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Macroeconomic shocks under alternative exchange rate regimes: the Irish experience

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The paper investigates the nature of Irish macroeconomic shocks and their correlation with German and UK shocks. A restricted VAR of real output and prices is employed to distinguish aggregate demand and supply shocks for the three countries. To identify the role of Irish exchange rate policy two periods are considered: the pre-ERM period and the ERM period. The results indicate that while the change in exchange rate policy had an effect on the nature of demand and supply shocks, the ERM did not have the effect of increasing the correlation of Irish shocks with Germany or the UK. Evidence of substantial asymmetric shocks with Germany and the UK exist. Thus, Ireland as a member of the EMU faces increased cost of adjustment to asymmetric macroeconomic shocks.

I. INTRODUCTION

A principal feature underpinning the European Monetary Union (EMU) is that there exist some optimum currency area.[1] The theory of optimum currency areas provides the framework for analysing a country's membership of the EMU. The purported benefits from savings in transactions costs with member countries and the effective completion of the Single Market are expected to outweigh the cost of diminished monetary policy autonomy. Moreover, independent monetary policy will no longer be an option to offset asymmetric (or country-specific) macroeconomic shocks. For this reason, if macroeconomic shocks have asymmetric effects, membership of the EMU can have real effects – in terms of output and employment. The cost of adjustment is reduced the more flexible are relative wages and labour mobility across countries. However, it is unlikely that relative wages and labour mobility will be flexible enough, at least in the short run, to lessen such costs. This feature of EMU is especially important for Ireland – a small open economy with strong trade links and labour mobility with the UK (see Baker *et al.*, 1996; Kavanagh *et al.*, 1998).

There has always been widespread political support for EMU in Ireland, with all the main political parties backing the movement towards EMU. The benefits from EMU in the form of perceived price stability and lower interest rates (i.e. the removal of risk premium associated with the sudden depreciation of sterling) through macroeconomic policy co-ordination are expected to outweigh the cost of adjustment, even if the UK does not join. Despite a large decline in its bilateral trade dependence, in 1994 some 28% of Irish exports was to the UK and 36% of imports was from the UK. A sterling depreciation reduces the competitiveness of Irish goods in the UK and in third-country markets and increases competition from UK imports in the Irish market. The '1992–3 ERM Currency Crises' highlighted the link between the trade pattern and exchange rate regime by focusing attention on the costs Irish industry would face with the UK as a non-member of the EMU and on the effect that this would have on Irish employment. The crises also highlighted the interaction between the wage determination process and the costs of exchange rate fluctuations. The UK remains an important determinant of Irish macroeconomic performance (Callen and FitzGerald, 1989; Duggan *et al.*, 1996).

This paper examines Ireland's decision to join the EMU by investigating the independence of Irish macroeconomic shocks, especially in relation to Germany – the anchor currency of the EMU. If shocks are asymmetric and if

[1] See Mundell (1961) for the seminal work on the theory of optimum currency areas.

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labour is not mobile between countries (for example, due to language and cultural barriers),[2] the cost for Ireland within a monetary union would be significant.[3] Furthermore, since the Maastricht criteria restricts fiscal policy, the previous policy response to a UK sterling depreciation, which was for the Irish pound to revalue accordingly, will not be available under EMU. An alternative action by Irish authorities might be to wait for the UK to join the EMU. Even in the presence of asymmetric shocks between Ireland and UK, the present flexible labour mobility between the two countries reduces the cost of adjustment and, therefore, would suggest that Ireland joins the EMU when the UK joins.

Recently a number of studies have examined the degree to which the European Union (EU) is an optimum currency area. The majority of these studies either ignore Ireland or its unique relationship with the UK. Eichengreen (1992) finds that real exchange rate variability is higher between the then 10 European Community[4] (EC) member states than between US regions, suggesting that the EC is not an optimum currency area. Moreover, since shocks are more asymmetric in the EC than in the US, this suggests a real cost in terms of larger regional unemployment differentials across the EC countries. In an extension of this earlier work, Bayoumi and Eichengreen (1993) find an EU core, comprised of Germany, France, Belgium, the Netherlands and Denmark, and an EU periphery of the UK, Italy, Spain, Portugal, Ireland and Greece, thus providing further evidence of a two-speed EMU (also see Dornbusch, 1990).

Employing an econometric methodology developed by Blanchard and Quah (1989), a number of recent studies have investigated the correlation of aggregate demand and supply shocks across the EU member countries (Bayoumi, 1992; Bayoumi and Eichengreen, 1993, 1994; Bayoumi and Taylor, 1995; Funke, 1997). The results are not encouraging, the size of the correlations of demand and supply shocks across countries varies greatly and are generally low, especially compared to the states of Germany and the US. However, Germany exhibits the highest cross-correlations, especially with Austria and the Netherlands.

Of the above studies that included Ireland in their analysis, the results are mixed and difficult to explain. For example, Bayoumi and Eichengreen (1993), using annual data for the 1960–88 period, were not able to interpret the finding of a negative correlation of supply and demand shocks with Germany. Contrary to their underlying framework that distinguishes the shocks, their estimated model for Ireland generated a decrease in real output from a positive supply shock. The correlation of supply and demand shocks with the UK are not reported. Funke (1997), using annual data for the slightly longer period of 1964–92, also find a negative correlation of supply shocks between Ireland and Germany, with demand shocks positively correlated. The correlation of demand and supply shocks with the UK are positive and larger. However, for both studies the correlations are insignificantly different from zero at the 5% level.

Duggan *et al.* (1996) provide the only recent substantive work on asymmetry Irish macroeconomic shocks. Using a macrosectoral model of the Irish economy,[5] Duggan *et al.* (1996) simulate the model for alternative shocks. Moreover, if the UK is not a member of the EMU, Ireland is exposed to certain types of shocks, especially in the short run. For example, the costs imposed on the Irish economy of a large sterling shock are greater when Ireland is a member of an EMU than outside it. Similarly, the cost for Ireland of a German demand shock is more severe when the UK is not a member of the EMU. In general, for Ireland, whether the UK is a member of the EMU does not affect the long-run response of macroeconomic shocks but does have severe short-term competitive effects.

In this paper, evidence on the relative importance of innovations in aggregate supply and demand on the level of economic activity in Ireland during the pre- and post-ERM periods is provided. Following Bayoumi (1992) and others, we use the standard aggregate supply-aggregate demand model with a long-run vertical supply curve as an organizing framework. We distinguish econometrically between supply and demand innovations and their effect on the level of real economic activity and prices for Germany, Ireland and the UK. The two types of shocks are identified by estimating a vector autoregression involving industrial production and price data and imposing econometric restrictions upon the system which are implied by the aggregate demand–aggregate supply framework. The correlation of shocks across the three countries distinguishes whether or not Ireland is in a DM or Sterling zone, and moreover, the significance of the cost of entry into the EMU without the UK.

The remainder of the paper is set out as follows. In Section II we outline the econometric technique employed in order to identify supply and demand disturbances. Section III gives a discussion of the data used and in Section IV we discuss our empirical results. A final section concludes.

[2] For a discussion of labour market adjustments see Blanchard and Katz (1992), Eichengreen (1993) and Decressin and Fatas (1995).
[3] A high level of labour mobility between Ireland and the UK (even with the UK not a member of the EMU) reduces the costs of adjustment to asymmetric shocks because exchange rate adjustment is not given up entirely (Melitz, 1995).
[4] Now called the European Union.
[5] The model is the HERMES model of the Irish economy (Bradley *et al.*, 1993).

II. ECONOMETRIC METHODS

In the traditional ADAS model with a long-run vertical supply curve, aggregate demand innovations result in only a temporary rise in output, while aggregate supply innovations permanently affect the level of aggregate output. That is, aggregate supply innovations increase real output (in both the short and long run) and depress prices, while demand innovations raise prices but can only raise output in the short run.[6]

Blanchard and Quah (1989) suggest an econometric technique to decompose a series into its temporary and permanent components, a variant of which is employed in this paper. One advantage of the Blanchard–Quah decomposition is that it identifies permanent and temporary shocks in a multivariate time series context.[7] Using an ADAS framework, Blanchard and Quah (1989) associate aggregate supply shocks with permanent shocks and aggregate demand shocks with temporary shocks.[8]

A number of recent studies have applied the Blanchard–Quah decomposition to macroeconomic variables (Gali, 1992; Gamber and Joutz, 1993; Bayoumi and Eichengreen, 1994; Bayoumi and Taylor, 1995; Gamber, 1996; Funke, 1997).[9] For this reason only a brief outline of the theoretical underpinnings of the decomposition is presented. The fundamental feature of the Blanchard–Quah technique is that it imposes a long-run restriction on the VAR to identify the decomposition.

Following Blanchard and Quah (1989), supply and demand shocks to real output can be identified by imposing appropriate restrictions on the Wold representation of time series for real and nominal variables. Consider a 2×1 vector of macroeconomic time series $x_t = [(1-L)y_t \; (1-L)p_t]'$, where L is the lag operator y_t is the logarithm of real output and p_t is the logarithm of the aggregate price level. Both $(1-L)y_t$ and $(1-L)p_t$ are assumed to be realizations at time t from a stationary stochastic process with its deterministic components removed. The variables y_t and p_t are thus assumed to be realizations of first-difference stationary or I(1) processes. By the multivariate form of Wold's decomposition x_t will have a moving average representation.

Engle and Granger (1987) demonstrates that if $[y_t \; p_t]$ is cointegrated[10] of order 1, 1, $[y_t \; p_t] \sim CI(1,1)$ then the vector of x_t is not well behaved, in that the moving average representation of that vector is noninvertible. Therefore, a necessary condition for the Blanchard–Quah decomposition is that the vector $[y_t \; p_t]$ is not cointegrated – for example, this prohibits estimating a vector of first-differenced stock prices and dividends using the Blanchard–Quah technique. If $[y_t \; p_t]$ is a cointegrating vector then an alternative decomposition technique is the Stock and Watson (1988) common trends representation. Cochrane (1994) examines the relationship between the Sims (1980), Blanchard–Quah (1989), and Beveridge–Nelson (1981) decompositions and cointegration and Crowder (1995) examines the relationship between the Blanchard–Quah decomposition, the Stock and Watson (1988) common trends representation and cointegration.

We will concern ourselves with non-cointegrating vectors. Consider a transformation of the Wold representation given by:

$$x_t = \sum_{j=0}^{\infty} L^j \begin{bmatrix} a_{11}(j) & a_{12}(j) \\ a_{21}(j) & a_{22}(j) \end{bmatrix} \begin{bmatrix} e_{d,t} \\ e_{s,t} \end{bmatrix}$$
$$= \sum_{j=0}^{\infty} L^j A(j) e_t \qquad (1)$$

where e_t is a 2×1 vector of innovations $[e_{d,t} \; e_{s,t}]'$ occurring at time t and $a_{mn}(j)$ $(m, n = 1, 2)$ represents the impulse response of the mth element of x_t to the nth element of e_t after j periods. By imposing restrictions on the coefficients of (1) and on the covariance matrix of the innovations, the elements of e_t can be identified as demand $(e_{d,t})$ and supply $(e_{s,t})$ innovations.

For a demand innovation to real output, the cumulative effect of the shock on changes in real output are zero. This implies the restriction

$$\sum_{j=0}^{\infty} a_{11}(j) = 0 \qquad (2)$$

Suppose that we estimate an unrestricted, nth order VAR for x_t, with the lag depth n chosen on statistical grounds, which yields a vector of innovations v_t:

$$\left[I - \sum_{j=1}^{n} L^j \Theta(j) \right] x_t = v_t \qquad (3)$$

[6] See, for example, Cuthbertson and Taylor (1987) Chapter 3.
[7] Beveridge and Nelson (1981) provide a univariate representation of identifying permanent and temporary shocks.
[8] While demand innovations may have permanent effects on the real side of the economy, it is supply innovations that are most likely, if not totally, to have a permanent effect on output. Whereas, those having only a temporary effect on output are likely to be due mostly if not totally to demand innovations. Moreover, if the permanent long-run effects on output of demand innovations are small relative to the long-run permanent effects of supply innovations, then the Blanchard-Quah methodology is useful as an organizing framework for empirical analysis.
[9] The econometric method has also been discussed by Quah (1990, 1992, 1995), Blanchard and Quah (1993), Lippi and Reichlin (1993, 1994) and Crowder (1995).
[10] That is, y_t and p_t are integrated of the order 1 (i.e. stationary in first differences) and there exists a vector $\beta (\neq 0)$ where $\beta'[y_t \; p_t]$ is integrated of order 0 (i.e. stationary).

where $\Theta(j)$ is the matrix of estimated coefficients at lag j. Since x_t is stationary, this can be inverted to obtain the estimated moving average representation:

$$x_t = \left[I - \sum_{j=1}^{n} L^j \Theta(j)\right]^{-1} v_t$$

$$= \sum_{j=0}^{\infty} L^u C(j) v_t \quad (4)$$

where $C(0) = I$. Equating (1) and (4), we can see that the VAR innovations will be linear combinations of the underlying demand and supply shocks:

$$v_t = A(0)e_t \quad (5)$$

where $A(0)$ is a 2×2 matrix. To recover the underlying demand and supply shocks from the VAR innovations Blanchard and Quah (1989) thus suggest four restrictions. Three restrictions can be obtained by normalizing the variance of $e_{d,t}$ and $e_{s,t}$ to unity and requiring them to be orthogonal. Let Ω be the variance-covariance matrix of v_t, then, using Equation 5, these restrictions can be written:

$$A(0)A(0)' = \Omega \quad (6)$$

From Equations 1, 4 and 5 we can deduce the impulse response functions in terms of $C(j)$ and $A(0)$:

$$A(j) = C(j)A(0) \quad (7)$$

Using Equations 2 and 7 we can then deduce a fourth restriction on $A(0)$:

$$\kappa' \sum_{j=0}^{\infty} C(j)A(0)\kappa = 0 \quad (8)$$

where $\kappa = (1\ 0)'$.

III. DATA AND PRELIMINARY ANALYSIS

Quarterly data for Ireland, Germany and the UK were obtained from the International Monetary Fund's International Financial Statistics database.[11] The data series of interest are the natural logarithm of real industrial production and consumer prices. The series are divided into two periods, corresponding to the pre-ERM period, 1960:1–1989:4, and the ERM period, 1979:3–1996:4. The pre-ERM period corresponds to a period of a fixed Irish-pound/pound-sterling (IR£/£stg) exchange rate and floating against the Deutschmark (DM). Ireland's entry into the ERM in March 1979 ended this exchange rate parity with sterling that had existed since 1922. The ERM period captures the change in Irish exchange rate policy to one of quasi-fixed exchange rate with the DM and floating against sterling.

It is arguable whether, for Ireland, the ERM period corresponds to a specific exchange rate regime period. Over the period 1979 to 1987, the Irish pound was devalued explicitly on two occasions, March 1983 and August 1986. The driving force behind these devaluations was the loss of competitiveness *vis-à-vis* the UK, induced by the depreciation of the DM/£stg exchange rate.[12] These devaluations suggest that during this period of ERM membership, the Irish authorities targeted an effective exchange rate index with weights given to sterling and the Deutschmark. Between 1987 and 1992, the Irish pound was stable against the DM and Irish interest rates and price inflation converged on Germans levels – a period of credible Deutschmark peg. Furthermore, the credibility of Irish exchange rate policy towards the ERM was improved when UK joined the ERM in 1989.

Germany's unification, Europe's recession and the ERM currency crises in 1992–3, changed the landscape of the ERM resulting in freer movements of bilateral exchange rates through the widening ERM bands. The impact from the September 1992 sterling devaluation (through leaving the ERM) highlighted the costs for Ireland entering into EMU with the UK as a non-member. Facing the combination of very high, and rising real interest rates, an appreciating currency, and falling official external reserves resulted in the Irish authorities devaluing the Irish pound on 30 January 1993.

Table 1 reports summary statistics on the series of interest. The sample autocorrelations reveal some degree of persistence and suggest that real output and prices are non-stationary. The impression that the series in question are realizations of non-stationary processes is confirmed by the standard unit root tests reported in Table 2. The sequential procedure employed in testing for unit roots follows Dickey and Pantula (1987) in order to ensure that only one unit root is present in the series. The unit root tests are the augmented Dickey–Fuller (ADF) test for the null hypothesis that the series in question is I(1) (Dickey and Fuller, 1979, 1981).[13] Consistent with previous studies, for each country real industrial production and consumer price series appear to be realization of first-difference stationary or I(1) processes. There is also no

[11] A monthly consumer price index for Ireland is only available from January 1997.
[12] The weakness of the dollar relative to the Irish pound is another reason for the 1986 devaluation.
[13] The choice of lag length was chosen using the Ljung–Box Q-statistic to ensure the residuals were approximately white noise (Ljung and Box, 1978).

Table 1. *Summary statistics*

	Ireland		United Kingdom		Germany	
	Pre-ERM	ERM	Pre-ERM	ERM	Pre-ERM	ERM
			(a) Output growth			
Mean	1.48	1.76	0.58	0.31	0.92	0.25
s.d.	2.46	2.74	2.24	1.41	1.89	1.72
$\rho(1)$	−0.22	−0.05	−0.09	0.33*	0.34*	0.47*
$\rho(2)$	0.04	0.13	−0.02	0.35*	0.10	0.22
$\rho(3)$	−0.02	0.10	0.08	0.08	0.14	0.32*
$\rho(4)$	0.01	−0.13	−0.18	0.58*	0.09	0.55*
$\rho(5)$	0.04	0.07	0.02	0.07	−0.15	0.31
$\rho(6)$	−0.02	0.14	0.05	0.22	−0.06	0.20
			(a) Inflation			
Mean	2.00	1.50	1.90	1.40	0.89	0.72
s.d.	1.74	1.57	1.63	1.22	0.68	0.62
$\rho(1)$	0.45*	0.67*	0.65*	0.46*	0.33*	0.03
$\rho(2)$	0.21	0.68*	0.54*	0.12	−0.15	0.09
$\rho(3)$	0.40*	0.69*	0.45*	−0.00	0.33	0.09
$\rho(4)$	0.59*	0.56*	0.64*	−0.07	0.73*	0.03
$\rho(5)$	0.34	0.59*	0.42	0.04	0.23	−0.11
$\rho(6)$	0.20	0.50	0.45	0.15	−0.19	0.04

The sample period is 1960:1–1978:4 for the pre-ERM subperiod and 1979:3–1996:4 for the ERM subperiod. The mean and standard deviation (s.d.) are expressed in percentage terms. $\rho(k)$ is the autocorrelation between x_t and x_{t-1}. An asterisk denotes that the sample autocorrelation is at least two standard deviations to the left or to the right of its expected value under the hypothesis that the true autocorrelation is zero.

Table 2. *Unit root and price–output cointegration tests*

		y_t	Δy_t	$\Delta^2 y_t$	p_t	Δp_t	$\Delta^2 p_t$	μ_t
Ireland:	Pre-ERM	−0.68	−4.47	−7.32	0.65	−5.43	−10.60	−1.15
	ERM	1.88	−3.65	−7.00	−2.44	−5.04	−5.52	−1.86
UK:	Pre-ERM	−1.18	−4.53	−6.90	0.28	−3.50	−4.73	−0.79
	ERM	−0.58	−4.10	−6.53	−1.06	−3.07	−4.66	−2.00
Germany:	Pre-ERM	−1.88	−3.90	−6.16	−0.19	−3.74	−4.42	−1.92
	ERM	−0.77	−3.61	−5.52	−1.27	−3.31	−4.10	−2.83

The sample period is 1960:1–1978:4 for the pre-ERM period and 1979:3–1996:4 for the ERM period. y_t is the natural logarithm of real industrial output; p_t is the natural logarithm of consumer prices; μ_t is the residual from an ordinary least squares regression of p_t on to y_t and a constant. Δ denotes the first difference. The unit root test is the augmented Dickey–Fuller (ADF) test statistic for the null hypothesis that the series is difference stationary (Dickey and Fuller, 1979, 1981). The lag truncation was chosen to ensure whiteness of the residuals. The unit root test of Δp_t for Ireland: ERM and UK: pre-ERM includes a time trend. For a 5% significance level the critical ADF is −2.89 (see, Fuller, 1976, p. 373). The cointegration test, μ_t is the ADF test; for a 5% significance level the critical value is −3.17 (see, Fuller, 1976, p. 371–3; Engle and Granger, 1987).

evidence of cointegration between real output and prices for each country and subperiod at the 5% level of significance. All the data series employed in the paper are plotted in Fig. 1.[14] None of the plots provide strong visual evidence of regime shifts in the processes. Irish and UK consumer prices appear to be of similar magnitude for both periods and consistently higher than the UK.

IV. EMPIRICAL RESULTS

A vector autoregressive representation of $[(1-L)y_t(1-L)p_t]'$ was estimated prior to effecting the decomposition and identifying the aggregate demand and supply innovations.[15] The lag length for the VAR was chosen as follows. First, ninth-order systems were estimated. We then

[14] The plot of the natural logarithm of industrial production and consumer prices indices are rebased so that the average price for 1960 is unity.

[15] Seasonal dummies were included in the VAR.

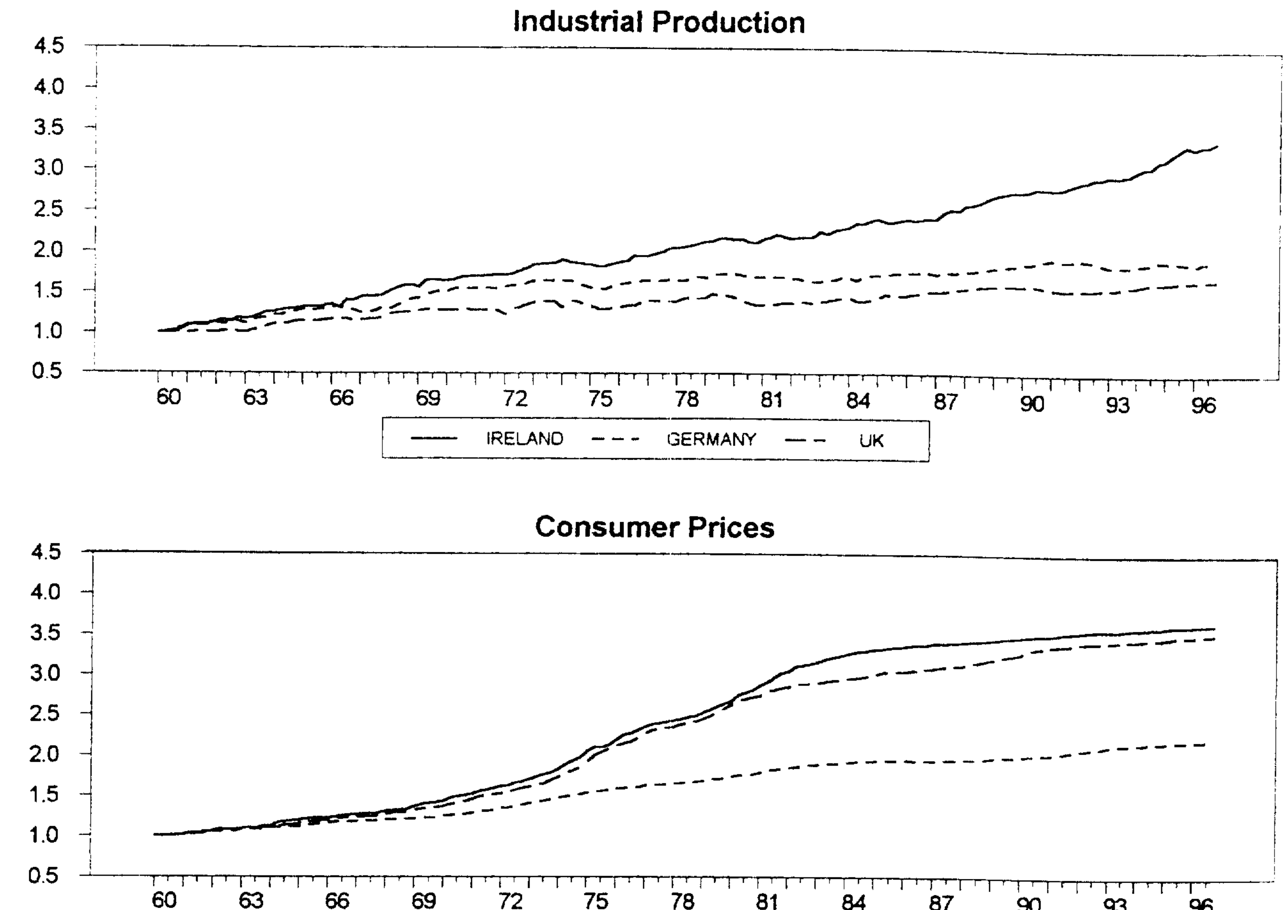

Fig. 1. *Output and prices, 1960:1–1996:4*

sequentially imposed and tested exclusion restrictions on the highest lags, using likelihood ratio tests, stopping when a significant (at the 5% level) statistic was encountered. The residuals were then checked for whiteness (using the Ljung-Box statistics), and the lag depth increased (if necessary) until they were approximately white noise. The appropriate lag lengths are reported in Table 3.

Given the estimates of the VAR parameters and the covariance matrix of VAR residuals we then carried out the VAR decomposition as outlined above. Using the estimated $A(0)$ matrix, as defined in Section II, we generated the impulse response functions for output and prices. The cumulative impulse response functions illustrating the effect of a one-unit (standard deviation) aggregate demand (temporary) and aggregate supply shock to real output and prices are shown in Figs 2 and 3. The impulse response functions are consistent with the standard ADAS framework with a long-run vertical supply curve.[16] An aggregate demand shock to inflation is positive and an aggregate supply shock is negative. Whereas, an aggregate demand shock has a zero long-run effect on real output.

Table 3. *Testing for lag length*

	Pre-ERM Period 1960:1–1978:4	ERM Period 1979:3–1996:4
Ireland	6	8
UK	7	6
Germany	8	3

Ninth-order systems were estimated. We then sequentially imposed and tested exclusion restrictions on the highest lags, using likelihood ratio tests, stopping when a significant (at the 5% level) statistic was encountered. The residuals were then checked for whiteness (using the Ljung–Box statistics), and the lag depth increased (if necessary) until they were approximately white noise.

Table 4 reports the fraction of the unconditional variation in real output and price movements due to aggregate demand shocks in short and long runs. The contribution of aggregate supply shocks is given by 100 minus the contribution of aggregate demand shocks. The forecast error variance in real output due to aggregate demand shocks

[16] The results for Ireland contrast with Bayoumi and Eichengreen (1993). Possible explanations include the higher frequency data used, the sample period considered and the length of the VAR.

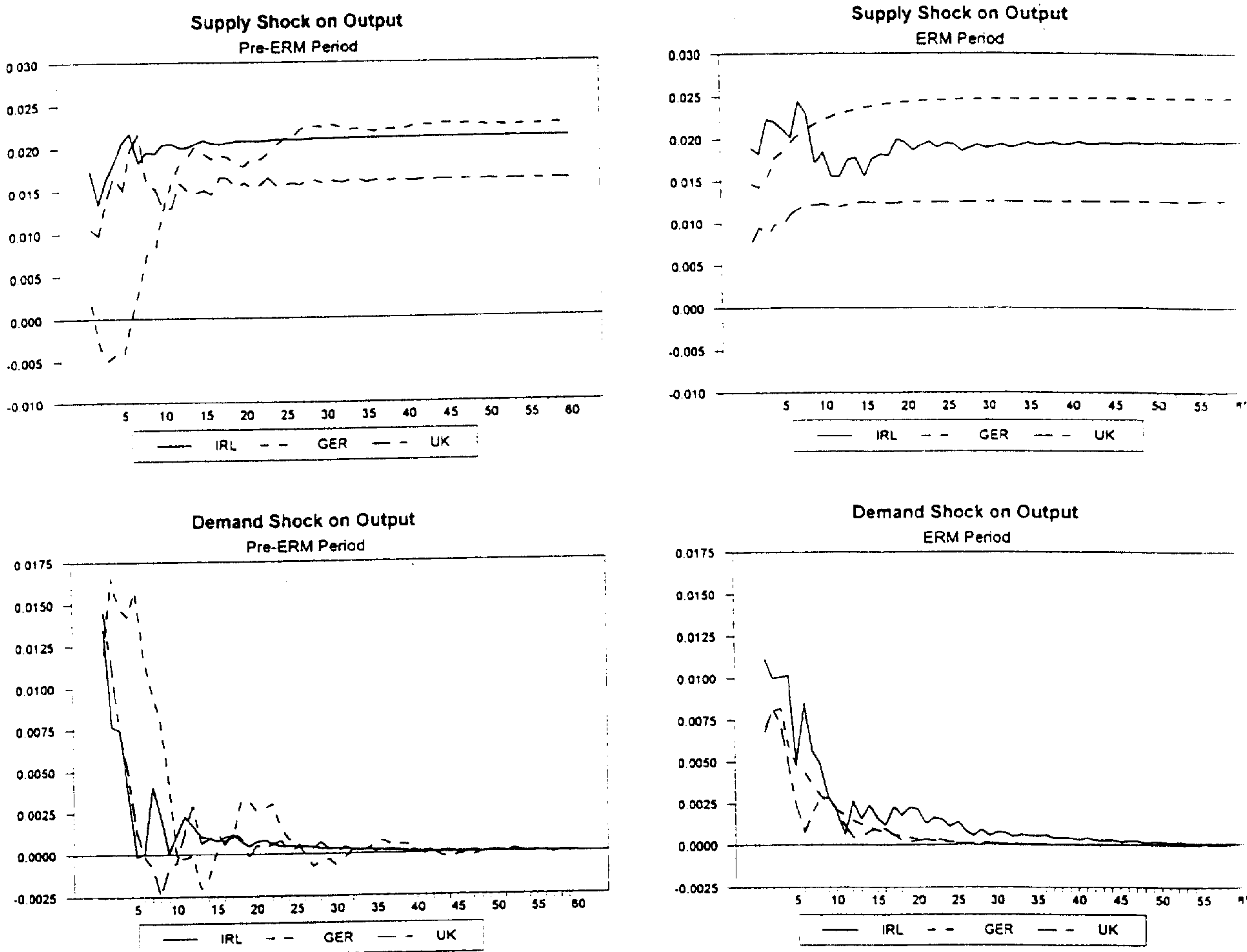

Fig. 2. *Impulse response functions on output*

Table 4. *Percentage of variation in output and prices explained by demand shocks*

		Output			Prices		
		1 Qtr	4 Qtrs	Long run	1 Qtr	4 Qtrs	Long run
Ireland:	Pre-ERM	37.65	41.13	43.64	65.48	66.78	[illegible]
	ERM	25.80	25.12	29.38	71.35	72.01	[illegible]
UK:	Pre-ERM	65.73	64.12	55.36	22.61	28.97	[illegible]
	ERM	43.22	45.39	49.91	83.74	82.81	[illegible]
Germany:	Pre-ERM	98.18	84.53	66.80	0.36	7.72	[illegible]
	ERM	18.99	20.29	20.92	60.72	59.07	[illegible]

Figures are the percentage of total variation in output and prices explained by demand shocks. The percentage of total variation in output and prices explained by supply shocks is given by 100 minus the variation explained by demand shocks. The sample period is 1960:1–1978:4 for the pre-ERM period and 1979:3–1996:4 for the ERM period.

varies across countries and subperiods. However, for the three countries, moving from the pre-ERM period to the ERM period an increased proportion of variation in output is explained by aggregate supply shocks and aggregate demand shocks explain more of the movements in prices in the ERM period. The findings are similar to Bayoumi (1992) and Bayoumi and Taylor (1995).

The results from the two periods indicates that the switch in the exchange rate regime has led to a change in the types of macroeconomic shocks being experienced across countries.

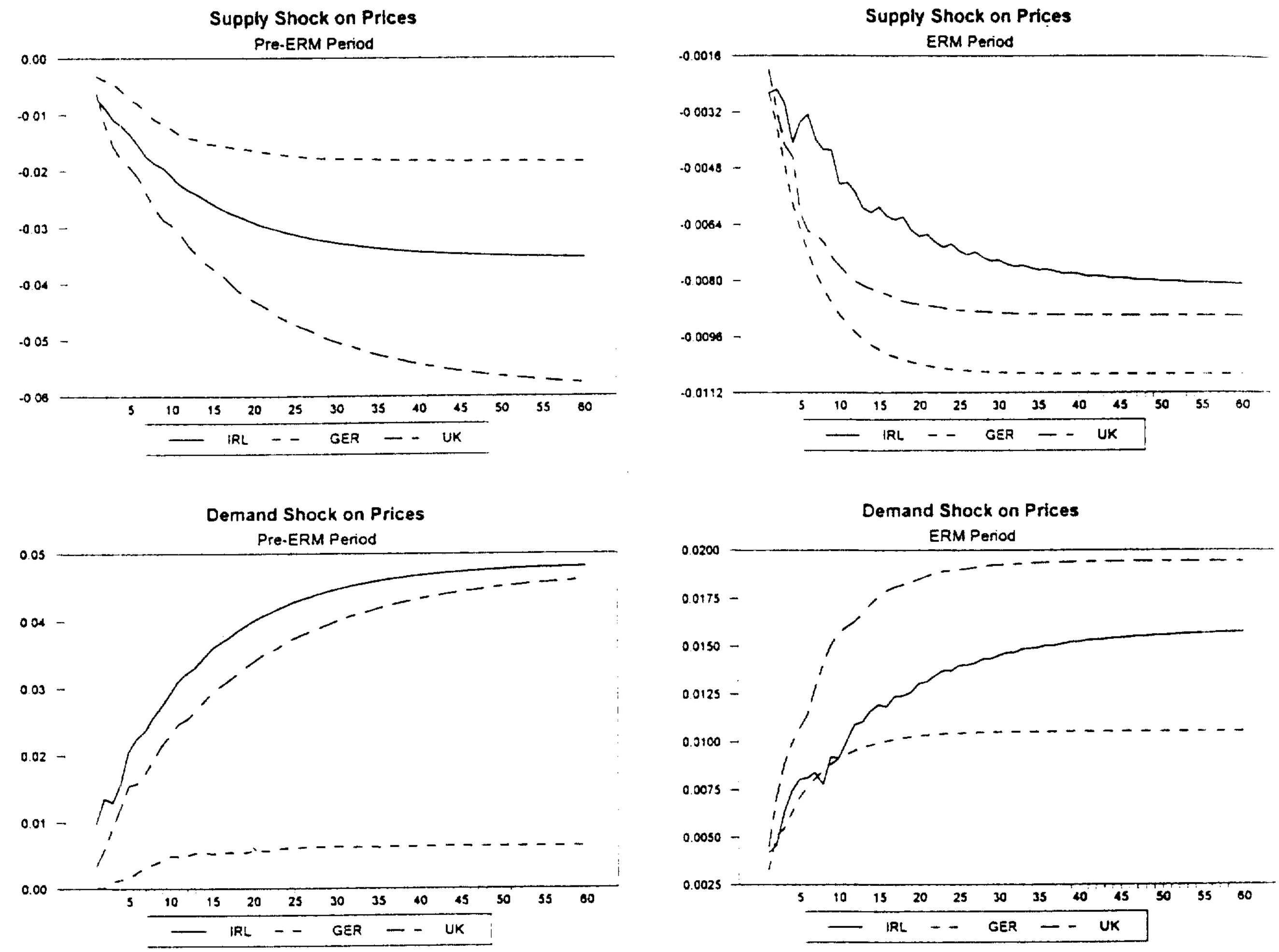

Fig. 3. *Impulse response functions on prices*

However, the effect of the ERM on macroeconomic shocks is less pronounced for Ireland and the UK – possibly because for both countries the change in exchange rate regimes is less obvious. Ireland has always pursued a (quasi) fixed exchange rate regime and the UK did not fix its exchange rate for any significant length of time. Germany experienced the greatest change in the types of macroeconomic shocks.[17]

The contemporaneous correlation of shocks across countries provides evidence on the degree to which shocks have become symmetric among the potential EMU countries. Table 5 reports the results from the correlation of demand and supply shocks among the three countries. For the pre-ERM period (a period of fixed no-margins link of the Irish pound and pound sterling) Irish demand and supply shocks were significantly positively (contemporaneously) correlated with the UK but not with Germany. Moreover, for the period after the break in the sterling link, there are no significant correlations of demand and supply shocks between Ireland and the UK. However, for this ERM period, Irish demand shocks were significantly positively correlated with Germany, no other significant contemporaneous correlations are found. Although, the effect for Ireland in joining the ERM appears to break the link with the UK, it did not have the effect of increasing the correlation of supply shocks with Germany – in fact the supply correlation became negative (though not significant). There remains substantial asymmetric shocks with Germany, the EMU anchor currency.[18]

In order to gain further insight into the relationship of the Irish with the UK and German economies, the results of tests for Granger causality among the underlying shocks

[17] A contributing factor here could be the effect of German unification.
[18] Eichengreen (1997) notes that since demand shocks are more likely to change with the advent of EMU it is more appropriate to concentrate on supply shocks when assessing the symmetry of shocks among EMU countries. Furthermore, demand shocks explain a smaller proportion of movement in Irish output.

Table 5. *Demand and supply shock correlations*

	Pre-ERM period		ERM period	
	Ireland	UK	Ireland	UK
	(a) Demand shocks			
UK	0.25*		0.11	
Germany	−0.09	0.07	0.31*	0.05
	(b) Supply shocks			
UK	0.31*		0.07	
Germany	0.01	0.20	−0.07	0.19

Figures are the correlation coefficients for demand and supply shocks between countries. The 5% significance level is $2/\sqrt{T}$, for the pre-ERM period it is absolute 0.23 and for the ERM period it is 0.24. An asterisk denotes significance at the 5% level. The sample period is 1960:1–1978:4 for the pre-ERM period and 1979:3–1996:4 for the ERM period.

Table 6. *Granger causality tests*

	Demand shocks	Supply shocks
	(a) UK Granger causes Ireland	
Pre-ERM period	2.33	0.05
	(0.07)	(0.99)
ERM period	0.76	1.76
	(0.56)	(0.15)
	(b) Germany Granger causes Ireland	
Pre-ERM period	1.93	0.75
	(0.12)	(0.56)
ERM period	0.56	0.82
	(0.69)	(0.52)

Figures are F-statistics from two fourth-order regressions (one for each shock) for Ireland, with lags of Ireland, Germany, and the UK shocks explaining Irish shocks. The F-statistic tests whether demand and supply shocks from Germany (and from the UK) Granger cause Irish shocks. Figures in parentheses are marginal significance levels. The sample period is 1960:1–1978:4 for the pre-ERM period and 1979:4–1996:4 for the ERM period.

for Ireland are reported in Table 6. We estimated two fourth-order regressions for Ireland (one for each type of shock) with lagged shocks of the three countries explaining Irish shocks. The results show that lagged German and UK shocks did not significantly explain, at the 5% level, movement in Irish shocks, for either period. At a weaker level of significance (for example, the 7% level) UK demand shocks positively explain Irish demand shocks in the pre-ERM period but not the ERM period. Taken together with the contemporaneous correlations reported in Table 5, unlike for Irish demand shocks, there is little evidence that Irish supply shocks can be explained by past German or UK supply shocks, especially in the ERM period.

Table 7. *Impulse response function correlations*

	Pre-ERM period		ERM period	
	Ireland	UK	Ireland	UK
	(a) Output response to a demand shock			
UK	0.90*		0.89*	
Germany	0.66*	0.61*	0.96*	0.95*
	(b) Output response to a supply shock			
UK	0.52*		−0.23	
Germany	0.76*	0.23	−0.24	0.96*
	(c) Price response to a demand shock			
UK	0.99*		0.95*	
Germany	0.97*	0.94*	0.91*	0.99*
	(d) Price response to a supply shock			
UK	0.99*		0.89*	
Germany	0.98*	0.96*	0.91*	0.99*

Figures are correlation coefficients between impulse response functions of output and prices to demand and supply shocks for Ireland, Germany and the UK. An asterisk denotes significance at the 5% level. The sample period is 1960:1–1978:4 for the pre-ERM period and 1979:3–1996:4 for the ERM period.

The independence of Ireland during the ERM period is further illustrated from the results of the correlation matrices for the impulse response functions of output and prices with respect to the two types of macroeconomic shocks shown in Table 7. Comparing the two periods, there appears to have been a significant increase in the correlation of the output response functions to a demand shock between Ireland and Germany.[19] For the ERM period, the correlations of output to demand shocks are positive and are higher between Ireland and Germany than with the UK. Most significant are the negative correlations of the output response functions to a supply shock between Ireland and the other two countries (marginally significant at the 10% level). A number of contributing factors of these findings are the recent growth in the foreign direct investment from multinationals, national wage bargaining agreements, dramatic improvements in human capital (through education), and a shift away from capital taxation

[19] A formal test for equality of the correlation coefficients across the subperiods is provided by Kendall and Stuart (1967, p. 984). Denoting two subperiods by subscripts 1 and 2, under the null hypothesis H_0: $\rho_1 = \rho_2$, the test statistic is

$$\frac{0.5\{\ln[(1+r_1)/(1-r_1)] + \ln[(1-r_2)/(1+r_2)]\}}{[1/(T_1-3)] + [1/(T_2-3)]}$$

and is distributed approximately standard normal. The sample correlation coefficient is given by r and the population by ρ and T_1 and T_2 are the number of observations in each subperiod.

Table 8. *Elongation ratios*

	Output response to a supply shock	Price response to a demand shock	Price response to a supply shock
Ireland:			
Pre-ERM	0.92	0.53	0.53
ERM	1.17	0.49	0.53
UK:			
Pre-ERM	0.97	0.42	0.46
ERM	0.96	0.72	0.77
Germany:			
Pre-ERM	0.34	0.58	0.60
ERM	0.86	0.81	0.77

Figures are the ratio of the impulse response after eight quarters to the long-run impulse response. The sample period is 1960:1–1978:4 for the pre-ERM period and 1979:3–1996:4 for the ERM period.

(Baker *et al.*, 1996, address a number of these issues).[20, 21] Ireland appears to be independent of Germany and the UK. Moreover, the reason for this independence provides the key to assessing the effects of asymmetric shocks that Ireland will face in the EMU.

The correlations of the price response functions to shocks between the three countries are very high with little change between the two periods, with the exception of a significant fall in the correlations of the price response to a supply shock between Ireland and the other two countries. However, all price correlations exceed 0.89. These results suggest that Ireland's monetary position is closely tied to the UK and, since becoming a member of the ERM, has also become more closely tied to Germany.[22] Thus providing evidence of policy co-ordination by Irish authorities.

Comparing the short and long-run response of a macroeconomic shock on output and prices reveals some persistence -- output and prices are slow to adjust to macroeconomic shocks. Table 8 reports the ratio of the impulse response after eight quarters to the long-run impulse response.[23] Comparing the ratios for the pre-ERM and ERM periods, there is weak evidence that for the ERM period output and price responses have become less elongated. For Ireland the output response to aggregate supply shocks has become less elongated and no substantial change in price response to either demand or supply shocks. The UK has not experienced a change in the persistence of output responses to supply shocks but price responses have become less elongated. The speed of price and output responses to aggregate demand and supply shocks in Germany was slow in the pre-ERM period and have become less elongated in the ERM period. These results are not inconsistent with the hypothesis and evidence that ERM membership has elongated the responses to macroeconomic shocks (see Artis and Taylor, 1989; de Grauwe, 1990; Bayoumi, 1992; Bayoumi and Taylor, 1995).[24]

Overall the results do not support the hypothesis that the ERM has resulted in symmetric shocks between Ireland and Germany. Further fixing of exchange rates implied by EMU, with the loss of domestic monetary policy and constrained fiscal policy, is likely to result in substantial adjustment costs for Ireland The correlations of the demand and supply shocks between Ireland and the UK in the pre-ERM period (fixed exchange rate with the UK) was significantly higher than the corresponding correlations between Ireland and Germany in the ERM period. However, while there is no evidence of a significant positive correlation of supply shocks between Ireland and Germany, there is weak evidence of reduced asymmetric demand shocks in the ERM period.

V. CONCLUSION

This paper has investigated the degree of independence of Irish macroeconomic shocks in relation to Germany and the UK using the correlation of aggregate demand and supply shocks across the three countries. The Blanchard and Quah (1989) VAR decomposition procedure is employed to distinguish the shocks. For each country, we decomposed output and prices due to demand and supply shocks for the period preceding the ERM, and for the ERM period itself. The sample periods capture the change in Ireland's exchange rate policy.

[20] The growth in Irish output in the last decade significantly exceeds Germany and the UK (see Fig. 1 and Table 1) and with the movement in Irish output primarily explained by aggregate supply shocks (Table 4), it is the output response to a supply shock that is likely to be least correlated with either Germany of the UK.

[21] Unlike for other ERM members, it is not clear that Ireland pursued a less flexible exchange rate policy in the ERM period as compared to the pre-ERM period – a period when the Irish pound was linked one-for-one without margin with sterling.

[22] The results also indicate that over time the response of the UK and Germany to macroeconomic shocks have become more similar – possible evidence of increased economic integration and globalization of markets.

[23] The elongation ratio for the output response to an aggregate demand shock cannot be calculated because the long-run response of output to a demand shock is zero.

[24] A slower adjustment to macroeconomic shocks (given by a lower elongation ratio) is consistent with (quasi) fixed exchange rates (Artis and Taylor, 1989). For the pre-ERM period, Ireland's exchange rate was fixed with the UK and thus Ireland always pursued a (quasi) fixed exchange rate regime. The period also includes the Bretton Woods system of the 1960s. For the ERM period, the DM was the anchor currency in the ERM and not prone to the large swings in competitiveness as evident in the other ERM members.

The results indicate that while the change in exchange rate policy had an effect on the nature of demand and supply shocks, shocks were not found to be highly correlated between the three countries. Similar to previous studies, a consistent feature of the ERM is that supply shocks explained a higher proportion of the movement in output than in the pre-ERM period. However, the effect of the ERM on macroeconomic shocks is less pronounced for Ireland than for Germany.

The link between Ireland and the UK is evident from the results of the correlation of shocks in the pre-ERM period. Irish demand and supply shocks were significantly positively correlated with the UK, but not with Germany. However, after the break in the sterling link, correlation coefficients between Ireland and the UK are insignificant. The reduced interdependence between Ireland and the UK is marked with increased interdependencies with Germany in the form of significant positive correlation of demand shocks between Ireland and Germany. However, more importantly, the ERM did not have the effect of increasing the correlation of supply shocks with Germany – in fact the supply correlation became negative. Evidence of substantial asymmetric shocks with Germany exist.

Further evidence of the independence of Ireland to macroeconomic shocks is provided by the negative (marginally significant at the 10% level) correlation coefficients of the output impulse response functions to a demand shock between Ireland and either Germany or the UK. Similarly, the ERM appears to have had the effect of decreasing the correlation of price movements to demand and supply shocks.

These results indicate that Ireland is presently not in an optimum currency area with either Germany or the UK. Moreover, because of inflexible relative wages in Ireland due to national wage agreements and barriers to labour mobility, Ireland as a member of the EMU faces increased cost of adjustment to macroeconomic shocks. These findings provide the starting point for future research to examine the nature and effects of asymmetric macroeconomic shocks for Ireland in a fixed exchange rate system of the EMU.

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