Temporary Cycles or Volatile Trends? Economic Fluctuations in 21 OECD Economies

by

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Abstract

Structural vector autoregressions (VARs) are used to distinguish between transitory (aggregate demand) disturbances to output and permanent (aggregate supply) disturbances. The results indicate that the two disturbances are of roughly equal importance in explaining fluctuations in growth and inflation across a wide range of OECD countries. This implies that economic fluctuations cannot be characterised as cyclical fluctuations around a fixed trend (the Keynesian synthesis view) or as continual movements in underlying supply potential (a view of real business cycle theorists), but as an amalgam of both effects. A method of distinguishing the effects of each type of disturbance on output and prices is then outlined. This makes it possible to measure 'supply potential' for each economy; we find evidence of a steady decline in the rate of increase of supply potential over time, a view consistent with the 'catch up' theory of post-war economic growth.

1 Introduction

How persistent are shocks to the economy? If the latest data on (say) real GDP show an unexpected rise, then how much of this rise reflects a rise in the long-run level of output and how much simply reflects a temporary improvement in real growth. The answer to this question is of considerable interest, both to economic forecasters trying to peer into the future and to the wider arena of macroeconomics. Clearly, an economy which is dominated by long-run "supply side" disturbances has very different implications from one which is constantly buffeted by short-term "aggregate demand" shifts. In the first economy the government can do little to iron out short-term fluctuations, and should instead concentrate on improving the level of potential output, whereas in the other economy the government may be able to play a useful role in minimising the short-term fluctuations.

Opinions on this issue have varied over the entire history of economics. The classical economists tended to view the economy as being dominated by supply disturbances, exemplified by "Sayes Law", that supply creates its own demand. This view was questioned by Keynes (1936), who argued that most fluctuations reflected underlying shifts in demand, and with the intellectual dominance of the "Keynesian synthesis" in the post-war period the pendulum swung almost completely, with fluctuations being seen as largely reflecting the interaction of temporary shocks with a sticky aggregate price level. More recently, there has been a revival of interest in the role of supply, exemplified by the burgeoning literature on real business cycles, in which prices are (generally) assumed to be fully flexible and economic fluctuations largely reflect fundamental changes in behaviour.

This paper uses structural vector autoregression (VAR) techniques to estimate the traditional aggregate demand - aggregate supply model. The estimation distinguishes two types of shocks, namely aggregate demand shocks, which have a temporary effect on the level of output, and aggregate supply shocks which have a permanent effect.(1) The analysis looks at the relative importance of these different shocks for both the short and long-run behaviour of output and inflation using annual data across 21 industrialised countries. By using such a large number of countries it is hoped to be able to make general conclusions about the relative importance of the two types of shocks for industrial countries. The aggregate demand and supply shocks are identified using a VAR decomposition proposed by Blanchard and Quah (1989) as extended by Bayoumi (1992). Since the results correspond to the familiar aggregate demand and aggregate supply framework, it is relatively simple to see how far the empirical results correspond to the underlying model. In addition, since the analysis requires a limited amount of data, we are able to report results for virtually all the members of the OECD on a consistent basis.

Our results have several applications. Real business cycle theory has caused renewed interest into the question of whether output fluctuations are best characterised by cycles around a deterministic trend or by volatility in the trend itself.(2) Our approach allows these views to be directly tested, and by making

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(1) There have been many earlier attempts to identify the level of persistence of shocks to output empirically. In addition to the VAR approach used here and in Blanchard and Quah (1989), other approaches include studying the time series properties of the data (for example the trends and cycles decomposition of Clarke (1987) or the non-parametric decomposition of Cochrane (1988) and using the simulation results from large models (either from "Keynesian" macroeconomic models with a supply side such as Wren-Lewis (1988) or simulations of a real business cycle model to see how far it can reproduce the stylised facts of the business cycle, as in the path-breaking paper of Kyland and Prescott (1982)).

(2) As shown by the literature on whether GNP in the US is a random walk, Christiano and Eichenbaum (1990) contains an overview of this literature.

a distinction between output growth attributable to aggregate supply and aggregate demand shocks we are able to estimate the level of supply potential. For each country we can thus determine how measured supply potential has grown over time, in absolute terms and relative to output; we can then examine whether each economy's supply potential is stable, or fluctuates along with output growth. The plausibility of the results may also be verified by examining how the model explains important global economic developments over the past three decades, such as the oil price shocks and subsequent recessions. Finally the model can be used as a forecasting tool: it is capable of predicting whether current levels of output and prices imply that the economy is undergoing a demand or supply shock and thus what the most likely future course of output and prices will be.

The plan of the rest of the paper is as follows. The next section discusses alternative theories of economic fluctuations. Section 3 discusses the underlying theoretical framework and how the underlying shocks are identified. Section 4 to 6 discuss the data, estimation techniques, and report the results from using this approach using data for 21 OECD countries. Section 7 outlines how the approach can be used to decompose current events into aggregate demand and aggregate supply shocks and provides model forecasts of output growth. Section 8 contains conclusions.

2 Alternative Theories of Economic Fluctuations

The post-war synthesis held the view that potential output grew steadily over time, reflecting steady movements of capital accumulation and productivity growth. GDP was therefore 'trend stationary'. Deviations from this trend represent the cyclical component and the variability of output around this trend gives a measure of the importance of the business cycle. This view of

fluctuations in output is true of Keynesian models, where multiplier and accelerator effects and capacity constraints explain the variability of output around supply potential.(3) Thus it is demand shocks which explain variation in output. The theory implies a path for output which can be summarised as follows, where y_t is output, y^*_t is potential output and c_t is the cyclical component:

$$y_t = y^*_t + c_t \qquad \textbf{(1.1)}$$

Supply potential y^*_t grows steadily over time, hence:

$$y^*_t = \alpha + \beta t \qquad \textbf{(1.2)}$$

The cyclical component c_t is some distributed lag of demand shocks

$$c_t = \psi(L)\, u_t \qquad \textbf{(1.3)}$$

So combining (1) to (3) $y_t = \alpha + \beta t + \psi(L)\, u_t$

This is shown in Figure 1 below:(4)

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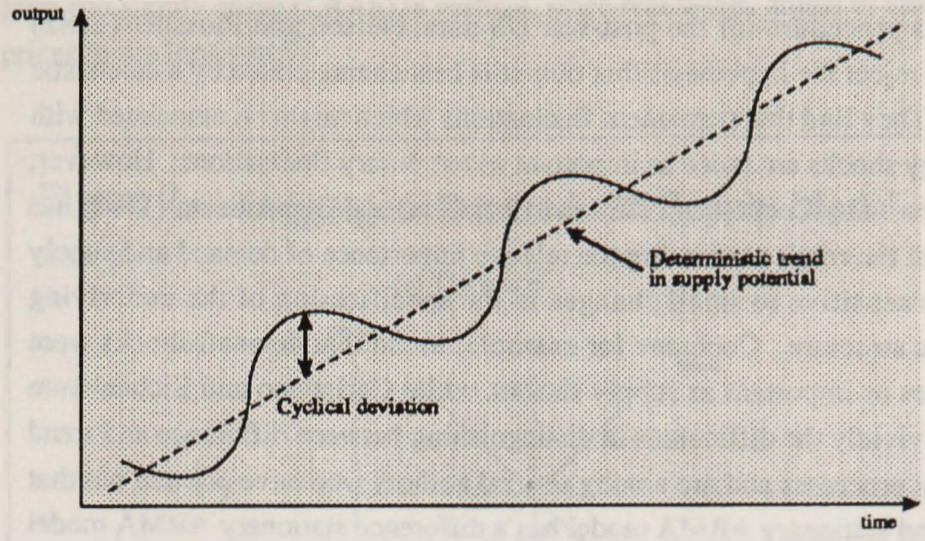
(3) It is also true of early neo-classical models such as Lucas (1977), where the assumptions of market clearing and rational expectations are augmented by the auxiliary assumption of imperfect information, so that the response to monetary shocks is sluggish.

(4) Taken from the inside cover of Dornbusch and Fisher (1987).

Keynesian synthesis view of fluctuations in output



Neo-classical theory has led to a radically different view of economic fluctuations. Real business cycle theories generally assume full information and market clearing. As a result there are no nominal rigidities in the economy. Instead, fluctuations in output are attributed to factors such as serially correlated 'technology shocks' which effect the supply potential of the economy. A positive technology shock raises the productivity of capital and labour, leading to higher investment and consumption. This means that output is characterised by a stochastic process that does not revert to a deterministic path. It is 'difference stationary' so that a shock to output in any period should affect forecasts of output in the infinite future. The stochastic trend formulation for the natural rate is:

$$y^*_t = y^*_{t-1} + \beta + u_t \qquad \textbf{(1.4)}$$

Testing the two alternative views of the formulation of GDP has been done by running regressions of the form:

$$y_t = \gamma_0 + \gamma_1 y_{t-1} + \gamma_2 t + \lambda(L)(y_{t-1} + y_{t-2})$$

and testing $H_0: \gamma_1 = 1$ **(1.5)**

Using this procedure for the post-war US data, Nelson and Plossner (1982) could not reject the hypothesis that output is best characterised by a stochastic process. They find that permanent fluctuations which might be associated with technology shocks are twice as important as temporary fluctuations. However, other research by Cochrane (1988) and Christiano and Eichenbaum (1990) has shown that the result concerning the relative importance of demand and supply shocks is sensitive to small changes in the specification of the underlying stochastic structure. Cochrane for example, found that demand shocks were three times as important as supply shocks, while Christiano and Eichenbaum illustrate vividly the difficulties in distinguishing between difference and trend stationary processes and are among several authors who have pointed out that every trend stationary ARMA model has a difference stationary ARMA model local to it and vice versa.

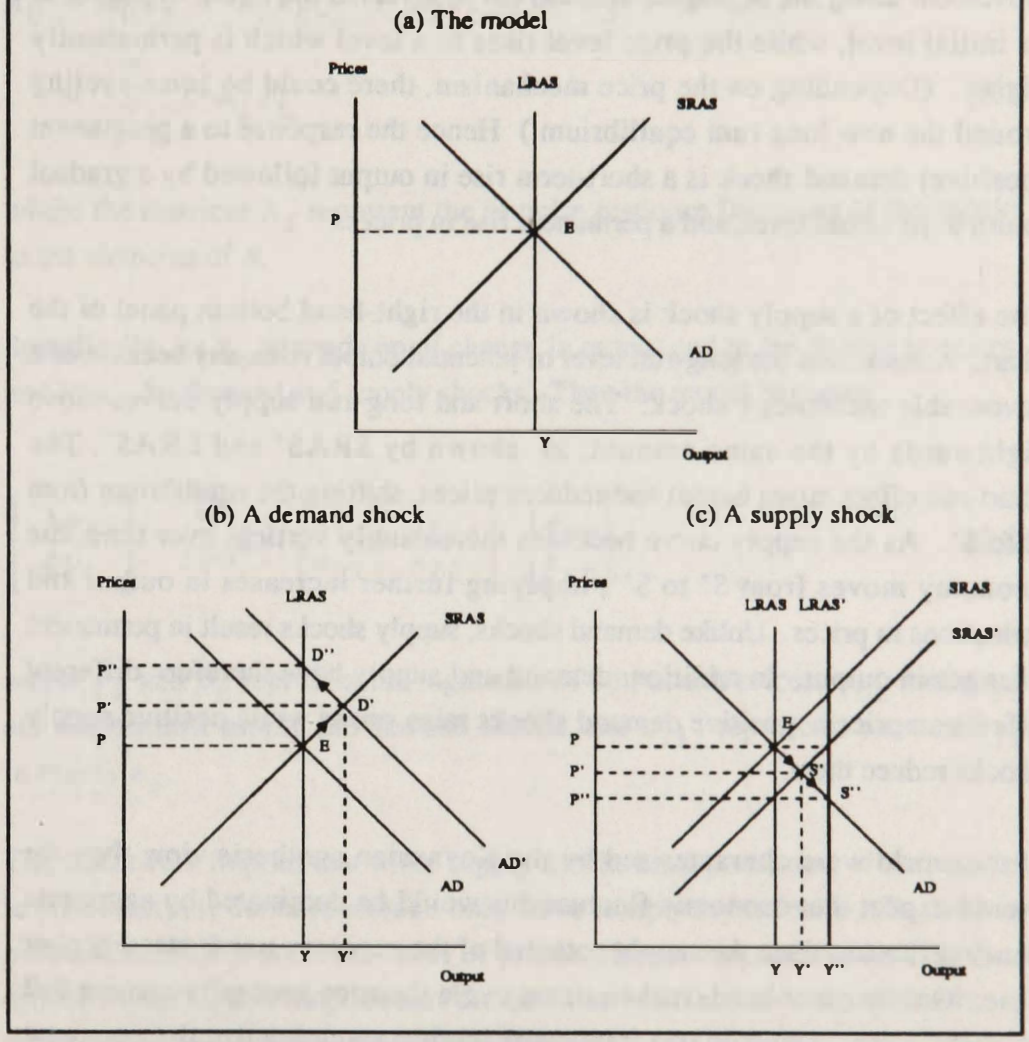
The question as to whether GNP has a unit root therefore looks unlikely to be answered conclusively, at least in the case of post-war US data on which the bulk of research has focused. However, the complementary question of whether permanent or transitory shocks dominate output growth is arguably more important in so far as it is highly influential in conditioning economic agents behaviour in reaction to changes in macro variables and also in governments policy objectives. It is arguable that answering this question in single variable models used in unit root tests omits valuable information conveyed in the development of prices, which may unlock the answer as to whether shocks are permanent or temporary. The next section suggests such a framework for distinguishing demand shocks, which have transitory affects on output, and supply shocks, whose effects on output are permanent.

3 Methodology

Our point of departure is the familiar aggregate demand and aggregate supply diagram, reproduced as the top panel in Chart 1. The aggregate demand curve (labelled AD) is downward sloping in the price output plane, reflecting the fact that lower prices, by raising money balances, boost demand. The short-run aggregate supply curve (SRAS) is upward sloping, reflecting the assumption

that wages are sticky and hence that higher prices imply lower real wages. The long-run supply curve (LRAS) is vertical, since real wages adjust to changes in prices in the long run.(5)

Figure 2 Aggregate Demand and Supply Model



(5) Although this is usually thought of as a closed economy model, it can be extended to include trade and the exchange rate. Textbook descriptions of the model include Dornbusch and Fischer (1986) Chapter 11, and Hall and Taylor (1988) Chapter 4-5.

The effect of a shock to aggregate demand is shown in the left half of the lower panel. The aggregate demand curve shifts from AD to AD', resulting in a move in the equilibrium from initial point E to the new intersection with the short run curves, D'. This raises both output and prices. As the aggregate supply curve becomes more vertical over time, the economy moves gradually from the short-run equilibrium D' to its new long-run equilibrium, D''. This movement along the aggregate demand curve involves the return of output to its initial level, while the price level rises to a level which is permanently higher. (Depending on the price mechanism, there could be some cycling around the new long rum equilibrium.) Hence the response to a permanent (positive) demand shock is a short-term rise in output followed by a gradual return to its initial level, and a permanent rise in prices.

The effect of a supply shock is shown in the right-hand bottom panel of the chart. Assume that the long-run level of potential output rises, say because of a favourable technology shock. The short and long-run supply curves move rightwards by the same amount, as shown by SRAS' and LRAS'. The short-run effect raises output and reduces prices, shifting the equilibrium from E to S'. As the supply curve becomes increasingly vertical over time, the economy moves from S' to S'', implying further increases in output and reductions in prices. Unlike demand shocks, supply shocks result in permanent changes in output. In addition, demand and supply have therefore different effects on prices; positive demand shocks raise prices while positive supply shocks reduce them.

If the world were characterised by the Keynesian synthesis view then we would expect that economic fluctuations would be dominated by aggregate demand shocks, since the supply potential of the economy trends steadily over time. On the other hand, real business cycle theories generally assume full market clearing, which in this framework implies assuming that the aggregate supply curve should be vertical, and hence aggregate demand shocks should have no effect on output.

The aggregate-demand - aggregate supply framework is estimated using a procedure proposed by Blanchard and Quah (1989), for decomposing

permanent and temporary shocks to a variable using a VAR, as extended by Bayoumi (1992).[6] Consider a system where the true model can be represented by an infinite moving average representation of a (vector) of variables, X_t, and an equal number of shocks, e_t. Formally, using the lag operator L, this can be written as:

$$X_t = A_0 e_t + A_1 e_{t-1} + A_2 e_{t-2} + A_3 e_{t-3} + \ldots\ldots$$

$$= \sum_{i=0}^{\infty} L^i A_i e_t \qquad (2.1)$$

where the matrices A_i represent the impulse response functions of the shocks to the elements of X.

Specifically, let X_t be made up of change in output and to the change in prices, and let e_t be demand and supply shocks. Then the model becomes

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L_i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} e_{dt} \\ e_{st} \end{bmatrix} \qquad (2.2)$$

where y_t and p_t represent the logarithm of output and prices, e_{dt} and e_{st} are independent supply and demand shocks, and a_{11i} represents element a_{11} in matrix A_i.

The framework implies that while supply shocks have permanent effects on the level of output, demand shocks only have temporary effects. (Both have permanent effects upon the level of prices.) Since output is written in first difference form, this implies that the cumulative effect of demand shocks on the change in output (Δy_t) must be zero. The model implies the restriction,

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(6) Quah (1991) discusses the issue of identifying restrictions for VARs. An important assumption which is required to ensure uniqueness of the decomposition is that the underlying series (growth and inflation in this case) are fundamental in a Wold sense, as pointed out by Lippi and Reichlin (1990).

$$\sum_{i=0}^{\infty} a_{11i} = 0. \qquad (2.3)$$

The model defined by equations (2.2) and (2.3) can be estimated using a vector autoregression. Each element of X_t can be regressed on lagged values of all the elements of X. Using B to represent these estimated coefficients, the estimating equation

$$\begin{aligned} X_t &= B_1 X_{t-1} + B_2 X_{t-2} + \ldots + B_n X_{t-n} + e_t \\ &= (I - B(L))^{-1} e_t \\ &= (I + B(L) + B(L)^2 + \ldots) e_t \\ &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \ldots \end{aligned} \qquad (2.4)$$

where e_t represents the residuals from the equations in the vector autoregression. In the case being considered, e_t is comprised of the residuals of a regression of current values of Δy_t and Δp_t on lagged values of each in turn; these residuals are labelled e_{yt} and e_{pt}, respectively.

To convert equation (2.4) into the model defined by equations (2.2) and (2.3), the residuals from the VAR, e_t, must be transformed into demand and supply shocks, ϵ_t. We assume that the underlying demand and supply shocks are linear combinations of the residuals from each of the two equations in the VAR. Thus

$$e_t = C\epsilon_t \qquad (2.5)$$

It is clear that, in the two-by-two case considered, four restrictions are required to define the four elements of the matrix C. The first two restrictions are normalisations which define the variances of the two underlying shocks ϵ_{dt} and ϵ_{st} to be unity. The third is that demand and supply shocks are orthogonal. This implies that the variance co-variance matrix of the demand and supply shocks is the identity. It should be noted that this restriction of

orthogonality does not imply that demand shocks cannot have a direct effect on aggregate supply and vice versa.

The final restriction, which allows the matrix C to be uniquely defined, is that demand shocks have only temporary effects on output.(7) As noted above, this implies equation (2.3). In terms of the VAR it implies,

$$\sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} 0 & . \\ . & . \end{bmatrix} \qquad (2.6)$$

This restriction allows the matrix C to be uniquely defined and the demand and supply shocks to identified.(8) The final restriction may be considered controversial as it is possible to think of channels through which demand shocks may have long lasting, if not permanent output effects, such as increasing returns to scale, hysteresis in the labour market and the effects of capital accumulation. We acknowledge these possibilities, but would argue that the effects are small relative to the standard responses of output and prices to demand and supply shocks in the aggregate demand - aggregate supply framework. In this case, the correct identification approaches the one used above, as proved in Blanchard and Quah (1989).

Note that this restriction affects the response of output to the two shocks, but says nothing about their impact on prices. The aggregate-demand-aggregate-supply model implies that positive demand shocks should raise prices in both the short and long run, while positive supply shocks should lower prices. Since these responses are not imposed, they can

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(7) This is where our analysis, based on the work of Blanchard and Quah (1989), differs from other VAR models. The usual decomposition assumes that the variables in the VAR can be ordered such that all the effects which could be attributed to (say) either a_t or b_t are attributed to whichever comes first in the ordering. This is achieved by a Choleski decomposition (Sims, 1980).

(8) Note from equation (2.4) that the long run impact of the shocks on output and prices is equal to $(I\text{-}B(1))^{-1}$. The restriction that the long-run effect of demand shocks on output is zero implies a simple linear restriction on the coefficients of this matrix.

be thought of as over-identifying restrictions useful for testing our interpretation of the results. These over-identifying restrictions, together with the intuitive nature of the underlying disturbances and of the relative importance of each shock across countries, make us relatively happy that we have indeed identified a useful dichotomy in the economy.

4 Data and Estimation

Annual data on real and nominal GDP spanning the period 1960-88 were collected from the OECD Annual National Accounts for 21 OECD member countries. For each country, growth and inflation were calculated as the first difference of the logarithm of real GDP and of the implicit GDP deflator. The GDP deflator was used to measure prices since it reflects the price of output rather than the price of consumption and is therefore the relevant variable for the aggregate supply curve.

The standard deviations of the raw data, growth and inflation are shown in Table 1. In presentation we have divided the countries into four separate groups so that divergent behaviour in and between geographical and political groups may be identified. The groups are the 'EC core', which consists of the original members of the narrow band of the ERM, the 'other EC', 'EFTA' and 'non-Europe' OECD. It is perhaps not surprising that for most countries output growth is less variable than inflation with Germany being the clearest exception to this result. It is striking that whereas countries have had fairly similar variability in output growth, variability in inflation is far more diverse. In particular variability in inflation in the EC core is less that half that in the 'other EC' and the same eight countries are those with the highest average rates of inflation. Further, Table 1 also shows the expected result holds true that those countries who have experienced the highest inflation rates on average, also appear to have suffered the most variable inflation: seven out of the eight countries which have experienced the most variable inflation are in the 'other EC' and the same eight countries are those with the highest average rates of inflation. The *a priori* expectation might be that this is indicative of larger demand shocks, and this is tested in Section 5.

Table 1

Standard Deviations and Means of Output Growth and Inflation

	STANDARD DEVIATION			MEAN		
	Output growth	Inflation	Ratio of standard deviations	Output growth	Inflation	Ratio of means
EC core						
Germany	0.022	0.017	1.28	0.029	0.039	0.74
France	0.018	0.030	0.58	0.035	0.071	0.49
Netherlands	0.022	0.028	0.79	0.032	0.053	0.60
Denmark	0.024	0.022	1.10	0.027	0.075	0.36
Belgium	0.022	0.024	0.90	0.032	0.052	0.61
mean	0.022	0.022	1.00	0.031	0.058	0.53
Other EC						
UK	0.020	0.051	0.40	0.025	0.082	0.20
Italy	0.023	0.053	0.42	0.037	0.100	0.37
Spain	0.026	0.043	0.61	0.040	0.104	0.39
Greece	0.034	0.066	0.52	0.046	0.111	0.41
Portugal	0.034	0.073	0.46	0.044	0.121	0.36
Ireland	0.022	0.049	0.44	0.038	0.091	0.42
mean	0.027	0.048	0.56	0.038	0.102	0.37
Non-EC Europe						
Switzerland	0.027	0.022	1.19	0.023	0.044	0.52
Austria	0.020	0.018	1.15	0.034	0.047	0.72
Sweden	0.018	0.027	0.67	0.028	0.071	0.39
Norway	0.016	0.033	0.49	0.039	0.065	0.60
Finland	0.023	0.036	0.64	0.037	0.082	0.45
mean	0.021	0.027	0.78	0.032	0.062	0.52
Non-Europe OECD						
US	0.023	0.024	0.94	0.032	0.050	0.62
Japan	0.033	0.038	0.86	0.060	0.048	1.25
Canada	0.021	0.030	0.70	0.043	0.057	0.75
Australia	0.020	0.040	0.50	0.040	0.076	0.52
New Zealand	0.036	0.053	0.67	0.023	0.093	0.25
mean	0.027	0.024	1.13	0.039	0.065	0.60
OECD unweighted mean	0.024	0.031	0.77	0.035	0.073	0.48
G7 weighted mean	0.024	0.031	0.78	0.037	0.057	0.65

[1] G7 weighted mean based on 1987 GDP weights in all tables.

To identify supply and demand disturbances, we estimated bi-variate VARs for each country in the sample. In all cases, the number of lags was set to two, since the Schwartz Bayesian information criterion indicated that all of the models had an optimal lag length of either one or two. A uniform lag of two was chosen in order to preserve the symmetry of the specification across countries. The estimation period was 1963-88.

Since the subsequent results are based on this decomposition, we will discuss the results from estimation in some detail. In the great majority of cases, the simulation results accord with the aggregate demand - aggregate supply framework. Figure 3 displays the output and price cumulative impulse response functions to each of demand and supply shocks for the countries in the EC core, other EC, EFTA, and non-European OECD nations. Figures 3a to 3h show the effect of demand and supply shocks on output. They illustrate the identifying restriction imposed that demand shocks have only temporary effects on output while supply shocks have permanent output effects. Figures 3a to 3d demonstrate that a positive demand shock raises output initially before the effect erodes over time as the restriction bites. Figures 3e to 3h show that supply shocks have a positive effect on output initially, which is reinforced over the longer run. Figures 3i to 3p shows the cumulative impulse response functions for prices; these confirm that the over-identifying restrictions are almost always satisfied in the short run, with aggregate demand shocks leading to a rise in prices and aggregate supply shocks a fall in prices. In only two cases, Ireland and Norway, do the results not appear to be interpretable in this framework. The long-run effect of aggregate demand disturbances also closely conform to the predictions of the model. In the case of aggregate supply disturbances, the prediction that prices continue to fall after their initial reduction is generally, but by no means universally found. In addition to Norway and Ireland, six other countries have perverse long-run responses of prices to supply shocks (though they have appropriate responses to demand shocks.) Five of these six are made up of Germany and its immediate neighbours (Netherlands, Denmark, Austria and Switzerland.) These perverse long-run responses may well reflect the operation of monetary policy in these economies, since as can be seen from Figure 1, the aggregate supply shock traces out the aggregate demand curve, which will be effected by the monetary authorities reaction function.

Two additional features of the impulse response functions can be seen from Figure 3. The first is that although demand shocks have no long-run effect on output, their contemporaneous effect on output (as measured by the initial

positions on the curves on the vertical axis)[9] is often seen to be greater than that of supply shocks. Thus it does not appear that the impulse response functions correspond to the real business cycle view of fluctuations. This is a feature to which we turn in the next section where we use a more precise measure of analysing the contemporaneous and long-run importance of supply and demand shocks. The second is that although the restrictions imply that demand shocks have no long-run effect, the responses indicate that it can take several years for the effect of such shocks to diminish to zero. Thus it is possible that demand shocks may have an important role in determining the level of output even in the medium term.

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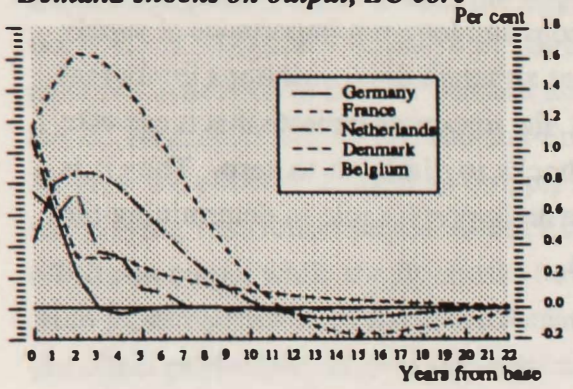
(9) Since the variances of the two shocks are normalised to unity, the size of the impulse response functions is a measure of the importance of a shock to the level of output.

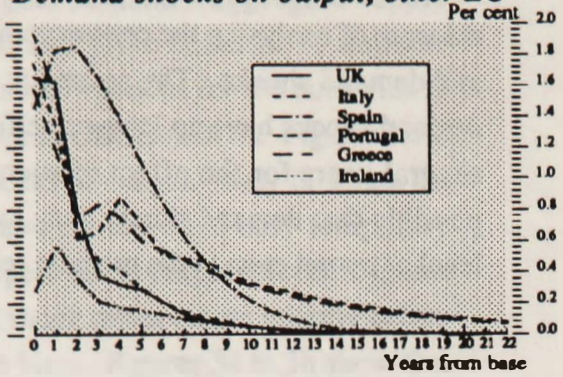
Figure 3: Impulse Response Functions:

a to d: Demand Shocks on Output

a



b



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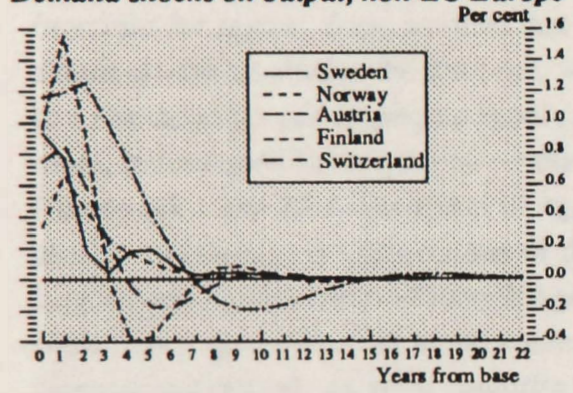
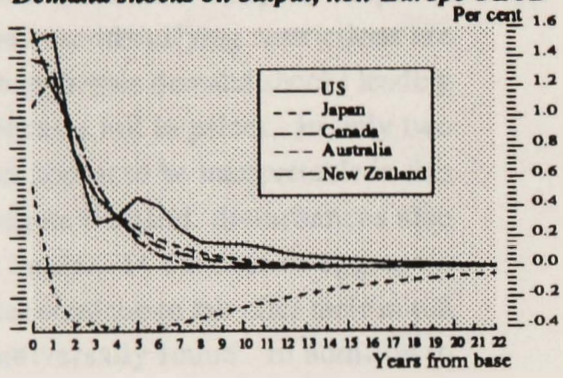
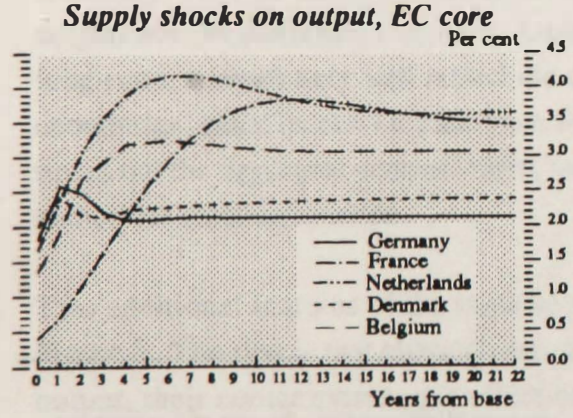


d



e to h: Supply Shocks on output

e



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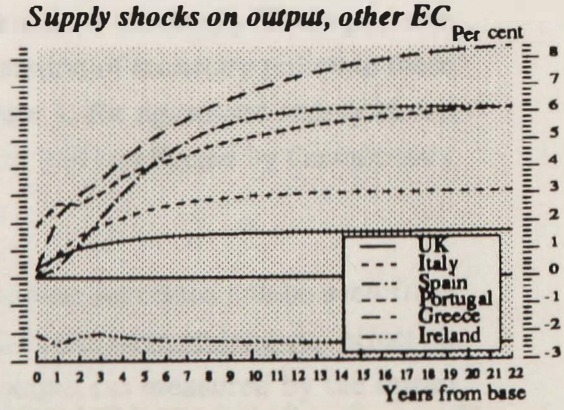
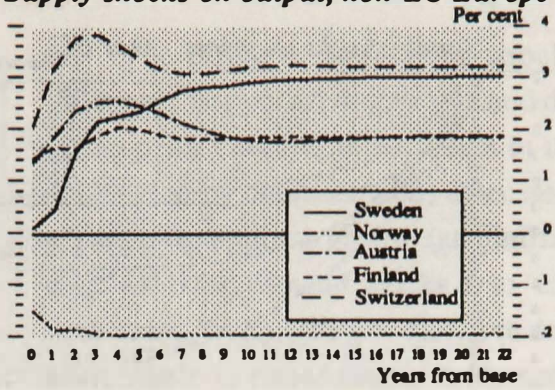


Figure 3 (continued)

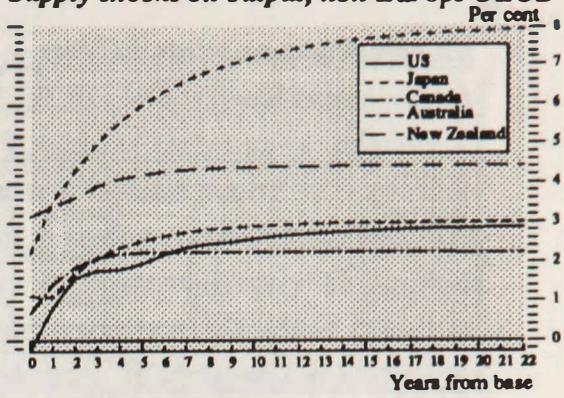
g

Supply shocks on output, non-EC Europe



h

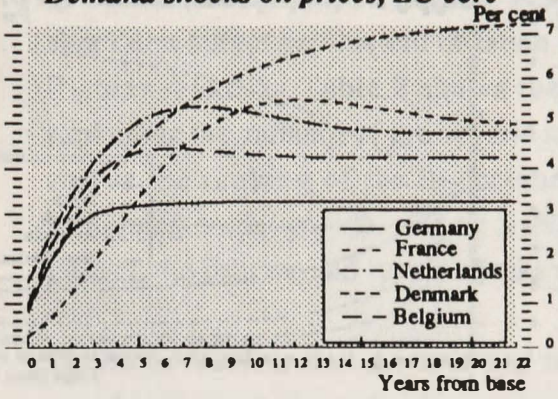
Supply shocks on output, non Europe OECD



i to l: Demand Shocks on Prices

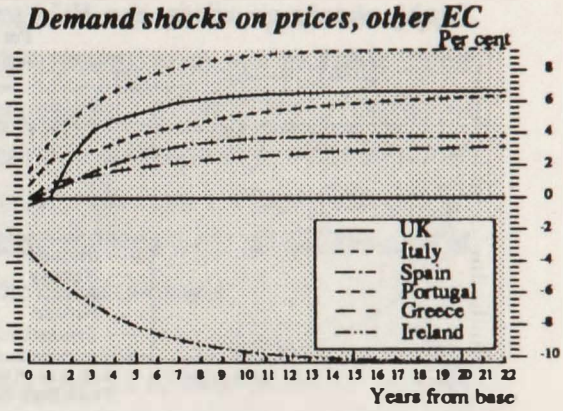
i

Demand shocks on prices, EC core



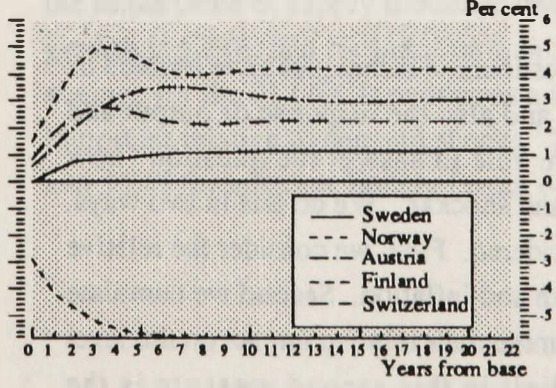
j

Demand shocks on prices, other EC



k

Demand shocks on prices, non-EC Europe



l

Demand shocks on prices, non-Europe OECD

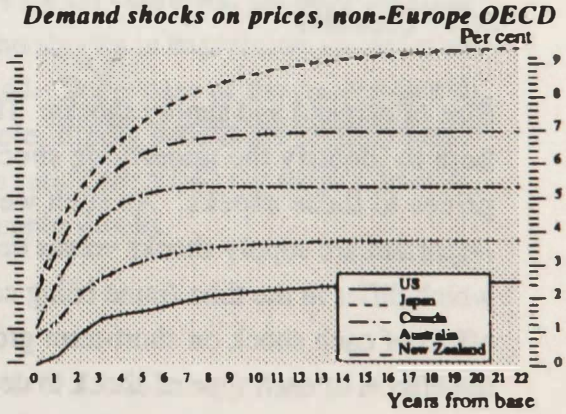
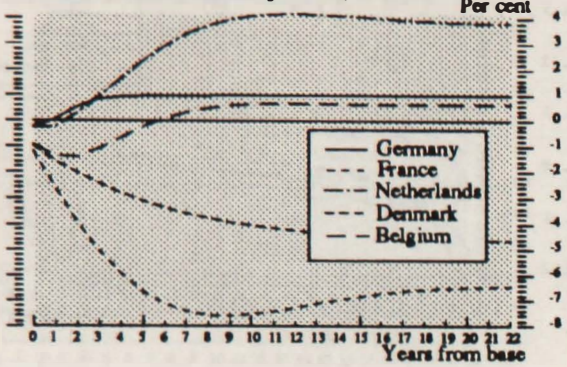


Figure 3 (continued)
m to p: Supply Shocks on Prices

m



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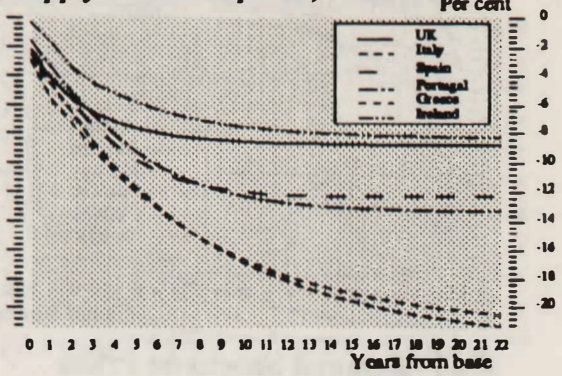
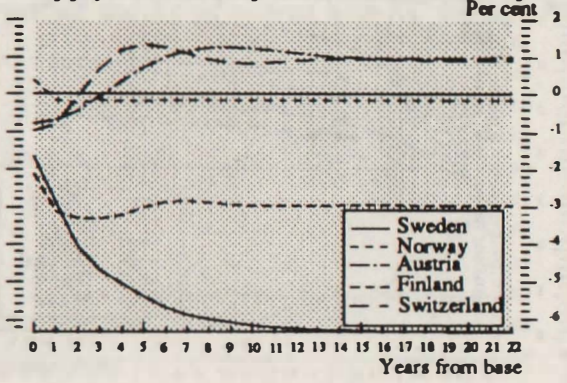
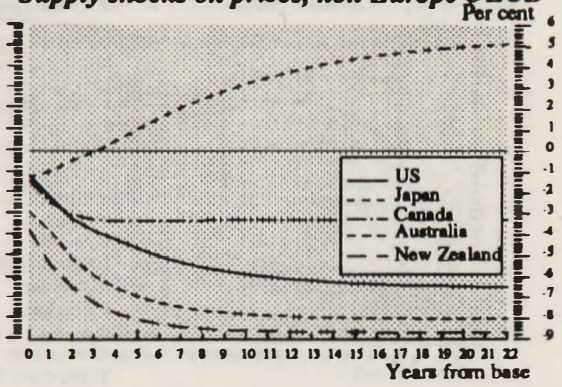


o



p



5 Results

Size of demand and supply shocks: The estimation techniques have enabled us both to identify the underlying shocks and also the response of output and prices to these shocks. As such we are able to answer the question "how important are supply shocks versus demand shocks?" We do this in two ways, which differ in the time frame being considered. First, we consider the relative effect of each shock on short-term growth and inflation. Second we cumulate the effects of each type of shock to determine their relative impact on the level of output in the medium term. Implicit in this second measure is the

identification of a measure of 'supply potential' for each economy; we also assess to what extent supply potential varies over time.

(a) The effect of underlying shocks on contemporaneous growth and inflation: The underlying supply and demand shocks are linear combinations of the price and output residuals in the structural vector autoregressions, determined by the restrictions discussed above. In each period the VAR also allows us to attribute growth (and inflation) to contemporaneous and previous supply shocks, demand shocks or to 'exogenous' factors (largely the constant term in the VAR). We can therefore determine whether volatility in growth is attributable to either supply or demand shocks. In terms of the aggregate demand - aggregate supply framework, having identified the underlying shifts in the demand and supply curves, we now allow for differing price elasticities of demand and supply in order to determine the relative importance of the shocks on output growth and inflation. The results are shown in Table 2 and Figures 4 and 5. Table 2 shows the importance of each disturbance in explaining the variance of growth and inflation in each country, while Figure 4 shows the ranking of the importance of demand and supply shocks in explaining output growth. Figure 5 shows the year-by-year decomposition of growth into demand and supply shocks in the G7 economies.

The main result is that demand and supply shocks appear to be of roughly equal importance in explaining variation in OECD countries' output growth and inflation. Taking the weighted average for G7 countries, the ratio showing the importance of supply shocks to demand shocks in explaining variation in growth is 52:48, and for inflation it is 56:44. In the case of the (unweighted) average for the 21 OECD nations as a whole, supply shocks are slightly more important relative to demand shocks. The ratios are 57:43 for output growth, and 55:45 for inflation, both in favour of supply shocks.

Table 2

Standard Deviation of the Contributions of Aggregate Demand and Supply Shocks to Growth and Inflation

	GROWTH			INFLATION		
	Supply shocks	Demand shocks	Ratio of shocks	Supply shocks	Demand shocks	Ratio of shocks
EC core						
Germany	0.020	0.009	2.30	0.007	0.015	0.47
France	0.010	0.012	0.88	0.026	0.010	2.71
Netherlands	0.019	0.007	2.87	0.014	0.020	0.71
Denmark	0.021	0.013	1.67	0.013	0.022	0.61
Belgium	0.016	0.013	1.13	0.012	0.018	0.68
mean	0.017	0.011	1.59	0.014	0.017	0.82
Other EC						
UK	0.006	0.019	0.29	0.031	0.029	1.09
Italy	0.011	0.019	0.58	0.033	0.032	1.06
Spain	0.018	0.015	1.20	0.040	0.008	4.79
Greece	0.020	0.017	1.23	0.042	0.010	4.38
Portugal	0.019	0.022	0.82	0.039	0.020	1.93
Ireland	0.021	0.005	3.97	0.029	0.032	0.91
mean	0.016	0.016	0.97	0.036	0.022	1.65
Non-EC Europe						
Switzerland	0.022	0.009	2.47	0.014	0.015	0.92
Austria	0.016	0.013	1.21	0.011	0.012	0.92
Sweden	0.013	0.011	1.17	0.023	0.005	4.61
Norway	0.015	0.006	2.56	0.006	0.032	0.20
Finland	0.015	0.016	0.93	0.023	0.028	0.81
mean	0.016	0.011	1.47	0.015	0.018	0.84
Non-Europe OECD						
US	0.013	0.017	0.77	0.020	0.007	2.83
Japan	0.026	0.009	2.82	0.018	0.028	0.62
Canada	0.011	0.017	0.63	0.018	0.022	0.84
Australia	0.012	0.012	1.00	0.030	0.013	2.27
New Zealand	0.031	0.016	1.95	0.041	0.025	1.65
mean	0.019	0.014	1.31	0.025	0.019	1.33
OECD mean	0.017	0.013	1.31	0.023	0.019	1.12
G7 (weighted) mean	0.015	0.014	1.04	0.020	0.016	1.28

In other words, just under half the shocks affecting growth in OECD economies are demand shocks which have had no long-run effect on output, while just under half are supply shocks which do affect supply potential. In

short, the international economy appears to be affected by a roughly even mixture of cyclical movements and changes in the underlying trend in output.

This sheds some light on alternative theories of economic fluctuations, discussed in section 2. If the traditional approach to business cycles were to be true then demand shocks which have only a transitory effect on output should best explain variation in output. If on the other hand the real business cycle more accurately describes actual fluctuations in output then supply shocks should account for most of this variability. The result for OECD economies that the ratio of supply to demand shocks is roughly half-and-half indicates that neither theory appears to dominate. However, the results show a marked divergence in the economies of the G7. This is visible by inspection of Figure 5 which suggests that demand shocks appear to be more important for the majority of the G7 economies, a proposition which is confirmed in Table 2, where it can be seen that for five out of the G7 economies demand shocks better explain fluctuations in output.

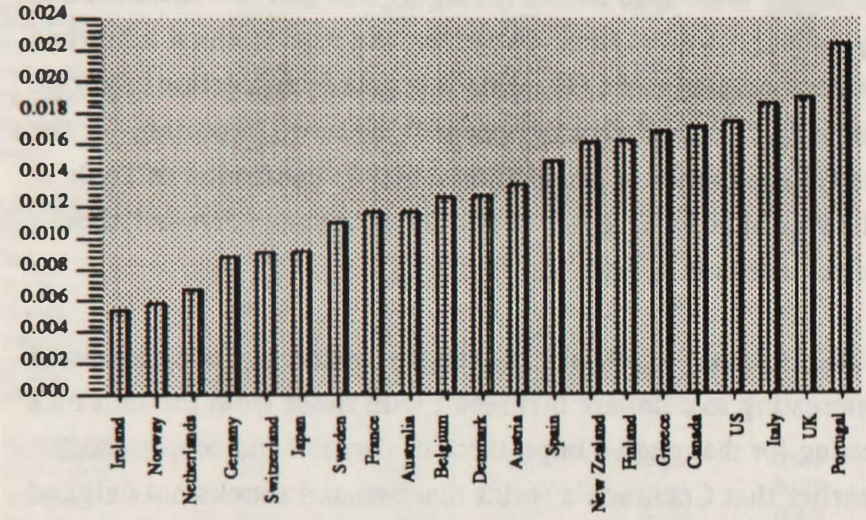
In the case of the US, transitory shocks outweigh permanent ones by a ratio of 57:43. It is interesting to compare this result with those from the unit root approach to testing for the relative importance of demand and supply shocks. It was noted earlier that Cochrane's result that demand shocks outweighed supply shocks by a ratio of 3:1 was roughly opposite to that of Nelson and Plossner, who found that supply shocks were twice as important. Our result, taking the very different approach of using VARs, is roughly in the centre of these two cases. This suggests that in the case of the US there are strong elements of both transitory and permanent shocks hitting output, but the traditional view of output fluctuations fits the data slightly better. Japan and Germany are the two economies in the G7 for whom supply shocks dominate fluctuations in output. In both cases the ratio is over 2:1 in favour of supply shocks. By contrast the smaller G7 countries all show larger demand shocks than supply shocks. This is particularly true of the UK, where demand shocks outweigh supply shocks by a ratio of four to one.

The results, that the US, UK, Italy and France and Canada have been more dominated by temporary fluctuations than Germany and Japan, correspond to

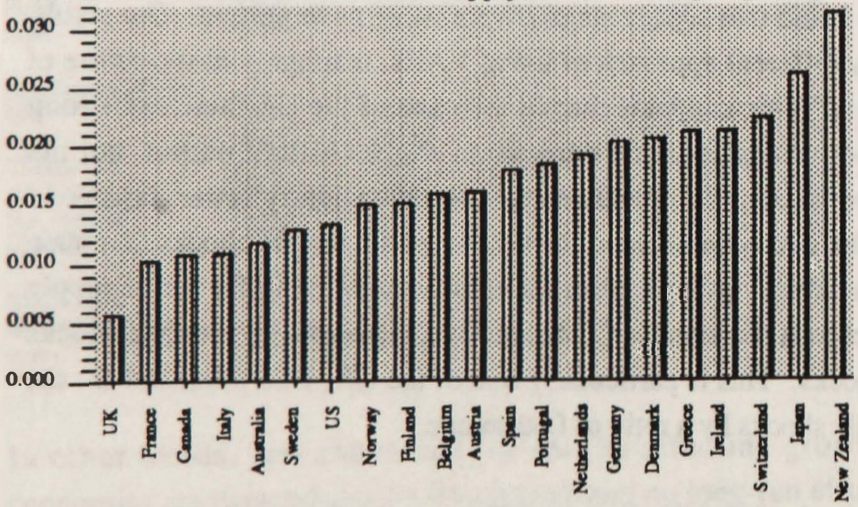
the general view of the activeness of government policy in these countries (a supposition supported by the results for other countries). To the extent these aggregate demand disturbances represent government macroeconomic policy, it appears that the overall effect of such policy may have been to raise the variability of output growth over time. Furthermore, these results appear to carry over to the decomposition using the levels of output, discussed below, which indicates little evidence of successful stabilisation.

Figure 4

Standard deviation of effect of demand shocks on output growth



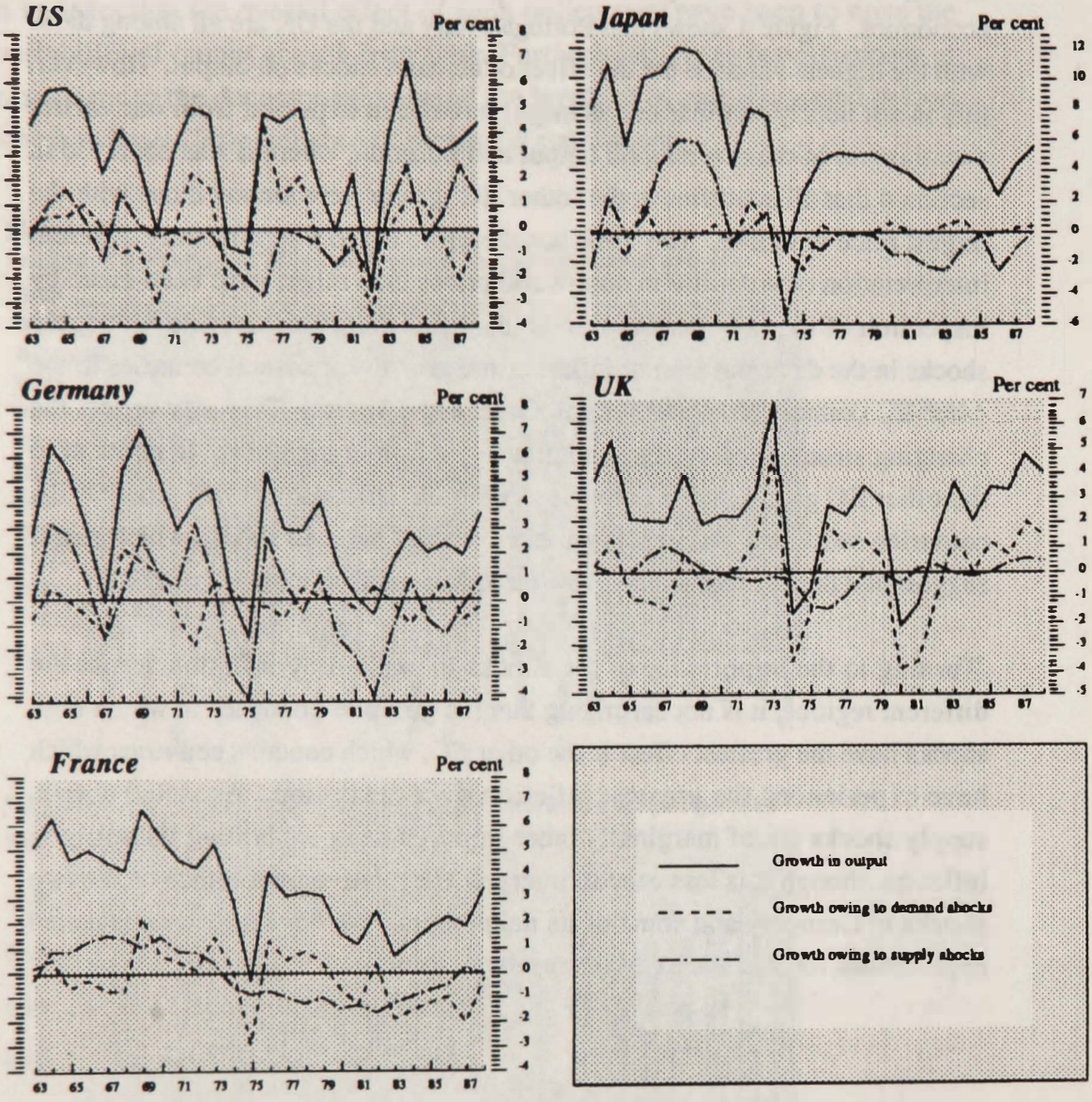
Standard deviations of the effect of supply shocks on output growth

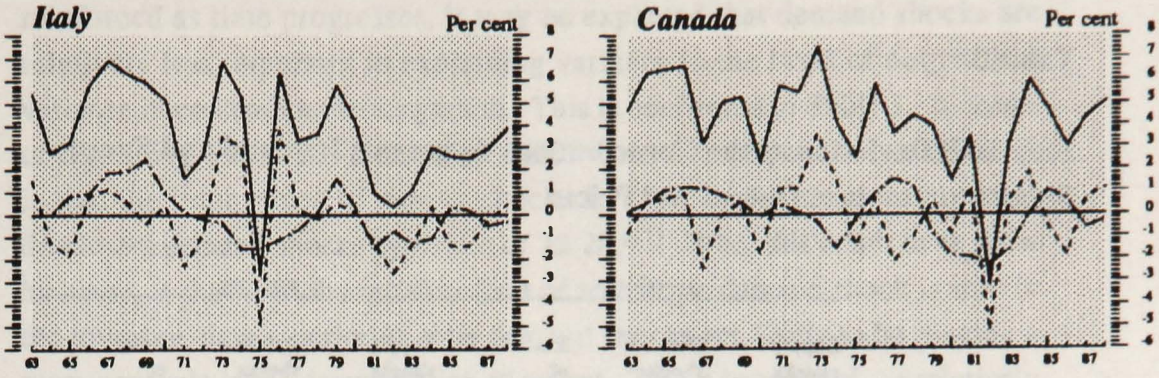


Turning to the relative size of the shocks across the country groupings, the countries forming the EC core undergo shocks to output which are the smallest in magnitude, followed by EFTA, the other EC and finally the non-European economies. Figure 4 shows that Portugal, Italy and the UK are all among those with the highest variance for the effect of demand shocks on output. However, this is not nearly so clear cut as might have been expected from our earlier examination of the raw data on output and inflation, where it was observed in section 4 that all countries in the 'other EC' group were among those with the largest price volatility. The VAR has therefore led to a significantly different interpretation of volatility in output and prices than might have been made by inspection of the raw data because it identifies the important role for supply shocks in the determination of inflation and growth for several countries in the other EC (namely Ireland Portugal, Greece and Spain.) This may reflect the changing structure of these economies away from agriculture. In contrast to the other EC group, those countries in the EC core, along with most EFTA countries and Japan, suffer less variance in their demand shocks which might suggest that their output would grow far less around the long-term trend.

Turning to the importance of the shocks in explaining inflation across the different regions, it is not surprising that the group of countries in which both shocks have the greatest effect is the other EC, which contains countries which have experienced the greatest inflation over the period. As stated above, supply shocks are of marginally more importance in explaining volatility in inflation, though it is less easy to interpret the relative importance of the two shocks in Germany and some of its neighbours. We have already suggested explanations for this feature of the results in section 4.

Figure 5 - Output Growth Attributable to Demand and Supply Shocks in the G7





(b) The effect of shocks on the level of output: Rather than looking at the effects of aggregate demand and aggregate supply disturbances on growth, we can examine the effect of the shocks on the level of output. By calculating the cumulative effect of all present and previous supply and demand shocks on output, we are able to identify how each in turn causes variance in its level over the medium term. This is shown in the Figure 6 for each country, where the level of output is compared to supply potential and the 'exogenous' level. The exogenous part of output is defined as that part which is not explained by contemporaneous or previous demand or supply shocks. It is dominated by the constant term in the VAR and thus grows at an (approximately) constant rate.(10) The cumulative effect of supply shocks over this exogenous level gives a measure of 'supply potential'. The importance of supply shocks in causing variance in the level of output may therefore be gauged by analysing how the difference between the exogenous level and supply potential varies over time. Similarly, the cumulative effect of demand shocks on the level of output is seen on the figure as the difference between output and supply potential, and the importance of demand shocks in determining variance in the level of output is gauged by analysing how this difference varies over time. Thus we are able to look at the effect of the different disturbances on the level of output over the full cycle. Hence we can see the degree to which variation in medium term output tends to reflect the different types of disturbances.

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(10) The rate is not quite constant because there is some initial imprecision because of the absence of previous shocks to which the endogenous variables can react in the early periods.

Table 3

Standard Deviation of the Contributions Aggregate Demand and Supply Shocks to Levels of Output and Prices

	OUTPUT			PRICES		
	Supply shocks	Demand shocks	Ratio of shocks	Supply shocks	Demand shocks	Ratio of shocks
EC core						
Germany	0.043	0.010	4.46	0.018	0.052	0.35
France	0.044	0.025	1.73	0.101	0.064	1.57
Netherlands	0.057	0.013	4.25	0.054	0.044	1.22
Denmark	0.033	0.017	1.97	0.043	0.136	0.31
Belgium	0.050	0.013	3.84	0.032	0.049	0.66
mean	0.045	0.014	3.34	0.049	0.069	0.72
Other EC						
UK	0.020	0.023	0.86	0.104	0.054	1.92
Italy	0.029	0.024	1.20	0.107	0.142	0.75
Spain	0.075	0.026	2.85	0.160	0.032	4.94
Greece	0.055	0.021	2.62	0.123	0.031	4.18
Portugal	0.047	0.030	1.59	0.141	0.084	1.68
Ireland	0.047	0.006	8.43	0.143	0.073	1.95
mean	0.046	0.022	2.10	0.130	0.069	1.87
Non-EC Europe						
Switzerland	0.060	0.013	4.63	0.024	0.040	0.60
Austria	0.050	0.020	2.52	0.030	0.035	0.86
Sweden	0.040	0.012	3.37	0.083	0.008	10.07
Norway	0.029	0.009	3.28	0.005	0.090	0.06
Finland	0.019	0.022	0.88	0.034	0.080	0.42
mean	0.040	0.015	2.61	0.035	0.051	0.69
Non-Europe OECD						
US	0.040	0.020	2.07	0.087	0.014	6.00
Japan	0.074	0.009	8.20	0.055	0.077	0.72
Canada	0.026	0.022	1.17	0.041	0.075	0.55
Australia	0.023	0.019	1.12	0.064	0.050	1.27
New Zealand	0.051	0.019	2.65	0.090	0.078	1.16
mean	0.043	0.018	2.40	0.067	0.059	1.15
OECD unweighted						
mean	0.044	0.017	2.50	0.074	0.062	1.19
G7 weighted mean	0.044	0.018	2.44	0.075	0.049	1.55

Given the imposed constraint that the effect of demand shocks on output declines to zero over time, while the effect of supply shocks tends to be

reinforced as time progresses, it may be expected that demand shocks are relatively less important in explaining variance in the level of output than variance in contemporaneous growth. This is confirmed in Table 3. In terms of explaining variance in the level of OECD countries output, the overall result is that the importance of supply shocks in explaining variance of output dominates demand shocks by a ratio of 72:28.(11) What this result does show however, is that even though the effect of any single demand shock is zero in the long run, at any period in time demand shocks are likely to be playing a prominent role in the determination of output. This is because of the relatively large magnitude of their initial impact on output and the long lags involved before their effects disappear.

However, although in all cases the effect of demand shocks in causing variation in the level of output is less important than on contemporaneous growth, the rating of countries according to the relative importance of demand and supply shocks is little changed when the level of output is used instead of the rate of growth. This seems to rule out the possibility that although demand shocks might cause variance in output growth, they might be smoothing out the level of output over the medium term. To the extent that such disturbances represent government policy actions, it does not therefore appear that such actions have succeeded in smoothing the path of output over time.

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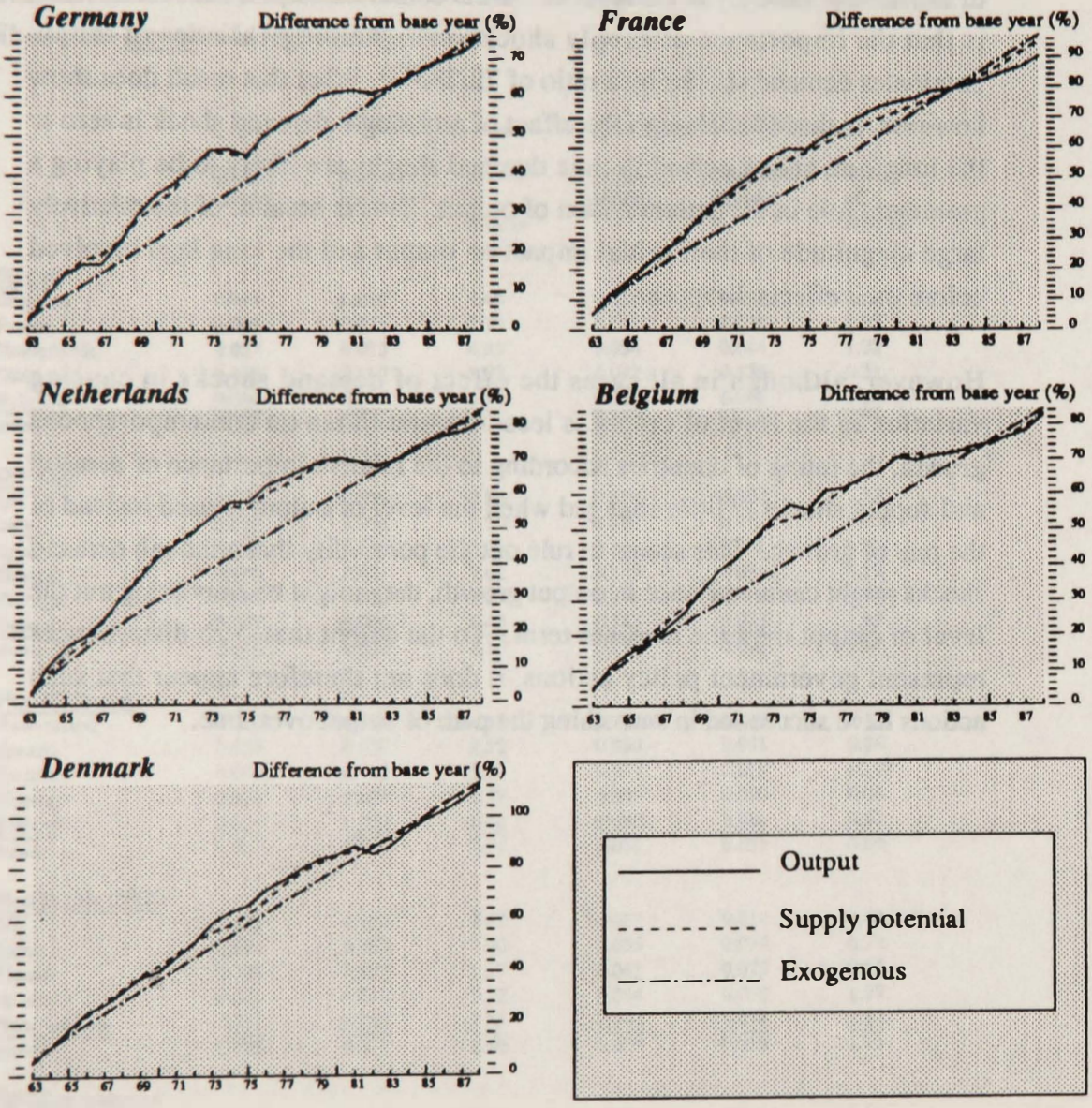
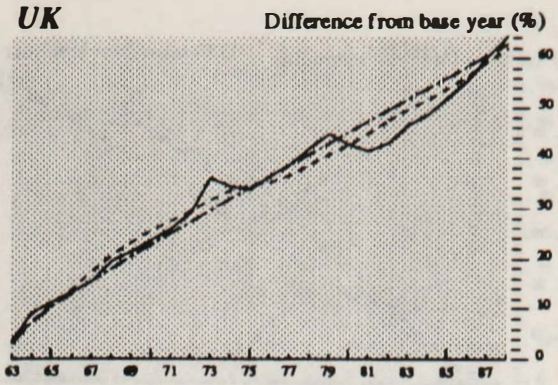
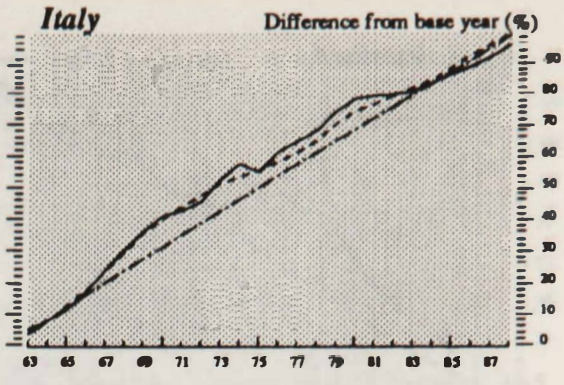
(11) In the case of prices, we find that supply shocks are slightly more important than demand shocks in explaining variances in the level of prices.

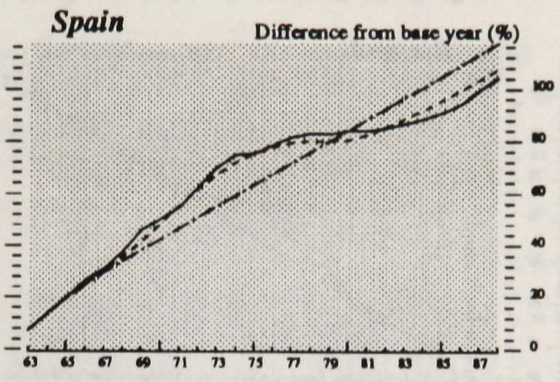
Figure 6 - Level of Output, Underlying Supply and 'exogenous factors' in OECD countries.
EC core

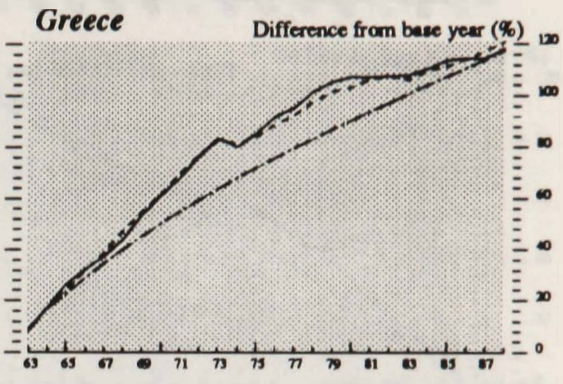


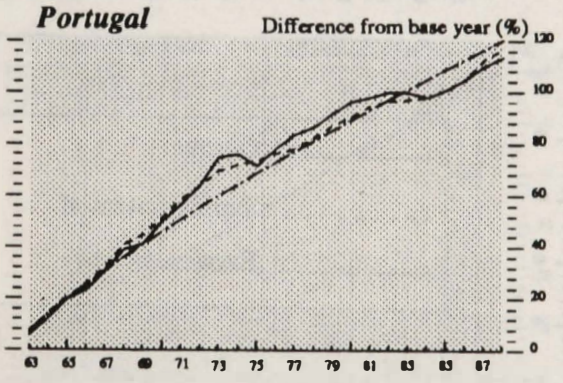
Other EC

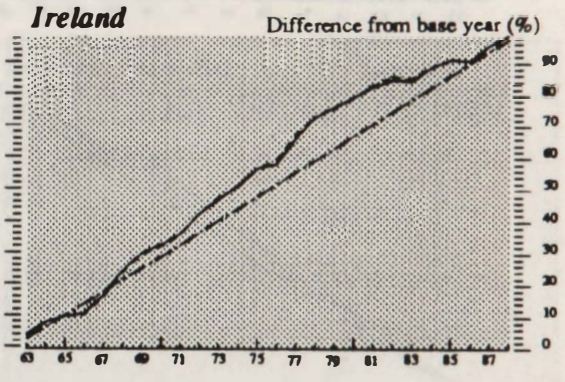

UK
Difference from base year (%)


Italy
Difference from base year (%)

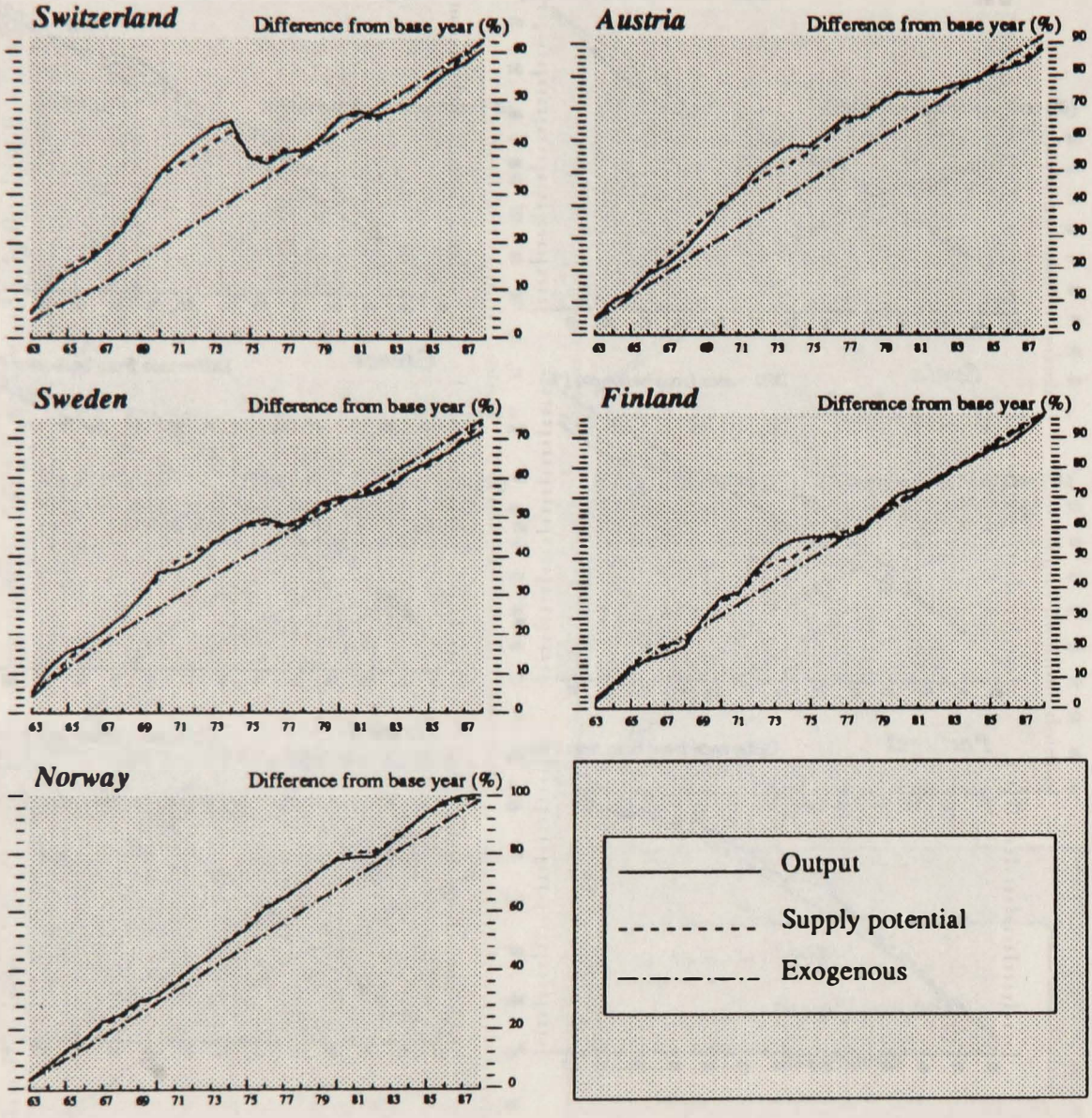

Spain
Difference from base year (%)


Greece
Difference from base year (%)

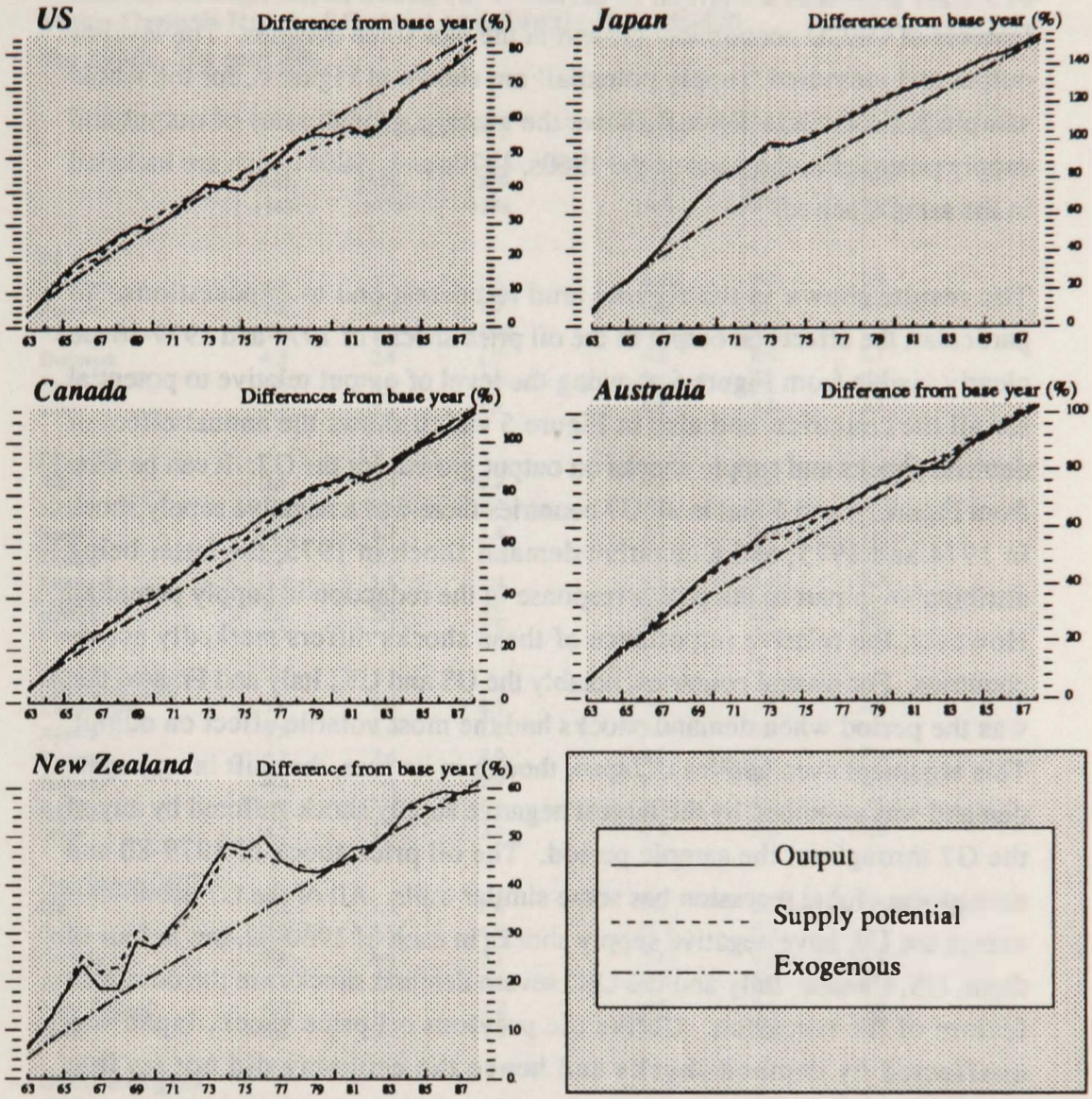

Portugal
Difference from base year (%)


Ireland
Difference from base year (%)

Non-EC Europe



Non-Europe OECD



Implications for underlying supply potential: The identification of an estimate of supply potential described in section 5 (b) above sheds light on several features of OECD economies' growth in the past three decades. The level of output and measured 'supply potential' are shown in Figure 6, for the whole sample period, while Table 4 shows the average growth rates of output and supply potential in the parts of the 1960s, 1970s and 1980s which are included in the sample period.

The results shown in the figures tend to correspond to expectations. In particular, the effects on output of the oil price shocks of 1974 and 1979-80 are clearly visible from Figure 6 showing the level of output relative to potential for all the countries, and also in Figure 5 which shows the annual effect of demand shocks and supply shocks on output growth for the G7. It can be seen from Figures 5 and 6 that in all G7 countries there was a negative supply shock in 1974 and 1975, and a negative demand shock in 1975, the latter being attributable in part to the policy response to the reduction in supply potential. However, the relative importance of these shocks differs markedly across countries. For several countries, notably the US and UK, Italy and France, this was the period when demand shocks had the most volatile effect on output. This argument even applies to Japan, though in its case, the shift in aggregate demand was swamped by the largest negative supply shock suffered by any of the G7 throughout the sample period. The oil price shock of 1979-80 and subsequent global recession has some similar traits. All of the G7 economies except the UK have negative supply shocks in each of 1980-82, but in four of them, US, Canada, Italy and the UK, severe demand shocks are the dominant feature of the recession. Unlike the previous oil price shock, Japan was unaffected by demand shocks and hence the economy did not tip into recession.

Table 4

Mean Growth Rates of Output and Supply Potential in the 1960s, 70s and 80s

	GROWTH IN OUTPUT			GROWTH IN SUPPLY POTENTIAL		
	1963-1969	1970-1979	1980-1988	1963-1969	1970-1979	1980-1988
EC core						
Germany	4.3	3.1	1.8	4.2	3.0	1.7
France	5.3	3.6	1.9	5.2	3.3	2.9
Netherlands	5.3	3.3	1.3	5.8	3.2	1.7
Denmark	4.3	2.4	1.7	4.2	2.6	2.1
Belgium	4.6	3.5	1.8	4.6	3.5	1.8
mean	4.8	3.2	1.7	4.8	3.1	2.1
Other EC						
UK	3.1	2.4	2.2	3.3	1.8	2.4
Italy	5.2	3.8	2.4	5.3	3.5	3.2
Spain	6.7	3.7	2.4	5.7	3.8	3.1
Greece	7.7	5.2	1.4	7.8	4.6	2.2
Portugal	5.9	5.1	2.4	6.3	4.2	3.3
Ireland	4.3	4.6	2.6	4.3	4.6	2.6
mean	5.5	4.4	2.3	5.4	3.8	2.8
Non-EC Europe						
Switzerland	3.9	1.4	2.1	3.8	1.4	2.3
Austria	4.5	4.0	1.8	5.0	3.7	2.0
Sweden	4.2	2.4	2.0	4.1	2.3	2.4
Norway	4.3	4.4	2.9	4.3	4.5	2.9
Finland	4.2	3.7	3.4	4.3	3.7	3.5
mean	4.2	3.2	2.4	4.3	3.2	2.6
Non-Europe OECD						
US	4.2	2.7	2.8	4.2	2.4	3.4
Japan	9.9	5.1	4.0	10.3	5.2	3.7
Canada	5.4	4.6	3.1	5.5	4.3	3.3
Australia	5.7	3.5	3.1	5.8	3.3	3.2
New Zealand	4.0	1.1	2.2	4.0	1.4	1.9
mean	5.0	3.4	3.0	6.0	3.3	3.1
OECD unweighted mean	4.9	3.6	2.3	5.1	3.4	2.7
G7 weighted mean	5.3	3.4	2.7	5.4	3.2	3.1

Turning to the decade by decade results in Table 4, we can see that supply potential varies considerably over time. In particular, it can be seen that for 15 out of the 21 countries growth in supply potential slowed in both of the sub-periods representing the 1970s and 1980s. (This can also be seen in Figure

6, where the path of supply potential generally has a bow shape, as it slows over time.) This is consistent with a "catch up" version of the Solow growth model in which economies are moving towards their long-run growth rate as the capital stock increases from a relatively low level. Further support for this view comes from an analysis of the countries whose growth rate has not slowed consistently over the period. The three major economies whose growth potential is estimated to have risen over the 1980s are the US, UK and Sweden which may all be characterised as more 'mature' economies, whose capital stock was not so severely effected by World War II who may therefore have been closer to their long-run steady state growth level.

Although growth in potential output has slowed, growth in actual output has slowed even faster. Because demand shocks have a prominent role in explaining variation in output even in the medium term, it is possible for output to deviate from supply potential for long periods of time. Negative demand shocks in the 1980s, have for many economies left output below supply potential in the later part of the sample period. The effect is clearly visible in the figures, where the typical path for output relative to supply potential is for output to exceed potential through the 1960s and 1970s, but to fall below potential in the early 1980s. It generally remained below potential until the end of the 1980s. This presumably reflects the disinflationary policy pursued in most OECD economies in the early 1980s. However, as Figure 6 shows, the performance of output relative to potential in the later part of the 1980s was more diverse across countries, reflecting both consolidation of inflationary gains and the more mixed inflationary performance in this period.

It is also interesting to examine the performance of those countries who were part of the ERM over the estimation period. We find that output has fallen and remained below potential in all ERM narrow band member's economies, though this is a more general phenomenon, being true for 18 out of the 21 countries analysed. What can be seen in Figure 6 is that the trend of output remaining below potential in the 1980s is far less pronounced for those of the major economies who have faced less of an external policy constraint. In Germany, the level of output has been very close to potential since the mid-1970s. In Japan, output has hardly deviated from supply potential at any

time in the sample period. In the US, output dipped briefly below potential following the recession in the early 1980s, and was close to potential since 1984. The UK underwent a sustained period of output remaining below potential from 1980 to 1986, but it was above potential until the end of the sample period. Overall, it appears that the disinflation in the ERM which allowed members to hold on to earlier inflationary gains has been achieved at least partly at the cost of significant short-term losses in output.(12)

7 Use of the Model as a Forecasting Tool

The analysis can also be used to decompose current events into demand and supply shocks and so forecast future developments in output and prices. First we check the models' forecasting properties: we use data up to 1988 to determine what the effect of demand and supply shocks up to that date would (in the absence of further shocks in the 1989-91 period) have implied for the future course of output up to 1991.

Next we utilise three years post-sample data (1989-91) to decompose current developments in output growth and inflation into underlying demand and supply shocks. By imposing the estimated coefficients of the VAR on to this latest data for output and prices, we are able to calculate the output and price residuals for a 'forecast' period from 1989 to 1991. As we have defined the underlying demand and supply shocks to be linear transformations of the output and price residuals, according to the restrictions described above, it is straightforward to identify the demand and supply shocks, using the linear transformation $\epsilon = C^{-1}e$ from equation (2.5) above. The results for the US, Japan Germany, France, Italy and the UK are shown in Figure 7.

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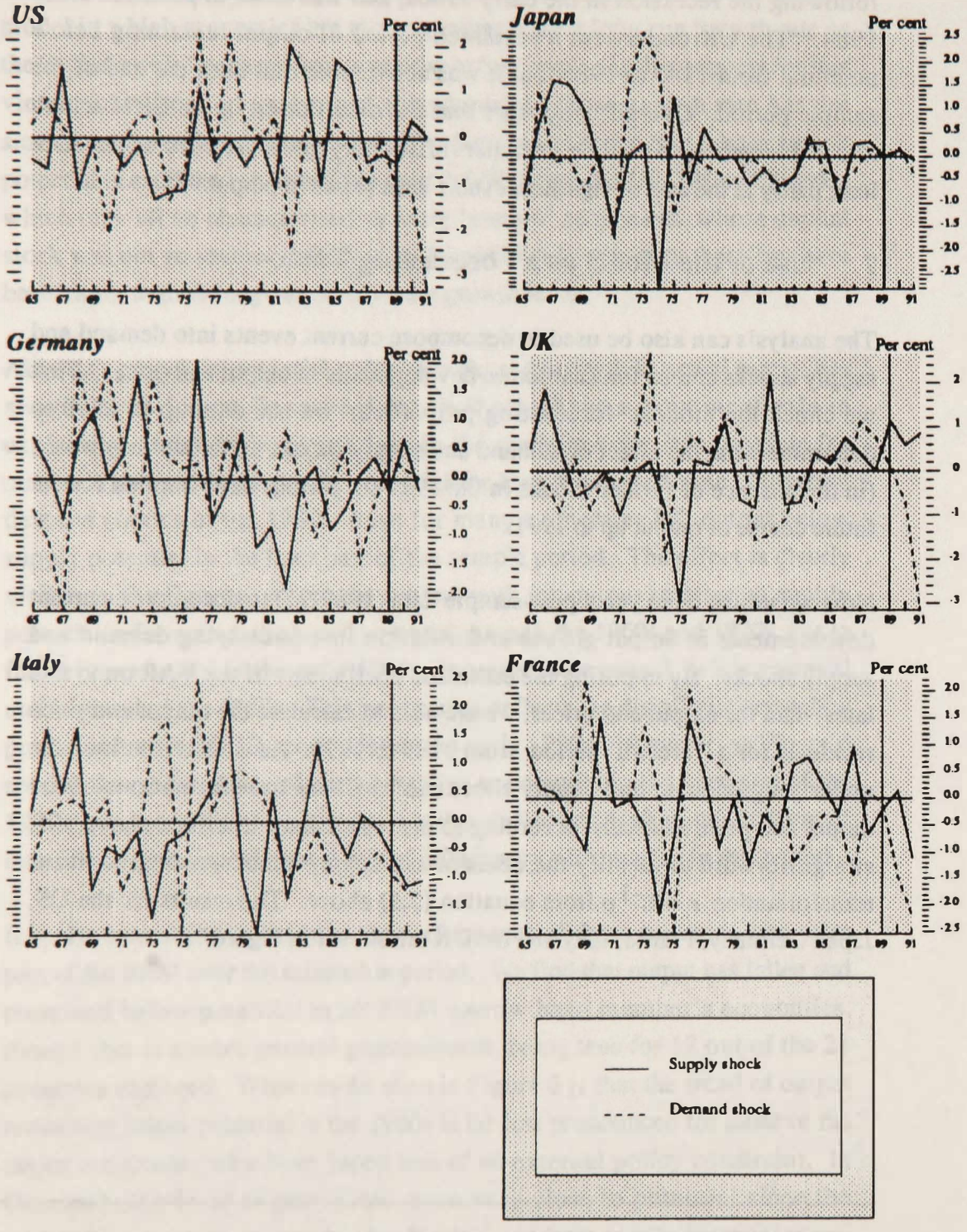
(12) De Grauwe (1989), in a more detailed study, comes to similar conclusions.

Figure 7

Demand and Supply Shocks Including Model Predictions for 1989-1991



Finally, from these underlying shocks we derive model forecasts for output growth by calculating the effect of previous demand and supply shocks on output, determined by the impulse response functions.

The results of the output forecasts of 1989-91 based on data up to 1988 are shown in Table 5. They are generally satisfactory. The relative accuracy of the forecasts does not represent a full test of the model because no account is taken of shocks in the period 1989 to 1991. For three of the six countries the 1989 growth rate is within 0.1% of the predicted value. The model under-predicts by 0.6% in the case of UK growth, but over predicts by 1.7% in the case of the US and Italy. From 1990 onwards the model does predict a slowdown in G7 growth but underestimates the pace of the slowdown in the US, UK, Italy and France.

Why did the model, based on data up to 1988, overestimate growth in the period 1989-91? Within the framework of demand and supply shocks, the reason is very clear from inspection of Figure 7, which shows the decomposition of current events into demand and supply shocks. Four of the largest economies are predicted to have suffered from severe and sustained demand shocks from 1989-91. In the case of the US, the model predicts that the current recession is very much a transitory phenomenon, attributable almost entirely to demand shocks. The US has been suffering from increasingly negative demand shocks since 1989 but in the same period has suffered hardly any negative supply shocks. This implies that on the basis of past shocks, US recovery should be relatively strong in the next few years. The model predicts that up to 1991 Japan was undergoing very small demand and supply shocks, a continuation of the pattern of shocks in Japan since the late 1970s. Of the ERM countries, there is little clear trend in Germany, though the effects of unification on the west German economy show up as a supply shock rather than a demand shock in 1991. In Italy the current slowdown is explained far more evenly by both negative supply and demand shocks, neither of which is anything like as severe as the demand shock being suffered by the US economy. The negative shocks in the three 'forecast' years 1989-91 imply that Italy has undergone successive negative demand shocks for each of the past ten years. There is a similar pattern in France, where the 1991

negative demand shock was, as in Italy, the most severe since 1975. In the mid-1980s this was offset by positive supply shocks, but recently, these have also turned negative, hence the slowdown in activity growth. The recent recession in the UK is, like the US, is identified as a demand shock. Slightly more surprisingly, the model identifies a significant beneficial supply shock in the UK for each of the years from 1988 to 1991.

Table 5

Model output growth forecasts of 1988-91 on data up to 1988

	Actual	Forecast	Effects of pre-89:	
			Supply shocks	Demand shocks
		US		
1988	4.4%	4.4%	1.4%	0.1%
1989	2.4%	4.1%	-0.1%	1.1%
1990	1.1%	3.6%	-0.0%	0.6%
1991	-0.8%	3.4%	0.5%	-0.1%
		Japan		
1988	5.6%	5.6%	0.2%	0.3%
1989	4.7%	4.7%	-0.2%	-0.1%
1990	5.1%	4.8%	-0.3%	-0.1%
1991	4.5%	4.9%	-0.1%	-0.1%
		Germany		
1988	3.6%	3.6%	0.9%	-0.3%
1989	3.8%	3.9%	0.5%	0.5%
1990	4.6%	3.4%	0.0%	0.4%
1991	3.0%	3.0%	-0.1%	0.2%
		France		
1988	3.5%	3.5%	-0.1%	-0.2%
1989	3.9%	4.0%	0.3%	-0.0%
1990	2.8%	4.5%	0.3%	0.5%
1991	1.3%	4.7%	0.3%	0.7%
		Italy		
1988	3.9%	3.9%	-0.3%	0.5%
1989	3.0%	4.7%	-0.2%	1.1%
1990	1.9%	4.3%	-0.1%	0.8%
1991	1.4%	4.0%	-0.1%	0.4%
		UK		
1988	4.1%	4.1%	0.4%	1.4%
1989	2.3%	1.7%	0.3%	-0.8%
1990	1.0%	1.4%	0.2%	-1.0%
1991	-2.3%	2.0%	0.1%	-0.3%

Table 6
Model of Forecasts

Model output growth forecasts for 1992-95 based on data up to 1991

	Forecast	Effects of pre-92:	
		Supply shocks	Demand shocks
		US	
1991	-0.8%	0.6%	-4.2%
1992	5.1%	0.9%	1.1%
1993	6.7%	0.5%	3.2%
1994	4.8%	0.1%	1.6%
1995	3.0%	0.1%	-0.1%
		Japan	
1991	4.5%	-0.2%	-0.4%
1992	5.1%	-0.2%	0.2%
1993	5.0%	-0.1%	0.0%
1994	4.9%	-0.1%	-0.1%
1995	4.9%	-0.1%	-0.0%
		Germany	
1991	3.0%	0.1%	0.0%
1992	2.5%	-0.2%	-0.2%
1993	2.7%	-0.1%	-0.1%
1994	2.9%	-0.0%	-0.0%
1995	3.0%	0.0%	0.0%
		France	
1991	1.3%	-0.2%	-2.2%
1992	3.6%	-0.1%	-0.1%
1993	3.8%	-0.3%	0.4%
1994	4.3%	-0.4%	1.0%
1995	4.5%	-0.4%	1.2%
		Italy	
1991	1.4%	-1.5%	-0.8%
1992	3.7%	-1.9%	1.9%
1993	3.8%	-1.3%	1.5%
1994	3.4%	-0.9%	0.6%
1995	3.4%	-0.7%	0.4%
		UK	
1991	-2.3%	1.0%	-5.6%
1992	3.7%	0.8%	0.6%
1993	5.6%	0.5%	2.9%
1994	3.8%	0.3%	1.2%
1995	2.6%	0.2%	0.1%

Finally, Table 6 shows model predictions for output growth for 1992 onwards, based on the past history of supply and demand shocks and a model parameterisation based on the pre-1989 sample period. Implicit in the forecast is the assumption of no supply or demand shocks from 1992 onwards. Given that the model attributes the current slowdown in global growth almost entirely to negative demand shocks which by definition have no permanent effect on output, it is not surprising that it predicts a marked rebound in output. The strength of the predicted rebound is, however, be unrealistically strong in most cases. Nevertheless, the forecasts do serve as a reminder that rarely in the past has the global economy failed to recover strongly from recession in an environment where generally low inflation may be indicative of the level of output being below potential.

8 Conclusions

We have proposed a framework to test and implement the simple aggregate demand - aggregate supply models and in particular, to test whether economies tend to be dominated by demand shocks, whose effect on output is only transitory, or supply shocks, which have permanent effects on output. To do this we estimated bi-variate VARs to analyse the relative and absolute magnitudes of the effect of aggregate demand and supply shocks on output and prices in each of 21 OECD economies. By determining the effect of the respective shocks in explaining fluctuations in growth and inflation, our results can test theories of business cycles which stress the importance of shocks which have temporary effects on output (the Keynesian synthesis) against real business cycle theories which stress the importance of permanent supply shocks.

Although there is some divergence among countries, we find that the two types of shocks are of similar importance overall; specifically our results indicate that if there is an unexpected rise in growth, then the probability this represents a permanent change in supply potential is just over 50:50. Hence it appears that the world is neither dominated by temporary aggregate demand shocks nor permanent aggregate supply shocks, but rather these disturbances are of similar

importance. Our results are therefore in the middle of alternative views of business fluctuations. Over the medium term, supply shocks become more important in explaining variation in the level of output, outweighing demand shocks by about 72:28. If output stays above trend for some time, there is a probability of around 72% that it will stay there. However, the relatively large magnitude of demand shocks and the long lags before their effect on output disappears means that they still have a major role in explaining variance in the level of output.

By accumulating the supply shocks we have been able to investigate the behaviour of underlying 'supply potential' over time. Because of the incidence of supply shocks, supply potential varies considerably over time, bringing into question the notion of a fixed underlying level of supply potential, which is a key part of traditional business cycle theory. We also find that the underlying rate of growth of supply potential has slowed over time, which is consistent with Solow's growth model. Actual growth has slowed even faster, so that for many countries (and not just those in the ERM), output has grown more slowly than supply potential in the 1980s.

Finally, we have used the model to decompose current events into demand and supply shocks. We have examined the implications for output in three countries. The current slowdown in several countries is seen to be attributable to diverse combinations of the two shocks.

In short, in testing across a wide range of 21 OECD economies, it would appear that we are roughly half way between the demand dominated view of Keynesian synthesis and the supply orientated view of real business cycle theorists. According to our results, the industrialised economies of the world experience both demand and supply shocks in roughly equal magnitudes: an eclectic view of the world works best.

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