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What Causes Irish Recessions: Fluctuations in Aggregate Demand or Aggregate Supply?

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Abstract: The new classical view of the market economy is used to impose restrictions on a vector autoregression of output, interest rates, prices and money, to identify aggregate demand and supply structural disturbances. We use the estimated structural vector autoregression to decompose Irish GDP growth into components associated with major macroeconomic disturbances in order to identify the likely causes of Irish recessions. The results suggest that recessions in the 1970s were mainly due to aggregate supply shocks and that aggregate demand shocks played an increasingly more important role in the recessions of the 1980s and 1991.

I INTRODUCTION

Recent studies by Shapiro and Watson (1988), Blanchard (1989), Blanchard and Quah (1989), Gali (1992), Keating (1992), and Walsh (1993) have used structural vector autoregresson models to provide useful insights on business cycle behaviour in the United States. This paper extends their analyses to examine how demand and supply shocks affect business cycle behaviour in Ireland. This application is of interest because a comparison of the Irish evidence with the results from the United States may highlight similarities or contrasts in business cycle behaviour in very small open economies and large, relatively closed economies like the United States.

A common interpretation of macroeconomic fluctuations relies on an IS-LM-AS framework. This model has a substantial influence on the views and

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understanding of policy makers and private agents on how the economy works and responds to various shocks. Many would have the view that aggregate demand shocks have Keynesian effects on output in the short run and classical effects on output in the long run. We adopt this view to identify unobservable demand and supply disturbances by assuming that aggregate demand shocks have transitory effects while aggregate supply shocks have permanent effects on output (see Blanchard (1989)). This approach falls between the traditional view of macroeconomic modelling, that short-run fluctuations are due to temporary demand shocks, and an early real business cycle view, that both short and long-run fluctuations in output were due to permanent supply shocks.

We use the estimated model to re-evaluate the empirical validity of the IS-LM-AS by examining how macroeconomic variables respond to four underlying shocks, namely, aggregate supply, autonomous demand, money demand and money supply. These are shocks identified by Gali (1992), Keating (1992), and Walsh (1993) for the US economy.

The estimated model produces impulse response functions which match predictions of the theoretical IS-LM-AS framework. In order to understand the possible causes of Irish recessions we examine how demand and supply shocks influence cyclical behaviour. The empirical analysis suggests that aggregate supply shocks were the main cause of Irish recessions in the 1970s and 1980 and aggregate demand shocks were the predominant cause of recessions in the 1980s and 1991. This is similar to findings in the United States.

The paper is organised as follows. Section II contains a brief discussion on the structural vector autoregression (SVAR) methodology. In Section III we use the SVAR approach to analyse Irish recessions and Section V concludes.

II THE MODEL

The IS-LM-AS model is the most common theoretical framework used by economists to analyse the effects of changes in some exogenous macroeconomic variables. It is the core of most intermediate level textbooks in macroeconomics. This model attributes movements in output to shocks in aggregate supply and/or aggregate demand. The aggregate supply function shows the level of output consistent with the economy's capital stock and labour market equilibrium. Shocks in aggregate supply arise from disturbances such as oil price movements, labour force changes, and technology improvements. Shocks in aggregate demand are due fluctuations in either the IS curve, such as fiscal shocks, changes in consumer behaviour or investors confidence, exchange rate movements and/or fluctuations in the LM curve such as money supply or demand shocks. The theoretical model we use to analyse Irish recessions can be represented by a four-equation system, consisting of equations for aggregate supply, autonomous demand, money demand and money supply. The system would be a substantial part of large scale macroeconomic models. It determines equilibrium values of real output, Y, nominal interest rates, r, real money balances, M/P and the nominal money supply, M. We assume that the structural model has the following form

$$AX_t = B(L)X_{t-1} + C\varepsilon_t \tag{1}$$

where X is the vector of endogenous variables [Y,r,M/P,M], ε is a vector of innovations to the unobserved structural disturbances. A, B, and C are matrices of full rank and B(L) is a matrix polynomial of order N in the lag operator. We assume that the elements of ε are mutually uncorrelated and serially independent with diagonal variance-covariance matrix Σ. We also assume that the diagonal elements of A and C are equal to unity. The matrix A allows for contemporaneous interactions among output, interest rates, prices and money supply. The matrix C allows innovations in one equation to directly affect other variables in the model. Premultipyling both sides of (1) by A^{-1} gives the reduced form associated with the structural model

$$\begin{aligned} X_t &= A^{-1}B(L)X_{t-1} + A^{-1}C\varepsilon_t, \\ X_t &= D(L)X_{t-1} + u_t, \end{aligned} \tag{2}$$

where u is a vector of reduced-form innovations. One needs a set of just-identifying restrictions on A and C to recover structural innovations and equations in (1).

There are two types of restrictions commonly used to identify the structural model, (see Shapiro and Watson (1988), Blanchard (1989), Blanchard and Quah (1989), Gali (1992), Walsh (1993)). Short-run restrictions are on the contemporaneous interactions among the variables, such as zero restrictions on A. Long-run restrictions are on the dynamic effects of the innovations on the X variables, such as demand shocks have no long-run effect on aggregate supply. We follow Walsh (1993) who argues that restrictions on contemporaneous interactions are controversial if for example rational agents use all the available information when forming expectations. The first set of restrictions we assume are that there are orthogonality conditions among the four structural shocks. Thus, assuming that C is diagonal we require a further six restrictions for exact identification.

The first three restrictions assume that aggregate demand shocks do not have any long-run effect on GDP. These restrictions distinguish between aggregate supply shocks which have long-run effects on output from aggregate demand shocks which are assumed to have only temporary effects.[1] The last three restrictions are based on a common assumption in the IS-LM-AS macroeconomic model, namely the long-run dichotomy between real and financial sectors of the economy. This implies that shocks to the LM curve do not affect the real interest rate and that in the long-run changes in the level of the money supply cause proportionate changes in the price level. Finally, since long-run changes in the level of the money supply cause proportionate changes in the price level, real money balances are not affected by money supply shocks in the long run.

The restricted IS-LM-AS model can be represented by the following set of equations (all lowercase variables except the nominal interest rate are in logarithms)

$$y_t = \sum_{i=1}^{N} \alpha_{1t} y_{t-i} + \sum_{i=0}^{N} \beta_{1i} r_{t-i} + \sum_{i=0}^{N} \gamma_{1i} (m-p)_{t-i} + \sum_{i=0}^{N} \delta_{1i} m_{t-i} + \varepsilon_t^{as}, \tag{3}$$

$$r_t = \sum_{i=0}^{N} \alpha_{2t} y_{t-i} + \sum_{i=1}^{N} \beta_{2i} r_{t-i} + \sum_{i=0}^{N} \gamma_{2i} (m-p)_{t-i} + \sum_{i=0}^{N} \delta_{2i} m_{t-i} + \varepsilon_t^{is}, \tag{4}$$

$$(m-p)_t = \sum_{i=0}^{N} \alpha_{3t} y_{t-i} + \sum_{i=0}^{N} \beta_{3i} r_{t-i} + \sum_{i=1}^{N} \gamma_{3i} (m-p)_{t-i} + \sum_{i=0}^{N} \delta_{3i} m_{t-i} + \varepsilon_t^{md}, \tag{5}$$

$$m_t = \sum_{i=0}^{N} \alpha_{4t} y_{t-i} + \sum_{i=0}^{N} \beta_{4i} r_{t-i} + \sum_{i=0}^{N} \gamma_{4i} (m-p)_{t-i} + \sum_{i=1}^{N} \delta_{4i} m_{t-i} + \varepsilon_t^{ms}, \tag{6}$$

where the restrictions are imposed by constraining the sum of certain coefficients to be zero. These are given in Table 1.

Since contemporaneous values of endogenous variables appear as explana-

Table 1: *Coefficient Restrictions*

In the y equation	$\Sigma\beta_{1i} = 0$	$\Sigma\gamma_{1i} = 0$	$\Sigma\delta_{1i} = 0$
In the r equation		$\Sigma\gamma_{2i} = 0$	$\Sigma\delta_{2i} = 0$
In the m–p equation			$\Sigma\delta_{3i} = 0$

1. As Blanchard and Quah (1989) and Gali (1992) point out there are models which allow for demand shocks to have long-run effects on output but if they exist, they are assumed small relative to aggregate supply shocks.

tory variables we estimate each equation by two stage least squares. We use N+1 lagged values of the four variables as instruments. The estimated residual for the output equation is used as an additional instrument in the other equations. The estimated residual for the interest rate equation is used as an additional instrument in the real money balances and nominal money supply equations. Finally, the estimated residual for the real money balances equation is used as an additional instrument in the nominal supply equation.

III DATA ANALYSIS

Equations (3)-(6) are estimated using annual Irish data over the years 1960-1992 (see Appendix I for data source). Certain properties of the series included in the model must be checked in order to determine the appropriate specification for estimation purposes. First, it is necessary to determine whether the series are difference-stationary or trend-stationary. Second, it is necessary to account for the possibility of breaks in the deterministic trend since Dickey-Fuller (1979) and Phillips-Perron (1988) tests may fail to reject the null hypothesis of a unit root if there is one large break in the level or growth rate of a series even if the underlying trend is deterministic. Third, if the variables are difference-stationary it is necessary to establish whether there are any cointegrating relationships linking the variables.

3.1 *Unit Roots, Trend Breaks and Cointegration*

Table 2 reports values of augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests for unit roots.

These test results should be interpreted with caution due to the fact that they have poor power against plausible local alternatives. Note also the sample size is small (33 observations). The results imply that all variables in

Table 2: *Tests for Unit Roots*

	Levels		*First Differences*	
Variable	*Dickey-Fuller*	*Phillips-Perron*	*Dickey-Fuller*	*Phillips-Perron*
y	–2.17	–1.81	–3.64**	–3.69**
r	–1.77	–1.78	–5.48***	–5.63***
m–p	–1.54	–1.58	–4.50***	–4.58***
m	–0.81	–0.89	–2.92*	–3.00**
p	–1.76	–1.69	–2.16	–1.69

Notes: * Reject the null hypothesis (unit root) at the 10 per cent level.
** Reject the null hypothesis at the 5 per cent level.
*** Reject the null hypothesis at the 1 per cent level.

levels are non-stationary and all variables in first differences except inflation are stationary. There appears to be major trend-breaks in inflation in the late 1970s which may be the reason why the unit root tests fail to reject the null hypothesis of a unit root in inflation.

Table 3 reports results of Zivot-Andrews (1992) unit root tests where the null hypothesis is that the series has a unit root and the alternative hypothesis is that the series is a trend-stationary process with a one-time break in trend occurring at an unknown point in time. These test results should also be interpreted with caution for similar reasons mentioned above. The results suggest that all variables are difference-stationary. While the preceding tests suggest that the models variables are non-stationary, it is possible that these variables share common non-stationary trends and linear combinations of the variables may be stationary. When variables are co-integrated short and long-run dynamics can be modelled by a vector error correction model. A VAR model made up of first differenced variables that are cointegrated involves "overdifferencing" and would therefore be inappropriate. Table 4 reports the results employing Johansen's (1988) multivariate trace and maximum eigenvalue tests for v cointegrating vectors.

Both the trace and maximum eigen value tests fail to reject the hypothesis of no cointegrating vectors. We therefore assume that it is appropriate to estimate a VAR model in first differences. As Walsh (1993) points out this assumption has no necessary implications for the long-run identifying restrictions, "since cointegration is a property of the stochastic disturbances while the identifying restrictions are restrictions on the coefficients of the model".

Table 3: *Zivot-Andrews (1992) Tests for Unit Roots*

	Levels			*First Differences*		
Variable	*Test A*	*Test B*	*Test C*	*Test A*	*Test B*	*Test C*
y	–4.04	–3.44	–3.76	–4.22**	–4.22*	–5.61***
r	–3.42	–3.98	–4.86	–5.91***	–5.42***	–5.84***
m–p	–3.06	–3.82	–3.72	–5.03***	–4.70***	–5.07***
m	–2.49	–3.37	–3.34	–4.59*	–4.91**	–5.37**
p	–5.33**	–2.67	–2.74	–3.64	–5.68***	–5.47***

Notes: * Reject the null hypothesis (unit root) at the 10 per cent level.
** Reject the null hypothesis at the 5 per cent level.
*** Reject the null hypothesis at the 1 per cent level.
Test A is a test for a break in the level of a series.
Test B is a test for a break in the growth rate of a series.
Test C is a test for a break in the level and growth rate of a series.

Table 4: *Johansen Test for Cointegration*
Four variable system: y, r, m–p, m

Null Hypothesis	*Trace*	*95 Per Cent Critical Value*	*Maximum Eigenvalue*	*95 Per Cent Critical Value*
v≤3	0.0003	3.76	0.0003	3.76
v≤2	4.65	15.41	4.65	14.07
v≤1	18.86	29.68	14.21	20.96
v=0	43.92	47.21	25.06	27.07

Finally, we estimated a simple unrestricted vector autoregression to determine lag length. The Schwarz information criterion for 3, 2 and 1 lag are –26.90, –28.12 and –28.90 respectively. The Akaike information criterion are –29.76, –30.03 and –29.86 for 3, 2 and 1 lag, respectively. This leads to ambiguous results in deciding between 1 or 2 lags. We choose 2 lags. Our results do not change much if we only use 1 lag in the estimated model.

3.2 *Dynamic Effects of Structural Shocks*

We use the estimated model to calculate the response of output, interest rates, inflation, etc., to each of the four structural disturbances. These responses are largely consistent with predictions of the IS-LM-AS model. While the impulse response functions illustrate the qualitative responses of variables in the system to underlying disturbances a variance decomposition of structural forecast errors will indicate the relative importance of these shocks. We discuss each of these in more detail.

3.2.1 Impulse Responses

The effects of positive one standard deviation aggregate supply shock on output, nominal and real interest rates, inflation, real money balances and money growth are summarised as follows.[2] The shock raises GDP permanently. The initial impact on GDP is an increase by 1.5 percentage points, which is bigger than responses to other shocks. The same variable reaches a peak in three years and levels out at 2.9 per cent. The initial impact on inflation is a fall of 0.7 per cent. Inflation soon rises as money growth accommodates the rise in prices. The monetary accommodation lowers nominal interest rates on impact. As demand for real money balances increase faster than the money supply the nominal interest rates rise by the third year. The IS-LM-AS model requires that aggregate demand increase to match the permanent increase in aggregate supply so real interest rates must and do fall.

2. Graphical illustrations are available from the authors upon request.

The dynamic effects of a positive IS shock imply that there is a strong initial impact on output which rises by 1.3 per cent on impact (with an impact multiplier of 0.7). The response lasts about 5 years. The shock raises nominal interest rates permanently. The initial impact on M3 growth is large at 4.5 per cent. Real rates rise initially as prices are slow to adjust, then fall as inflation exceeds the nominal interest rate and then rise again as inflation falls. Sluggish price adjustment suggests that there are important nominal rigidities in the Irish economy. In the long run the real interest rate increase crowds out expenditures in order to reduce aggregate demand to its initial level. Inflation and money growth are not affect by IS shocks in the long run.

Impulse responses to a positive shock to money demand imply that output falls by 0.7 per cent as real interest rates rise by 180 basis points. Only the level of real money balances are permanently affected by the money demand shock, their long-run level is 5.5 per cent higher. The impact of a nominal money supply shock on money supply growth is temporary and declines quickly. The increased liquidity causes the nominal interest rate to fall by 30 basis points on impact and the real interest rate to fall 70 and 200 basis points in the second and third years after the initial shock. The responses suggest that the liquidity effect dominates the anticipated inflation effect on impact but is dominated by the latter effect after a year. The fall in the real interest rate increases aggregate demand causing GDP to rise by 1 per cent in the second year after the shock. The impact multiplier is .21 which rises to .39 and declines thereafter. The hump-shaped pattern of the output response to a money supply shock is commonly found in US studies (see Gali (1992), Walsh (1993)),

3.2.2 Variance Decompositions

We consider the contribution of IS-LM-AS disturbances to the variance of k-step ahead forecast errors based on information at time t. Table 5 reports the variance decompositions of the structural forecast errors of the variables in first differences at horizons up to 10 years.

We find that the short-run variability in output is largely accounted for by both aggregate supply and IS shocks. This in contrast with the traditional Keynesian view that short-run output fluctuations are primarily due to aggregate demand shocks. Short and long-run variability in nominal interest rates are largely accounted for by IS shocks, although aggregate supply shocks also influence their short-run behaviour. We also find that the short-run variability in real money demand is largely accounted for by money supply and IS shocks. In the long-run 50 per cent of the variability is accounted for shocks to money demand itself. In sum IS shocks account for a larger percentage of short-run fluctuations in output, interest rates and

Table 5: *Variance Decompositions*

Component	*Aggregate Supply*	*IS*	*Money Demand*	*Money Supply*
GDP				
1 year	44.87	36.09	12.28	6.77
2 year	58.64	21.63	9.53	10.19
10 year	83.33	8.18	3.56	4.93
Nominal interest rate				
1 year	34.37	58.73	3.29	3.62
2 year	27.12	61.94	5.45	5.39
10 year	9.96	78.88	4.46	6.70
Real balances				
1 year	0.60	38.91	7.99	52.49
2 year	5.18	44.38	3.67	40.76
10 year	6.34	21.81	53.26	18.59
Money growth				
1 year	0.03	46.12	0.02	53.83
2 year	3.04	49.01	3.16	44.78
10 year	5.08	45.96	6.52	42.44

money supply growth than is commonly found in studies of the US economy (see Gali (1992)) which may reflect the openness of the Irish economy.

3.3 *Decomposing GDP*

In this section we present an informal interpretation of Irish GDP growth fluctuations over 1964-1992. We can use the estimated model to decompose the historical values of GDP growth into a base projection (or deterministic trend) and the accumulated effects of current and past innovations in the various shocks. The estimated contribution of aggregate demand and supply factors to the cyclical component of GDP growth are summarised in Table 6. The six major recessions are dated by Fagan and Fell (1992) using coincident indicator methods.

The rows in Table 6 give the estimated percentage contribution of both

Table 6: *AD/AS Components of the Change in GDP During Six Recessions*

Recession	*1965-66*	*1974-75*	*1979-80*	*1982-83*	*1985-86*	*1991*
Demand	–40.7	31.8	25.4	–65.1	–48.9	–135.7
Supply	–59.3	–132.2	–125.6	–34.9	–51.1	35.7

major shocks to the decline of GDP from trend during six major recessions (i.e. aggregate demand accounted 40.7 per cent of the decrease in the growth rate of real GDP in 1965-66). The estimates suggest that aggregate supply shocks were largely responsible for recessionary periods in the 1970s and 1980 and aggregate demand shocks played a more important role in the 1980s and were the sole cause of the 1991 recession.

The first recession to hit Ireland in the 1960s was in 1965-66. Both shocks to the demand and supply contributed to the fall in the stochastic component of real GDP growth. The demand shock (in this case a negative LM shock) was probably due to tight monetary policy. Real and nominal interest rates rose and M1 and M3 growth rates fell over this period. The supply shock was probably due to a fall in labour productivity and the capital stock. The 1967-73 boom was caused by a combination of shocks. Consumption, government spending and investment grew sharply. Real oil prices fell during the period and labour productivity rose.

The recessions in the 1970s were caused by aggregate supply shocks due to very large increases in real oil prices. While negative IS shocks contributed to the 1974-75 recession due to depressed private sector investment and a loss in competiveness, total aggregate demand shocks played a counter-cyclical role as the money supply also grew at unprecedented rates.

The recessions in the 1980s were caused by both shocks. On the demand side consumption fell sharply in 1982; government spending, investment and the money supply also fell. On the supply side growth rates in employment and productivity were at the lowest over the 1964-92 time period. In 1986 there was a sharp fall in real oil prices. This was probably one of the main supply side factors which caused the late 1980s boom. There was considerable growth in aggregate demand during the late 1980s, net exports, consumption and investment grew during this period. Real interest rates fell slightly during the mid-1980s but remained high and started to increase prior to the 1991 recession. Since this recession was caused by aggregate demand shocks, high real interest rates may have been a factor contributing to the sharp decline in investment.

IV CONCLUSIONS

We develop and estimate a simple macroeconometric model which is designed to represent a IS-LM-AS framework. Structural vector autoregression methods are used to identify four underlying shocks. The impulse response functions from the estimated model match predictions of the theoretical model. Historical decompositions of GDP growth suggest that supply shocks were the predominant cause of Irish recessions in the 1970s and early 1980s and aggregate demand shocks played a more important role in the recessions of the 1980s and 1991.

Whether these supply and demand shocks were purely external and outside the control of the government is a matter of public concern. A more detailed examination of the internal and external nature of these shocks should provide some more fuel for the on-going debate. This is a topic for future research.

APPENDIX I

The data source for the CPI is OECD Main Economic Indicators. The data source for output, money and interest rates is the Department of Finance/ ESRI 1992 databank. The databank mnemomics are B0410=GDP in 1985 constant prices, CUP+CA+DA=M3 where CUP is currency in the hands of the public, CA are current accounts and DA are deposit accounts and RX is the interest rate on 91 day Exchequer bills.

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