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The Relative Importance of Symmetric and Asymmetric Shocks: The Case of United Kingdom and Euro Area*

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Abstract

We show how a simple model with sign restrictions can be used to identify symmetric and asymmetric supply, demand and monetary policy shocks in an estimated two-country structural VAR for the UK and Euro area. The results can be used to deal with several issues that are relevant in the optimal currency area literature. We find an important role for symmetric shocks in explaining the variability of the business cycle in both economies. However, the relative importance of asymmetric shocks, being around 20% in the long run, cannot be ignored. Moreover, when we estimate the model for the UK and US, the degree of business cycle synchronization seems to be higher. Finally, we confirm existing evidence of the exchange rate being an independent source of shocks in the economy.

I. Introduction

A lot of questions in the international business cycle literature are still unresolved. In particular, the optimal currency area (OCA) debate is still open and very topical. Consider, for instance, the entry of a large number of accession countries to the European Union that also might join the Eurozone relatively soon. On the other hand, Sweden and the United Kingdom decided not to enter or, at least, to postpone the introduction of the euro. In this paper, we tackle some important issues of the OCA-literature using a simple two-country structural vector autoregression (SVAR) framework. We show how to estimate the relative importance of symmetric and asymmetric shocks for business cycle variability of potential currency area members. Furthermore, the proposed framework allows us to examine whether the monetary policy reaction to symmetric shocks was historically different between the individual countries, and can be used to investigate the role of the exchange rate in the economic adjustment process. Both questions are also very relevant in the OCA-literature. We provide empirical evidence for the United Kingdom (UK) vs. the Euro area

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and compare the results vis- à-vis the United States (US) as a benchmark. These issues are directly reflected in the five economic tests, announced by the UK government, that would need to be met to become a member of the Euro area.[1] The methodology, however, can easily be applied to other country-pairs as well.

In the context of a single currency, the resemblance of the business cycles of the participating countries is a major concern. Differences in cyclical situations and underlying disturbances can complicate monetary policy because a common interest rate would not be optimal for the individual member countries. The degree of business cycle synchronization is therefore very important to evaluate the costs and benefits of a currency area. Bayoumi and Eichengreen (1993) apply SVARs to compare the correlations of supply and demand shocks across European countries and US states. Their work has been extended or updated by, for example, Chamie, De Serres and Lalonde (1994), Erkel-Rousse and Mélitz (1995) and Artis (2003). A crucial problem in this literature is that these studies only focus on structural shocks not taking into account the propagation mechanism, while the global business cycle is determined by the interaction between the two. In addition, spill-over effects across countries are ignored. Countries constituting a monetary union mostly have close trade linkages. Even idiosyncratic shocks could then rapidly be transmitted to the other countries to become effectively 'common' or symmetric shocks (Bergman and Hutchison, 1998). On the other hand, a shock can be purely common (e.g. oil price shocks) and still produce opposite output effects. In the end, what really matters to evaluate the adequacy of a single monetary policy is the *impact* of a shock on the economy, not whether the shock is idiosyncratic or common.

In this paper, we take this problem seriously and estimate the dynamic effects of symmetric and asymmetric shocks. The shocks are identified in a way that is relevant to the OCA-literature. We use a form of sign restrictions that were introduced by Uhlig (2005) to identify monetary policy shocks and extended by Peersman (2005) for a larger set of structural innovations. More specifically, we elaborate on Mountford (2005) and Farrant and Peersman (2006) by making a distinction between symmetric and asymmetric shocks. Symmetric shocks are identified as disturbances that generate effects on a set of macroeconomic variables that are going in the same direction for both areas under investigation, whereas asymmetric shocks are assumed to have not the same sign in both areas. The relative importance of both disturbances to explain the overall business cycle can then be estimated. We find an important contribution of symmetric shocks with the Euro area to explain UK business cycle variability. However, the role of asymmetric shocks is economically also significant and cannot be ignored. Strikingly, we find a higher degree of business cycle synchronization between the UK and the US in the long run.

As a side issue, the empirical framework also allows us to analyse two other relevant issues in the OCA-literature. Even if symmetric shocks dominate the business cycle, the required interest rate response at the individual country level could be different if, for instance, the propagation mechanism is dissimilar or the economic structure is different.

[1]The five economic tests are: (i) are business cycles and economic structures compatible with Eurozone interest rates on a permanent basis? (ii) if problems emerge, is there sufficient flexibility to deal with them? (iii) would joining the euro create better conditions for firms making long-term decisions to invest in Britain? (iv) what impact would entry into the euro have on the UK's financial services industry? and (v) would joining the euro promote higher growth, stability and a lasting increase in jobs?

Our method allows us to partly investigate this issue. In particular, it is possible to examine whether the interest rate reaction to symmetric shocks was historically different in the UK and Euro area. We find that this was actually not really the case.

Another important issue is the role of the exchange rate in the economic adjustment process. The loss of a flexible exchange rate as an automatic stabilization mechanism can be considered as a cost for a country joining a monetary union. A different situation arises if the foreign exchange market fails to offer any stabilization benefit. It may even be that the exchange rate is an independent source of shocks and imbalances to the economy are driven by irrational movements in financial markets rather than economic fundamentals (Buiter, 2000). Structural VARs are often used to determine the role of the exchange rate but disagree in their results.[2] A shortcoming of most of these studies is that the VARs are estimated in relative variables, which implies that the same propagation mechanism for shocks originating in both economies is assumed. Furthermore, such an approach does not provide any information about the relevance of these disturbances for the level variables, for instance economic activity. Other studies estimate a one-country open economy VAR without relative variables, which, however, can generate biased results for exchange rate dynamics because no distinction is made between symmetric and asymmetric shocks. Our more general two-country framework incorporates both shortcomings. We confirm the evidence of the UK–Euro area exchange rate being an independent source of shocks.

The rest of the paper is structured as follows. Section II explains the methodology and the empirical model. Results are reported in section III for the sample period 1974–2008. A distinction is made between the analysis of impulse response functions, the relative importance of symmetric and asymmetric shocks and the factors driving exchange rate fluctuations. Finally, section IV concludes.

II. Methodology

Structural VARs have become a basic analytical tool in modern macroeconomics, in particular for the analysis of the dynamic effects of structural disturbances. Accordingly, VARs are often used to examine the above mentioned issues. We elaborate on the existing models of Mountford (2005) and Farrant and Peersman (2006) by making a distinction between symmetric and asymmetric shocks in a two-country VAR. We first define symmetric and asymmetric shocks in a context useful for the OCA-literature. In the section 'The underlying model and restrictions' we implement the restrictions in the model of Farrant and Peersman (2006), which distinguishes between aggregate supply, demand, monetary policy and exogenous exchange rate innovations. Results for the UK–EA and UK–US will be discussed in section III.

The identification of symmetric and asymmetric shocks

According to the OCA theory, the member countries of a currency area should experience similar movements of the business cycle. The traditional OCA-literature typically focuses

[2]Clarida and Gali (1994), Funke (2000) and Chadha and Prasad (1997) find an important role for the exchange rate acting as a stabilization mechanism. On the other hand, Artis and Ehrmann (2000), Canzoneri, Valles and Vinals (1996) and Farrant and Peersman (2006) find that the exchange rate seems mostly to reflect shocks originating in the foreign exchange market itself.

on asymmetric shocks. Only if the countries of a monetary union share similar shocks to their economy, a common monetary policy is acceptable for all the individual countries and the lower is the cost of giving up an independent monetary policy. Influential empirical papers like Bayoumi and Eichengreen (1993), Chamie *et al.* (1994), Erkel-Rousse and Mélitz (1995) and Artis (2003) estimate individual country SVARs, and compare the correlations of supply and demand shocks as a criterion to join a monetary union.

A crucial problem of these studies is the focus on the correlation of structural shocks not taking into account the propagation mechanism. The global business cycle is, however, determined by the interaction of structural disturbances and economic dynamics. Moreover, spill-over effects across countries are not taken into account. Members of a currency area typically have close trade linkages. Hence, even pure idiosyncratic shocks could be passed-through to the other countries. In the context of a monetary union, these shocks do not create serious difficulties because the required monetary policy reaction will be similar or, at least, in the same direction. On the other hand, pure common shocks are not necessarily innocuous because they may generate opposite effects across countries.[3] For example, if one country is a net exporter of oil and the other a net importer, a common oil shock could have very different effects in the two economies creating problems in a monetary union.[4] When measuring costs and benefits of a single currency, it is therefore important to define a shock depending on its impact on the economy irrespective of being common or idiosyncratic. This is exactly what we do in this paper. The way we identify a structural innovation is determined by its impact and takes into account the potential spill-over effects of trade linkages. In addition, the underlying model we introduce in the section 'The underlying model and restrictions' is a two-country VAR, which allows us to examine the economic dynamics and the influence on the overall business cycle.

We define a shock as respectively symmetric or asymmetric when:

$$\text{sign}\left[R(A)^{pq}_{t+k}\right] = \text{sign}\left[R(B)^{pq}_{t+k}\right] \tag{1}$$

$$\text{sign}\left[R(A)^{pq}_{t+k}\right] \neq \text{sign}\left[R(B)^{pq}_{t+k}\right] \tag{2}$$

where $R(A)^{pq}_{t+k}$ and $R(B)^{pq}_{t+k}$ are the impulse response functions of variable p at lag k to a shock in q at time t in country A and B, respectively. Accordingly, a symmetric shock has the same impact on a set of variables in both countries in terms of its *signs*. Conversely, the signs of the impact of an asymmetric shock are the opposite in both countries. The magnitude of the impact and the propagation mechanism can, however, still be different, and is determined by the estimation results. Spill-over effects across countries are also taken into account, which is what matters for countries sharing one currency. Consider, for instance, an idiosyncratic shock in country A. If this shock is largely transmitted to country B through trade, this shock is identified as symmetric with our method. An important aspect of this approach is then the implicit timing allowed for the spill-over effects to take place, that is, the value of k. In order to have an appropriate common monetary policy stance, spill-overs should take place relatively quickly. If we impose the restrictions to be contemporaneously binding, only immediate spill-overs of idiosyncratic shocks are

[3]For instance, the way common shocks are defined in dynamic factor models.

[4]See for example Peersman and Van Robays (2009), who find that common oil shocks even have substantial asymmetric effects within the Euro area, i.e. a group of pure oil-importing countries.

identified as symmetric shocks. In contrast, if we introduce the restrictions only after a number of lags, sluggish spill-over effects are also considered as symmetric shocks. The robustness for alternative values of k will be discussed in section III.

The underlying model and restrictions

Once we have defined symmetric and asymmetric shocks, we can introduce the restrictions in an SVAR and estimate the relative importance for business cycle fluctuations. More specifically, we implement the restrictions in the model of Farrant and Peersman (2006) and this for several reasons. First, they estimate the effects of aggregate supply, aggregate demand, monetary policy and exchange rate shocks using an SVAR with sign restrictions.[5] The advantage of their procedure is that no zero constraints need to be imposed for the identification of the shocks. Because symmetric and asymmetric shocks, as defined in the section 'The identification of symmetric and asymmetric shocks', are also identified using the signs of the impact, it is very convenient to start with this model. Second, the disturbances they consider are appropriate for our analysis. Bayoumi and Eichengreen (1993) only identify aggregate supply and demand shocks. Others, for example, Chamie *et al.* (1994) have also disentangled monetary policy shocks from other aggregate demand shocks since the former can influence the historical correlations of overall demand shocks. In particular, idiosyncratic monetary policy shocks are not relevant anymore in the context of a currency union and hence should be filtered out. Third, the model contains the short-term nominal interest rate for both countries as the monetary policy instrument, which should allow to examine whether central banks have historically reacted in a different way to symmetric shocks. After all, even symmetric shocks could require a different policy reaction due to, for instance, a different monetary transmission mechanism. Finally, the model also makes it possible to investigate the role of the exchange rate in the economic adjustment process, another important topic in the OCA-literature. Farrant and Peersman (2006), like Clarida and Gali (1994), estimate a two-country model in relative variables assuming the same propagation mechanism for shocks originating in both economies. A side issue of our approach is that we can check the robustness of their results in a two-country VAR without this assumption.

Farrant and Peersman (2006) use sign restrictions that are derived from a stochastic two-country open macro model with sticky prices developed by Clarida and Gali (1994). Their restrictions on the signs of the impulse response functions in the short run can be summarized in the matrix below, where y is output, p the price level, i the interest rate and q the real exchange rate.[6]

The intuition of the restrictions is very appealing and consistent with a large class of other models. A positive relative supply shock has a positive effect on relative output, a negative effect on relative prices and there is a fall in the nominal interest rate differential. While a depreciation of the real exchange rate is expected in the long run, the short-run effect is uncertain in the model and hence no restriction is imposed on this variable. After

[5] See Mountford (2005) for a similar strategy in a small open economy context.

[6] Variables with an $*$ are foreign counterparts, i.e. the model is represented in relative output, prices and interest rates. All variables are log-levels, except the interest rates that are in per cent. A rise in q is a depreciation of the real exchange rate.

	$y-y^*$	$p-p^*$	$i-i^*$	q
Relative supply	≥ 0	≤ 0	≤ 0	?
Relative demand	≥ 0	≥ 0	≥ 0	≤ 0
Relative monetary policy	≤ 0	≤ 0	≥ 0	≤ 0
Exchange rate	≥ 0	≥ 0	≥ 0	≥ 0

a positive relative demand shock, relative output, relative prices and relative interest rate all rise, accompanied by an appreciation of the real exchange rate. A restrictive relative monetary policy shock leads to a fall in relative output and prices and an appreciation of the exchange rate. Finally, an exogenous depreciation of the exchange rate causes output and prices to increase and the central bank reacts by increasing the interest rate to offset inflationary pressures.

In order to make a distinction between symmetric and asymmetric disturbances as described in the section 'The identification of symmetric and asymmetric shocks' we now define the two-country model in level variables and impose the following sign restrictions to disentangle symmetric and asymmetric supply, demand and monetary policy shocks, as well as exogenous exchange rate disturbances:

	y	p	i	y^*	p^*	i^*	q
Symmetric supply	≥ 0	≤ 0	≤ 0	≥ 0	≤ 0	≤ 0	?
Symmetric demand	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	?
Symmetric monetary policy	≤ 0	≤ 0	≥ 0	≤ 0	≤ 0	≥ 0	?
Asymmetric supply	≥ 0	≤ 0	≤ 0	≤ 0	≥ 0	≥ 0	?
Asymmetric demand	≥ 0	≥ 0	≥ 0	≤ 0	≤ 0	≤ 0	≤ 0
Asymmetric monetary policy	≤ 0	≤ 0	≥ 0	≥ 0	≥ 0	≤ 0	≤ 0
Exchange rate	≥ 0	≥ 0	≥ 0	≤ 0	≤ 0	≤ 0	≥ 0

The restrictions are fundamentally still the same as in Farrant and Peersman (2006), but extended to symmetric and asymmetric innovations. A symmetric positive supply shock is a shock that has a positive effect on output and a negative effect on prices and the nominal interest rate, but now in both countries simultaneously. After a positive symmetric aggregate demand shock, both economies experience a rise in output, prices and the interest rate. A symmetric restrictive monetary policy shock (rise in the nominal interest rate) has a negative effect on output and prices in both countries. Given that restrictions are only imposed on the direction of the impact, symmetric shocks can still have different effects in terms of magnitude. To examine whether monetary policy has reacted differently to symmetric shocks in the past, we simply compare the responses of i and i^*. No restrictions are imposed on the responses of the real exchange rate to symmetric shocks, which is determined by the data.

The identification of asymmetric supply, demand and monetary policy shocks is similar. We only assume a shock to be asymmetric if the direction of its effects is the opposite in both economies. Note that, because the restrictions are imposed as $\leq$ or $\geq$, a zero impact is always possible. An asymmetric supply shock has a positive effect on output and a negative impact on prices and the nominal interest rate in country A, whereas the opposite happens in country B with respect to the direction of the impact. After a positive asymmetric aggregate demand shock, output, prices and the interest rate rise in country A and fall in country B.[7] In addition, there is an appreciation of the real exchange rate. The difference between asymmetric aggregate demand and asymmetric monetary policy shocks is a negative co-movement of the individual country interest rate response with domestic output and prices, and an appreciation of the real exchange rate after a restrictive asymmetric monetary policy shock. Finally, an exogenous exchange rate shock (depreciation in country A) has a positive effect on output, prices and nominal interest rate in country A, while there is a fall of all three variables in country B. If this shock explains a large part of exchange rate and output fluctuations, the exchange rate can be considered as a potential source of shocks.[8]

III. Results

We estimate the model for the UK vs. the Euro area. One of the five economic tests set by the UK government to become a member of the Euro area requires cyclical convergence so that they and others could live comfortably with the same interest rate on a permanent basis. As a benchmark, we compare the results with a two-country VAR for the UK and the US. The analysis can, however, easily be applied to other country-pairs as well. The sample period for all estimations is the post Bretton Woods period, 1974–2008.[9] Consider the following specification for a vector of endogenous variables Y_t:

$$Y_t = c + \sum_{i=1}^{n} A_i Y_{t-i} + B\varepsilon_t \tag{3}$$

where c is an $(n \times 1)$ matrix of constants, A_i is an $(n \times n)$ matrix of autoregressive coefficients and ε_t is a vector of structural disturbances. The endogenous variables, Y_t, that we include in the VAR are domestic output (y_t), prices (p_t) and nominal interest rate (i_t), foreign output (y_t^*), prices (p_t^*) and nominal interest rate (i_t^*) and the real bilateral exchange rate (q). The VAR model is estimated in log-levels (except the interest rates). Lag length is determined by standard likelihood ratio tests and AIC information criterion which turns out to be two for EA–UK and US–UK.

Following Uhlig (2005) and Peersman (2005), we use a Bayesian approach for estimation and inference.[10] Our prior and posterior belong to the Normal–Wishart family. Because there are infinite number of admissible decompositions for each draw from the posterior when using sign restrictions, we use the following procedure. To draw the 'candidate

[7] Or output, prices and the nominal interest rate in country B, at least, do not rise.

[8] Note that, what really matters in our analysis is whether country A responds in a particular way when country B exhibits a certain pattern of signs, how extreme these differences are, how often they occur and most importantly, how relevant they are for the overall business cycle. The patterns of signs evident in the impulse response functions could be consistent with several types of shocks, but the general labeling makes the analysis more convenient. Consider, for instance, a commodity price shock. If such a shock generates a decline in economic activity and a rise of inflation in both economies, the shock is labelled as a symmetric aggregate supply shock. If, for some reason (e.g. commodity exporter vs. a commodity importer), output does not decline in one of the economies, the shock will be labelled as an asymmetric disturbance.

[9] Estimations for shorter sample periods are available upon request but do not alter the main conclusions.

[10] For a full explanation of the methodology, see Peersman (2005) or Peersman and Straub (2009).

truths' from the posterior, we take a joint draw from the posterior for the usual unrestricted Normal–Wishart posterior for the VAR parameters as well as a uniform distribution for the rotation matrices.[11] We then construct impulse response functions. If the impulse responses to an individual shock are consistent with the imposed conditions for this shock, the results for the specific shock are accepted. Otherwise, the draw is rejected, which means that this draw receives zero prior weight.[12] For output and prices, the time period over which the sign constraints are binding, k, is set equal up to four quarters. For interest rates and the real exchange rate we only impose a restriction during one quarter because these are more flexible variables.[13] More specifically, baseline estimations are done with $k = 0, \ldots, 4$ for output and prices and $k = 0, 1$ for the interest rate and real exchange rate. We also discuss the results for a higher starting value of k (i.e. $k = 2, \ldots, 4$ for output and prices and $k = 2$ for interest rate and real exchange rate), which allows a longer period for spill-over effects to take place.

In the next subsection, we first perform an impulse response analysis to evaluate the plausibility of the estimations and to compare the historical monetary policy responses in both countries. The relative importance of symmetric and asymmetric shocks is discussed in the section 'The relative importance of symmetric and asymmetric shocks' whereas the section 'The role of the exchange rate' describes the contribution of all shocks to the exchange rate.

Impulse response analysis

Impulse response functions are reported in Figures 1 and 2 for, respectively, EA–UK and US–UK. The figures report the median (full black lines) together with 84th and 16th percentiles (dotted lines) based on 1,000 draws from the posterior. These are the baseline results, that is with contemporaneously imposed sign conditions. The grey lines are the impulse response functions (median of the posterior) using restrictions that are only binding two lags after the shocks, so a longer period for spill-over effects is allowed. For each draw from the posterior, we also calculate an impulse response function for the output, prices and interest rate differentials. Note that this way of reporting implies that the median and percentiles response functions do not represent one single draw or a single set of orthogonal shocks. In particular, the median impulse response function of one variable to a specific shock is not necessarily from the same orthogonal system as the median response function shown from another variable to the shock.[14]

Whereas a symmetric supply shock has a very persistent impact on economic activity in the UK and EA, both countries experience only a temporary rise of output after a symmetric demand shock. Notably, the effects of both shocks are in the short run significantly greater in the UK than the EA. This is not the case when we compare the effects of symmetric supply and demand shocks in the US and UK (see Figure 2). Also prices react significantly

[11] Note that the rotation algorithm searches in all dimensions simultaneously, which implies that the order in which the shocks are identified does not matter for the outcome.

[12] The overall acceptance rate is around 1 out of 100 candidate draws.

[13] See also Farrant and Peersman (2006), our benchmark model.

[14] See also Fry and Pagan (2007) for a comprehensive discussion of this issue. As an alternative, they suggest to report the responses of one orthogonal system that minimizes the distance with the median responses.

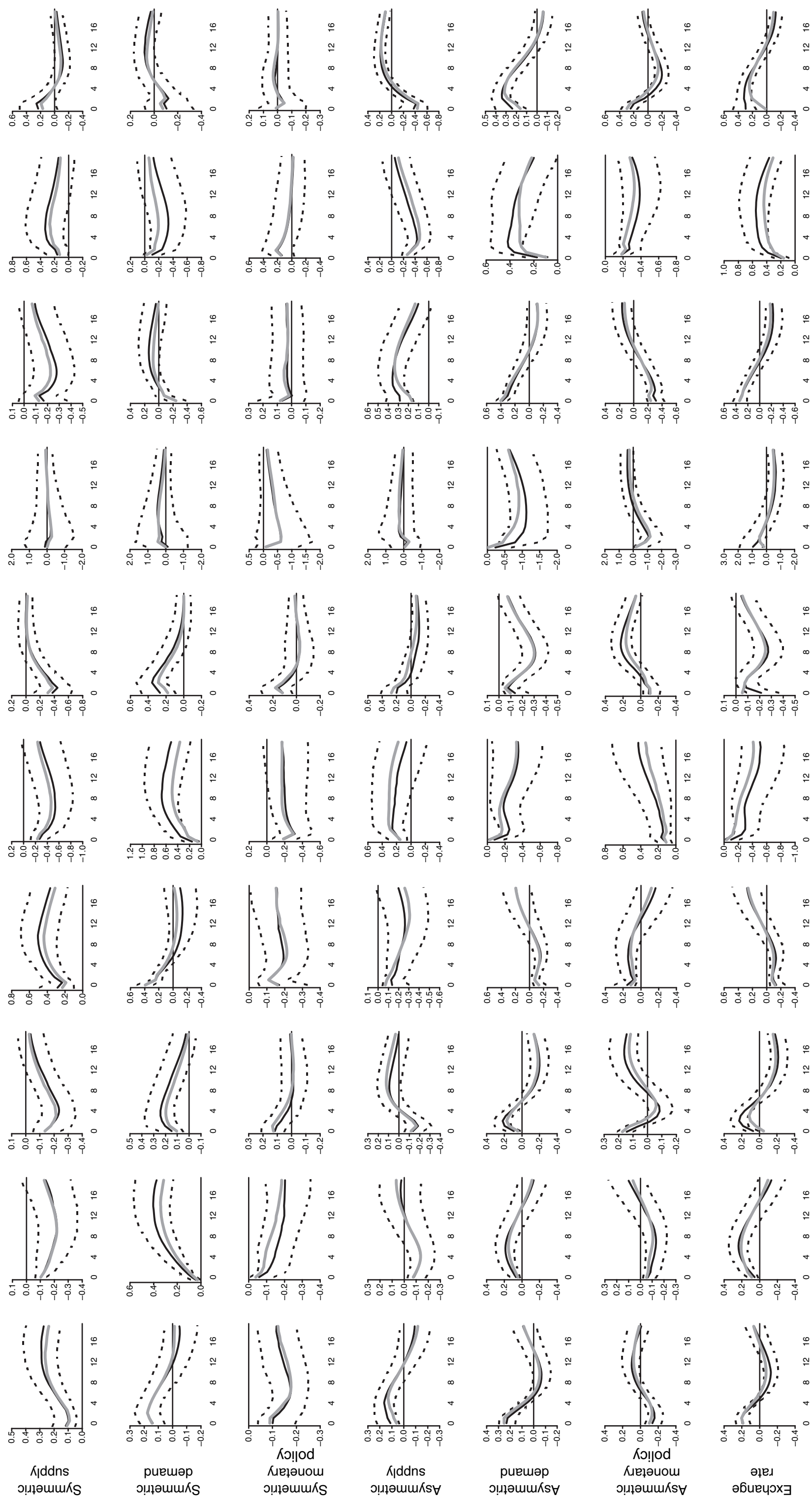

Fig. 1. Euro area/United Kingdom – impulse response functions
Note: Median impulse responses from the posterior with 16th and 84th percentiles error bands. Grey line is median impulse response when restrictions are only imposed 2 lags after the shocks.

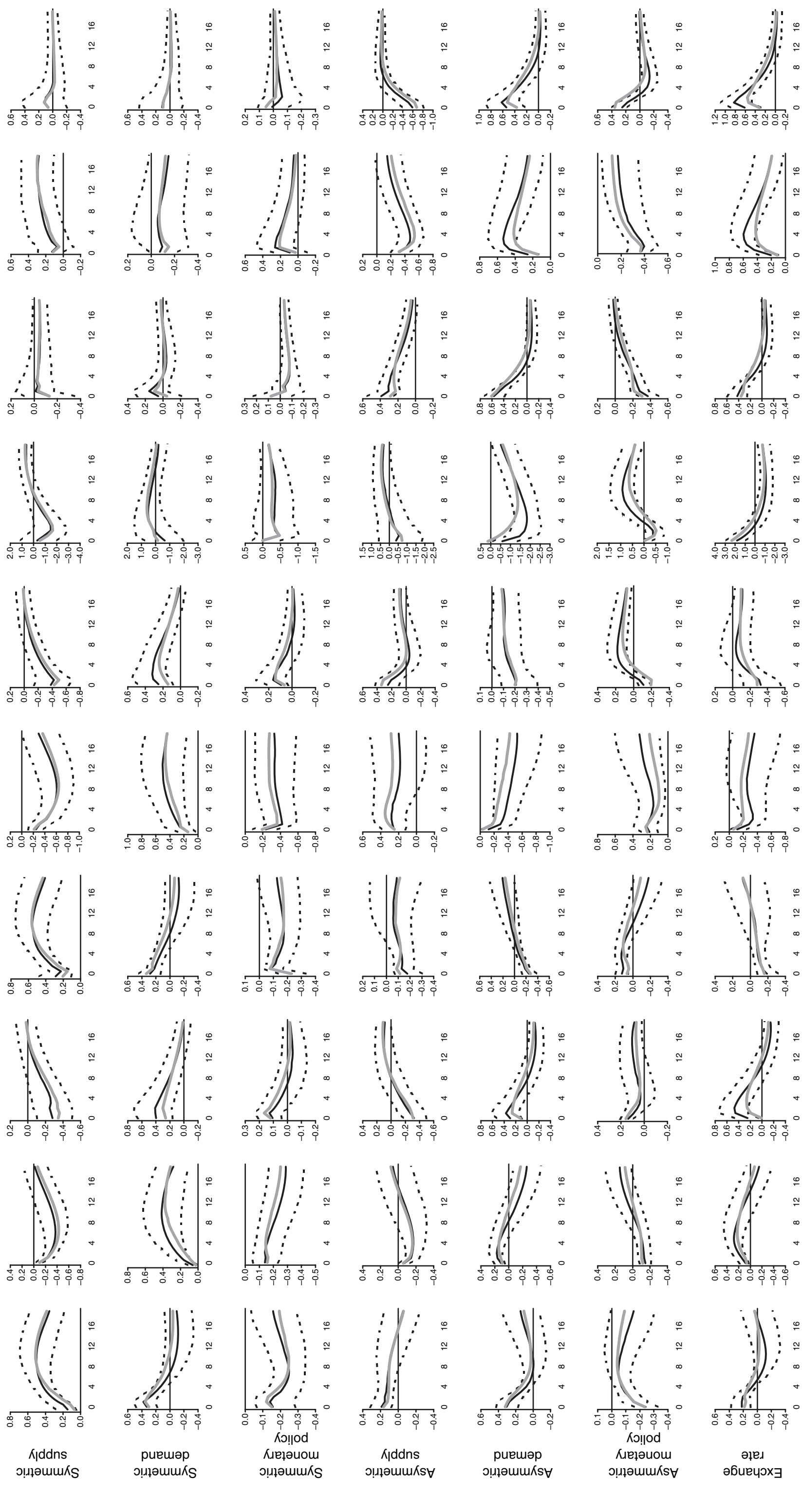

Fig. 2. United States/United Kingdom – impulse response functions
Note: Median impulse responses from the posterior with 16th and 84th percentiles error bands. Grey line is median impulse response when restrictions are only imposed 2 lags after the shocks.

faster in the UK than the EA. The faster responses of output and prices in the UK could be the result of a more flexible economy or a quicker propagation mechanism. Surprisingly, despite the different pass-through, we do not find a relevant different historical reaction of the interest rate in both economies, and also the exchange rate does not really move. Hence, a common monetary policy stance is not expected to create serious difficulties when confronted with symmetric shocks.[15] Furthermore, there seems to be no significant differences in the responses to symmetric monetary policy shocks in the UK and EA, which is also encouraging in the context of a single currency. Both economies experience a similar u-shaped reaction of output and a permanent fall of prices after a common restrictive policy shock. Finally, impulse response functions to an asymmetric supply, demand and monetary policy shock are reported in, respectively, the fourth, fifth and sixth rows of Figure 1. By construction, we have an asymmetric reaction in both countries for all variables and a significant reaction of the real exchange rate. The patterns of most responses are in line with the results for the UK–US estimations, as shown in Figure 2.

The results turn out not to be sensitive for the time period over which the restrictions are binding. If we allow a longer period for the spill-over effects to take place (grey lines in Figures 1 and 2), impulse response functions are very close to the results when also contemporaneous constraints are imposed. The only relevant exception is the reaction of the real exchange rate to an asymmetric demand shock for the US–UK, which is much smaller in the very short-run.

The relative importance of symmetric and asymmetric shocks

A central question in this paper is obviously the relative importance of symmetric and asymmetric shocks for business cycle fluctuations. In the context of a monetary union, it is important that the contribution of asymmetric shocks to the variability of the business cycle is as limited as possible. Forecast error variance decompositions of economic activity are shown in Table 1. We only report the medians of the posterior distribution at a horizon of respectively 0, 4 and 20 quarters.[16] The medians of the posterior when the restrictions are only imposed 2 lags after the shocks are reported between parentheses.

Consider first the EA–UK results. In the very short run (0–4 quarters after the shocks), UK business cycle fluctuations are mainly driven by symmetric shocks with the EA, that is around 75%. Twenty per cent is explained by asymmetric shocks and 5% by exchange rate disturbances. Taking into account that bilateral exchange rate shocks and asymmetric monetary policy shocks disappear in a monetary union, there is only around 10–15% left, which is driven by asymmetric aggregate supply and demand shocks. In the long run (after 20 quarters), however, this share rises to 20–25% depending on the horizon of the imposed conditions. When we consider the Euro area business cycle, the contribution of asymmetric shocks is much larger in the short run, being more than 50% within one quarter and still between 45–47% after 1 year. The contribution in the long run is more similar to the UK.

[15]Note that a dissimilar (or not) historical interest rate response could be the consequence of different economic structures, but also because of different preferences of central banks. Hence, we have to be a bit careful when interpreting the results. Overall, we can only conclude that monetary policy did not react differently to (symmetric) shocks that moved the economies in the same direction within the sample period.

[16]Full results are available upon request.

TABLE 1

Forecast error variance decomposition of output

Euro area – United Kingdom VAR	*EA output*			*UK output*		
	0 quarters	*4 quarters*	*20 quarters*	*0 quarters*	*4 quarters*	*20 quarters*
Symmetric shocks	26 (26)	37 (37)	61 (62)	77 (82)	73 (78)	64 (61)
Supply	*8 (7)*	*9 (9)*	*37 (34)*	*24 (18)*	*41 (36)*	*46 (41)*
Demand	*12 (13)*	*17 (19)*	*10 (11)*	*44 (55)*	*22 (30)*	*9 (9)*
Monetary policy	*6 (5)*	*11 (9)*	*14 (17)*	*9 (9)*	*10 (12)*	*8 (11)*
Asymmetric shocks	51 (51)	47 (45)	29 (29)	18 (13)	22 (18)	28 (31)
Supply	*8 (4)*	*14 (8)*	*11 (10)*	*5 (3)*	*10 (7)*	*13 (17)*
Demand	*32 (41)*	*19 (28)*	*9 (11)*	*5 (6)*	*5 (7)*	*7 (8)*
Monetary policy	*11 (7)*	*13 (10)*	*9 (8)*	*7 (5)*	*6 (4)*	*7 (6)*
Exchange rate shocks	23 (23)	16 (18)	10 (9)	5 (5)	5 (5)	9 (8)

United States – United Kingdom VAR	*US output*			*UK output*		
	0 quarters	*4 quarters*	*20 quarters*	*0 quarters*	*4 quarters*	*20 quarters*
Symmetric shocks	40 (37)	61 (57)	72 (77)	61 (62)	69 (69)	74 (80)
Supply	*5 (4)*	*28 (19)*	*48 (53)*	*24 (13)*	*44 (33)*	*59 (62)*
Demand	*28 (26)*	*24 (29)*	*11 (10)*	*22 (34)*	*16 (28)*	*9 (9)*
Monetary policy	*6 (7)*	*10 (8)*	*12 (14)*	*15 (16)*	*8 (8)*	*7 (8)*
Asymmetric shocks	48 (53)	29 (34)	20 (17)	29 (30)	24 (24)	20 (16)
Supply	*9 (7)*	*7 (6)*	*7 (5)*	*8 (5)*	*8 (6)*	*6 (5)*
Demand	*24 (30)*	*15 (21)*	*8 (8)*	*17 (23)*	*11 (16)*	*8 (7)*
Monetary policy	*15 (16)*	*7 (8)*	*5 (4)*	*4 (2)*	*6 (3)*	*6 (3)*
Exchange rate shocks	12 (10)	10 (9)	8 (6)	10 (8)	7 (7)	6 (5)

Note: Median values of the posterior, normalized to sum to 100; median when restrictions are only imposed 2 lags after the shocks in parenthesis.

When we compare the results with the US–UK estimations, we find a much higher contribution of symmetric shocks in the long run, or a higher synchronization of the cycles.[17] In sum, we find that symmetric shocks with the Euro area are very important in explaining the UK business cycle. The long-run contribution of asymmetric shocks, however, cannot be ignored. In addition, the UK cycle seems to be more synchronized with the US. The output contribution of asymmetric shocks is much smaller in these two countries.

The role of the exchange rate

A flexible exchange rate can be considered as a mechanism to stabilize output and inflation variability. The loss of such an automatic stabilizer is a cost for a country that enters a monetary union. However, it may also be that the exchange rate itself is an independent source of shocks which disturbs the economy. A crucial question is then how relevant exogenous shocks to the exchange rate are for overall exchange rate fluctuations and what is the impact of these shocks on output volatility.

[17]The contribution of symmetric shocks is, depending on the specification, 74–80% in the long run for the US–UK, whereas this is 61–64% in the EA–UK VAR.

There already exist a large body of evidence on the role of the exchange rate in the economic adjustment process, relying on structural VARs, but there is disagreement in the results. Clarida and Gali (1994), Funke (2000) and Chadha and Prasad (1997) find an important role for the exchange rate acting as a shock absorber. On the other hand, Artis and Ehrmann (2000), Canzoneri *et al.* (1996) and Farrant and Peersman (2006) find that the exchange rate is more a source of shocks. Most of these studies estimate the VARs in relative variables, which implies that the same propagation mechanism is assumed for shocks originating in both economies. Furthermore, such an analysis does not allow to evaluate whether exchange rate disturbances are important for the level of economic activity in each economy, that is only the contribution to relative output variability could be measured.

Artis and Ehrmann (2000) estimate a one-country open economy VAR without relative variables. Such an approach can also generate biased results, in particular when there is an important role for symmetric shocks. In contrast to asymmetric shocks, the exchange rate is not expected to react in a significant way to symmetric shocks, or at least differently. As a consequence, the estimated stabilization role of the exchange rate to, for instance, an *average* (symmetric and asymmetric) demand shock will be biased. Our approach takes all these points seriously because we estimate a two-country VAR without relative variables, and because we distinguish between symmetric and asymmetric shocks. Hence, we could check the robustness of the existing empirical evidence.

Table 2 shows the variance decomposition of the exchange rates for respectively the EA–UK and US–UK. The contribution of disturbances to the exchange rate captures the role of the exchange rate as an independent source of shocks. We find a very high contribution of exchange rate noise in the short run, explaining 34% of Sterling–Euro and 51% of Sterling–Dollar variability within one quarter. The contribution is lower in the long run, i.e. respectively 16 and 21% after 20 quarters. Notably, when we only impose the restrictions from lag 2 after the shocks onwards, the short-run contribution turns out to be considerably lower for the EA–UK, while somewhat higher for the US–UK. Overall, these values are much higher than the original Clarida and Gali (1994) results and even slightly higher than those find by Farrant and Peersman (2006). On the other hand, the

TABLE 2

Forecast error variance decomposition of the exchange rate

	EA–UK			*US–UK*		
	0 quarters	*4 quarters*	*20 quarters*	*0 quarters*	*4 quarters*	*20 quarters*
Symmetric shocks	52 (73)	47 (50)	32 (37)	34 (22)	42 (47)	31 (38)
Supply	*22 (33)*	*16 (18)*	*11 (13)*	*17 (13)*	*25 (31)*	*16 (23)*
Demand	*25 (28)*	*21 (18)*	*13 (13)*	*17 (8)*	*14 (12)*	*11 (12)*
Monetary policy	*6 (12)*	*11 (15)*	*7 (11)*	*0 (0)*	*3 (3)*	*4 (4)*
Asymmetric shocks	14 (24)	44 (45)	52 (51)	15 (14)	42 (25)	49 (41)
Supply	*9 (15)*	*11 (14)*	*10 (13)*	*10 (11)*	*9 (11)*	*8 (11)*
Demand	*2 (2)*	*18 (9)*	*29 (23)*	*5 (3)*	*32 (12)*	*32 (23)*
Monetary policy	*3 (7)*	*16 (23)*	*13 (15)*	*0 (0)*	*2 (2)*	*8 (6)*
Exchange rate shocks	34 (3)	9 (4)	16 (12)	51 (64)	16 (28)	21 (21)

Note: Median values of the posterior, normalized to sum to 100; median when restrictions are only imposed 2 lags after the shocks in parenthesis.

contribution of exchange rate shocks is still remarkably lower than the results obtained in Artis and Erhmann (2000).

More relevant is obviously the contribution of exchange rate disturbances to output fluctuations. Table 1 also contains the contribution of exchange rate shocks to output variability. For the UK, this is 5% in the short run. The contribution, however, increases to a value close to 10% in the long run, which is quite a lot. For the Euro area itself, the contribution to output variability within one quarter is even considerably higher at 23%. Accordingly, exogenous exchange rate shocks (or at least exchange rate movements not explained by aggregate supply, aggregate demand and monetary policy shocks) can be considered as an important source of business cycle fluctuations. One could argue that it is difficult to investigate whether the exchange rate has been acting as a stabilizer or an independent source of shocks for Sterling–Euro because the exchange rate is calculated as a weighted average of individual countries for the period prior to 1999, a period where interventions in the FX market did not always take place simultaneously. This statement is correct, but the results for the US–UK VAR are similar.

IV. Conclusions

Several countries will probably join EMU in the near future or are facing the choice to join the Eurozone. The traditional starting point for this issue is the theory of OCAs. According to this theory, the member countries of a currency area should experience similar movements of the business cycle. When cyclical situations are different, a single stance of monetary policy is not optimal for the individual countries. Hence, an important part of the costs to join the Euro area depends on the synchronization of the cycles, or the relative importance of symmetric and asymmetric shocks.

In this paper, we have provided empirical evidence for the UK vs. the Euro area, and the results are compared with the US as a benchmark. To do so, we have estimated two-country structural VAR models. We propose an identification strategy based on sign restrictions, which allows to disentangle symmetric and asymmetric supply, demand and monetary policy shocks as well as exogenous exchange rate disturbances. The results suggest a very important role for symmetric shocks with the Euro area in explaining UK output fluctuations. The relative importance of asymmetric supply and demand shocks, however, cannot be ignored because the latter explain around 20% of output variability in the long run. The degree of synchronization seems also to be higher with the US, especially in the long run.

A related question is the role of the exchange rate as an independent source of shocks rather than being an adjustment mechanism. We find a significant role for the exchange rate acting as an independent source of shocks. Exchange rate disturbances against the euro explain around 10% of long-run output variability in both economies. In the very short run, this is even 23% for the Euro area.

In interpreting the results, however, some caution is required. In particular, it is not possible to say how data generated from a period when the economies operate under a given regime change when a new monetary regime is established. Hence, an extension of the present study could be an application on members that recently joined the Euro area once enough data is available. A related extension could be the analysis of other countries who have joined the European Union recently and might introduce the euro relatively soon such as a large number of accession countries.

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