

Should the Nordic Countries Join A European Monetary Union? An Empirical Analysis

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Abstract

This paper examines the implications for the Nordic countries (Denmark, Finland, Norway and Sweden) of participating in the final stage of the European Monetary Union. Economic linkages with Germany are estimated using a time series econometric approach under both the Bretton Woods and the post-Bretton Woods exchange rate regimes. Output responses of the Nordic countries to permanent and transitory disturbances emanating from Germany are estimated and compared with two small “core” EU members, Belgium and the Netherlands.

We find that the long-standing EU members (Belgium, Denmark and the Netherlands) are closely intergated with Germany in that German shocks have a direct and large impact on their output developments. These linkages appear much weaker for Finland, Norway, and Sweden. Common European disturbances also do not distinguish the Nordic countries from the non-Nordic countries.

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1 Introduction

Finland will most likely be the only Nordic country to join the first stage of European Monetary Union (EMU) if it begins on schedule in 1999. In the autumn of 1994, the voters of Sweden and Finland decided to join the European Union (EU), while those in Norway decided to remain outside. In Denmark, the voters had earlier decided not to join the single currency area but remain otherwise a fully-integrated member of the EU. Denmark, however, maintains the option of having another voter referendum. The government of Sweden decided on a similar course, in essence renegeing on the commitment made when voters accepted the Maastricht Treaty, by announcing in Spring 1997 that it would not be among the first group of EU countries forming monetary union.¹ Only Finland therefore appears fully committed at this point to membership in EU and EMU at the outset.

The desirability of entry into the EU and the monetary union rests in large part of the perceived benefits and costs. The benefits of monetary unification and the establishment of a single currency area are generally identified as lower transactions costs associated with the elimination of national currencies, increased credibility of participating governments' commitment to price stability, and greater efficiency of resource allocation through the elimination of exchange rate related uncertainty.²

The main costs of a single currency area, on the other hand, are giving up the value of changing the exchange rate when desired and, more broadly, losing the option of following an independent monetary policy. This option is especially important if countries in the monetary union are facing asymmetric shocks, in which case exchange rate adjustments and separate monetary policies could help to stabilize nation-specific aggregate fluctuations.³

¹In making this decision the Swedish government decided not to follow the advice of the Riksbank's (Sweden's central bank) governing board which had recommended that Sweden be among the first group of countries forming EMU.

²Eichengreen (1992) uses these categories in discussing the potential benefits of a European monetary union. He concludes that, in principle, the benefits are small, meaning that maintenance of firmly fixed exchange rates between distinct national currencies would reap most of the benefits. However, he suggests that the special circumstances allowing governments to commit to fixed exchange rates are not present in Europe today. The *One Market, One Money* report by the Commission of the European Communities (1990) is more optimistic over the benefits of monetary union.

³See De Grauwe (1992) for a comprehensive non-technical discussion of the economics of monetary unification and a critique of the optimal currency area literature. Fratianni and von Hagen (1992) systematically investigate issues of a European monetary union using a three country game-theoretic model. They employ model simulations to determine the welfare effects of various disturbances.

Several recent studies have evaluated various aspects of the entry of the Nordic countries into EMU.⁴ However, there has been surprisingly little empirical investigations of the specific costs and benefits from the macroeconomic perspective. Sardelis (1993) investigates whether the business cycle in the Nordic countries tends to move in synchronization with the EU average, and finds relatively low real GDP correlations with the EU over the 1972–91 period. The contributions of Bayoumi and Eichengreen (1993a,1993b) are to identify fundamental demand and supply disturbances for each European country, and correlate these disturbances with those in Germany.⁵ The countries with high correlations with Germany are termed “core” EU, and those with low correlations are termed “periphery”. Among Nordic countries, Bayoumi and Eichengreen find that Sweden seems to fit best with the core EU, while Norway and Finland are similar to the periphery group. Whitt (1993) follows a similar approach but finds less evidence for a core group prepared for EMU.

One common statistical feature to both these approaches is that the correlation coefficients reflect both fundamental shocks and economic structure. The “core” country disturbances identified by Bayoumi and Eichengreen, for example, may be highly correlated with German shocks either because of symmetry in their fundamental disturbances or because German disturbances are being transmitted to these economies. The former is the traditional indicator, while the latter captures the degree of economic linkage between countries, which in turn depends on the exchange rate regime.⁶ In principle, both the degree of economic linkage as well as the symmetry of disturbances are important criteria for judging the desirability of monetary union. Separating these two components is important, however, since a main objective of the EC is to increase economic integration (financial, goods and labor) among member states. This implies that the “core/periphery” distinc-

⁴In a background study to a Swedish government report (SOU, 1994), Wihlborg (1993) considers the microeconomic aspects of joining a monetary union from the Swedish perspective. He argues that greater economic integration in Europe must lead to either monetary union or flexible exchange rates; increased currency substitution would preclude fixed rates as a viable option.

⁵Supply and demand disturbances are derived from the time series of domestic output and inflation and identifying demand shocks as those having only temporary effects on real output. The shocks for each country are estimated independently of other countries. The imposition of the long-run neutrality restriction to identify structural time series models was first used by Blanchard and Quah (1989). See Hutchison and Walsh (1992) and Bergman (1996) for a discussion of this methodology.

⁶For example, most models predict that a German monetary shock will have the strongest output effect (positive) on those economies maintaining rigid pegs to the DM and having strong trade links with Germany. In this case, German monetary shocks will induce higher output correlations between Germany and the EMS countries than between Germany and non-EMS countries.

tion may change dramatically particularly if economic linkage rather than commonality of disturbances is most important.

Our research investigates these issues for the Nordic countries. We also focus on Germany as the key currency country in the EU, but differ from other work by estimating models which explicitly incorporate structural linkages with Germany. We seek to (i) explicitly measure how closely the Nordic countries are tied to Germany, (ii) determine whether these ties are related to exchange rate regimes, and (iii) identify similar patterns observed in the structural shocks among Nordic countries and two small “core” EMS members (Belgium and the Netherlands).

By investigating the pattern of structural shocks (controlling for the influence of the German economy), we hope to shed light on whether symmetric disturbances or economic structure best explain the willingness of the small European countries to fix their exchange rate to the German Mark. We examine whether the Nordic countries with mixed political support for joining EMU, share characteristics similar to ERM “core” members Belgium and the Netherlands. We also attempt to control for exchange rate regimes by estimating the models for both the Bretton Woods period — when exchange rates between Germany and the Nordic countries were tied via the dollar standard — and the post-Bretton Woods era, when exchange rate parities with Germany changed much more frequently. Choosing two long-standing ERM members for comparison with the Nordic countries also serves this purpose.

Our empirical work uses structural vector autoregression (VAR) models with cointegration restrictions to identify the linkages of each country in the sample with Germany and to identify the fundamental disturbances. A strength of this approach is that it allows us to distinguish between permanent shocks having long-lasting effects (for example, productivity or supply-side shocks) and transitory shocks having only short-term effects (for example, demand shocks). We identify four independent disturbances; domestic and German permanent and transitory shocks. We also add oil prices to model treating oil shocks as exogenous to capture potentially large structural differences in energy production and dependence between Norway, on the one hand, and the other three Nordic countries, on the other. The country-specific disturbances (permanent and transitory shocks) are therefore measured net of oil and German influences. Using these estimates we are able to measure the degree of structural linkage with Germany and the nature of fundamental disturbances comparing Nordic countries with Belgium and the Netherlands.

The paper is structured in the following manner. Section 2 presents the empirical model and a description of the methodology applied to identify the structural shocks. In section 3, we present the empirical results and section 4 concludes the paper.

2 Empirical Analysis

2.1 Methodology

Let us assume that the joint behavior of the multivariate process, x_t , comprised of German industrial production, y_t^g , German inflation, Δp_t^g , focus-country industrial production, y_t^j where $j = \text{Denmark, Finland, Norway, Sweden, Belgium and Netherlands}$, and focus-country inflation, Δp_t^j , can be represented by a vector autoregressive (VAR) process with Gaussian errors. We will also assume that these endogenous variables are affected by the change in the oil price, z_t , which is determined outside the system. All variables are in logarithms. The dynamic simultaneous equations model can then be written as:

$$x_t = \rho + \sum_{k=1}^p A^{(k)} x_{t-k} + \sum_{k=1}^p B^{(k)} z_{t-k} + \varepsilon_t \quad (1)$$

where the vector ρ is a constant, A and B are 4×4 and 4×1 matrices respectively, and ε_t is a four dimensional error vector. The initial values x_0, \dots, x_{1-p} and z_0, \dots, z_{1-p} are taken as fixed. In addition we assume that x_t is nonstationary whereas the exogenous variable, the change in oil prices, is assumed to be stationary. Under these assumptions, the dynamic simultaneous equations model given in equation (1) can be written in a vector moving average form,

$$\Delta x_t = C(1)\rho + C(L)\varepsilon_t + C(L)B(L)z_t$$

The structural VMA model (disregarding deterministic terms and exogenous variables) linking the structural disturbances (supply and demand shocks) of interest to the observed variables may be written as:

$$\Delta x_t = R(L) v_t \quad (2)$$

where v_t is a vector of structural shocks, $E[v_t v_t']$ is diagonal and $R(L)$ is a matrix polynomial. We assume that our system of variables are affected by German and focus-country permanent and transitory shocks. In particular, we let $v_t = [\varphi_t^g \ \varphi_t^j \ \psi_t^g \ \psi_t^j]'$ where φ denotes permanent shocks while ψ denotes transitory shocks. Our problem now is how to recover the structural shocks in (2) from conventional estimates of the VAR in (1). A useful approach is to let $R(L) = C(L)\Gamma^{-1}$ where the matrix Γ translates and identifies the structural shocks v_t from estimates of the residuals ε_t , i.e., $v_t = \Gamma\varepsilon_t$. In the next section we discuss how the Γ matrix can be constructed.

2.2 Identification

After estimating the model in (1), some additional identifying restrictions on the estimated disturbance terms are necessary to calculate the structural shocks, impulse response functions and variance decompositions. Such identifying restrictions have taken a variety of forms in the recent literature. One approach achieves identification by imposing *a priori* restrictions on the contemporaneous interactions among the variables in the system. These restrictions normally take the form of exclusion restrictions following a recursive structure popularized by Sims (1980).

Another approach introduced by Blanchard and Quah (1989) is to impose long-run restrictions on the impulse response pattern. This approach achieves identification by dividing the shocks into two groups, those having only transitory effects on the variables in the system and those having permanent effects on at least one variable. Typically permanent shocks are associated as supply shocks whereas transitory shocks are viewed as demand shocks.

A third approach, which we will use, is to base identification on a common trends model following King, Plosser, Stock and Watson (1991), Warne (1993) and Quah (1994). Within this approach knowledge about the cointegration space allows us to identify both permanent and transitory shocks. In our model, since we are decomposing disturbances into two groups (two permanent shocks and two transitory shocks), it follows that there should be two cointegration vectors and, thus, two common trends in the data. In the Appendix we discuss in some detail how, in the general case, the two permanent shocks and the two transitory shocks are identified using estimates of our model.

We begin by following the approach of Bayoumi and Eichengreen in assuming that inflation rates are stationary and output levels are non-stationary but not cointegrated.⁷ Following this literature (e.g., Bayoumi and Eichengreen (1993a,1993b), Blanchard and Quah (1988) and others) we also interpret permanent shocks as supply disturbances and transitory shocks as demand disturbances.

Our stationarity assumptions imply that the data generating process is characterized by two supply shocks and two demand shocks, i.e., two cointegration vectors and two common trends. Within this framework, the system may be exactly identified by two additional restrictions. One restriction is needed to distinguish between the two supply shocks and one restriction is needed to similarly disentangle the two demand shocks. To

⁷This may seem counter intuitive. But while disturbances emanating from Germany may leave a permanent imprint on focus-country output, domestic disturbances are also determining long-run output movements.

identify the supply shocks, we assume that focus-country supply shocks cannot affect German industrial production in the long-run. This is natural since the six countries we examine can be regarded as small open economies relative the German economy. This restriction, including the implicit assumption that demand shocks only leave transitory imprints on the variables, implies that the long-run system linking the two supply shocks to the observable variables can be written as

$$\begin{bmatrix} y_t^g \\ y_t^j \\ \Delta p_t^g \\ \Delta p_t^j \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ \gamma_{21} & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} \tau_t^g \\ \tau_t^j \end{bmatrix}$$

where the parameter γ_{21} is freely estimated and measures the long-run effect from German supply shocks on the focus country, and τ_t^g and τ_t^j are the foreign and domestic common trends, respectively.⁸ With no further restrictions it is possible to identify the two supply shocks affecting our system.

The two demand shocks can be identified using a procedure discussed in detail by Warne (1993) and Quah (1994) and shown in Appendix A. They propose an identification scheme similar to the standard Choleski based identification suggested by Sims (1980) discussed above. The individual effects of the two demand shocks are distinguished by assuming that a certain innovation does not exert contemporaneous impact on one selected variable. In our particular application, we assume that focus-country demand shocks have no first period effect on German inflation. We could, of course, add additional restrictions such as also restricting the first period response of German industrial production. In this case, our system would be over-identified. We choose not to add over-identifying restrictions, however.

Since some of the shocks in v_t only give short-run effects on the variables, certain coefficients in $R(1)$ must be zero. In our model, with two transitory shocks (demand shocks), this implies that the last two columns of $R(1)$ are zero. The first two columns contain the factor loadings of the common trends, i.e., measure the long-run impact on certain variables from the two supply shocks. Moreover, our assumption that the focus-country permanent shock has no long-run effect on Germany implies that the second element in the first row of $R(1)$ is zero.

⁸Note that we have normalized the effects from the supply shocks such that a one percent positive German supply shock leads to a one percent rise in the level of German industrial production in the long-run. This normalization makes it easier to compare estimates of the different countries below.

We have now the necessary tools to examine the influence of German and focus-country disturbances on each country and investigate the properties of the estimated structural shocks. This is the focus of the next section.

3 Empirical Results

3.1 Data

The data set consists of monthly observations on industrial production and inflation measured by the consumer price index for the four Nordic countries Denmark, Finland, Norway and Sweden and two non-Nordic countries, Belgium and the Netherlands. All data are obtained from IFS except industrial production in Denmark (compiled by Danmarks Nationalbank) and Belgium (taken from OECD MEI database).⁹ The crude petroleum prices in dollars are obtained from the Citibase data base, converted into German Marks (at the spot exchange rate) and real values (deflated by German CPI). All variables are expressed in natural logarithms and are not seasonally adjusted. We examine two non-overlapping subperiods: the Bretton Woods era from 1960:1–1970:12 and the post-Bretton Woods period from 1974:1–1995:12.

3.2 Model estimates

In this section we estimate the structural VAR model given in equation (1) for each country separately (adding seasonal dummy variables), identify the system along the lines described above, and extract the four structural shocks. To examine whether domestic structural shocks in the small European countries are symmetrical, we simply present correlation coefficients. We also control for the German influence by computing variance decompositions of focus-country output.

Prior to estimating the structural VAR model, however, we have to determine the lag length, test the restrictions imposed in our identification procedure above, i.e., that there are two cointegration vectors in the data and that inflation in both Germany and the focus country is stationary. In Table 1, we report p-values from univariate Ljung-Box and Engle's LM tests for ARCH, for the two samples. From this table we note that, at the five percent level, the null hypothesis (i.e., that the residuals are not autocorrelated) can be rejected in only three out of 20 cases in the Bretton Woods period and in two out

⁹We thank Ninette Pilegaard Hansen at the *Economic Policy Research Unit* at the Copenhagen Business School for providing the Danish data.

of 24 cases in the post–Bretton Woods period. The null hypothesis of no ARCH (up to lag 6) can be rejected more often, in particular in the latter sample. We reject this null in two cases in the earlier sample period and in nine cases in the latter sample. However, our interpretation is that our models are reasonably well specified. These test statistics do not change that much when adding more lags to the VAR model. For example, using 12 lags in the VAR model we reject the two null hypothesis above as often as when we have 6 lags in the model.

Table 2 reports the results from using the so–called Johansen approach of testing for cointegration, i.e., likelihood ratio trace tests and eigenvalues, see e.g., Johansen (1991) and Johansen and Juselius (1992). One potential problem with our model is that we have added a (stationary) exogenous variable to our model. This will affect the asymptotic distribution of the trace tests. However, using the standard critical values for a model with linear trends, the LR trace tests suggest two cointegrating vectors in five cases, one cointegration vector in four cases, and four cointegration vectors (i.e. all variables are stationary) in one case. Looking at the eigenvalue associated with each trace test (reported in parenthesis below the test statistic), we note that they are typically quite high for two cointegration vectors and drop substantially when adding a third vector. The trace statistic is also quite close to the standard critical value when testing $r = 1$. Following this way of reasoning, we make the judgement that $r = 2$ for an additional four cases. For Finland (during the Bretton Woods period) and the Netherlands (during the post–Bretton Woods period) our results suggest one and three cointegration vectors, respectively. Given the inherent difficulty in determining the number of cointegration vectors when sample sizes are limited, we proceed on the assumption that 2 cointegration vectors exist for all of the countries.

We test whether industrial production and inflation are stationary using a likelihood ratio test and assuming that there are 2 cointegration vectors in the data. The results from these tests are summarized in Table 3. These test statistics suggest that we often can reject the null hypothesis that the data series are stationary. In general, the p–values of tests of the null that industrial production is stationary is lower than for testing inflation. Our interpretation is that our assumptions made in context to the discussion about identification are rejected in many cases. One way to proceed is then to assume that all four variables are nonstationary, forming two cointegration vectors and apply our identifying restrictions discussed above.¹⁰ However, if all variables are included in both

¹⁰Note that our identifying restrictions discussed above are not affected by the fact that all variables are contained in the cointegration space, see Appendix A.

cointegration vectors, it follows that all variables are affected by the permanent shocks in the long-run. The long-run model linking the two common trends (the two permanent shocks), and imposing the same long-run restriction as is used above can be written

$$\begin{bmatrix} y_t^g \\ y_t^j \\ \Delta p_t^g \\ \Delta p_t^j \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ \gamma_{21} & 1 \\ \gamma_{31} & \gamma_{32} \\ \gamma_{41} & \gamma_{42} \end{bmatrix} \begin{bmatrix} \tau_t^g \\ \tau_t^j \end{bmatrix}$$

In this case, we note that permanent focus-country shocks will have long-run effects on foreign inflation. To impose the overidentifying restriction that the parameter γ_{32} measuring this long-run effect is zero, we have to introduce a restriction on the cointegration space. In particular, if focus-country inflation can be excluded from one of the two cointegration vectors, then the parameter $\gamma_{32} = 0$. This overidentifying restriction is tested in Table 4. The low p-values of likelihood ratio tests of this null hypothesis suggest that this hypothesis can be rejected at conventional significance levels.

These mixed results are resolved by estimating three separate structural models. The first model imposes the restriction that both German and focus-country inflation are stationary (our base model), the second assumes that inflation is nonstationary, and the third assumes that inflation is nonstationary and imposes the overidentifying restriction discussed above. Comparing correlations of extracted structural shocks from these three groups of models reveal only minor differences. The main conclusions that can be drawn from the analysis are unaffected of our assumptions concerning inflation (if inflation is stationary or nonstationary). The same conclusion emerges from the impulse response analysis. However, variance decompositions are significantly affected when inflation is nonstationary. We report the base-model results (assuming that inflation is stationary) as well as the variance decompositions which highlight the sensitivity of the results to alternative model specification.¹¹

3.3 Correlation of focus-country supply and demand shocks

To examine whether domestic disturbances in the focus country are symmetrical, we examine correlations among supply and demand shocks after they have been adjusted for the influence of the German variables and oil prices. The major questions addressed here are (i) whether country-specific supply and demand shocks of the Nordic EU members (Denmark, Finland and Sweden) show a similar pattern to Belgium and the Netherlands;

¹¹Results for the other two models are available on request from the authors.

(ii) whether Norwegian supply and demand shocks show a distinct pattern from the other countries, which in turn may explain the decision of Norwegian voters to reject EU membership; and (iii) whether there is any distinctive common pattern among the countries favoring EMU entrance during the first stage (Belgium, Finland and the Netherlands).

Table 5 shows the simple correlations and significance levels among domestic supply shocks for each pair of countries in the sample. Correlations for both the Bretton Woods (10 pairs, shown in lower triangle) and post-Bretton Woods (15 pairs, shown in upper triangle) samples are provided. Five of the correlations (33%) are significant at the 5 percent level of confidence or better during the post-Bretton Woods sample and two (20%) are significant in the Bretton Woods sample. Common supply shocks, abstracting from oil price disturbances, appear with somewhat more frequency during the post-Bretton Woods period.

Looking more closely at the correlations among supply shocks for country pairs for the post-Bretton Woods sample, we find that 2 of the 6 Nordic-Nordic pairs are significant, 2 of the 8 Non-Nordic and to Nordic pairs are significant, and the single Non-Nordic to Non-Nordic pairing is significant. No special distinction between the Nordic and Non-Nordic countries in the sample is apparent. Correlations from the Bretton Woods period reveal, by contrast, that 2 of 6 Non-Nordic to Nordic correlations are significantly negative but that no other correlations are not significant. That is, during the Bretton Woods sample, only supply shocks in the Netherlands were negatively correlated with supply shocks in Norway and Finland.

Table 6 shows the simple correlations and significance levels among domestic demand shocks. The table reveals that 9 of the 15 (60%) demand shock correlations are significant during the post-Bretton Woods period, but only 1 of 10 (10%) during the Bretton Woods period. The importance of common demand shocks appear to be much more important in the current environment than previously. Although a number of the demand shock correlations are significant in the more recent period, the Nordic to non-Nordic distinction again does not appear to be particularly important: half (3) of the Nordic to Nordic correlations are significant, somewhat less than two-thirds (5) of non-Nordic to Nordic correlations are significant, and the single non-Nordic to non-Nordic correlation is significant.

It is also useful to compare these correlation coefficients with the correlation between German shocks estimated in each of the six focus-country models. If the models are correct, German structural shocks estimated within each system should be identical. The tests show (not shown in the paper) that German shocks from each model are highly correlated (and always significant), the correlation coefficients are around 0.8 except for

two cases where the correlation is higher than 0.6.

3.4 Importance of German shocks

Tables 5 and 6 are measuring the pairwise correlations among the supply and demand shocks, respectively, for our sample countries after controlling for the influence of disturbances transmitted from Germany and oil prices. To examine the effect of German supply and demand shocks on smaller European economies under the Bretton Woods and post-Bretton Woods periods, we compute the impulse responses of focus-country output to German shocks and their relative importance. In particular, we examine the influence of a standardized supply shock and demand shock on the evolution of focus-country output over time holding other factors constant.¹² While the impulse response analysis provides information on the effects of standardized German supply and demand shocks during the sample periods, it does not take the actual variability of focus-country output into consideration. Whether German shocks played a larger or smaller role in determining output fluctuations in the small European economies depends on both the strength of the linkages as well as the importance of the disturbances emanating in Germany. This is investigated through variance decompositions.

3.4.1 Impulse responses

German supply shocks should be interpreted as productivity developments and other factors that are standardized to effectively cause a one percent permanent rise in German output. To get a more concrete understanding of these disturbances emanating from Germany, figure B.1 in Appendix B shows the response of Germany output in the short- and long-run to a positive German supply shock. Each of these effects is estimated separately for each group of (focus-country) equations. The effects are very similar regardless of the model estimated: a German supply shock immediately increases German output, with the impact effect ranging from 0.5 percent to over 1 percent, and relatively quickly (within two years) converges on the long-run value of 1.0 percent. Hence, an important channel of transmission of the “Germany supply shock” to the smaller European countries is via a large short-run and permanent rise in German output.

Figure 1 shows the output response for each country to a one unit German supply shock during the Bretton Woods period (solid line) and post-Bretton Woods period

¹²We normalize the system such that a one percent supply shock leads to a one percent permanent change in German output.

(dashed line). In every case, the output response to a German supply shock is greater in the post-Bretton Woods period than in the Bretton Woods period. This difference is substantial in Belgium and the Netherlands, the two countries in the sample presumably best integrated with Germany via their long-standing membership in the EU and having the strongest exchange rate link. (Denmark is also a long-standing EU member, but data is not available to make a comparison with the earlier episode.)

Perhaps most interesting for our purposes, however, is that the long-standing EU and “core” ERM members — Belgium, Denmark and the Netherlands — are much more influenced by German supply shocks than are Finland, Norway and Sweden. In the recent sample period, output in Belgium, Denmark and the Netherlands each increased by over 0.70 percent one-year after a German supply shock and the long-run effect is 1.02 percent, 0.82 percent, and 0.94 percent, respectively. By contrast, the long-run (short-run; one-year) effects on output in the other Nordic countries are 0.28 (0.14) percent in Finland, 0.41 (0.23) percent in Norway, and 0.33 (0.28) percent in Sweden. Perhaps not surprising, these results indicate that members of our sample identified as by Bayoumi and Eichengreen as “core” EU members are most exposed to supply shocks emanating from Germany — not because of the symmetry between fundamental disturbances in Germany and the smaller EU countries but because of the economic structure linking the economies.

The evidence on German demand shocks is more difficult to interpret than the supply shocks. Demand shocks are identified as having only short- and medium-run effects on focus-country (and German) output, and the dynamics in most cases are complicated. To gain a better understanding of these disturbances, Figure B.2 in Appendix B shows the effects of German demand shocks on German output. In every case the impact effect is positive and then gradually, but with considerable oscillation, dampens to zero (the long-run restriction). The initial impact effect ranges from 0.4 to 0.6. An important channel of transmission of German demand shocks therefore will be through the initial positive impact on German output.

The effects of German demand shocks on focus-country output is shown in Figure 2 for the post-Bretton Woods period.¹³ Although considerable short-run variation is evident, the transmission of the German demand shock is generally positive in Belgium, Denmark and Sweden and negative in Finland. The effects on output in the Netherlands and Norway is mixed in the sense that the initial positive impact from the German demand

¹³The impulse responses for the Bretton Woods period, omitted for brevity, show a similar pattern. These results are available from the authors upon request.

shock is subsequently followed by negative impulses in several periods.

The strongest effect of the German demand shock is evident in Belgium. The impact effect in Belgium is to increase industrial production by about 0.4 percent, with a peak rise after 4 months and followed by a gradual decline. After two years the effect on Belgium is still about 0.09 percent. This strong positive effect may reflect the strength of the trade linkages between the two economies. The strongest negative short-run effect, by contrast, is seen in Finland. Industrial production in Finland is 0.35 percent below the baseline five months after the German demand shock, and roughly unchanged after 7 months.

3.4.2 Variance decompositions

Another way of measuring the importance of Germany on the output of the smaller European economies is to decompose the percentage of the focus-country's output forecast error variance at different horizons to that part attributable to German supply shocks, German demand shocks, and other disturbances. These variance decompositions are shown in Table 7.

A significant portion of the output (forecast error) variances of the three long-standing EMU members — Belgium, Denmark and the Netherlands — are explained by German disturbances, mainly emanating from supply-side shocks. German shocks explain 20 percent or more of the one-month ahead output variance for these countries, with Belgium at the high end (33 percent). Over the longer horizon, the percentage of total variance explained rises, with a range from 45 percent (Denmark) to 77 percent (Belgium).

This evidence is consistent with the impulse responses tracing out the effects of German supply shocks in that the other countries in the sample (i.e., Finland, Norway and Sweden) seem much less influenced by the German economy. The range of output forecast error variance in Finland, Norway and Sweden explained by German shocks is 0–5 percent after the initial disturbance and 6–21 percent over the longer-term forecast horizon.

An interesting feature of Table 7 is the small percentage of output variance explained by German demand disturbances, defined as those shocks having only transitory effects on output. By construction and definition, German demand shocks do not influence the forecast error variance of output in the long-run. But it is noteworthy that German supply shocks also dominate the short- to medium-term output variance explained by Germany. That is, German demand shocks play a small role even in those cases such as Belgium (4 percent), Denmark (0 percent) and the Netherlands (1 percent) where a substantial part of the one-month ahead forecast error variance in output is explained by German disturbances (supply and demand). Hence, these results suggest that permanent

shocks emanating from Germany are by far the most important.

Focus-country demand disturbances, by contrast, play a much more important role in explaining output fluctuations. The one-period ahead output forecast error variance explained by domestic demand disturbances in the post-Bretton Woods period, for example, range from 7 percent (Denmark) to 36 percent (Sweden). These disturbances play a more important role in four of the countries.

The only qualitative important difference in results from the three alternative models that we estimated is in the variance decompositions. Comparing our base-model specification with the second model (described above), we find that German shocks — an aggregate over supply and demand — explain less of focus-country output variance in every case. This is shown in Table 8. The same pattern also emerges comparing our base-model with the third model estimates (not shown for brevity). In some instances this difference may be substantial. In particular, the base-model estimates of the German influence over output variance in Belgium and the Netherlands is much larger than the estimates from the two alternative models. This sensitivity to model specification should be recognized when drawing conclusions from the empirical work.

4 Conclusion

Our results suggest that common shocks among the small European economies considered in our sample do not help explain why some countries have chosen to join the first group of countries starting the single currency area in Europe and why others have opted to remain outside. Common European disturbances do not distinguish the Nordic countries from the non-Nordic countries, nor do they distinguish long-standing EU members from the others in our sample.

Economic linkages to Germany, however, appear to distinguish these groups of countries. In particular, permanent shocks emanating from Germany have a much larger impact on output in the countries in our sample which have been long-standing EU members (Belgium, Denmark and the Netherlands) than the other Nordic countries (Finland, Norway and Sweden). This result holds up both in the impulse response functions and the variance decompositions. German transitory shocks, by contrast, appear to have only minor influence on the small European economics we have investigated.

Domestic shocks (permanent and transitory shocks) explain the remaining part of output variance. In the short- and medium-term, domestic transitory shocks explain quite a significant part of output variance in all countries except for Denmark. Nonetheless,

the overall pattern that emerges is that permanent shocks (German and domestic) also explain the greater part of the short- and medium-term output variance.

Commonality of disturbances and linkages to Germany do not seem to explain voters' and governments' decisions for or against monetary union. The countries with the strongest (Belgium) and weakest (Finland) linkages to Germany are both firmly committed to monetary union in Europe. And Denmark, with very strong economic linkages to Germany, plans to remain outside the single currency area. The relative commonality or asymmetry of economic disturbances also appears of limited value in explaining the political motivations for joining EMU. Perhaps, this is not surprising. We have shown that countries which have been identified as potential "core" EU members are characterized mainly by their strong trade and financial linkages with Germany. As a major objective of the EU is economic integration, one would anticipate that the linkages of new EU members (Finland and Sweden) with Germany should strengthen over time, in turn increasing the desirability of monetary union as conventionally measured.

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Appendix A: Identification of permanent and transitory shocks

In this appendix we discuss the identification scheme used to identify the four structural shocks in our dynamic simultaneous model given in (1). Let us, in the following discussion disregard the exogenous variable. Under these assumptions, our VAR model can be written as

$$A(L)x_t = \rho + \varepsilon_t \quad (\text{A.1})$$

where the 4×4 matrix polynomial $A(z) = I_4 - \sum_{j=1}^p A_j z^j$, where z is a complex number, I_4 is the 4×4 identity matrix and L is the lag operator. The 4 dimensional vector of innovations ε_t is assumed to be a white noise sequence with $E[\varepsilon_t] = 0$ and a nonsingular covariance matrix $E[\varepsilon_t \varepsilon_t'] = \Sigma$. We also assume that the vector time series x_t is integrated of order one, i.e., $\det[A(z)] = 0$ iff $|z| > 1$ or $z = 1$. Since we have assumed that the vector time series is integrated of order one it is well known that the VAR model in (A.1) can be written as the following vector error correction, VECM, model

$$A^*(L)\Delta x_t = \rho + \alpha\beta'x_{t-p} + \varepsilon_t \quad (\text{A.2})$$

where $A^*(L) = I_4 - \sum_{i=1}^{p-1} A_i^* L^i$ and $A_k^* = -\sum_{l=k+1}^p A_l$. The rank of the matrix $\alpha\beta'$ is important since it determines the cointegration rank, i.e., the number of cointegration vectors in the system.

Next, consider how the estimates of the VECM model can be used to identify the structural (orthogonal) disturbances in the system. Suppose that we estimate the cointegration vector β and assume that the cointegration rank is 2. From Granger's representation theorem (cf. Engle and Granger (1987), Johansen (1991) or Warne (1993)) we know that the VAR model in (A.1) which is cointegrated of order (1,1) can be rewritten as the following vector moving average, VMA, model

$$\Delta x_t = \delta + C(L)\varepsilon_t \quad (\text{A.3})$$

where $C(L) = I_4 + \sum_{j=1}^{\infty} C_j L^j$ and $\delta = C(1)\rho$. Furthermore, if we let

$$C(L) = C(1) + (1 - L)\tilde{C}(L)$$

where $\tilde{C}(L) = \sum_{i=0}^{\infty} \tilde{C}_i L^i$ and $\tilde{C}_i = -\sum_{j=i+1}^{\infty} C_j$ for $i \geq 0$ (cf. Stock (1987)) we get the reduced form common trends, CT, model

$$x_t = x_0 + C(1)\xi_t + \tilde{C}(L)\varepsilon_t \quad (\text{A.4})$$

where

$$\xi_t = \rho + \xi_{t-1} + \varepsilon_t. \quad (\text{A.5})$$

This model implies that we have decomposed the vector time series into two orthogonal components, a permanent component reflecting the common trends and a transitory component reflecting the stationary part of the system. Our main interest, however, lies in the structural common trends model

$$x_t = x_0 + \Upsilon\tau_t + \Phi(L)v_t \quad (\text{A.6})$$

where

$$\tau_t = \mu + \tau_{t-1} + \varphi_t \quad (\text{A.7})$$

Υ is the 2×4 loading matrix, τ_t is a bivariate vector of random walks with drift μ and $\Phi(L) = \sum_{j=0}^{\infty} \Phi_j L^j$ is finite for all L . Let the four dimensional vector of residuals $v_t = \begin{bmatrix} \varphi_t' & \psi_t' \end{bmatrix}'$ where φ_t is the bivariate vector of permanent shocks, satisfying $E[v_t] = 0$ and $E[v_t v_t']$ is diagonal. The structural common trends model in (A.6) and (A.7) implies that we have decomposed the vector time series x_t into two components, permanent and a transitory component in accordance to the decomposition of the reduced form common trends model in (A.4) and (A.5). A comparison of the permanent components of these two models imply that $\Upsilon\varphi_t = C(1)\varepsilon_t$ and $\Upsilon\Upsilon' = C(1)\Sigma C(1)'$ (cf. Warne (1993)). It is thus possible to estimate the loading matrix Υ from estimates of the VMA model in (A.3). To this end, let $\Upsilon = \Upsilon_0\pi$ where π is a 2×2 lower triangular matrix and Υ_0 satisfies $\beta'\Upsilon_0 = 0$.

Following Warne (1993) we choose a 4×4 nonsingular matrix Γ such that $v_t = \Gamma\varepsilon_t$. We can now rewrite the VMA model in (A.3) in the following manner:

$$\Delta x_t = \delta + C(L)\varepsilon_t = \delta + C(L)\Gamma^{-1}v_t \quad (\text{A.8})$$

where $C(L)\Gamma^{-1} = R(L)$. Warne (1993) also provide us with

$$\varphi_t = (\Upsilon'\Upsilon)^{-1}\Upsilon'C(1)\varepsilon_t$$

and

$$\psi_t = \alpha(U\alpha)^{-1}(Q_2')^{-1}$$

where $Q_2'Q_2 = \zeta'\Sigma^{-1}\zeta$, $\zeta = \alpha(U\alpha)^{-1}$ and U is a selection matrix.

Consider next using the common trends framework to identify the effect of permanent and transitory disturbances, i.e., how we estimate the matrix Γ . Following Quah (1994) and Warne (1993), our system comprised of four variables, two common trends ($k = 2$)

and two cointegration vectors ($r = 2$) together with the definition of π above, uniquely determine 3 parameters. We will therefore require 1 additional restriction to separately identify the two permanent shocks and 1 restriction to disentangle the two transitory shocks.

Write the system that links the four variables to the two permanent trends, the German trend τ_t^g and the focus-country trend τ_t^j , as

$$\begin{bmatrix} y_t^g \\ y_t^j \\ \Delta p_t^g \\ \Delta p_t^j \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -\frac{\beta_{24}}{d} & \frac{\beta_{14}}{d} \\ -\frac{\beta_{23}}{d} & \frac{\beta_{13}}{d} \end{bmatrix} \begin{bmatrix} \pi_{11} & 0 \\ \pi_{21} & \pi_{22} \end{bmatrix} \begin{bmatrix} \tau_t^g \\ \tau_t^j \end{bmatrix} \quad (\text{A.9})$$

where $d = (\beta_{24}\beta_{13} - \beta_{23}\beta_{14})$. Note that the system reflects the cointegration restrictions because the first matrix on the RHS of the equation is the orthogonal complement to β (normalized), i.e., β_{\perp} whereas the next matrix is the lower triangular π matrix. With no further restrictions on this system it is possible to identify the common trends since (A.9) can be written as

$$\begin{bmatrix} y_t^g \\ y_t^j \\ \Delta p_t^g \\ \Delta p_t^j \end{bmatrix} = \begin{bmatrix} \pi_{11} & 0 \\ \pi_{21} & \pi_{22} \\ \frac{-\beta_{24}\pi_{11} + \beta_{14}\pi_{21}}{d} & \frac{\beta_{14}\pi_{22}}{d} \\ \frac{\beta_{23}\pi_{11} - \beta_{13}\pi_{21}}{d} & \frac{-\beta_{13}\pi_{22}}{d} \end{bmatrix} \begin{bmatrix} \tau_t^g \\ \tau_t^j \end{bmatrix}. \quad (\text{A.10})$$

Our identifying restriction made above is that the focus-country trend τ_t^j does not affect German output in the long-run. This single restriction is sufficient to distinguish the two trends. Of course, more restrictions may be examined from this structure. For example, suppose that we believed that the focus-country trend τ_t^j had no effect on German inflation in the long-run. In this case the second element in the third row should be equal to zero. This is an overidentifying restriction that is testable in this framework.

Let us now turn to the identification of the transitory shocks. Our system contain as described above two transitory shocks, ψ_t^g and ψ_t^j . Write the system that links the data to the transitory shocks as

$$\begin{bmatrix} y_t^g \\ y_t^j \\ \Delta p_t^g \\ \Delta p_t^j \end{bmatrix} = \begin{bmatrix} \zeta_{11} & \zeta_{12} \\ \zeta_{21} & \zeta_{22} \\ \zeta_{31} & \zeta_{32} \\ \zeta_{41} & \zeta_{42} \end{bmatrix} \begin{bmatrix} q_{11} & q_{12} \\ 0 & q_{22} \end{bmatrix} \begin{bmatrix} \psi_t^j \\ \psi_t^g \end{bmatrix} \quad (\text{A.11})$$

where $\zeta = \alpha(U\alpha)^{-1}$, as stated above. Here, the α matrix denotes the error correction terms, and the q matrix is the inverse of a Choleski decomposition of $\zeta'\Sigma^{-1}\zeta$. The choice

of α as the first RHS term in this expression allows us to identify transitory shocks that are orthogonal to the common trends. The selection matrix U can be chosen such that 1 element in ζq is zero. Let $\zeta_{31} = 0$ such that the system in (A.11) can be written as

$$\begin{bmatrix} y_t^g \\ y_t^j \\ \Delta p_t^g \\ \Delta p_t^j \end{bmatrix} = \begin{bmatrix} \zeta_{11} q_{11} & \sum_{j=1}^2 \zeta_{1j} q_{j2} \\ \zeta_{21} q_{11} & \sum_{j=1}^2 \zeta_{2j} q_{j2} \\ 0 & \sum_{j=1}^2 \zeta_{3j} q_{j2} \\ \zeta_{41} q_{11} & \sum_{j=1}^2 \zeta_{4j} q_{j2} \end{bmatrix} \begin{bmatrix} \psi_t^j \\ \psi_t^g \end{bmatrix}. \quad (\text{A.12})$$

This single restriction of no contemporaneous effect from the focus-country transitory shock on foreign inflation is sufficient for identification of the two transitory shocks.

Table 1: Univariate tests for autocorrelation and ARCH.

		Bretton Woods			
		Eq. 1	Eq. 2	Eq. 3	Eq. 4
Finland	L–B	0.91	0.02	0.28	0.02
	LM	0.55	0.20	0.97	0.84
Norway	L–B	0.72	0.07	0.46	0.35
	LM	0.74	0.61	0.94	0.92
Sweden	L–B	0.57	0.02	0.21	0.61
	LM	0.05	0.56	0.92	0.51
Belgium	L–B	0.63	0.88	0.07	0.82
	LM	0.04	0.00	0.49	0.89
Netherlands	L–B	0.95	0.20	0.60	0.90
	LM	0.19	0.33	0.98	0.68
		post–Bretton Woods			
Denmark	L–B	0.26	0.07	0.91	0.13
	LM	0.00	0.15	0.05	0.01
Finland	L–B	0.01	0.26	0.92	0.46
	LM	0.00	0.22	0.02	0.54
Norway	L–B	0.09	0.60	0.82	0.74
	LM	0.00	0.72	0.09	0.85
Sweden	L–B	0.19	0.83	0.95	0.63
	LM	0.00	0.10	0.24	0.16
Belgium	L–B	0.04	0.48	0.60	0.35
	LM	0.00	0.72	0.10	0.05
Netherlands	L–B	0.06	0.52	0.96	0.20
	LM	0.00	0.75	0.15	0.00

Note: L–B refers to Ljung–Box tests of the null hypothesis that the residuals are not autocorrelated with 31 and 36 degrees of freedom, respectively. LM refers to Engle’s LM test of the null of no ARCH in the residuals with 6 degrees of freedom. Only p–values are reported in the Table.

Table 2: LR trace tests for cointegration.

	Bretton Woods			
	$r = 0$	$r = 1$	$r = 2$	$r = 3$
Finland	75.97 ⁺ (0.367)	18.88 (0.089)	7.25 (0.056)	0.02 (0.000)
Norway	79.58 ⁺ (0.352)	25.30 (0.158)	3.86 (0.026)	0.63 (0.005)
Sweden	76.79 ⁺ (0.332)	26.38 (0.146)	6.61 (0.050)	0.22 (0.002)
Belgium	98.80 ⁺ (0.345)	45.88 ⁺ (0.248)	10.18 (0.075)	0.45 (0.004)
Netherlands	113.61 ⁺ (0.433)	42.65 ⁺ (0.206)	13.77 ⁺ (0.063)	5.68 ⁺ (0.044)
	post-Bretton Woods			
Denmark	82.34 ⁺ (0.147)	41.58 ⁺ (0.131)	5.23 (0.019)	0.32 (0.001)
Finland	53.29 ⁺ (0.118)	21.01 (0.061)	4.83 (0.016)	0.55 (0.002)
Norway	54.82 ⁺ (0.094)	29.54 ⁺ (0.082)	7.46 (0.029)	0.00 (0.000)
Sweden	85.18 ⁺ (0.209)	25.00 (0.080)	3.65 (0.014)	0.05 (0.000)
Belgium	84.79 ⁺ (0.192)	29.95 ⁺ (0.072)	10.61 (0.037)	0.82 (0.003)
Netherlands	69.69 ⁺ (0.172)	21.08 (0.049)	8.24 (0.021)	2.71 (0.010)

Note: Eigenvalues associated with each null hypothesis are reported in parenthesis below each LR trace statistic. Tests are performed within the unrestricted dynamic simultaneous equations model given in equation (1) using 6 lags. (+) denotes significance at the 10 percent level.

Table 3: Tests for stationarity.

	Bretton Woods				
	$y^f \sim I(0)$	$y^d \sim I(0)$	$\Delta p^f \sim I(0)$	$\Delta p^d \sim I(0)$	Δp^f and $\Delta p^d \sim I(0)$
Finland	11.12*	10.89*	3.92	0.94	14.47*
Norway	19.62*	19.08*	5.52 ⁺	5.38 ⁺	16.00*
Sweden	17.81*	16.08*	7.78*	4.71 ⁺	25.54*
Belgium	27.20*	23.38*	3.18	1.87	57.82*
Netherlands	23.95*	23.59*	13.67*	0.41	16.45*
	post-Bretton Woods				
Denmark	32.01*	33.55*	20.48*	24.59*	39.52*
Finland	11.03*	14.19*	4.40	9.46*	18.01*
Norway	18.67*	20.94*	5.71 ⁺	14.43*	20.71*
Sweden	17.86*	21.38*	3.41	10.24*	13.23*
Belgium	16.29*	17.99*	7.09*	11.09*	28.82*
Netherlands	5.95 ⁺	7.42*	0.61	0.07	13.64*

Note: The LR test statistic is χ^2 distributed with 2 degrees of freedom. Tests are performed within the unrestricted dynamic simultaneous equations model given in equation (1) using 6 lags and assuming that the cointegration rank is 2. (*) denotes significance at the 5 percent level and (+) at the 10 percent level.

Table 4: Tests of overidentifying restriction.

Bretton Woods					
Denmark	Finland	Norway	Sweden	Belgium	Netherlands
	0.05	0.02	0.01	0.18	0.00
post-Bretton Woods					
0.00	0.05	0.05	0.08	0.02	0.54

Note: The null hypothesis is that domestic inflation does not enter one of the two cointegration vectors. The LR test statistic is χ^2 distributed with 1 degrees of freedom. Only p-values are reported in the table. Tests are performed within the unrestricted dynamic simultaneous equations model given in equation (1) using 6 lags and assuming that the cointegration rank is 2.

Table 5: Correlations among domestic supply shocks, Bretton Woods\post-Bretton Woods.

Bretton Woods\post-Bretton Woods						
	DK	FIN	NOR	SWE	BEL	NDL
DK	1.000	0.017	-0.019	0.069	0.069	0.013
FIN		1.000	0.130*	0.143*	0.018	0.076
NOR		0.125	1.000	0.102	0.155*	0.068
SWE		0.036	-0.001	1.000	0.169*	0.076
BEL		0.064	0.006	-0.006	1.000	0.290*
NDL		-0.182*	-0.163 ⁺	0.122	0.027	1.000

Note: (*) denotes significance at the 5 percent level, and (+) at the 10 percent level.

Table 6: Correlations among domestic demand shocks, Bretton Woods\post-Bretton Woods.

Bretton Woods\post-Bretton Woods						
	DK	FIN	NOR	SWE	BEL	NDL
DK	1.000	0.097	0.185*	0.048	0.167*	-0.008
FIN		1.000	0.166*	0.061	0.135*	0.148*
NOR		0.204*	1.000	0.144*	0.052	0.133*
SWE		0.035	-0.016	1.000	0.203*	0.054
BEL		-0.047	-0.001	0.137*	1.000	0.128*
NDL		-0.023	0.042	0.097	0.011	1.000

Note: (*) denotes significance at the 5 percent level, and (+) at the 10 percent level.

Table 7: Output variance explained by German supply (GES) and demand shocks (GED) and focus country supply (DS) and demand shocks (DD).

		Bretton Woods				post-Bretton Woods			
		GES	GED	DS	DD	GES	GED	DS	DD
Denmark	1					19.5	0.0	73.7	6.8
	6					29.8	0.9	62.5	6.8
	12					34.2	0.7	60.3	4.7
	24					38.2	0.5	58.6	2.7
	36					40.0	0.3	57.7	1.9
	∞					44.7	0.0	55.3	0.0
Finland	1	3.9	14.4	72.0	9.7	0.4	0.0	74.7	25.3
	6	4.9	6.0	81.8	7.3	2.2	1.0	70.0	26.8
	12	4.2	3.7	87.5	4.6	2.0	0.6	74.7	22.7
	24	3.1	2.0	92.4	2.4	2.3	0.3	81.4	16.0
	36	2.7	1.3	94.3	1.7	2.7	0.2	85.4	11.7
	∞	1.8	0.0	98.2	0.0	5.5	0.0	94.5	0.0
Norway	1	21.5	2.2	76.2	0.1	0.7	0.4	91.8	7.1
	6	22.4	3.5	72.0	2.1	5.8	1.2	81.2	11.8
	12	22.2	3.0	72.4	2.4	6.4	1.3	82.0	10.3
	24	21.2	2.3	74.6	1.8	8.5	0.9	83.3	7.2
	36	20.7	1.8	76.0	1.5	10.6	0.7	83.4	5.3
	∞	18.4	0.0	81.6	0.0	21.0	0.0	78.9	0.0
Sweden	1	8.8	0.1	89.5	1.6	2.9	2.5	58.9	35.7
	6	18.1	2.4	75.5	4.0	7.7	3.4	64.9	24.1
	12	20.8	2.3	73.9	2.9	7.7	2.1	77.0	13.2
	24	24.6	1.4	72.2	1.8	8.1	1.1	84.2	6.6
	36	26.6	1.0	71.1	1.3	8.4	0.7	86.6	4.3
	∞	31.8	0.0	68.1	0.0	8.9	0.0	91.1	0.0
Belgium	1	0.2	12.2	83.1	12.2	28.3	4.3	42.0	25.3
	6	4.4	4.1	81.9	9.6	50.1	6.4	24.0	19.5
	12	14.4	3.1	76.0	6.6	59.7	4.7	21.8	13.7
	24	20.9	1.9	73.1	4.1	68.6	2.5	21.4	7.5
	36	23.8	1.4	71.8	3.0	71.8	1.6	21.9	4.7
	∞	31.5	0.0	68.5	0.0	76.6	0.0	23.4	0.0
Netherlands	1	52.7	1.9	44.0	1.3	19.5	0.5	57.3	22.7
	6	60.6	1.0	34.9	3.5	39.0	1.0	40.7	19.3
	12	62.2	0.7	35.0	2.2	50.9	0.6	32.7	15.7
	24	64.2	0.3	34.3	1.1	59.6	0.3	30.3	9.8
	36	64.9	0.2	34.1	0.7	63.1	0.2	30.1	6.6
	∞	66.3	0.0	33.7	0.0	69.0	0.0	31.0	0.0

Table 8: Output variance explained by German shocks in alternative model specification.

		Model 1		Model2	
		Bretton Woods	post-Bretton Woods	Bretton Woods	post-Bretton Woods
Denmark	1		19.5		17.8
	6		30.7		31.7
	12		34.9		34.9
	24		38.7		36.1
	36		40.3		36.5
	∞		44.7		37.5
Finland	1	18.3	0.4	0.2	1.5
	6	10.9	3.2	4.4	3.9
	12	7.9	2.6	5.7	2.6
	24	5.1	2.6	6.4	2.6
	36	4.0	2.9	6.6	2.9
	∞	1.8	5.5	7.2	3.9
Norway	1	23.7	1.1	1.7	0.4
	6	25.9	7.0	1.9	3.3
	12	25.2	7.7	1.8	4.5
	24	23.5	9.4	1.7	6.6
	36	22.5	11.3	1.6	7.7
	∞	18.4	21.0	1.4	10.6
Sweden	1	8.9	5.4	1.2	2.7
	6	20.5	11.1	2.7	7.1
	12	23.1	9.8	3.2	6.1
	24	26.0	9.2	3.9	5.8
	36	27.6	9.1	4.2	5.8
	∞	31.8	8.9	5.2	5.7
Belgium	1	12.4	32.6	0.0	10.8
	6	8.5	56.5	1.4	34.8
	12	17.5	64.4	4.6	42.1
	24	22.8	71.1	6.7	46.2
	36	25.2	73.4	7.6	47.3
	∞	31.5	76.6	10.1	48.8
Netherlands	1	54.6	20.0	7.7	13.7
	6	61.6	40.0	11.1	28.3
	12	62.9	51.5	12.0	38.9
	24	64.5	59.9	13.1	45.0
	36	65.1	63.3	13.5	46.9
	∞	66.3	69.0	14.3	49.6

Note: Model 1: German and focus country inflation are stationary. Model 2: German and focus country inflation are nonstationary and there are two cointegration vectors in the data. The cointegration vector is unrestricted, i.e., all variables are included in both vectors.

Figure 1: Impulse response of output to German supply shocks during the Bretton Woods (solid line) and the post-Bretton Woods (dashed line) periods.

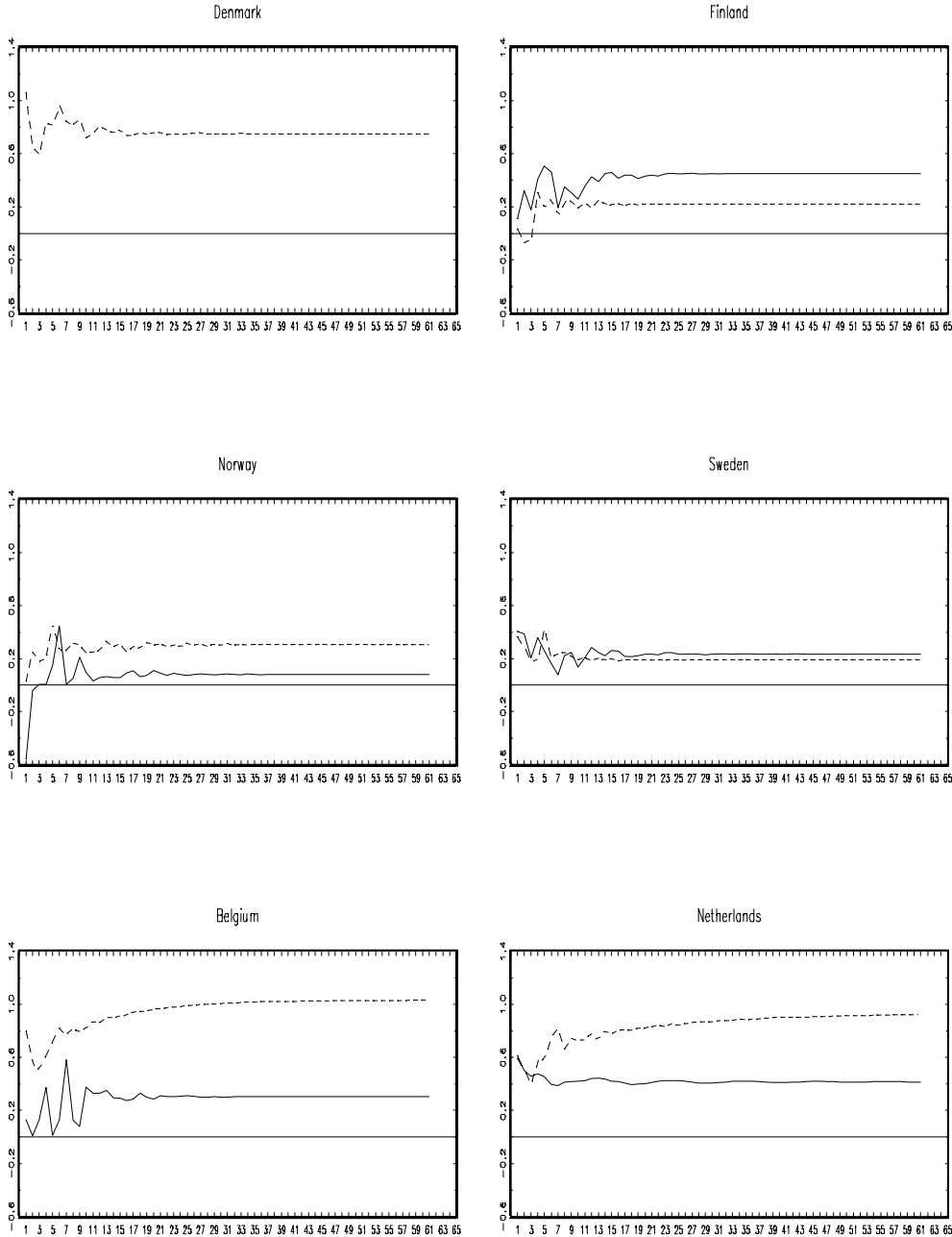
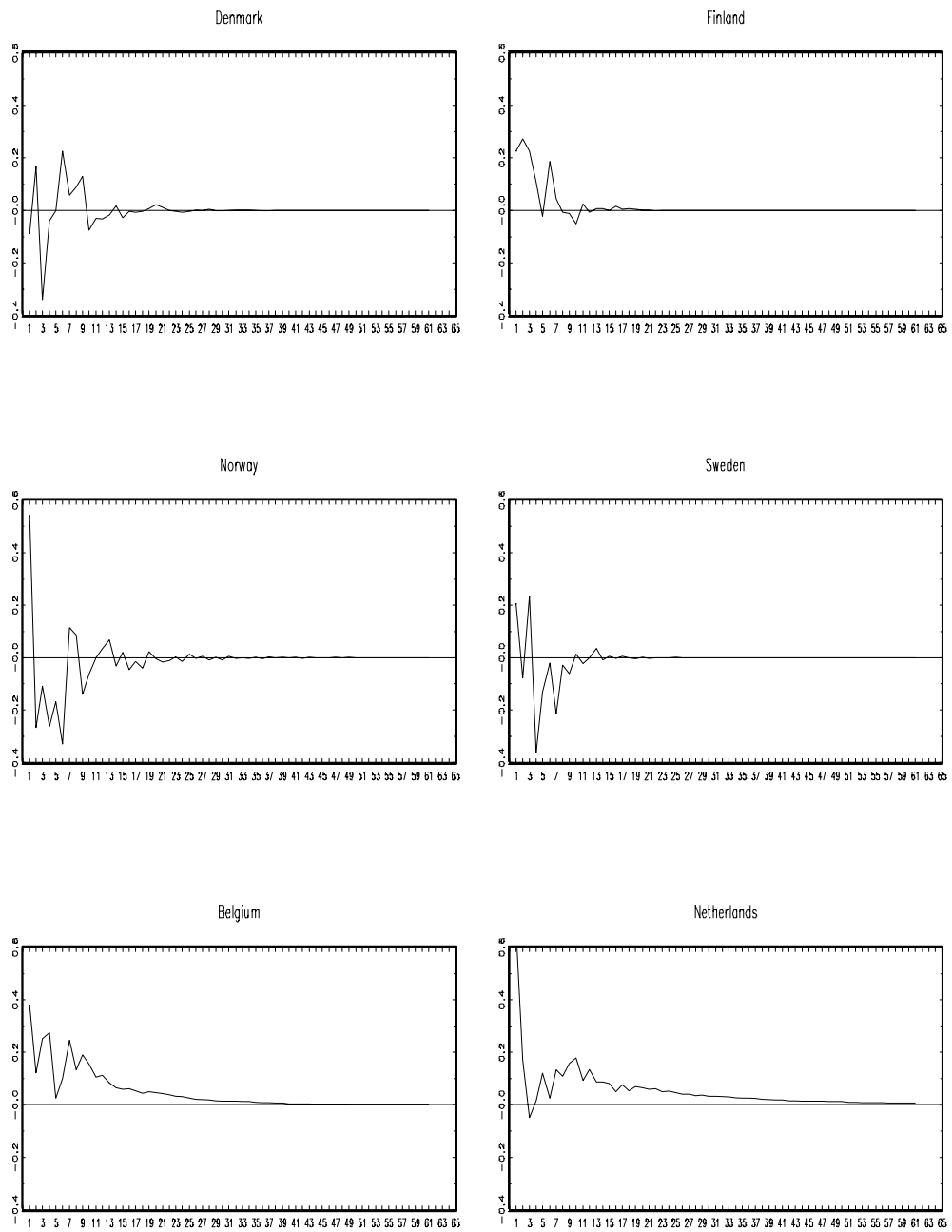


Figure 2: Impulse response of output to German demand shocks during the post-Bretton Woods period.



Appendix B: Impulse responses of German output and inflation to German supply and demand shocks.

Figure B.1: Impulse response of German output to German supply shocks during the Bretton Woods (solid line) and the post-Bretton Woods (dashed line) periods.

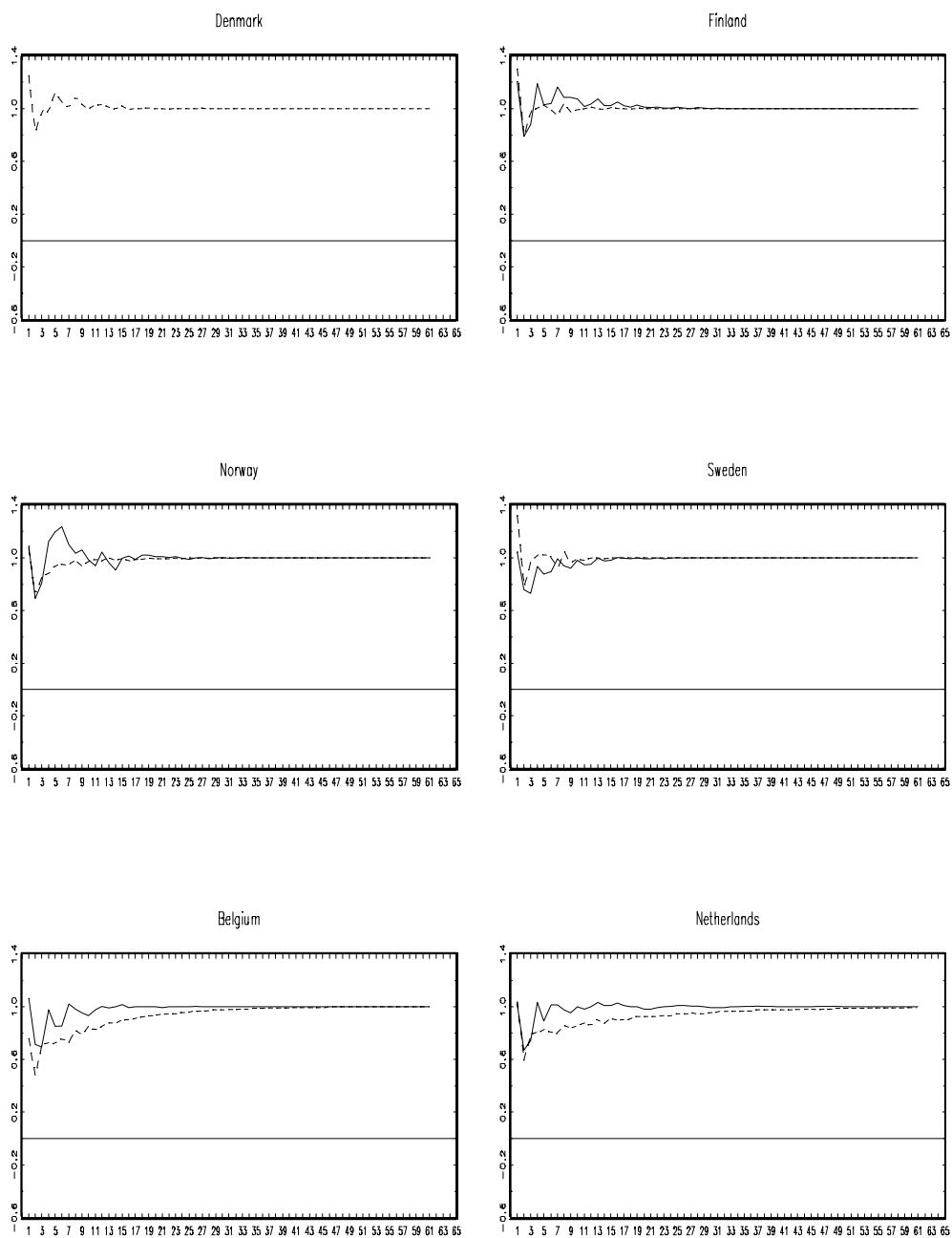


Figure B.2: Impulse response of German output to German demand shocks during the post-Bretton Woods period.

