Aggregate Demand and Supply Shocks in Europe: 1860-1987

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1. Introduction

European countries have experienced substantial economic fluctuations in real and nominal variables over the last one hundred years. Both the rate of growth of output and the rate of inflation have been very volatile. During the same time, European economies have been subject to a variety of major and minor shocks including technological changes, two world wars, and a number of economic policy experiments. What has been the role of shocks like these in the macroeconomic history of Europe? What have been the sources of the real and nominal fluctuations of the last century?

Recent research in macroeconomics has shown that plausible and defensible assumptions can be used in order to identify two sources of shocks: shocks that have a permanent effect on output and shocks that only affect output in the short-run. The first include changes in the labour force or technology, and are identified as aggregate supply (AS) shocks; the latter include monetary and spending changes and are identified as aggregate demand (AD) shocks. The identifying restriction, therefore, is that aggregate demand disturbances (like a monetary expansion) can only temporarily alter real output. This amounts to assuming that the long-run aggregate supply curve is vertical. The influence of the two types of shocks on prices is left unrestricted.

This paper uses the identification technique described above to distinguish between aggregate demand and aggregate supply shocks, and investigate their importance for the observed fluctuations in the output growth and inflation rates of three countries: Italy, Sweden, and the United Kingdom [1]. The periods under examination are 1861 1987 for Italy and Sweden, and 1868-1987 for the UK. The identification of the two types of shocks was successful for Sweden and the UK, but ambiguous for Italy.

Somewhat surprisingly, one of the empirical findings is the high degree of similarity exhibited by the three countries, both with respect to their responses to the shocks, and to the timing and magnitude of the shocks themselves. This implies that whatever the differences of the three countries, their similarities cannot be ignored. As expected, it is also found that aggregate demand shocks are mainly responsible for price fluctuations at all horizons, and more so in the long-run. Interestingly, however, aggregate supply innovations seem to explain a significant fraction (50% or more) of *short-run* output fluctuations. This finding, which is robust across the three countries examined, diminishes the significance aggregate demand shocks are thought to have for business cycles.

2. Methodology

The method used here, the structural vector autoregression (VAR) approach, is a modification of the "atheoretical" VAR approach developed by Sims (1980). Sims's method has been criticized mainly for imposing theoretically implausible restrictions (Cooley and LeRoy, 1985). However, recent research has shown how Sims's technique can be modified to take into account identifying restrictions that are derived from economic theory and are, therefore, defensible. Examples include Blanchard and Quah (1989), Shapiro

[1] In the literature the emphasis has been on the historical importance of aggregate demand shocks, and especially those related to monetary policies in several countries. For European countries, see FRIEDMAN and SCHWARTZ (1982), CAPIE and WEBBER (1985), and PATAT and LUTFALLA (1990). More recently, KEATING and NUE (1990) focused on aggregate supply shocks in historical time series.

and Watson (1988), Keating and Nye (1990), and Cecchetti and Karras (1992).

The variables of interest are real output and the price level. These variables are assumed to be driven by two types of shocks: aggregate supply shocks (u^S) and aggregate demand shocks (u^D). Aggregate supply shocks include changes in the labour supply, the capital stock, and the level of technological sophistication. Aggregate demand shocks come mainly from changes in monetary or fiscal policies. The assumption that will be used to achieve identification of the two separate types of disturbances is that only aggregate supply shocks have a long-run effect on output; aggregate demand shocks affect output only temporarily (this identification scheme has been first proposed by Blanchard and Quah)[2]. An increase in the money supply, for example, may initially affect real output because of rigid wages and/or prices but in the long-run wages and prices fully adjust and output returns to its "natural" trend. The trend itself is determined by aggregate supply conditions. Put differently, we assume that the long-run aggregate supply curve is vertical so that demand shocks have no persistent effects on output. Even though this assumption is controversial, it is plausible as a first-order approximation: even if aggregate demand shocks exert some permanent influence on output, this influence is likely to be small compared to the effects of supply shocks.

Assume that the structural model is

$$y_t = a_{ys}(L)\, u_t^S + a_{yd}(L)\, u_t^D \tag{1a}$$

$$p_t = a_{ps}(L)\, u_t^S + a_{pd}(L)\, u_t^D \tag{1b}$$

or

$$(y_t, p_t)' = A(L)\,(u_t^S, u_t^D)' \tag{1}$$

[2] Another line of research achieves identification through contemporaneous (rather than long-run) restrictions. Examples include BERNANKE (1986), BLANCHARD (1989), and BLANCHARD and WATSON (1986).

where y is the rate of growth of real output, p is the rate of growth of the price level (i.e., the inflation rate), and the a's are polynomials in the lag operator, L. Then, the Blanchard-Quah identification assumption imposes the restriction a_{yd} (1)=O. Thus, aggregate demand shocks can have no permanent, or long-run, effect on the rate of output growth, y. The effects of u^D and u^S on inflation, p, are left unrestricted by (1b).

Inverting (1) we obtain:

$$B\ (L)\ (y_t,\ p_t)' = (u_t^S\ u_t^D)' \tag{2}$$

where B (L) = A (L) $^{-1}$. Equivalently,

$$b_{ys}\ (L)\ y_t + b_{ps}\ (L)\ p_t = u_t^S \tag{2a}$$

$$b_{yd}\ (L)\ y_t + b_{pd}\ (L)\ p_t = u_t^D \tag{2a}$$

which is the system that will be estimated subject to the restriction b_{ps} (1)=O. This will allow us to estimate the structural shocks by $\hat{u}^S$, and $\hat{u}^D$.

With what degree of confidence can we interpret $\hat{u}^S$ and $\hat{u}^D$ as the "aggregate supply" and "aggregate demand" innovations, respectively? The estimated model can be used to answer this question. Economic theory predicts that a positive aggregate supply shock leads to an increase in output and a reduction in prices, whereas a positive aggregate demand shock leads to an increase both in output and prices. If equations (2a) and (2b) generate a behaviour for y and p that is consistent with these predictions, then our identification is successful.

3. Estimation and Results

The estimation periods are 1861-1987 for Italy and Sweden, and 1868-1987 for the UK[3]. Annual observations are used. Even though

[3] Data for Italy and Sweden for the 1861-1975 period are from MITCHELL (1980).

the choice of countries and time periods was primarily dictated by data availability, the sample used is quite general: the time periods are large enough to include a number of interesting episodes, and hopefully therefore, a lot of identification power, and the three countries are as dissimilar as one could hope within Western Europe.

The initial step of the empirical implementation requires estimation of (2a) and (2b) subject to the restriction $b_{ps}(1)=0$. It is crucial for the estimation that the series involved be stationary. Table 1 presents the results of several unit root tests, that seem to support

Table 1
STATIONARITY TESTS

ITALY

x	p	DF(T)	DF(F)	p	ADF(T)	ADF(F)	pp(t)
y	o	9.37**	43.9**	4	4.83**	11.65**	8.05**
p	o	4.15**	8.6**	4	3.78*	7.13**	5.05**

SWEDEN

x	p	DF(T)	DF(F)	p	ADF(T)	ADF(F)	pp(t)
y	o	12.00**	71.9**	4	5.54**	15.34**	11.72**
p	o	4.68**	11.0**	4	3.79*	7.24**	5.01**

UNITED KINGDOM

x	p	DF(T)	DF(F)	p	ADF(T)	ADF(F)	pp(t)
y	o	7.95**	31.7**	4	5.60**	15.60**	7.61**
p	o	4.30**	9.3**	4	3.20*	5.12**	4.50**

The model is $(1\text{-}L)x_t = \alpha + \lambda x_t + \sum_{1=1}^{p} (1\text{-}L)x_{t-i} + u_t$. [DF(t)] is the absolute value of the t-ratio for λ (the Dickey-Fuller t). DF(F) is the F-ratio for the hypothesis $(\alpha, \lambda) = (0,0)$. The augmented versions of the statistics, [ADF(T)] and ADF(F), were calculated with four lags. PP(t) is the Phillips-Peron (1988) Z(t) statistic. Critical values from Fuller (1976) and from Dickey and Fuller (1981).
**: significant at 1%, *: significant at 5%.

Data for the UK for the 1868-1975 period are from Friedman and Schwartz (1982). All series have been updated to 1987 with data from Liesner (1989).

the hypothesis that neither the rates of output growth, nor the inflation rates of any of the three countries contain a unit root. Based on these results, the system (1a)-(1b) subject to the Blanchard-Quah restriction was estimated in growth rates and the estimated shocks $\hat{u}^S$ and $\hat{u}^D$ were obtained. To check robustness, models with different lag lengths were estimated for each country, but gave very similar results, offering no indication that estimation is sensitive to lag specification. What follows is based on the models with 4 lags.

First, we want to know whether the estimated shocks can be interpreted as aggregate demand and aggregate supply innovations. To examine this, Table 2 reports the impulse response functions for

Table 2
Impulse Response Functions

ITALY

	Response of OUTPUT to shock in		Response of PRICES to shock in	
Year	AS	AD	AS	AD
1	4.26	-3.83	3.84	12.65
2	4.03	-5.88	6.16	22.90
3	5.29	-3.50	4.64	30.68
5	6.09	-1.93	3.11	42.39
10	5.97	-0.08	-1.12	47.29
20	5.80	-0.00	-1.75	46.25
30	5.81	-0.00	-1.73	46.26

SWEDEN

	Response of OUTPUT to shock in		Response of PRICES to shock in	
Year	AS	AD	AS	AD
1	4.07	2.03	-2.43	3.93
2	3.57	1.57	-4.03	7.60
3	3.16	1.02	-4.31	9.74
5	4.10	0.30	-3.47	11.49
10	3.70	-0.18	-1.86	9.44
20	3.70	-0.00	-2.23	9.58
30	3.69	0.00	-2.22	9.54

UNITED KINGDOM

	Response of OUTPUT to shock in		Response of PRICES to shock in	
Year	AS	AD	AS	AD
1	2.13	2.11	-3.52	2.49
2	2.43	2:66	-4.48	5.17
3	2.49	2.48	-4.61	7.95
5	3.37	0.74	-5.71	12.29
10	2.65	0.15	-6.22	13.22
20	2.67	0.00	-6.33	13.63
30	2.67	0.00	-6.34	13.64

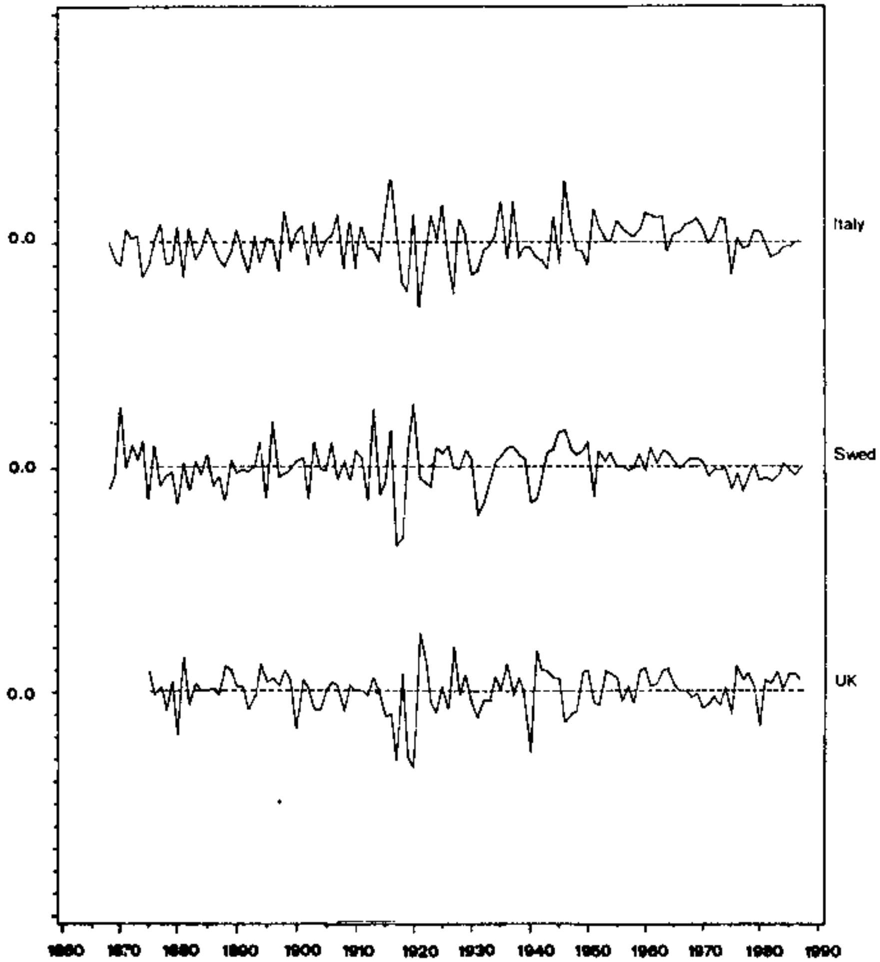
output growth and inflation in the three countries. These functions simulate the responses of the variables y and p over time to (positive or "favourable") innovations of one standard deviation in each of the structural shocks. The impulse response functions for Sweden and the UK are in total agreement with our *a priori* assumptions from economic theory: output responds positively to both u^S and u^D, and prices respond negatively to u^S and positively to u^D. This means that for these two countries the identification has been successful and we can safely interpret the two shocks as aggregate supply and aggregate demand shocks. In the case of Italy, however, our interpretation has to be more cautious. Table 2 shows that in Italy output is found to respond positively to u^S (as expected) but negatively to u^D (which contradicts our a priori expectation). Also, prices rise after an increase in u^D (as theory predicts) but also rise after an increase in u^S (contrary to theory)[4]. This means that our theoretical model describes Italy imperfectly and that the estimated innovations for Italy may not

[4] The reason for these results in the case of Italy may very well be the observations for the years 1940-1945, that combine high inflation rates (from 18% to 142%) with negative rates of real growth (from -3% to -23%). By construction, our estimation technique labels the event a demand- side disturbance, and a positive one. Because these observations are important (i.e., large) enough to possibly overwhelm the rest of the sample, positive demand shocks become associated with high prices and low output. KEATING and NYE (1990) report a similar problem for Italy, and also for Norway, Sweden, and France. In their case, however, the source of the problem must be different (probably the small samples used) because the 1940s are outside their sample, and because Sweden is adequately described here.

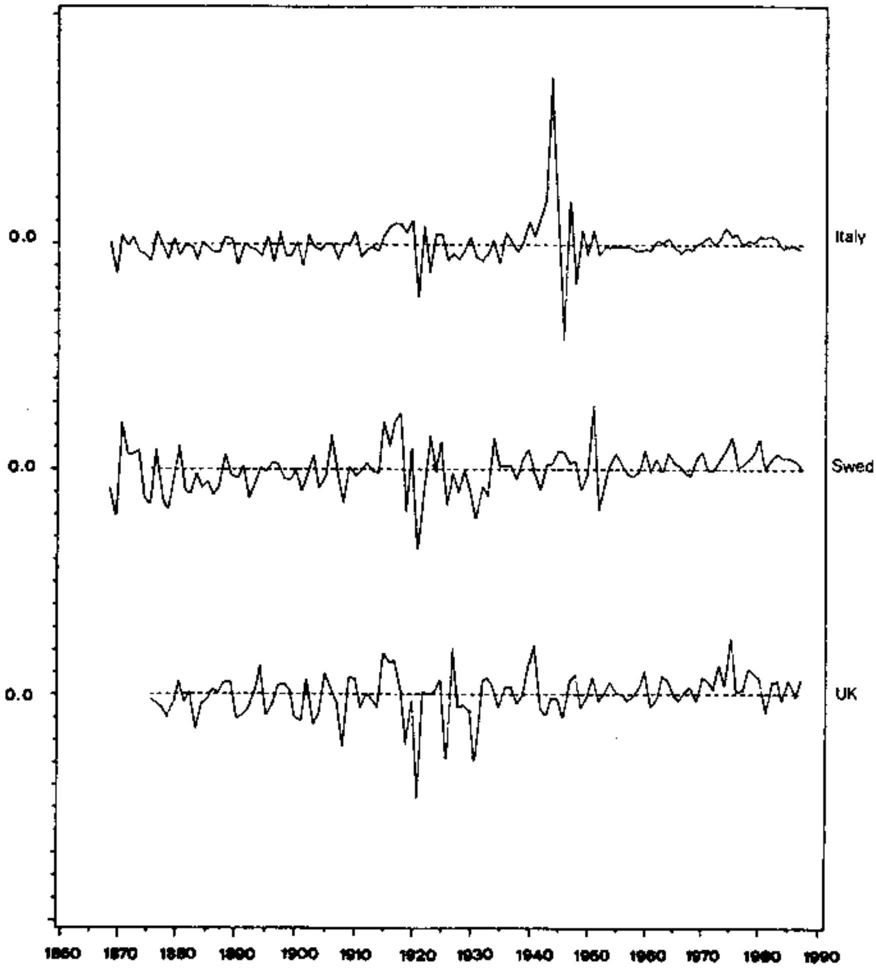
correspond to the theoretical aggregate supply and aggregate demand shocks (although they will be called such in the remainder of the paper).

Graphs 1 and 2 plot the estimated shocks in standard deviations units. Graph 1 shows that large supply shocks are the exception rather

Graph 1
Aggregate Supply Shocks



Graph 2
Aggregate Demand Shocks



than the rule. For all three countries, the period of the greatest volatility was roughly the two decades from 1915 to 1935. It is also interesting that the aggregate supply shocks during this period were almost perfectly synchronous in the three countries. For example, all three countries were hit by large negative supply shocks in the period from 1917 to 1920 and again from 1930 to 1932. 1940 was also a year that Sweden and the UK experienced a significant supply shock[5]. It follows that wars can only be partly responsible for unfavourable supply shocks because the involvement of the three countries in both world wars was very different. Disruptions in international trade due to war might be more responsible than the war itself. Graph 1 also supports the view that supply shocks (positive and negative) have generally declined in importance since the 1950s for the countries of our sample. Thus, the oil shocks of 1974 and 1979 show only as minor disturbances compared to the shocks of the 1920s and 1930s. Aggregate demand shocks, presented in Graph 2, appear to be even more synchronous[6]. Once more, wars do not seem to be able to explain this phenomenon entirely; for example, in 1921 all three countries experienced a significant negative aggregate demand shock. The two world wars, however, are associated with large positive aggregate demand shocks, and this is true even for Sweden that maintained neutrality. The largest aggregate demand shock is the one for Italy in 1944 (7.5 standard deviations), which can be traced to the 140% inflation rate of that year.

Table 3
Variance Decompositions

ITALY

	Fraction of OUTPUT explained by shock to		Fraction of PRICES explained by shock to	
Year	AS	AD	AS	AD
1	55.28	44.72	8.43	91.57
4	59.54	40.46	2.83	97.17
8	77.30	22.70	0.91	99.09
20	90.17	9.83	0.36	99.64

[5] However, it seems that aggregate supply shocks are synchronized only during specific episodes and not for the entire sample. Correlation coefficients for the aggregate supply shocks are (with significance levels in parentheses): .16 (.08) for Italy-Sweden, -.26 (.005) for Italy-UK, and .05 (.62) for Sweden-UK.

[6] Correlation coefficients for the aggregate demand shocks are (with significance levels in parentheses): .25 (.006) for Italy-Sweden, .24 (.01) for Italy-UK, and .59 (.00) for Sweden-UK.

SWEDEN

	Fraction of OUTPUT explained by shock to		Fraction of PRICES explained by shock to	
Year	AS	AD	AS	AD
1	80.11	19.89	27.69	72.31
4	86.57	13.43	16.77	83.23
8	92.37	7.63	10.19	89.81
20	96.89	3.11	7.15	92.85

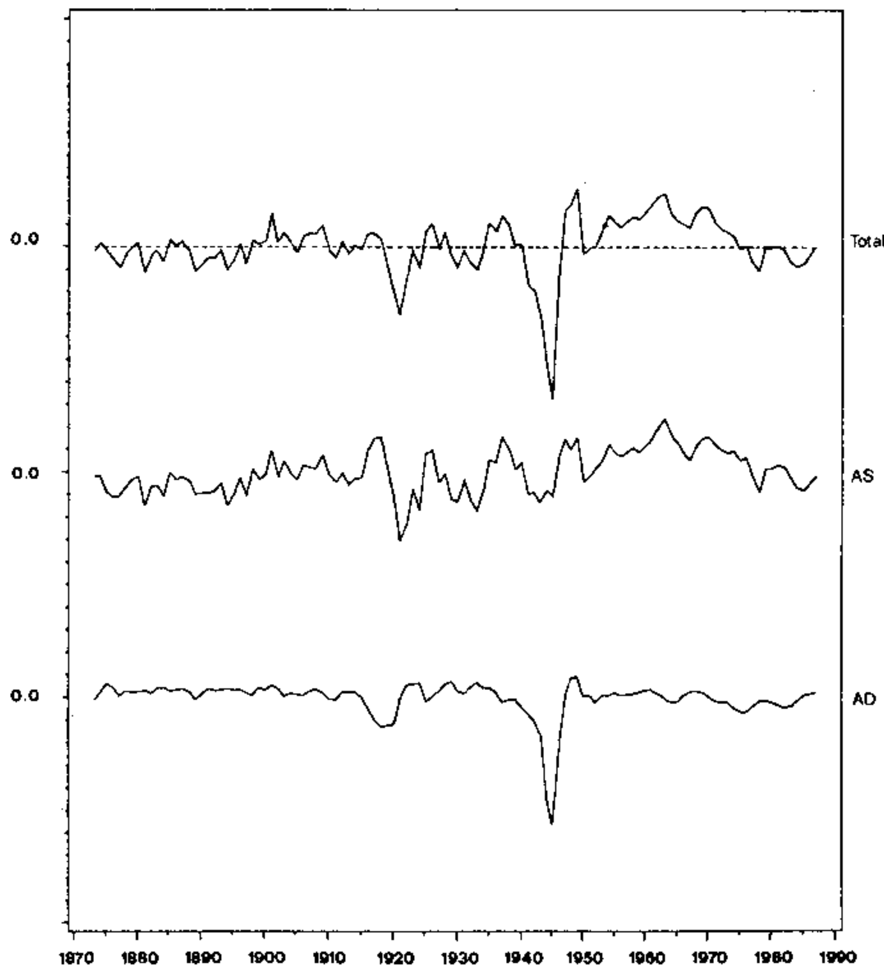
UNITED KINGDOM

	Fraction of OUTPUT explained by shock to		Fraction of PRICES explained by shock to	
Year	AS	AD	AS	AD
1	50.64	49.36	60.07	39.93
4	52.41	47.59	27.86	72.14
8	69.16	30.84	20.66	79.34
20	86.29	13.71	18.64	81.36

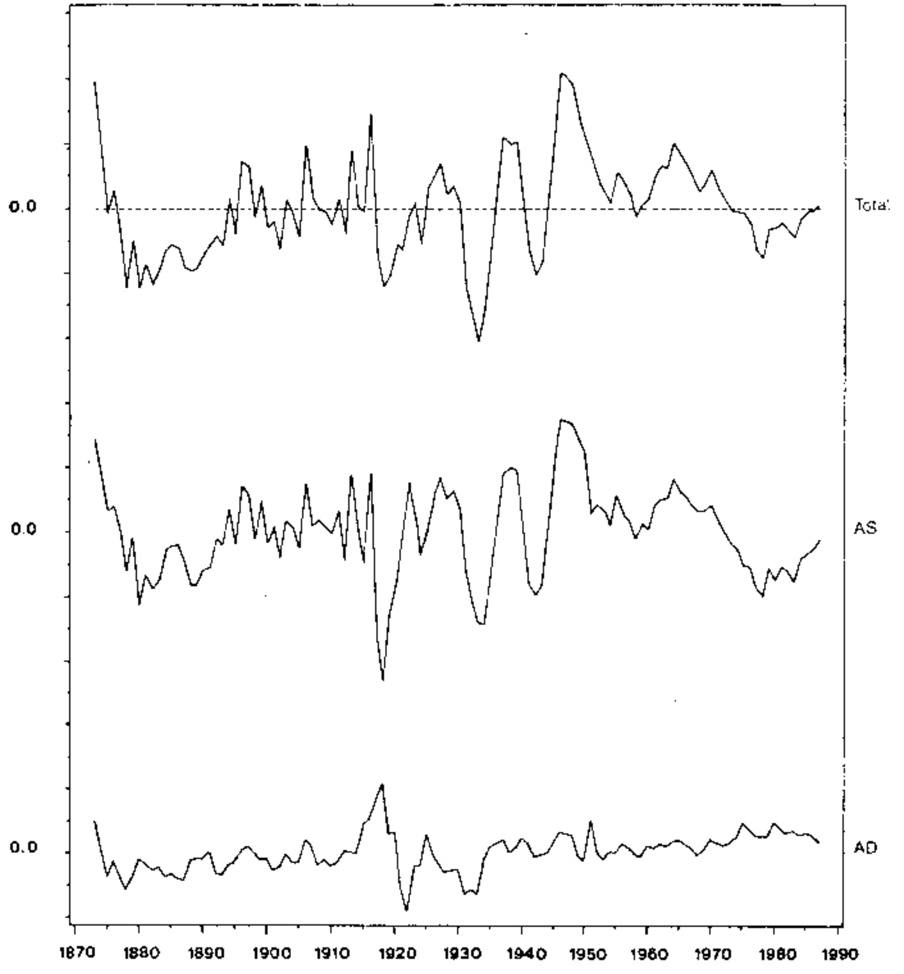
Table 3 shows the variance decompositions for output growth and inflation. The numbers reported indicate the percentage of the forecast error in each variable that can be attributed to each of the structural innovations at different horizons. The decompositions are reported for four horizons which, given the length of the sample, can be interpreted as the short-run (1 year ahead), the medium-run (4 to 8 years ahead), and the long-run (20 years ahead). The contribution of aggregate demand innovations to output dies out in the long-run, by construction (because of the $a_{yd}(1)=O$ constraint that has been imposed on the model). A striking feature of Table 3 is that aggregate supply is very important (and perhaps dominant) for output even in the short-run, and this is a finding robust across the three countries. This is particularly pronounced in Sweden, where aggregate supply innovations explain 80% of the variability in output in the first year. In Italy and the UK aggregate supply is responsible for about half of the first year output variance. The finding that aggregate supply shocks are important at business cycle frequencies, implies that the significance of aggregate demand shocks for business cycles might have been exaggerated. Regarding inflation, the results are not surprising. Aggregate demand shocks dominate in the long-run in all countries, and even in the short-run in Italy and Sweden. The importance of aggregate supply shocks for prices decreases over time. This is consistent with the hypothesis that inflation is a monetary phenomenon in the long-run.

The impulse response functions and the variance decompositions examined so far, quantify the importance of the structural disturbances *on average* (i.e, over the whole period under consideration). At least of equal interest is the contribution of the shocks to the fluctuations of each variable at any point in time (i.e., in any given year). This will allow an investigation of the importance of aggregate supply and aggregate demand shocks at specific historic episodes. For output this is done in Graphs 3, 4, and 5, for Italy, Sweden, and the UK, respectively. Here, aggregate supply shocks seem to contribute more to output movements. However, most significant downturns, and especially those of the early 1920s in Italy and the UK, and those of the early 1930s in Sweden and the UK, have required the contribution of both types of shocks. On the contrary, the 1917-1921 contraction in Sweden is pure aggregate supply, and the early 1940s Italian downturn is primarily due to aggregate demand (although in the second case identification is more problematic). Graphs 6, 7, and 8 show the contribution of the two kinds of shocks to inflation. As expected, aggregate demand shocks contribute the most. This is especially true for Italy (subject to the interpretation problem) and Sweden, and less so for the UK.

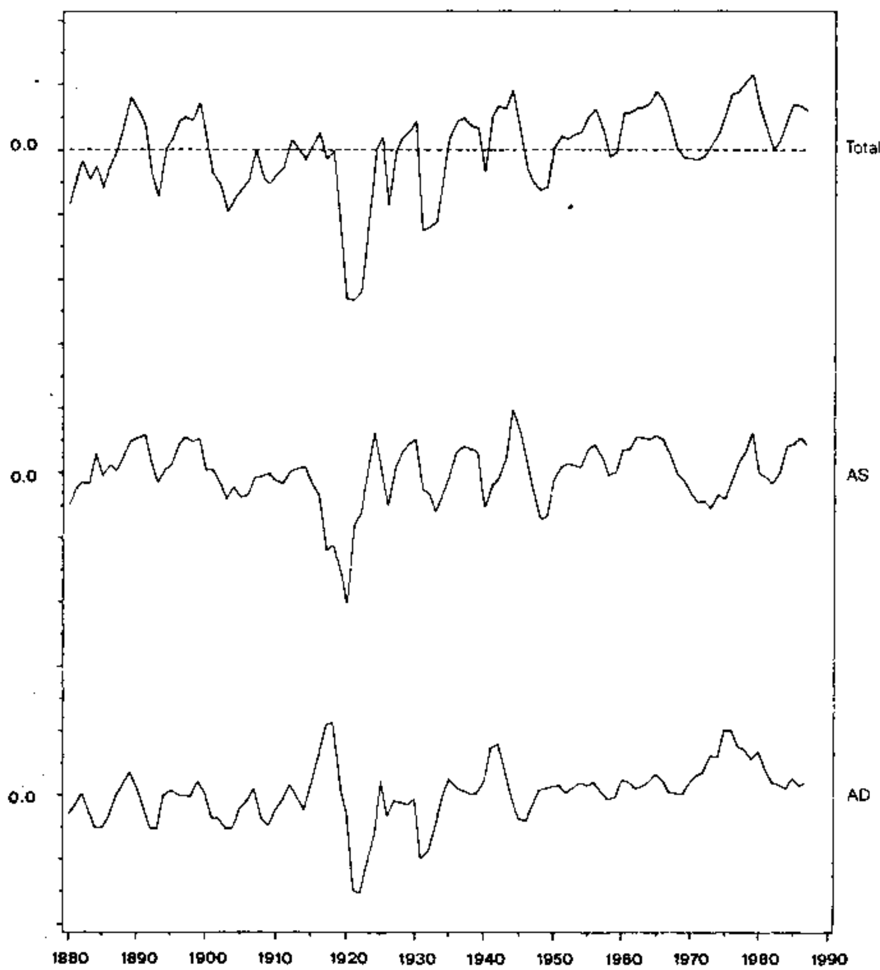
Graph 3
Italy
Components of Output Forecast Error



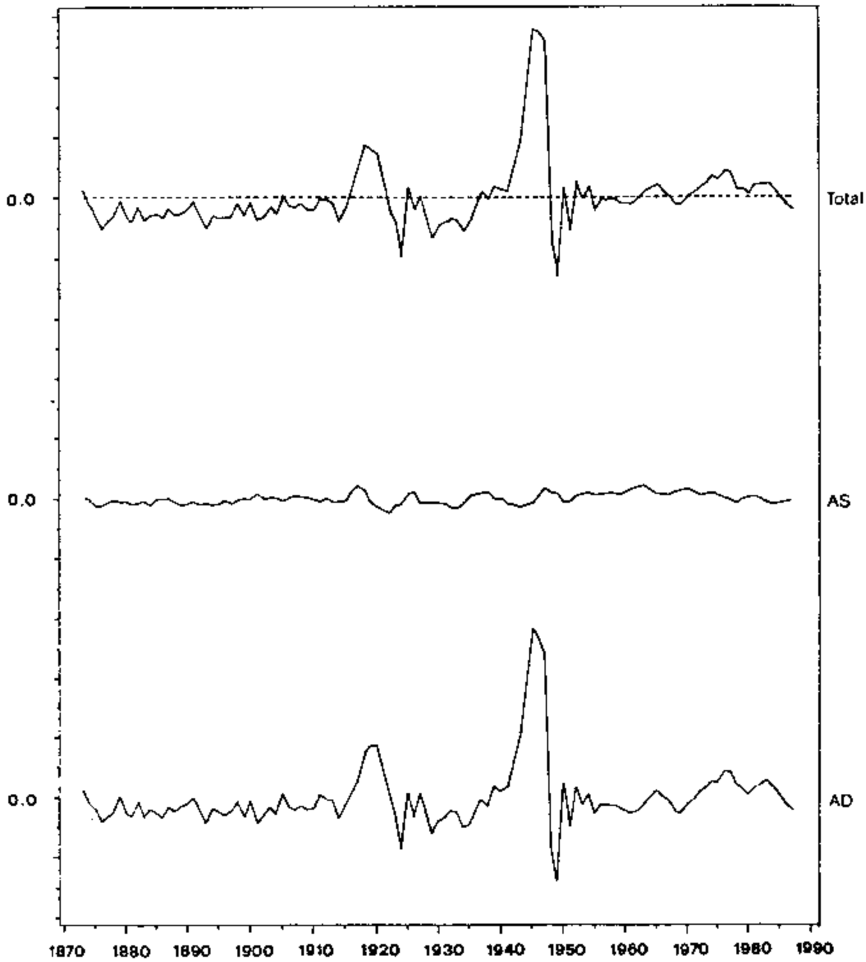
Graph 4
Sweden
Components of Output Forecast Error



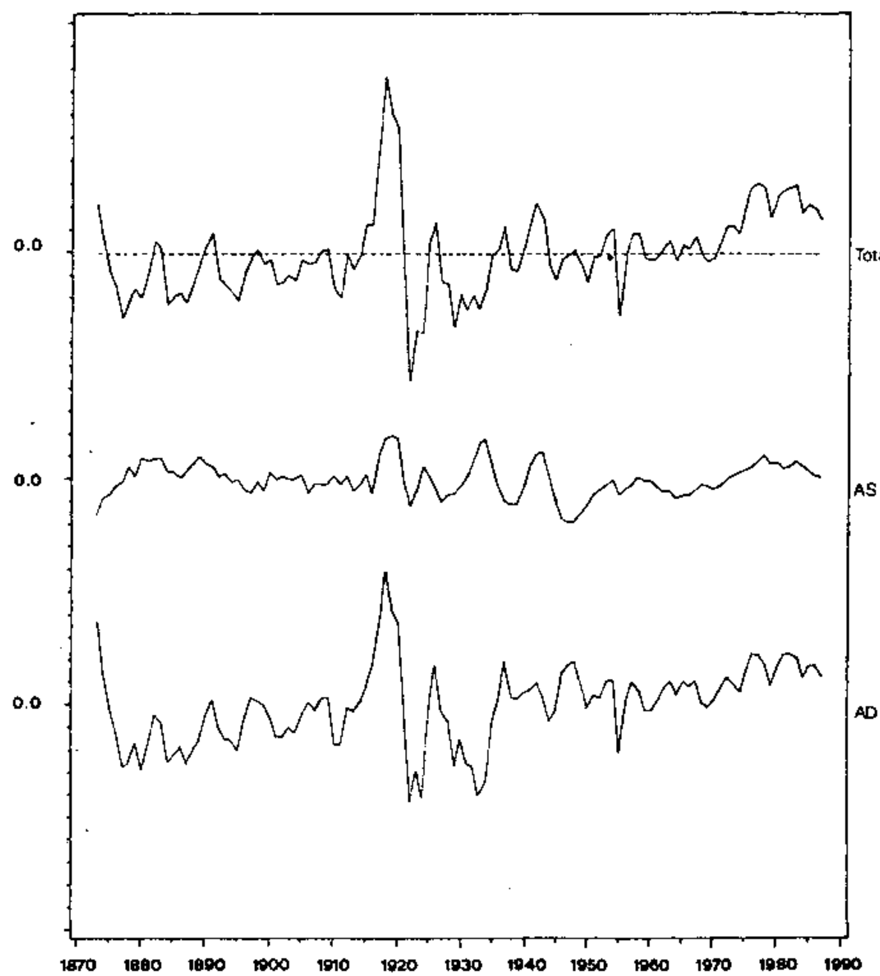
Graph 5
UK
Components of Output Forecast Error



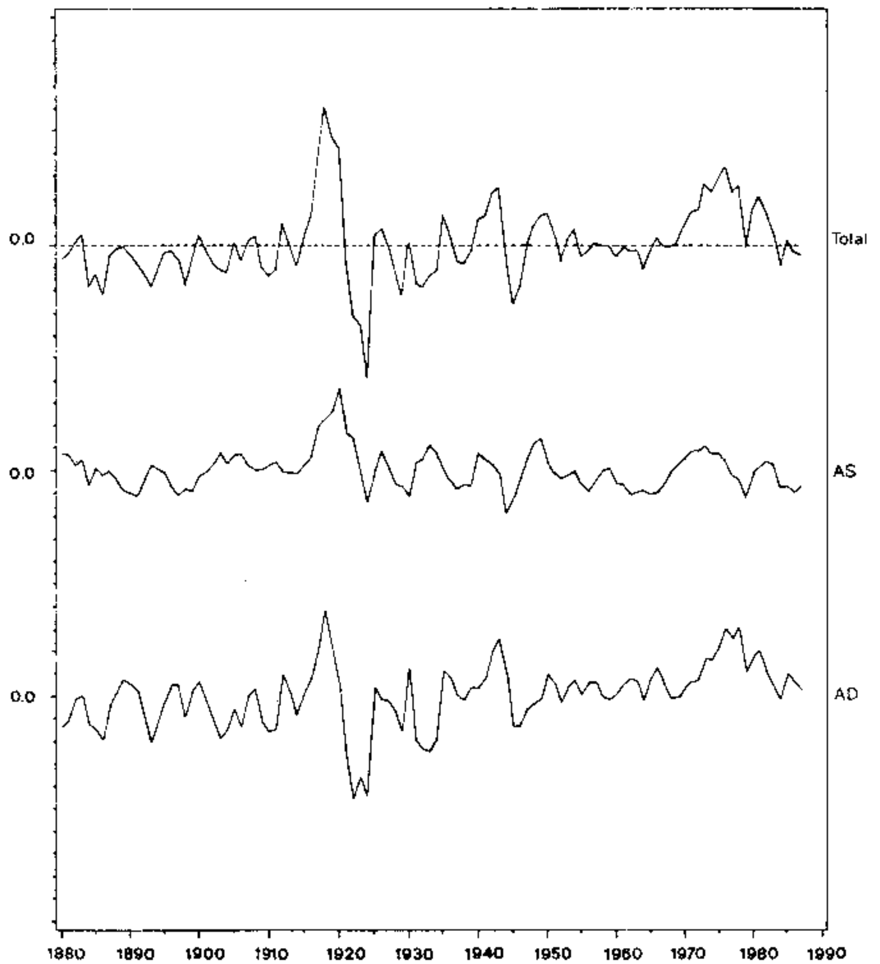
Graph 6
Italy
Components of Prices Forecast Error



Graph 7
Sweden
Components of Prices Forecast Error



Graph 8
UK
Components of Prices Forecast Error



4. Conclusions

This paper used the structural VAR approach to investigate the importance of aggregate demand (AD) and aggregate supply (AS) shocks for the macroeconomic fluctuations in Italy, Sweden, and the United Kingdom since the 1860s. Identification of these shocks was achieved by postulating that aggregate demand shocks have no long-run effects on output (the Blanchard-Quah assumption). The identification was successful for Sweden and the UK where positive AD shocks were shown to raise output and prices, whereas favourable AS shocks increased output and reduced prices. In the case of Italy, however, the identification is potentially problematic because AD shocks raise prices but reduce output, and AS shocks increase output but also increase prices.

An interesting result is that aggregate demand shocks appear to be synchronous in the three countries for the entire period. Aggregate supply shocks are also highly synchronized but only during episodes of great volatility. This implies that the degree of integration and interdependence of the three economies was higher than generally thought.

Another interesting finding is that aggregate supply shocks account for a significant fraction of output variability (50% or greater) even in the short-run. This means that the contribution of AS shocks to business cycles might have been underestimated. On the other hand, the variability of prices was largely explained by AD disturbances, as expected.

There is also evidence that the severity of AS and AD shocks has declined since the 1950s in the countries examined. The period with the greatest volatility was the 20 years from 1915 to 1935. Wars were found to be associated with positive AD shocks. Large AS shocks, however, can more safely attributed to the consequences of wars, like disruptions to trade, rather than to the wars themselves.

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