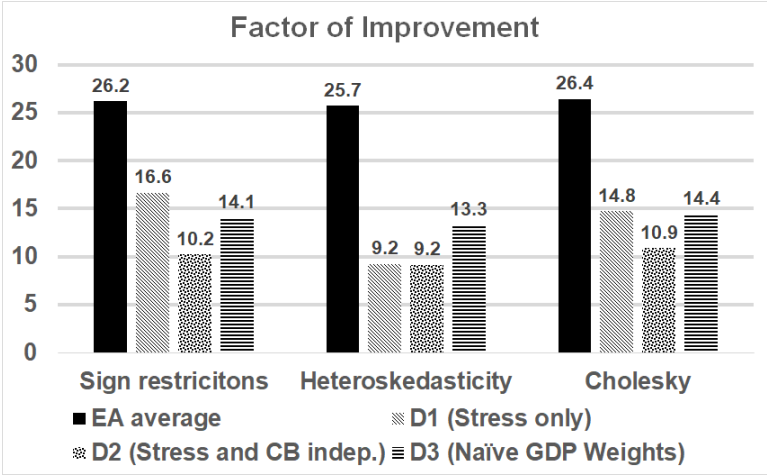
4.2 Alternative Doppelganger Construction

The doppelganger in our baseline specification is constructed matching six additional covariates, apart from the stress measure. Figure shows that our results remain valid for more parsimonious estimations of the doppelganger. The specifications of the doppelganger D1 and D2 are motivated by matching only variables that are tightly related to monetary stress, which is our measure of interest. While the doppelganger D1 matches only the monetary policy stress prior the introduction of the common currency, D2 includes also the independence of the central bank. Doppelganger D3 is constructed using a naïve weighting, analogously to the average euro area. It represents the average (gdp-weigthed) non-euro area country. The alternative doppelgangers have a tendency to be outperformed by the average euro area country by a even greater margin, than the baseline results.

4.3 Alternative Measure

In theoretical models monetary policy is often evaluated according to its effects on welfare. In this context, welfare losses induced by certain outcomes that result from the objectives and the rule implemented by the central bank are expressed as a loss function. Excess inflation and excess output fluctuations are inefficiencies in the New Keynesian literature and thus reduce welfare. From this type of welfare analysis, an optimal outcome can be derived and a rule can be designed, which approximates this outcome as close

Figure 4: Factor of improvement of monetary stress for the average euro area country and three alternative doppelgangers



Notes: The figure displays the post-euro to pre-euro ratio of the monetary stress measure $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for the euro area (EA) average and the alternatives doppelgangers D1-D3 after applying the country weights w_i to the individual country factor of improvement as in the tables 3 and 2. The identification assumptions are sign restrictions, identification using heteroskedasticity, and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

as possible. Galí (2015) uses a loss function of the form

$$L = \frac{1}{2}\left[\left(\sigma + \frac{\phi+\alpha}{1-\alpha}\right) var(\tilde{y}_t) + \frac{\epsilon}{\lambda} var(\pi_t)\right], \tag{14}$$

to evaluate simple policy rules, where the parameters stem from a simple representative agent model.[34] The variance of the output gap and of the inflation rate both induce welfare losses with respect to the optimal outcome. As an additional robustness check, we have repeated parts of our analyses based on L. Instead of using monetary policy stress derived from econometric models, we use the observed welfare losses through the lens of the loss function.. Even though the concepts are different - monetary policy stress

[34] In the loss function L, $\Theta = \frac{1-\alpha}{1-\alpha+\alpha\epsilon}$ and $\lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta}\Theta$. Table 22 in the appendix summarizes the parameter values from the reference and their interpretation.

represents deviations from empirically estimated rules with no judgment about monetary policy optimality and welfare while L is directly related to a theoretical welfare concept - the comparison should lead to similar results. It is fairly obvious that other forces than monetary policy are probably at play when determining the variance of output and inflation such as supply, demand and technology shocks. This is precisely why the variance of the identified monetary policy shock has been our preferred measure so far. Also it makes clear what the SCM method is important for the comparison as it offers the possibility of controlling for potential trends in the model variables. Figure 8 in the appendix summarizes the results from the repeated SCM exercise based on the welfare losses derived from the loss function above.[35] For both samples, the figure tells the same story: the average euro area - EA 10 and EA 12 - country outperforms its doppelganger - based on 8 or 11 non-EMU countries - in both comparisons.

From this robustness check we conclude that even without a stochastic model, euro area monetary policy has improved by more than a synthetic doppelganger and we are still unable to detect evidence in favor of the one-size-fits-none reasoning.

5 Interpretation

The empirical exercise delivers four important results, which this section puts into context. First, we find a worldwide tendency toward better monetary policy. Second, the average euro area country outperforms its doppelganger. Third, despite some heterogeneity, individual countries mostly outperform their doppelganger. Fourth, the deviations from the policy rule in the euro area are not correlated with the foreign exchange rate.

5.1 The general tendency toward better monetary policy

The professionalization and formalization of monetary policy between the 1970s and 1990s clearly explain the overall trend of better monetary policy.

[35] L is a period-by-period loss function. In our empirical analysis we used the variance of inflation and the output-gap the two sample periods.

Trivially, central banks are likely to have become better in monetary policy implementation over time. Clarida et al. (1998) offer the failure to accurately forecast reserve demand as a potential interpretation for monetary policy shocks. That is, whenever a central bank has a problem with setting its *operational target*, which correctly represents its monetary policy stance, this would show up as an unexpected innovation, which is orthogonal to the inflation and output-gap in our SVAR model. Bindseil (2014) and Bindseil (2016) argue that by 2007, monetary policy implementation approaches by most central banks were "well-focused and transparent compared to the 1920-1990 period."

(Svensson, 2010) provides an overview of how central banks adopted explicit goals for inflation over time.[36] While the Banca d'Italia ended being a *branch* of the Italian treasury in 1981 (Passacantando, 2013), it took the Bank of England until the Blair years in 1997 to become independent (Andréadès, 2013). All three - professionalization, independence, and the adoption of explicit targets - will push a central bank toward a strategy that brings it closer to following the objectives of stability of inflation and/or output. In the SVAR-model we use, this would imply that anything unrelated to the *new* objective of stabilization - for example interest rate setting in order to support the treasury - would end up as a residual in the reduced form, ultimately implying a higher variance of the identified shock.

In most estimated policy rules (such as those used in Clarida et al. (2000)), some form of the inflation target or long-term inflation expectations are incorporated in the intercept terms of the policy function. In our estimation, we assume that the inflation target and long-term expectations are stable throughout the sample periods. However, there is evidence that in the pre-1999 period, this assumption might be violated (Cogley and Sargent, 2005; Bomfim and Brayton, 1998). This would show up as unexplained variance in the VARs in the pre-1999 period.

[36] He counts New Zealand as the first country to embrace explicit inflation targeting (1989/1990).

5.2 The advantages of adopting the euro

Within the global trend, the average euro area country has performed better than its doppelganger. As discussed, and despite some heterogeneity across the countries, the factors driving the global trend seem to be particularly strong before 1999 both within and outside the euro area. Therefore, the SVAR should be a fair approximation for all the countries in our sample and for some individual heterogeneity to be averaged out. The typical 'one size fits none' reasoning is that the unification of interest rate setting is problematic because national central banks were abolished while heterogeneous business cycles and inflation rates prevailed. Implicitly, this reasoning implies that monetary policy before the introduction of the euro was indeed designed to stabilize national business cycles. If those assumptions were correct, improvements in the fit of monetary policy should not have taken place; in particular compared to non-euro area countries.

The empirical results from the last section challenge this reasoning. In fact, one can find empirical evidence against many of the assumptions of the 'one size fits none' reasoning: Campos et al. (2017) assess the synchronization of business cycles across the world. They find that business cycles generally more synchronized since 1999 than before and find a significantly stronger tendency toward convergence in the euro area. Similarly, Franks et al. (2018) provide empirical evidence for a high degree of convergence of inflation rates in the euro area.

The 'one-size-fits-none'-reasoning does not take into account that some countries had to respond to foreign exchange developments because their currencies were dominated by the D-Mark or U.S. dollar in the sense of Gopinath et al. (2020). In particular, the EMS de jure and de facto constrained euro members - by a varying degree - in their ability to implement monetary policy according to their national needs. In fact, many decisions to change interest rates can be traced back to either the stabilization of the exchange rate system or political reasons.[37] A very homogeneous result across the euro area countries

[37] Appendix F provides a short description of the mechanisms and the history of the EMS.

is that none of them experienced monetary stress because of exchange rates after adopting the euro. This is evidence that creating a common currency offered protection against being dominated by the D-Mark or the U.S. dollar. Nevertheless, in terms of conduct of monetary policy, some countries might have benefited more than others.

5.3 Heterogeneity of the single country estimates

The results from a single country perspective are well in line with the predictions of Chari et al. (2019), who argue that while a subset of countries might have joined the EMU in order to obtain more central bank independence, others might have profited from the improved coordination. In particular, Germany might have had motives beyond solely improving its already well-functioning monetary policy. Germany's persistent current account surplus is likely to be associated with its persistent decline in the real effective exchange rate since the introduction of the euro.[38] Table 2 and the application of the SCM in table 15 reveals that there is heterogeneity in the absolute improvement and that there may be some heterogeneity in the relative improvement of monetary policy fit in the euro area.

To a large extent, the heterogeneity in absolute improvements of the euro area countries reflects the state of development of the national economies and, in particular, their monetary authorities and their position in the EMS. Austria, Finland, and Germany tend to have relatively low factors of improvement while France, Italy, Portugal, and Spain have relatively high factors of improvement. In particular, Austria and Germany appear to have had a level of monetary policy quality already before the euro's introduction, which was unmatched in the whole sample of OECD countries. This is reflected in the failure of the doppelgangers to replicate the data in terms of central bank independence, average inflation, the average nominal interest rate, and the pre-euro stress estimate itself. Thus, when the factor of improvement of those countries is compared to their individual doppelgangers, the comparison is unfair due to the general trend toward better monetary policy making

[38] Engler et al. (2014) discuss how the euro area countries can create and offset such imbalances in a currency union.

observed around the world.
At the same time, the positive performance of other countries - such as France, Italy, Portugal, and Spain - compared to their doppelganger countries can be seen as just the other side of the same coin: The introduction of the euro allowed those countries that had no chance to implement independent monetary policy in the EMS to participate in the formalization and improvement trend in monetary policy making. Those countries - constrained by their inferior position in the EMS (Giavazzi and Giovannini, 1987) - simply had much more to gain from an improvement in central bank policies than those countries that were already able to implement inflation targeting-type policies in the past.

6 Conclusion

Increased central bank credibility, the conduct of more rule-based policy and becoming a global reserve currency have made the euro a success. We identify a global trend of declining monetary stress due to more formalized, transparent, and experienced monetary policy. Within this trend, the average euro area country outperforms its non-euro area doppelganger.
Following its creation, the common currency protected all euro area countries from receiving monetary stress due to foreign exchange fluctuations. This is not true for all our benchmark countries. In Australia, Norway, Switzerland and the UK, US-Dollar fluctuations still correlate with monetary stress. We interpret this as evidence that the beneficial effects of the common currency prevail and delegating monetary policy to the ECB did not cause stress.
The interpretation that the countries *lost* their individual interest rates to stabilize the economy is not consistent with our findings for two reasons. First, the leeway to stabilize the economy was small prior to the introduction of the euro, as the countries had to import the monetary policy of other countries and set interest rates according to the needs of exchange rate stabilization. Second, the reasoning neglects the positive aspects of central bank coordination/commitment and the size effect of the euro, which is studied by Chari et al. (2019) and Gopinath et al. (2020). Our results are robust

across time samples, country samples, and identification strategies. For the individual countries only Austria, Finland, and Germany are outperformed by their doppelganger. However, these countries had little leeway to improve their central banks performance. Moreover, Germany, in particular, might not necessarily have joined the euro area to improve its monetary policy but rather to achieve a higher level of real exchange rate stability.

The euro area would benefit from a constructive discussion on how to prevent future crisis and further synchronize business cycles. A more stable union may further ease the conduct of monetary policy. Therefore, a common debt instrument, stronger automatic stabilizers, as well as the completion of the banking union and the capital markets union should be prioritized in policy discussions. Further, policymakers should be aware of the importance of improved central bank credibility, the conduct of rule-based policy and the dominance of the euro, when considering joining or leaving the currency union.

References

Abadie, A. and Gardeazabal, J. (2003). The economic costs of conflict: A case study of the basque country. *American economic review*, 93(1):113–132.

Andréadès, A. M. (2013). *History of the Bank of England*. Routledge.

Berger, H. and De Haan, J. (2002). Are small countries too powerful within the ecb? *Atlantic Economic Journal*, 30(3):263–282.

Bergsten, C. F. and Gagnon, J. E. (2017). *Currency conflict and trade policy: A new strategy for the United States*. Columbia University Press.

Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How much should we trust differences-in-differences estimates? *The Quarterly journal of economics*, 119(1):249–275.

Bindseil, U. (2014). *Monetary policy operations and the financial system*. OUP Oxford.

Bindseil, U. (2016). Evaluating monetary policy operational frameworks. In *Speech at the Jackson Hole conference on*, volume 31.

Bomfim, A. and Brayton, F. (1998). Long-run inflation expectations and monetary policy. *Dillen, H. dan Hopkins, E., Forward Interest Rates and Inflation Expectations: The Role of Regime Shift Premia and Monetary Policy, BIS*.

Born, B., Müller, G. J., Schularick, M., and Sedláček, P. (2019a). The costs of economic nationalism: evidence from the brexit experiment. *The Economic Journal*, 129(623):2722–2744.

Born, B., Müller, G. J., Schularick, M., and Sedlacek, P. (2019b). Stable genius? the macroeconomic impact of trump.

Boumans, D. and Garnitz, J. (2019). Ifo world economic survey database–an international economic expert survey. *Jahrbücher für Nationalökonomie und Statistik*, 237(1):71–80.

Campos, N. F., Fidrmuc, J., and Korhonen, I. (2017). Business cycle synchronisation in a currency union: Taking stock of the evidence. *Bank of Finland Research Discussion Paper*, (28).

Canova, F. and De Nicolo, G. (2002). Monetary disturbances matter for business fluctuations in the G-7. *Journal of Monetary Economics*, 49(6):1131–1159.

Chari, V. V., Dovis, A., and Kehoe, P. J. (2019). Rethinking optimal currency areas. *Journal of Monetary Economics*.

Chow, G. C. and Lin, A.-l. (1971). Best linear unbiased interpolation, distribution, and extrapolation of time series by related series. *The review of Economics and Statistics*, pages 372–375.

Clarida, R., Galı, J., and Gertler, M. (1998). Monetary policy rules in practice: Some international evidence. *European Economic Review*, 42(6):1033–1067.

Clarida, R., Gali, J., and Gertler, M. (2000). Monetary policy rules and macroeconomic stability: evidence and some theory. *The Quarterly journal of economics*, 115(1):147–180.

Clarida, R., Galí, J., and Gertler, M. (2001). Optimal monetary policy in open versus closed economies: An integrated approach. *American Economic Review*.

Cogley, T. and Sargent, T. J. (2005). The conquest of US inflation: Learning and robustness to model uncertainty. *Review of Economic dynamics*, 8(2):528–563.

Dincer, N. N. and Eichengreen, B. (2013). Central bank transparency and independence: updates and new measures.

Enderlein, H. (2005). One size fits none. *Central Banking*, 15(4):24–8.

Enderlein, H., Spiess, J., Guttenberg, L., and Vitorino, A. (2013). *Blueprint for a cyclical shock insurance in the euro area*. Notre Europe Brussels.

Engler, P., Ganelli, M. G., Tervala, J., and Voigts, S. (2014). *Fiscal devaluation in a monetary union*. Number 14-201. International Monetary Fund.

Faia, E. and Monacelli, T. (2008). Optimal monetary policy in a small open economy with home bias. *Journal of Money, credit and Banking*, 40(4):721–750.

Fleming, J. M. (1962). Domestic financial policies under fixed and under floating exchange rates. *Staff Papers*, 9(3):369–380.

Franks, M. J. R., Barkbu, M. B. B., Blavy, M. R., Oman, W., and Schoelermann, H. (2018). *Economic Convergence in the Euro Area: Coming Together or Drifting Apart?* International Monetary Fund.

Fritsche, J. P. and Harms, P. C. (2019). 20 years of common european monetary policy: Reasons to celebrate. *DIW Weekly Report*, 9(20):179–187.

Galí, J. (2015). *Monetary policy, inflation, and the business cycle: an introduction to the new Keynesian framework and its applications*. Princeton University Press.

Gali, J. and Monacelli, T. (2005). Monetary policy and exchange rate volatility in a small open economy. *The Review of Economic Studies*, 72(3):707–734.

Garriga, A. C. (2016). Central bank independence in the world: A new data set. *International Interactions*, 42(5):849–868.

Giavazzi, F. and Giovannini, A. (1987). Models of the ems: is europe a greater deutschmark area? In *Global macroeconomics: Policy conflict and cooperation*, pages 237–272. Springer.

Gopinath, G., Boz, E., Casas, C., Díez, F. J., Gourinchas, P.-O., and Plagborg-Møller, M. (2020). Dominant currency paradigm. *American Economic Review*, 110(3):677–719.

Hamilton, J. D. (2017). Why you should never use the hodrick-prescott filter. *Review of Economics and Statistics*, (0).

Holston, K., Laubach, T., and Williams, J. C. (2017). Measuring the natural rate of interest: International trends and determinants. *Journal of International Economics*, 108:S59–S75.

Höpner, M. and Spielau, A. (2018). Better than the euro? the european monetary system (1979–1998). *New Political Economy*, 23(2):160–173.

Iacoviello, M. and Navarro, G. (2019). Foreign effects of higher us interest rates. *Journal of International Money and Finance*, 95:232–250.

Issing, O. (2001). The single monetary policy of the european central bank: One size fits all. *International finance*, 4(3):441–462.

Kydland, F. E. and Prescott, E. C. (1977). Rules Rather than Discretion: The Inconsistency of Optimal Plans. *Journal of Political Economy*.

Meese, R. A. and Rogoff, K. (1983). Do they fit out of sample? *Journal of international economics*, 14:3–24.

Mundell, R. A. (1963). Capital mobility and stabilization policy under fixed and flexible exchange rates. *Canadian Journal of Economics and Political Science/Revue canadienne de economiques et science politique*, 29(4):475–485.

Nergiz Dincer, N. and Eichengreen, B. (2014). Central bank transparency and independence: Updates and new measures. *International Journal of Central Banking*.

Obstfeld, M., Shambaugh, J. C., and Taylor, A. M. (2005). The trilemma in history: tradeoffs among exchange rates, monetary policies, and capital mobility. *Review of Economics and Statistics*, 87(3):423–438.

Passacantando, F. (2013). Building an institutional framework for monetary stability: the case of italy (1979-1994). *PSL Quarterly Review*, 49(196).

Quint, D. (2016). Is it really more dispersed? *International Economics and Economic Policy*, 13(4):593–621.

Rigobon, R. (2003). Identification through heteroskedasticity. *Review of Economics and Statistics*, 85(4):777–792.

Sapir, A., Wolff, G. B., et al. (2015). Euro-area governance: what to reform and how to do it. Technical report.

Sturm, J.-E. and Wollmershäuser, T. (2008). The stress of having a single monetary policy in europe.

Svensson, L. E. (2010). Inflation targeting. In *Handbook of monetary economics*, volume 3, pages 1237–1302. Elsevier.

Taylor, J. B. (1993). Discretion versus policy rules in practice. In *Carnegie-Rochester conference series on public policy*, volume 39, pages 195–214. Elsevier.

Uhlig, H. (2005). What are the effects of monetary policy on output? results from an agnostic identification procedure. *Journal of Monetary Economics*, 52(2):381–419.

Woodford, M. (2003). Interest and prices: Foundations of a theory of monetary policy, princeton university.

Wyplosz, C. (2016). The six flaws of the eurozone. *Economic Policy*, 31(87):559–606.

A Data Appendix

This Data Appendix describes the complete Data Sources used in all sections or subsections in this paper.

A.1 Data for section 2.1

Output-Gap and Inflation data follow from the quarterly series reported in section A.2. The quarterly interest rates are quarterly averages for the particular countries also in section A.2.
Natural Interest rates follow from Holston et al. (2017) and can be downloaded from `https://www.newyorkfed.org/research/policy/rstar`. For the unavailable countries (single Euro Area countries) the same codes were used and calculated by the authors of this paper.
Inflation Expectations data are from Boumans and Garnitz (2019). For the time before the start of the sample therein, moving averages of 4 quarters of past inflation were used to approximate adaptive expectation formation.

A.2 Data for section 3.1

Table 4: Sources for quarterly Real GDP Time Series

Measure: Real GDP		**Frequency: Quarterly**	
Country	**DS Mnemonic**	**Source**	**Comment**
Austria	OEOEXO03D	OECD Quarterly National Accounts	2015=100
Belgium	BGOEXO03D		
Finland	FNOEXO03D		
France	FROEXO03D		
Germany	BDOEXO03D		
Greece	GROEXO03D		
Ireland	IROEXO03D		
Italy	ITOEXO03D		
Luxembourg	LXOEXO03D		
Netherlands	NLOEXO03D		
Portugal	PTOEXO03D		
Spain	ESOEXO03D		
Australia	AUOEXO03D		
Canada	CNOEXO03D		
Denmark	DKOEXO03D		
Japan	JPOEXO03D		
Mexico	MXOEXO03D		
New Zealand	NZOEXO03D		
Norway	NWOEXO03D		
Sweden	SDOEXO03D		
Switzerland	SWOEXO03D		
United Kingdom	UKOEXO03D		
United States	USOEXO03D		

Table 5: Sources for quarterly Nominal GDP Time Series

Measure: Nominal GDP		**Frequency: Quarterly**	
Country	**DS Mnemonic**	**Source**	**Comment**
Austria	OEOEXA03B	OECD Quarterly National Accounts	Current Prices, Annual Levels
Belgium	BGOEXA03B		
Finland	FNOEXA03B		
France	FROEXA03B		
Germany	BDOEXA03B		
Greece	GROEXA03B		
Ireland	IROEXA03B		
Italy	ITOEXA03B		
Luxembourg	LXOEXA03B		
Netherlands	NLOEXA03B		
Portugal	PTOEXA03B		
Spain	ESOEXA03B		
Australia	AUOEXA03B		
Canada	CNOEXA03B		
Denmark	DKOEXA03B		
Japan	JPOEXA03B		
Mexico	MXOEXA03B		
New Zealand	NZOEXA03B		
Norway	NWOEXA03B		
Sweden	SDOEXA03B		
Switzerland	SWOEXA03B		
United Kingdom	UKOEXA03B		
United States	USOEXA03B		

Table 6: Sources for monthly interest rate series

Measure: Interest rates		**Frequency: monthly**	
Country	**DS Mnemonic**	**Source**	**Comment**
Austria	OEprate.	European Central Bank	Policy Rate
Belgium	BGprate.	European Central Bank	Policy Rate
Finland	FNOIR030R	OECD Main Economic Indicators	Money Market Rate
France	FRINTER3	OECD Main Economic Indicators	Money Market Rate
Germany	BDINTER3	OECD Main Economic Indicators	Money Market Rate
Greece	GRprate.	European Central Bank	Policy Rate
Ireland	IRprate.	European Central Bank	Policy Rate
Italy	ITINTER3	OECD Main Economic Indicators	Money Market Rate
Luxembourg	LXI60L..	International Financial Statistics	Start: 1985
Netherlands	NLINTER3	OECD Main Economic Indicators	Money Market Rate
Portugal	PTprate.	European Central Bank	Policy Rate
Spain	ESINTER3	OECD Main Economic Indicators	Money Market Rate
Australia	AUI60...	International Financial Statistics	Money Market Rate
Canada	CNBCBPR	Datastream	Policy Rate
Denmark	DKBCBPR	Datastream	Policy Rate
Japan	JPprate.	Bank of Japan	Policy Rate
Mexico	MXMIR060R	OECD Main Economic Indicators	Money Market Rate
New Zealand	NZMIR076R	OECD Main Economic Indicators	Money Market Rate
Norway	NWI60...; nwprate.	International Financial Statistics; Norges Bank	Money Market rate until 2017; From 2017 Policy Rate
Sweden	SDprate.	Sveriges Riksbank	Policy Rate
Switzerland	SWINTER3	OECD Main Economic Indicators	Money Market Rate
United Kingdom	UKprate.	Bank of England	Policy Rate
United States	USINTER3	Refinitiv	Money Market Rate
Euro Area Countries	EMINTER3	European Central Bank	All from 1999: Money Market Rate

Table 7: Sources for monthly consumer price index series (used for frequency conversion by interpolation)

Measure: CPI		**Frequency: Monthly**	
Country	**DS Mnemonic**	**Source**	**Comment**
Austria	OECONPRCF	National Statistical Office	
Belgium	BGCONPRCF	National Statistical Office	
Finland	FNCONPRCF	National Statistical Office	
France	FROCP009F	OECD Main Economic Indicators	
Germany	BDCONPRCF	National Statistical Office	
Greece	GRCONPRCF	National Statistical Office	
Ireland	IRCONPRCF	National Statistical Office	
Italy	ITCONPRCF	National Statistical Office	
Luxembourg	LXOCP009F	OECD Main Economic Indicators	
Netherlands	NLCONPRCF	National Statistical Office	
Portugal	PTCONPRCF	National Statistical Office	
Spain	ESCONPRCF	National Statistical Office	
Australia	AUCCPI..E	National Statistical Office/Refinitiv	
Canada	CNCONPRCF	National Statistical Office	
Denmark	DKCONPRCF	National Statistical Office	
Japan	JPCONPRCF	National Statistical Office	
Mexico	MXCONPRCF	National Statistical Office	
New Zealand	NZCCPI..E	National Statistical Office/Refinitiv	
Norway	NWCONPRCF	National Statistical Office	
Sweden	SDCONPRCF	National Statistical Office	
Switzerland	SWCONPRCF	National Statistical Office	
United Kingdom	UKOCP009F	OECD Main Economic Indicators	
United States	USCONPRCF	Bureau of Labor Statistics	

Table 8: Sources for monthly industrial production series (used for frequency conversion by interpolation)

Measure: Industrial Production		**Frequency: Monthly**	
Country	**DS Mnemonic**	**Source**	**Comment**
Austria	OEOPRI35G	OECD Main Economic Indicators	
Belgium	BGOPRI35G	OECD Main Economic Indicators	
Finland	FNOPRI35G	OECD Main Economic Indicators	
France	FROPRI35G	OECD Main Economic Indicators	
Germany	BDOPRI35G	OECD Main Economic Indicators	
Greece	GROPRI35G	OECD Main Economic Indicators	
Ireland	IROPRI35G	OECD Main Economic Indicators	
Italy	ITOPRI35G	OECD Main Economic Indicators	
Luxembourg	LXOPRI35G	OECD Main Economic Indicators	
Netherlands	NLOPRI35G	OECD Main Economic Indicators	
Portugal	PTOPRI35G	OECD Main Economic Indicators	
Spain	ESOPRI35G	OECD Main Economic Indicators	
Australia	AUCIND..G	National Statistical Office/Refinitiv	
Canada	CNOPRI35G	OECD Main Economic Indicators	
Denmark	DKOPRI35G	OECD Main Economic Indicators	
Japan	JPOPRI35G	OECD Main Economic Indicators	
Mexico	MXOPRI35G	OECD Main Economic Indicators	
New Zealand	NZCUNP..O	National Statistical Office/Refinitiv	Unemployment Rate
Norway	NWOPRI35G	OECD Main Economic Indicators	
Sweden	SDOPRI35G	OECD Main Economic Indicators	
Switzerland	SWCIND..G; SWI66..XR	National Statistical Office/Refinitiv; International Financial Statistics	Constructed from both series
United Kingdom	UKOPRI35G	OECD Main Economic Indicators	
United States	USOPRI35G	OECD Main Economic Indicators	

Notes: In Mexico data collection for industrial production only starts in January 1980, thus causing a delay of the sample start due to the trend extraction exercise, In New Zealand data collection for the unemployment rate only starts in March 1986, thus causing a further delay of the sample start

A.3 Data for section 3.2

Central Bank Independence index taken from Garriga (2016) and can be downloaded from `https://sites.google.com/site/carogarriga/cbi-data-1`
Average interest rate is the unweighted average of the monthly interest rate series for the respective time periods.
Average inflation rate is the unweighted average of the growth rate in the respective time period based on the quarterly GDP deflator series derived from the ratio of nominal to real GDP

Table 9: Sources for SCM weight calculation covariates II

All Frequencies: Annually (1999)								
	Measure: Total GDP			Measure: Population Size			Measure: GDP per Capita	
Country	**DS Mnemonic**	**Source**	**Comment**	**DS Mnemonic**	**Source**	**Comment**	**DS Mnemonic**	**Source**
Austria	OEAUVGDP	DG ECFIN AMECO		OEOCFTPP	OECD Economic Outlook		OEWDUGY7C	World Bank WDI
Belgium	BGAUVGDP	DG ECFIN AMECO		BGOCFTPP	OECD Economic Outlook		BGWDUGY7C	World Bank WDI
Finland	FNAUVGDP	DG ECFIN AMECO		FNOCFTPP	OECD Economic Outlook		FNWDUGY7C	World Bank WDI
France	FRAUVGDP	DG ECFIN AMECO		FROCFTPP	OECD Economic Outlook		FRWDUGY7C	World Bank WDI
Germany	BDAUVGDP	DG ECFIN AMECO		BDOCFTPP	OECD Economic Outlook		BDWDUGY7C	World Bank WDI
Greece	GRAUVGDP	DG ECFIN AMECO		GROCFTPP	OECD Economic Outlook		GRWDUGY7C	World Bank WDI
Ireland	IRAUVGDP	DG ECFIN AMECO		IROCFTPP	OECD Economic Outlook		IRWDUGY7C	World Bank WDI
Italy	ITAUVGDP	DG ECFIN AMECO		ITOCFTPP	OECD Economic Outlook		ITWDUGY7C	World Bank WDI
Luxembourg	LXWDLGSKA	World Bank WDI	/1000000000	LXPOPTOT.	Statistics Luxemburg	/1000	LXWDUGY7C	World Bank WDI
Netherlands	NLAUVGDP	DG ECFIN AMECO		NLOCFTPP	OECD Economic Outlook		NLWDUGY7C	World Bank WDI
Portugal	PTAUVGDP	DG ECFIN AMECO		PTOCFTPP	OECD Economic Outlook		PTWDUGY7C	World Bank WDI
Spain	ESAUVGDP	DG ECFIN AMECO		ESOCFTPP	OECD Economic Outlook		ESWDUGY7C	World Bank WDI
Australia	AUAUVGDP	DG ECFIN AMECO		AUOCFTPP	OECD Economic Outlook		AUWDUGY7C	World Bank WDI
Canada	CNAUVGDP	DG ECFIN AMECO		CNOCFTPP	OECD Economic Outlook		CNWDUGY7C	World Bank WDI
Denmark	DKAUVGDP	DG ECFIN AMECO		DKOCFTPP	OECD Economic Outlook		DKWDUGY7C	World Bank WDI
Japan	JPAUVGDP	DG ECFIN AMECO		JPOCFTPP	OECD Economic Outlook		JPWDUGY7C	World Bank WDI
Mexico	MXAUVGDP	DG ECFIN AMECO		MXOCFTPP	OECD Economic Outlook		MXWDUGY7C	World Bank WDI
New Zealand	NZAUVGDP	DG ECFIN AMECO		NZOCFTPP	OECD Economic Outlook		NZWDUGY7C	World Bank WDI
Norway	NWAUVGDP	DG ECFIN AMECO		NWOCFTPP	OECD Economic Outlook		NWWDUGY7C	World Bank WDI
Sweden	SDAUVGDP	DG ECFIN AMECO		SDOCFTPP	OECD Economic Outlook		SDWDUGY7C	World Bank WDI
Switzerland	SWAUVGDP	DG ECFIN AMECO		SWWD8FD7P	World Bank WDI	/1000	SWWDUGY7C	World Bank WDI
United Kingdom	UKAUVGDP	DG ECFIN AMECO		UKOCFTPP	OECD Economic Outlook		UKWDUGY7C	World Bank WDI
United States	USAUVGDP	DG ECFIN AMECO		USOCFTPP	OECD Economic Outlook		USWDUGY7C	World Bank WDI

A.4 Data for section 3.4

Table 10: Sources for monthly exchange rate series

Measure: DM FX rates		**Frequency: Monthly**	
Country	**DS Mnemonic**	**Source**	**Comment**
Austria	BDWU5015A	Deutsche Bundesbank	
Belgium	BDWU5001A		
Finland	BDWU5002A		
France	BDWU5012A		
Ireland	BDWU5017A		
Italy	BDWU5007A		
Netherlands	BDWU5000A		
Portugal	BDWU5004A		
Spain	BDWU5006A		
Measure: US-Dollar FX rates		**Frequency: Monthly**	
Austria	OEXRUSD.	Bank of England	
Belgium	BGXRUSD.		
Finland	FNXRUSD.		
France	FRXRUSD.		
Germany	BDXRUSD.		
Ireland	IRXRUSD.		
Italy	ITXRUSD.		
Netherlands	NLXRUSD.		
Portugal	PTXRUSD.		
Spain	ESXRUSD.		
Australia	AUXRUSD.		
Canada	CNXRUSD.		
Denmark	DKXRUSD.		
Japan	JPXRUSD.		
New Zealand	NZXRUSD.		
Norway	NWOCC016		1/NWOCC016
Sweden	SDXRUSD.		
Switzerland	SWXRUSD.		
United Kingdom	UKXRUSD.		
United States	1/BDXRUSD.		1/BDXRUSD.

B SCM statistics

Table 11: SCM weights

	SR	**IH**	**Cholesky**
AU	0%	0%	0%
CA	0%	0%	21%
DK	0%	0%	0%
JP	2%	0%	9%
NO	6%	1%	4%
CH	5%	12%	3%
UK	86%	86%	63%
US	1%	1%	0%

Notes: SCM weighting vectors for the baseline specification, different identification assumptions: Sign restrictions (SR), Identification using heteroskedasticity (IH) and zero restrictions (Cholesky) following the recursive ordering described in equation 9

Table 12: **Monetary policy stress** in the euro area (EA) and its doppelganger

	Stress EA	Stress EA doppelganger
SR	28.55	29.25
IH	0.007	0.001
Cholesky	135.35	138.01

Notes: Average monetary policy stress $\hat{\sigma}^2_{1,MP}$ in the euro area (EA) and its doppelganger replication following from as the last column $X_0 w$ in equation 10. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH), and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

Table 13: **Key characteristics** of the euro area average and its doppelganger

	EA average	D SR	D IH	D CHOL
CB Independence	0.48	0.32	0.30	0.30
GDP	1203.06	1161.08	1202.73	1203.51
i	9.24	9.49	9.35	9.08
GDP Growth	2.62	3.02	2.97	3.18
Inflation	8.58	6.85	7.67	6.77
GDP per capita	34501.86	34187.25	34501.46	34501.22

Notes: The average euro area (EA) country and its doppelganger (D) replications following from $X_0 w$ as in equation 10. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH) and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

C Supplementary results

Table 14: **Factor of improvement** of monetary stress for the average euro area country and its doppelganger

	EA average	EA doppelganger
IH	25.7	18.1
SR	26.2	16.5
Cholesky	26.4	18.5

Notes: The table displays the post-euro to pre-euro ratio of the monetary stress measure $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for the euro area average and its doppelganger after applying the SCM country weights w_i to the individual country factor of improvement as in the tables 3 and 2 . The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH), and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

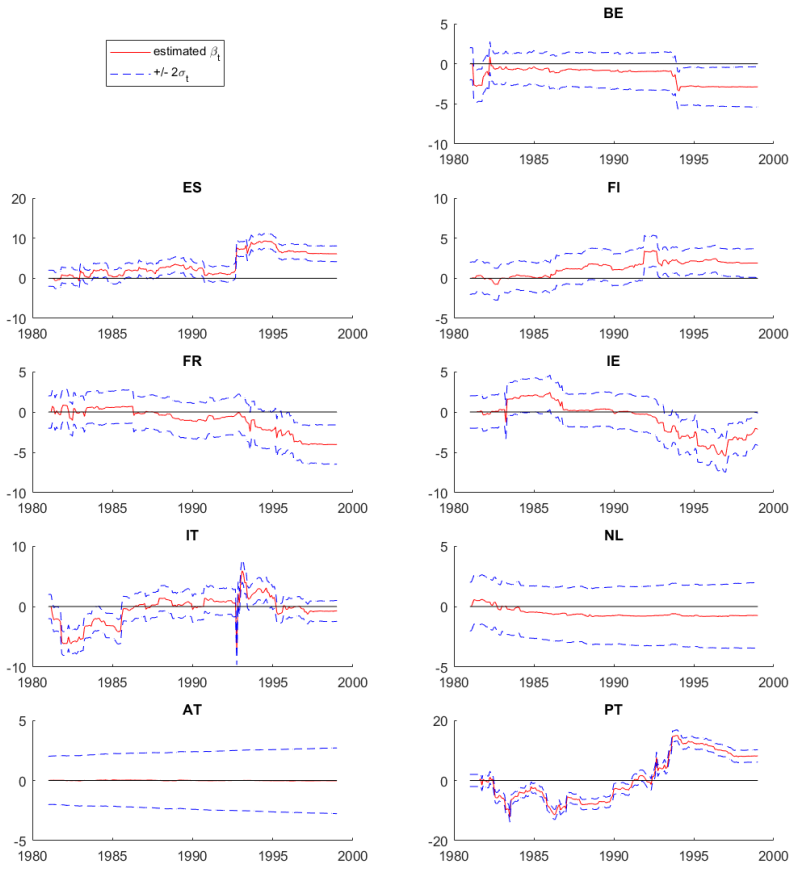
Table 15: **Factor of improvement** of monetary stress for individual euro area countries and their doppelgangers

	A SIGN	D SR	A HET	D IH	A Chol	D Chol
DE	*10*	*24*	*14*	*19*	*16*	*22*
BE	**21**	**20**	**21**	**17**	**24**	**17**
ES	**26**	**17**	**21**	**20**	**25**	**18**
FI	*3*	*22*	*6*	*19*	*5*	*17*
FR	**24**	**18**	**21**	**19**	**24**	**20**
IE	**21**	**21**	**22**	**16**	**19**	**16**
IT	**45**	**19**	**35**	**18**	**43**	**20**
NL	**29**	**13**	**14**	**12**	**17**	**11**
AT	*4*	*13*	*3*	*14*	*4*	*13*
PT	**127**	**17**	**238**	**20**	**114**	**18**

Notes: The table displays the post-euro to pre-euro ratio of the monetary stress measure $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for every country (A) compared to an estimate for a doppelganger (D) for every individual country. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH), and zero restrictions (Chol), following the recursive ordering described in equation 9.

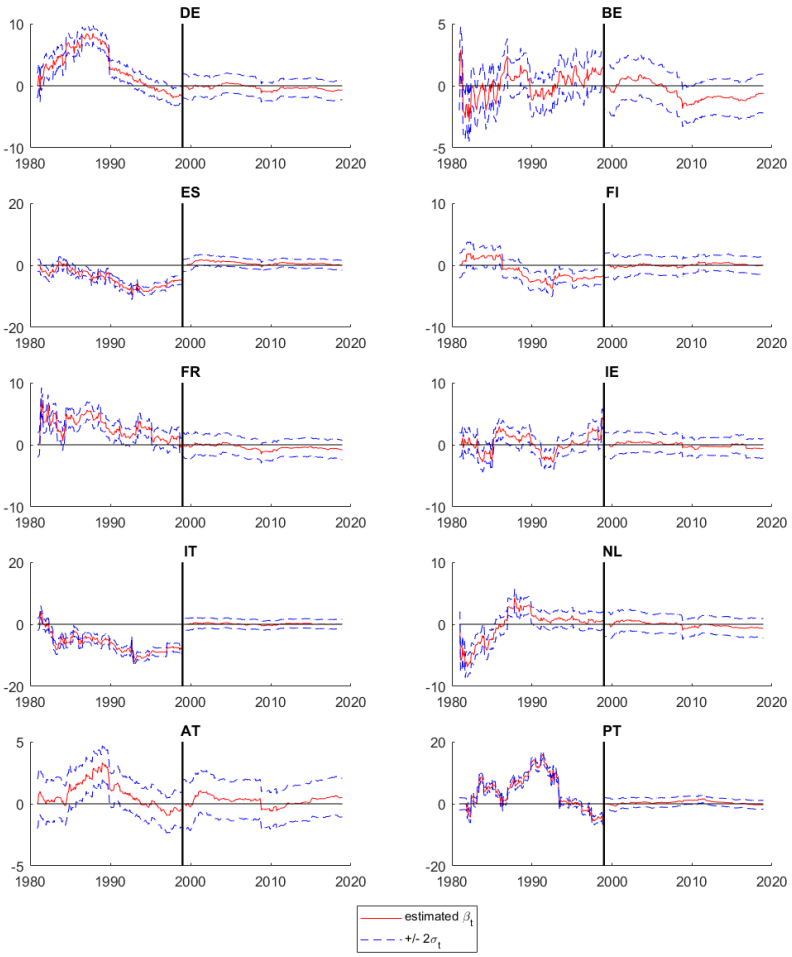
D Graphs

Figure 5: Monetary stress and the D-Mark



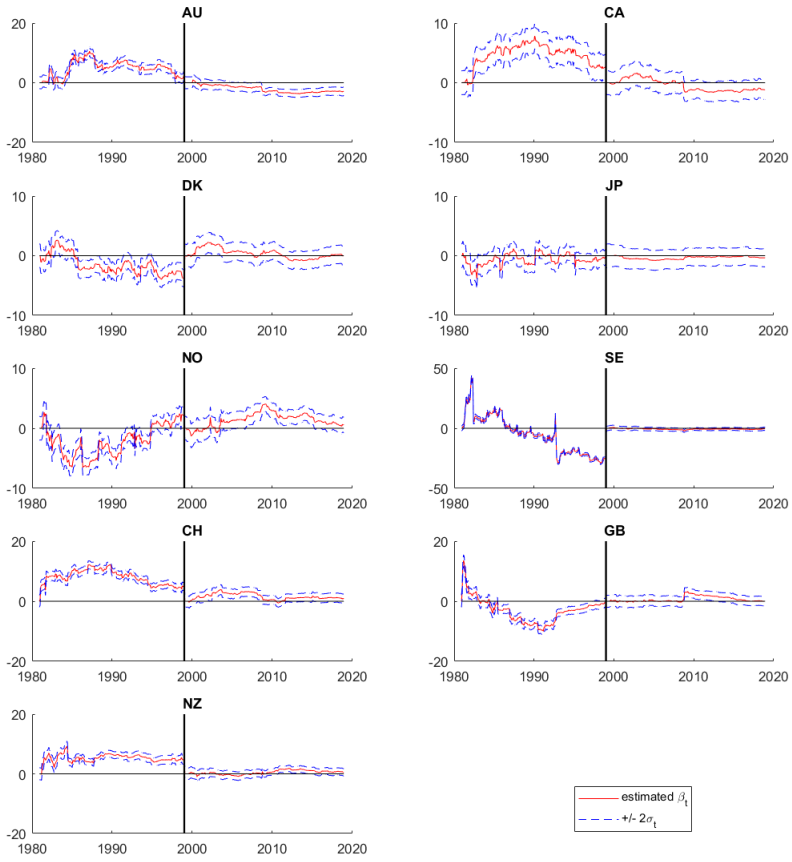
Notes: Time-varying impact of ΔE_t (change of D-Mark/national currency) on $\omega_t^{MON-POL}$, Belgium (1), Spain (2), Finland (3), France (4), Ireland (5), Italy (6), Netherlands (7), Austria (8), Portugal (9)

Figure 6: Monetary stress and the U.S. dollar, euro area countries



Notes: Time-varying impact of ΔE_t (change of Dollar/national currency) on $\omega_t^{MON-POL}$, Germany (1), Belgium (2), Spain (3), Finland (4), France (5), Ireland (6), Italy (7), Netherlands (8), Austria (9), Portugal (10)

Figure 7: Monetary stress and the U.S. dollar, non-euro area countries



Notes: Time-varying impact of ΔE_t (change of Dollar/national currency) on $\omega_t^{MON-POL}$, Australia (1), Canada (2), Denmark (3), Japan (4), Norway (5), Sweden (6), Switzerland (7), United Kingdom (8), New Zealand (9)

E Robustness Exercises

E.1 Shortening of the time sample

Table 16: Key results for the euro area and its doppelganger using a shorter time sample

	Time Sample: 1993 - 2006			
	EA average factor	EA doppelganger factor		
IH	2.52	1.62		
SR	15.17	8.69		
Cholesky	8.15	4.36		
	EA Average	D SR	D IH	D Cholesky
CB Independence	0.48	0.33	0.32	0.35
GDP	1203.06	1203.11	1203.02	1200.11
i	7.75	7.92	7.87	5.45
GDP Growth	2.33	2.27	2.28	1.56
Inflation	3.44	3.34	3.37	3.36
GDP per capita	34501.86	34502.02	34502.17	34506.68

	Stress EA	Stress EA doppelganger
SR	10.23	10.25
IH	0.13	0.05
Cholesky	16.45	13.58

Notes: Results for the euro area (EA) average and its doppelganger (D) after applying the SCM country weights w_i to the individual country factor of improvement in monetary policy stress $\frac{\hat{\sigma}^2_{1,MP,i}}{\hat{\sigma}^2_{2,MP,i}}$ for the time sample 1993 - 2006. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH), and zero restrictions (Cholesky), following the recursive ordering described in equation 9. Below, the attributes of the doppelganger for the different identification assumptions.

Table 17: **Factor of improvement** of the individual euro area countries using a shorter time sample

	DE	**BE**	**ES**	**FI**	**FR**	**IE**	**IT**	**NL**	**AT**	**PT**
SR	0.68	0.74	0.55	2.48	5.36	1.02	41.50	2.83	0.21	102.41
IH	3.07	3.05	2.38	0.74	3.53	2.56	0.38	4.95	2.15	0.26
Cholesky	1.48	0.51	0.77	2.30	5.16	1.66	26.20	2.23	0.15	43.63

Notes: Results for the time sample 1993 - 2006. $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for a sample of 10 euro area countries. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH), and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

Table 18: **Factor of improvement** of the individual non-euro area countries using a shorter time sample

	AU	**CA**	**DK**	**JP**	**NO**	**CH**	**UK**	**US**
SR	7.50	8.86	16.37	0.85	3.70	0.63	0.24	0.34
IH	2.63	1.41	0.37	2.08	0.35	1.56	1.79	8.44
Cholesky	11.20	9.16	8.87	2.17	5.38	0.29	0.36	1.11

Notes: Results for the time sample 1993 - 2006. $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for a sample of 8 non-euro area countries. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH), and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

E.2 Increased country sample for 1993-2006

Table 19: Key results of the euro area and its doppelganger using a shorter time sample and more countries

Expansion of the Country Sample for 1993-2006

	EA	EA doppelganger		
Het	2.45	1.54		
SR	12.15	1.53		
Cholesky	8.33	1.17		
	EA Average	D SR	D IH	D Cholesky
CB Independence	0.48	0.34	0.33	0.33
GDP	1171.73	1171.63	1171.72	1171.60
i	6.21	5.79	9.51	5.53
GDP Growth	2.35	2.94	2.95	2.24
Inflation	2.34	2.52	10.35	2.66
GDP per capita	34362.96	34363.18	34362.96	34363.22

	Stress_SVAR	Stress Doppelganger
SR	4.91	4.84
IH	0.13	0.28
Cholesky	16.92	17.80

Notes: Results for the euro area (EA) average and its doppelganger (D) after applying the SCM country weights w_i to the individual country factor of improvement in monetary policy stress $\frac{\hat{\sigma}^2_{1,MP,i}}{\hat{\sigma}^2_{2,MP,i}}$ for the time sample 1993 - 2006 with five additional countries. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH), and zero restrictions (Cholesky), following the recursive ordering described in equation 9. Below, the attributes of the doppelganger for the different identification assumptions.

Table 20: Factor of improvement of the additional countries

	GR	**LU**	**SE**	**MX**	**NZ**
SR	0.95	0.16	7.50	5.74	0.21
IH	0.31	0.90	0.05	1.98	0.52
Cholesky	15.91	0.16	6.79	8.92	0.24

Notes: Results for the time sample 1993 - 2006. $\frac{\hat{\sigma}^2_{1,MP}}{\hat{\sigma}^2_{2,MP}}$ for two additional euro area and 3 additional non-euro area countries. The identification assumptions are Sign restrictions (SR), Identification using heteroskedasticity (IH), and zero restrictions (Cholesky), following the recursive ordering described in equation 9.

E.3 Exclusion of Portugal

Table 21: Factor of improvement of the euro area excluding Portugal

Exclusion of Portugal	
	EA
IH	20.23
SR	23.56
Cholesky	24.11

Notes: Results for the euro area (EA) average (excluding Portugal) factor of improvement in monetary policy stress $\frac{\hat{\sigma}^2_{1,MP,i}}{\hat{\sigma}^2_{2,MP,i}}$ for the baseline country/time sample.

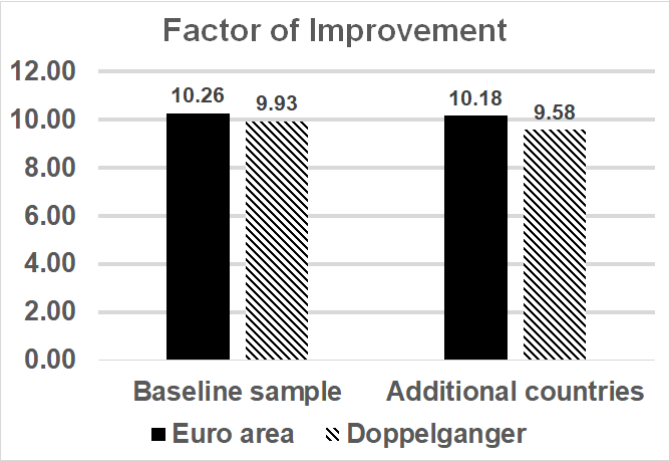
E.4 Results based on loss functions

Table 22: Loss function parameters

Parameter	**Value**	**Interpretation**
β	0.99	Household's discount factor
σ	1	Intertemp. subst. elasticity of consumption
ϕ	1	Labor supply elasticity
α	$\frac{1}{3}$	Capital share of output
ϵ	6	Substitution elasticity of consumption
θ	$\frac{2}{3}$	Calvo probability
λ	0.0425	Impact of marg. costs on inflation

Notes: Parametrization for the loss function L from Galí (2015)

Figure 8: Factor of improvement based on a loss function



Notes: Results for the euro area (EA) average factor of improvement in loss $\frac{L^{pre}}{L^{post}}$ for the baseline sample (10 EA countries vs. 8 non-EA countries) and the augmented sample (12 EA countries vs. 11 non-EA countries). The doppelganger is constructed, matching 6 the six baseline covariates and L^{pre}

F EMS, monetary policy, and crises[39]

The EMS, which existed from 1979 until the introduction of the euro, consisted of two elements: the European Exchange Rate Mechanism (ERM) and the European Currency Unit (ECU), which served as an accounting unit.[40] The economies participating in the ERM set central rates in relation to the ECU currency basket and limit exchange rate fluctuations to ± 2.5 percent[41]

[39] Box 2 of Fritsche and Harms (2019)

[40] The ERM is the central element of the EMS, which is why it is the focus of this box. The ERM still exists today as ERM II and serves as an official system for countries of the European Union. Countries interested in adopting the euro must participate in ERM II for two years. Since most Eastern European countries interested in the euro have already introduced it, Denmark is currently the only participating country.

[41] From the outset, Belgium, Denmark, France, Germany, Ireland, and the Netherlands participated in the system and used these 2.5 percent as a fluctuation margin. Italy was granted a larger margin of ± six percent until 1990, as were Spain, which joined the EMS in 1989, the United Kingdom (1990), and Portugal (1992).

around this rate.[42] The international foreign exchange markets determined the fluctuations between these upper and lower limits while central rate adjustments were the result of political negotiations and required the approval of all participants. The participating central banks were obliged to defend the upper and lower limits by buying and selling their own currencies as well as foreign currencies. They also could act providently within the fluctuation margins.[43]

In order to counter structural economic divergences, such as wage, inflation, and foreign trade developments, many adjustments to central rates took place, particularly in the early 1980s. Generally, some countries tended to devalue their currencies more often (France and Italy) and others (Germany and the Netherlands) only appreciated them (Höpner and Spielau, 2018). Therefore, Germany and, in particular, its Bundesbank played a dominant role in the EMS.

The role of monetary policy as it is understood today is not easy to identify in this system. The EMS was, on the one hand, a fixed exchange rate system, but on the other, it offered the possibility of discretionary adjustments. If central banks have to operate to a large extent on the foreign exchange markets by buying or selling their own currency, it affects the supply of liquidity to the financial system and, thus, the interest rate. If, for example, the Bundesbank was exposed to an extremely high demand for the Deutsche Mark and, thus, to high revaluation pressure, it would have to increase the supply of the Deutsche Mark just as drastically in order to counteract that pressure. In most cases, such stabilization is not possible without affecting the interest rate. Conversely, a change in the interest rate motivated by monetary policy (such as a rise in interest rates to combat inflation) can trigger devaluation or revaluation pressure in another country. If the other country does not want to adjust the exchange rate but has already exhausted the means to intervene in the foreign exchange market, the only remaining option is an

[42] The EMS was already largely de facto abolished over the course of the EMS crisis in 1992/1993 when the fluctuation margins were increased to $\pm$ 15 percent.

[43] Through the "Very Short Term Financing Facility," each currency was available to the countries at short notice in a theoretically unlimited volume on the condition that the foreign currency loans were repaid after 45, and later 75, days.

interest rate increase. Both cases are examples of interest rate changes that clearly do not contribute to national macroeconomic stabilization.

Such economically unjustifiable interest rate decisions regularly occurred in the EMS. As early as the beginning of the 1980s, many other central banks copied a surprising three percentage point interest rate hike by the Bundesbank in order to prevent a devaluation.[44] This problem was exacerbated by the gradual abolition of capital controls from 1987 onwards under the Single European Act.

Many economists believe that the largest crisis of the EMS is a direct consequence of the fall of the Berlin Wall and the Bundesbank's reaction. Reunification and the resulting costs acted as a major economic stimulus package in Germany, while large parts of the EU struggled with recession or weak growth. When the inflation rate exceeded the five percent mark in 1992, the Bundesbank decided to raise interest rates several times. After the abolition of capital controls, the pressure exerted by the financial markets increased significantly. There was great uncertainty regarding how long the central banks of the other countries would be able to keep up with the Bundesbank and maintain their commitment to the Deutsche Mark, despite widely diverging economic trends.

In Scandinavia, which was first attacked by currency speculation in early September 1992, the Swedish Riksbank attempted to stabilize its exchange rate by temporarily raising interest rates as high as 500 percent. Later, speculation also hit the EMS. The Bank of England drastically raised the key interest rate on September 16, 1992, despite the United Kingdom's weak economy, as did the Bank of Italy. Ultimately, monetary policy was unable to counter speculative pressure and both countries left the EMS.

[44] Between March 1979 and February 1980, the Bundesbank increased the discount rate from four to seven percent.