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DEMAND AND SUPPLY SHOCKS IN INDUSTRIAL OUTPUT

Andrea Gavosto [1] and Guido Pellegrini [1]

ABSTRACT

In this paper we investigate the impact of three different kinds of disturbances on industrial output in Italy. They originate respectively in aggregate demand, technology and the labour supply. We first illustrate the theoretical restrictions which permit identification of the three shocks. Then the econometric identification is achieved by extending the Blanchard and Quah (1989) bivariate procedure to a multivariate case. We then compute the permanent component of industrial output. Our main conclusions are: i) output variability is significantly affected by technological shocks at all frequencies. Labour supply disturbances are also relevant, while demand shocks have a minor impact on the series; therefore the short-run behaviour of industrial production is largely explained by supply side shocks; ii) demand shocks play a more important role during the seventies than during the eighties. We suggest this might be due to a more counter-cyclical stance of economic policy during the last decade.

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1. Banca d'Italia, Research Department.

Introduction (*)

A number of recent studies[2], following the seminal article by Nelson and Plosser (1982), have found that output follows a non-stationary (unit root) process. This result seems to hold across different countries and historical periods. The main implication, from the point of view of time series analysis, is the persistence of the effects of random shocks on output. Whereas the effect of a serially independent shock on the level of a stationary variable fades away with time, the effect on a non-stationary variable persists indefinitely. The variable shows no tendency to revert to a mean or "equilibrium" level.

This finding has prompted a good deal of research, both in the econometric and the economic field. On the one side, econometricians have reconsidered the traditional decomposition of output into a deterministic trend and a cyclical component: the permanent component of output can now be more adequately described by a stochastic trend. At the same time, economists have started to look more closely into the origins of such persistent innovations. The existence of a stochastic trend has in fact deep implications for economic analysis.

(*) Helpful comments from an anonymous referee are gratefully acknowledged. Angelina Cheche and Liliana Pulcini provided skillful assistance. The paper is the result of joint work; however sections 1 and 2 were materially drafted by A. Gavosto, section 3 and the appendices by G. Pellegrini.

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2. See, for instance, Clark (1989) and Wasserfallen (1988). For a different interpretation, see Perron (1989). Recently, Christiano and Eichenbaum (1989) and Rudebusch (1990) have stressed the difficulty of inferring the existence of unit roots in macroeconomic time series.

Traditionally, macroeconomic theory has kept long-term output growth separate from short-run business fluctuations. The former, it used to be argued, depends on supply-side factors, such as capital stock, labour force and technology, which determine a "full-employment" equilibrium level of output, whose movements are approximated by a linear trend. On the other hand, there are transitory shocks from the demand side which deviate output from its long-run path of growth, giving rise to a cyclical pattern of activity. These are short-run disequilibrium phenomena, however, whose magnitude may be relevant but whose impact is bound to fade away with time.

Now, this dichotomy between high - frequency business fluctuations and low - frequency growth has been seriously challenged by the findings about the integrated nature of output. If all innovations can affect the level of output permanently, it may not be legitimate to make a distinction between long-run trend and short-run cycles. In the extreme, output behaviour both in the long and in the short run can be explained by a unique source. This is what one strand of real business cycle theory asserts[3], positing that output movements are completely due, both at high and at low frequencies, to supply side innovations[4], in particular to technological shocks. In this case, a univariate time series analysis is sufficient to fully account for the cyclical behaviour of output (see Watson, 1986). As a matter of fact, the notion that supply shocks can drive output in the

3. Main references are Kydland and Prescott (1982), Long and Plosser (1983), Prescott (1986), Lucas (1987). For critical reviews, see McCallum (1988) and Mankiw (1989).

4. Recently, Plosser (1989) has drawn attention to the possibility that shocks to consumers' tastes give rise to real business cycles.

short-run is not new. Even Keynesian macroeconomists have extensively entertained the idea that the adverse fluctuations of output in many industrialised countries during the seventies and the early eighties originated on the supply side, be it the oil shocks of 1973 and 1979, the productivity slowdown of the seventies or the union push of the late sixties. In a series of contributions, summarised in their 1985 book, Bruno and Sachs offer a comprehensive and convincing treatment of the subject. Still, these negative impulses were regarded as having essentially transitory effects, arising from rigidities in wages and prices. Once relative prices had adjusted to their equilibrium levels, which might require a rather long time, output would return to its previous path of growth. As such, these supply disturbances were kept conceptually distinct from growth factors. Now, the potentially permanent character of every shock to output has obscured the distinction between business cycles' and growth.

The idea that shocks that affect the economy in the long-run can also move the economy at high frequencies, appealing as it is, has motivated a good deal of recent research (see, for instance, Campbell and Mankiw, 1987a, 1987b, 1989, and Stock and Watson, 1988). Nevertheless, there is no agreement among economists on the notion that fluctuations at all frequencies have only one origin. In particular, demand innovations are still regarded as an important source of output movements, at least in the short-run. Consequently, a more general approach has emerged of late: different kinds of shocks, from both the demand and the supply side, are taken into account in explaining the variability of output (Blanchard and Quah, 1989, and Shapiro and Watson, 1988). Identification of these shocks is achieved by way of a set of long-run assumptions, as suggested by economic theory. We intend to apply this approach to Italian output. In other words, we take the findings about the integrated nature of output seriously and allow for the existence of a stochastic trend. This will be further decomposed and the contributions of a set of driving variables assessed, in hopes of finding new insights on the characteristics of recent business cycles.

A few words on the methodology are in order. The approach, put forward by Blanchard and Quah and known as "structural VAR", consists of estimating a VAR of the variables of interest, deriving its germane Vector Moving Average representation and imposing a set of identifying restrictions on the long-run coefficients and the variance-covariance matrix of the MA innovations, in order to recover structural disturbances. It is different both from traditional model estimation and from reduced-form VAR, as advocated by Sims. In the former, identification is often achieved by imposing exclusion restrictions on the equations, so that endogenous variables cannot affect exogenous ones and are in turn affected by some, but not all, of the relevant predetermined variables. The drawback to this kind of analysis is that it also imposes a tight dynamic specification, since the choice of the lags of the explanatory variables is often controversial. In practice we know very little about the actual adjustment processes of economic variables, so that any restriction is necessarily arbitrary. This is particularly limiting whenever we want to examine the behaviour of a series across the entire spectrum of frequencies. The advantage of the structural VAR approach vis-à-vis the traditional modelling strategy is that it does not restrict the pattern of dynamic responses. This is also true of reduced-form VARs, of course. Compared to the latter, structural VARs are able to exploit the a priori information coming from economic theory, rather than relying on an arbitrary ordering of the variables (which is tantamount to imposing a set of arbitrary identification restrictions; see Blanchard, 1989, on this issue). Naturally enough, there are limitations to this approach too: a major one is that the identifying assumptions cannot be tested (this is also true of the traditional strategy, of course). Therefore, the assumption that one shock (demand, say) has no long-run impact on output may lead, if wrong, to serious misinterpretations of the events. Besides, serious difficulties in interpreting the origin of the shocks may arise, if two or more disturbances have a similar qualitative long-run impact on the variables of interest. Finally, a related issue is that structural VAR representations might be too restrictive, when compared to more traditional econometric macromodels. In fact, at the state of the art, long-run restrictions are of the kind: "the shock affects or does not affect the variable in the long run", whereas identification could also be achieved by setting the value of the coefficient to be any number.

The rest of the paper is organised as follows. In section I, our identifying assumptions are made explicit. In section II, the variables of interest are introduced and their time series properties discussed. In the following sections, we present our results and draw the main conclusions. Methodological and data appendices follow.

1 - Model

We are interested in identifying the main determinants of Italian industrial output since 1965. In our view, three kinds of shocks have played a major role in explaining output fluctuations:

a) technological shocks. These may occur following the introduction of new equipment, the updating of the workforce's skills or a different organisation of work within the factories. Although one may be inclined to think of these shocks as having generally beneficial effects, this is not necessarily the case: for instance, the adoption of restrictive working practices, quite widespread during the seventies, may be seen as a negative innovation.

b) labour supply shocks. What we have in mind here are both demographic factors, like the entry of new cohorts into the labour force, and the consequences of decisions by incumbent workers whether or not to participate and, if so, for how many hours. Given the prominent role played by unions in the industrial sector during most of our sample, these shocks may well reflect different unions' attitudes rather than purely voluntary decisions by optimising agents. Analogously, well-known phenomena such as industrial, occupational and, above all, geographical mismatches can be interpreted, in this context, as negative disturbances to the labour supply.

c) demand shocks. We refer here to disturbances to overall (domestic and foreign) demand in the manufacturing sector. No attempt will be made to draw a distinction between disturbances from the money and from the goods sides (on this issue see Gali, 1988), nor will we try here to identify permanent shocks to consumers' preferences.

A few words of caution are needed at this point. It is certainly arbitrary to restrict one's attention to these three sources of innovation alone. Other factors might have played a significant role in explaining output fluctuations: energy prices are an obvious candidate. In addition, by looking at the manufacturing industry alone, we necessarily neglect the interrelations between it and other segments of the economy, such as the service and the public administration sectors, whose importance has grown considerably in the recent past. On the other hand, a detailed investigation of these and related issues would have added too much complexity to our model, insofar as the indentifying restrictions are concerned. Therefore, we have chosen to treat them in a simpler, albeit ad hoc, fashion, using control variables in the estimation. Another potentially troublesome aspect of our methodology is the assumption, necessary in order to achieve identification, that the three shocks we are considering are uncorrelated at all leads and lags. We can think of many reasons why this might not be true. For instance, the adoption of new technology may be enhanced by a boom in aggregate demand. Alternatively, a negative disturbance to demand may bring about a change in the climate of industrial relations reducing unions' power and favouring more flexible working practices, which in our framework will be accounted as positive technological shocks or, possibly, as an increase in labour supply. We believe that only a fully-fledged model could eventually capture all the interrelations among the relevant variables. Nevertheless, we are confident that a decomposition into orthogonal shocks can provide useful insights by making it possible to focus at least on the proximate causes of output fluctuations. To proceed from there down the line and attribute a unique origin to each shock would probably require a logical step our methodology does not allow and which we are not prepared to make. In order to provide a further defence of our approach, it should be said that the orthogonalisation, implied by the methodology, tends to divide the reduced-form errors in such a way as to lump together all the correlated disturbances. In this sense, all the shocks which are not originally caused by demand, say, but are nevertheless highly correlated to demand, will end up as demand innovations in our final breakdown: this should largely dispose of the criticism mentioned above. The interpretation of the origins of the shocks may be an issue (and it certainly is), but the methodology looks sound enough.

The assumptions we make in order to identify the shocks can be illustrated as follows. Similarly to Shapiro and Watson (1988), we consider a long-run Cobb-Douglas production function:

$$Y_t = Z_t \, L_t^{\alpha} \, K_t^{1-\alpha} \tag{1}$$

where L_t and K_t are respectively labour supply and the (predetermined) capitale stock. Z_t is (stochastic) technical progress. In steady state (defined by the absence of shocks), the capital-output ratio is constant, as in the standard neoclassical grouth model (see Solow, 1965, and Swan, 1965). Therefore the production function can be written (in logs) as

$$Y_t = \phi_o + l_t + \frac{1}{\alpha} z_t \tag{2}$$

where ϕ_o is a constant term which depends on the steady-steady capital-output ratio. We assume further that both a labour supply and technical progress follows a random walk:

$$l_t = l_{t-1} + \varepsilon_t^l \qquad (3)$$

$$z_t = z_{t-1} + \varepsilon_t^z \qquad (4)$$

where ε_t^l and ε_t^z are white noises. Substituting (3) and (4) into (2), we obtain that

$$\Delta Y_t = \varepsilon_t^l + \frac{1}{\alpha} \varepsilon_t^z$$

where ΔYt is the (log) change in output. Innovations in the supply of labour and technology have thus a temporary effect on the rate of change of output but a permanent one on its level. Also, we assume that in the long run the amount of labour supplied by households is invariant in relation to technical progress. This result is not necessarily true in general, but can be derived under the assumption of a logarithmic utility function, so that income and substitution effects cancel each other out.

We can now turn to aggregate demand. We believe that demand plays an extremely important role in short-run fluctuations by causing output and inputs to deviate from their long-run levels. How protracted these departures from steady state can be is a moot question that is at the core of the current economic debate. We will leave it to be determined by the data themselves. The only crucial restriction we impose on demand is to rule out permanent effects on the long-run level of output. Again, this is in line with standard growth theory.

The assumption of demand neutrality in the long run is not uncontroversial. One can easily think of channels through which aggregate demand components might impinge on output permanently: for example, distortionary taxes, government expenditure on education, and money itself, if hysteresis phenomena are deemed to be important. We do not ignore the importance of these effects. Indeed, we think that the growing body of analysis on the "micro" effects of demand disturbances is extremely promising. Nonetheless, in a macroeconomic framework such as ours (and even in more traditional modelling strategies), it is still very difficult to incorporate these effects by detecting the impulses and highlighting the channels of transmission in a satisfactory way. Furthermore, we believe that the long run effects of demand, if any, are tiny compared with those of supply factors. If this is the case, then the methodology used here delivers a "nearly correct" decomposition, as proved by Blanchard and Quah (1989).

We can now summarise our main identifying assumptions. We are interested in identifying three shocks: a demand shock (e^d), and two supply shocks, technology (e^τ) and labour supply (e^l). We consider three economic variables (their characteristics will be examined later): manufacturing output, total hours worked in the manufacturing sector and total demand in the industry. The first two will be shown to be non-stationary, whereas the third is stationary almost by construction (see below). We assume that the level of output can permanently affected by technology and labour supply innovations (with positive elasticities); on the other hand, demand is neutral in the long-run. All shocks can have transitory effects on output: their persistence is to be established by the data.

Hours worked are also allowed to vary freely in the short run. Workers can be off their labour supply, as implied by a variety of models, such as the inflation-augmented Phillips curve or the Taylor contract model. In the long run, the driving force behind hours is labour supply innovations, whereas technology is assumed to have no effect, in line with the postulated absence of wealth effects on leisure.

Finally, demand is a stationary series and, as such, tends to return to its mean level. Hence, no disturbance can permanently affect its long-run level, although temporary responses can indeed occur.

We now sketch the estimation procedure (details are given in the Appendix). First, we estimate a VAR for output, hours and demand.[5] Then we invert it to obtain the corresponding VMA representation in terms of residuals. We impose our restrictions on the long-run matrix (which contains the sums of the moving average coefficients) and on the variance-covariance matrix in order to recover structural disturbances from the estimation residuals. Finally, impulse response functions and the relative contributions of the shocks to output variability are assessed. A general caution regarding the methodology is necessary at this point. While the disturbances are <u>defined</u> by the identification procedure, their economic interpretation is subjective and depends on the researcher's prior assumptions. If one believes that output is affected permanently by demand shocks and not, say, by supply, this procedure can be applied just the same: only the "labels" attached to the disturbances will be interchanged.

Before we proceed to examine the results, a look at the variables is in order.

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5. A comprehensive study of the use of the VAR model in the analysis of economic fluctuation can be found in Starck (1990).

2 - Data

The decision to restrict our analysis to the manufacturing sector was unavoidable. Long-run properties, such as stationarity, can only be assessed on time series which span many years, since it is low frequencies we are interested in. In Italy sufficiently, albeit not ideally, long series can only be found for manufacturing; most of the data series for the rest of the economy begin too late. All variables are quarterly and seasonally adjusted. The sample goes from 1965 to 1989. Details can be found in the Appendix.

Our measure of manufacturing output is the index of industrial production[6], based in 1985 and corrected for the different number of working days in each year (Figure 2.1). We decided to use this index rather than value added for two reasons: data are available from 1953, onwards, while consistent information on value added only dates back to 1970; the survey is conducted on a monthly basis, ensuring a more precise assessment of intrayear fluctuations. On the other hand, and in contrast with value added, the index is at constant weights. Although weights have been changed five times in our sample, changes in output composition are necessarily captured with some lags. In addition, the index is affected by the degree of integration between sectors of the economy. Since 1978, manufacturing firms have transferred a large proportion of their activities to specially created downstream firms, often belonging to the service sector (see

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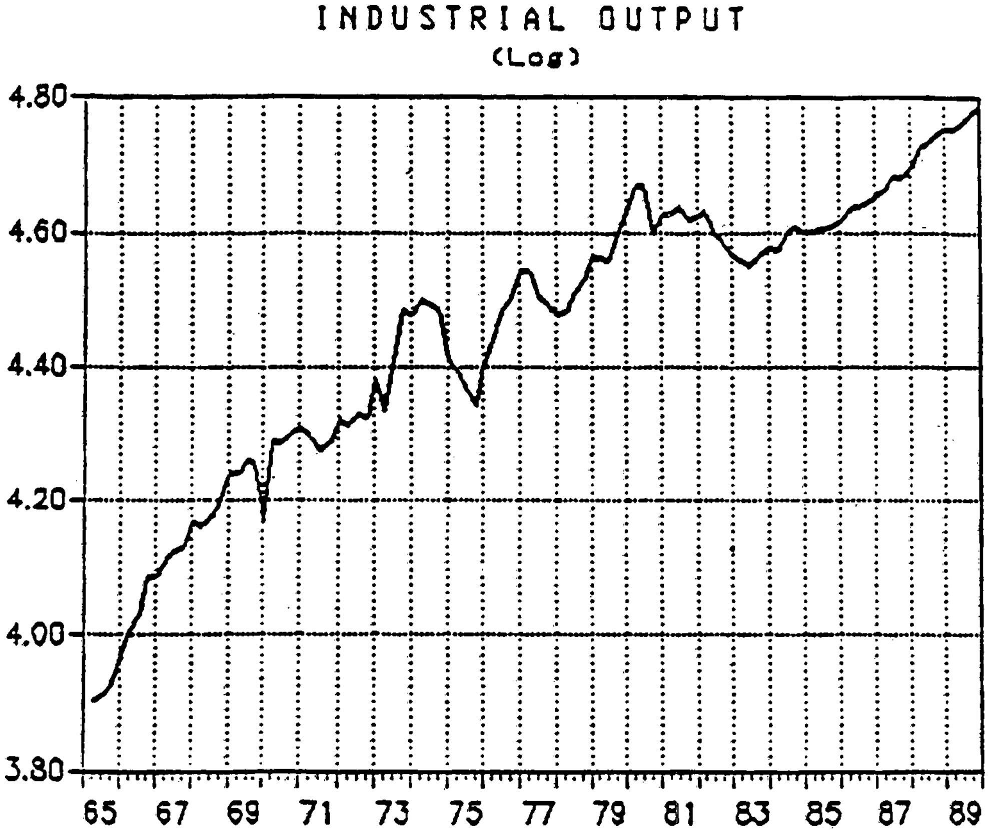
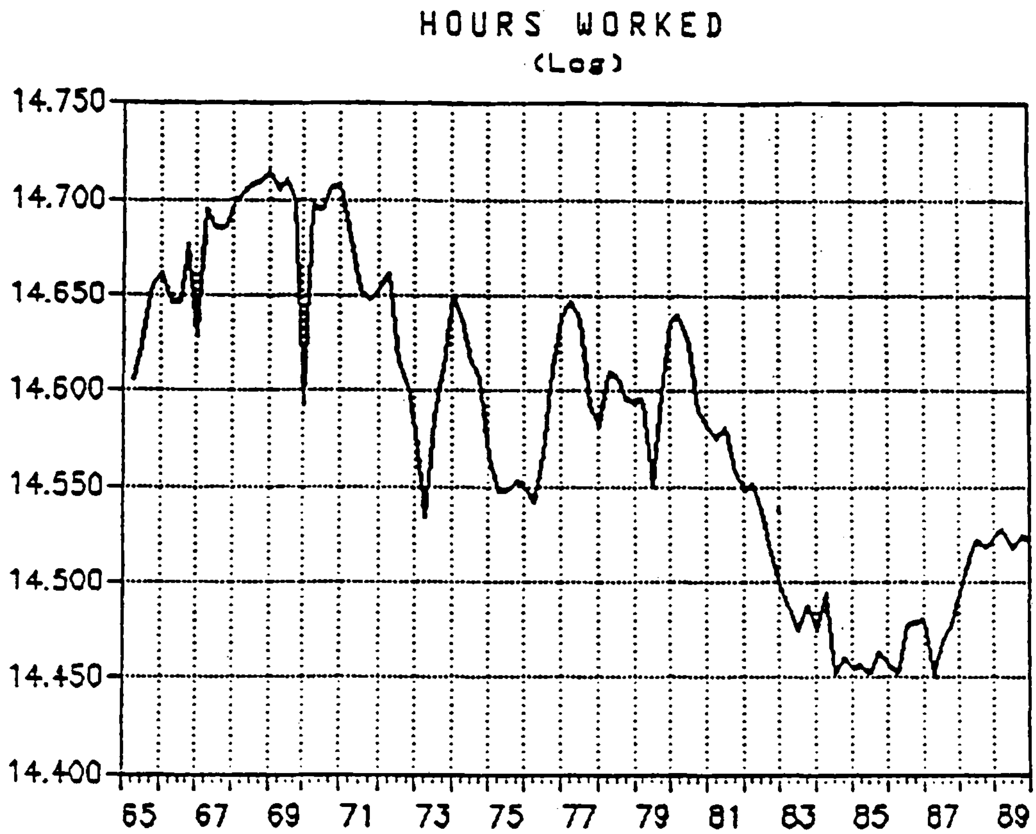
6. Industrial production is equal to manufacturing output plus the energy sector's output. Because the energy sector (coal, electricity, water and gas) accounts for a small portion (about 3 per cent) of industrial production, we will use the terms manufacturing and industrial output interchangeably.

Fig. 1



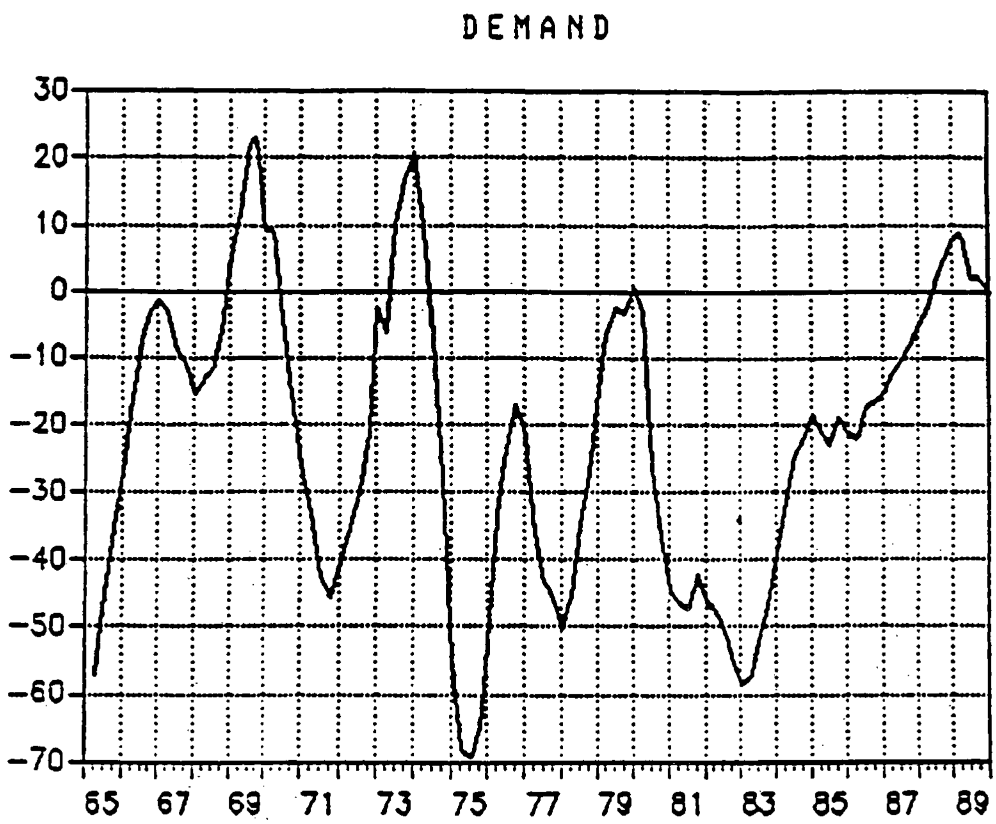
INDUSTRIAL OUTPUT
(Log)
4.80
4.60
4.40
4.20
4.00
3.80
65
67
69
71
73
75
77
79
81
83
85
87
89

Fig. 2



HOURS WORKED
(Log)
14.750
14.700
14.650
14.600
14.550
14.500
14.450
14.400
65
67
69
71
73
75
77
79
81
83
85
87
89

Fig. 3


DEMAND
30
20
10
0
−10
−20
−30
−40
−50
−60
−70
65
67
69
71
73
75
77
79
81
83
85
87
89

Pellegrini, 1988). Thus our results need to be interpreted with some caution. The analysis of the variance of industrial output has suggested using a logarithmic transformation.

Labour input is measured by total hours worked in industry (Figure 2). This variable captures the effective use of labour, both at the extensive (number of workers) and at the intensive (per capita hours) margin. The total number of hours of full or partial temporary layoffs for which Wage Supplementation Fund benefits were paid has been subtracted. The variable is in log.

The demand variable is the ISCO-ME index (Figure 3). This is quite different from what can be found in the literature. On a regular monthly basis, ISCO (a government-sponsored agency) asks a panel of manufacturing firms whether the orders they have received for the following month are above or below the "normal" level. What firms mean by normal is obviously open to question[7]. The index will then capture short-run movements off the permanent component of sectorial demand, which necessarily coincides with the permanent component of output in the long-run, thus reflecting monetary and fiscal policy decisions, as well as foreign demand

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7. Looking at fig. 3, it is apparent that during the period the mean of the variable is negative and below its "normal" (zero) level. That is, on average, firms have answered that their orders were below the normal level. This finding is common to all the countries where similar survey are normally conducted (see European Economy, 1991). This may raise an issue either on the assumptions (in particular that of a uniform distribution) made in order to aggregate individual replies or, somehow more profoundly, on the very idea of normality among respondent firms. These questions are beyond this paper, however. To our purposes, what matters is that the series is stationary (see below) and that it reflects true demand's fluctuations. The level of the variable as such is unimportant, as it will become clear later.

fluctuations. The index is stationary almost by construction and is therefore particularly helpful for our analysis, since it comes as close as possible to a direct measure of transitory demand shocks. In this sense, it is a much more satisfactory variable than traditional demand indicators, such as the unemployment rate, used by Blanchard and Quah: the latter can in fact turn out to be a poor approximation to demand fluctuations, especially if hysteresis phenomena are important. An attempt to differentiate between domestic and foreign demand, using information from the survey, was unsuccessful, as the two components move in very close conjuction.

Our estimation strategy relies heavily on the correct differencing of the series. Therefore all series, including the oil price, have been subjected to a detailed investigation of their long-term statistical properties. The augmented Dickey-Fuller (1979,1981) tests for stationarity are presented in Table 1. The null hypothesis is that the series are I(1); the alternative is that they are stationary around a deterministic trend. In the case of demand, the alternative is a random walk with no drift. The number of relevant lags has been chosen after a search procedure based on the Lagrange Multiplier test, reported in cols 2 and 3 for one and four lags respectively. Although the limited power of the tests is well-known, they show that the null of non-stationarity cannot be rejected for the industrial output index[8]. In the sample total hours worked and relative oil price are also I(1). On the other hand, their first differences are stationary. As expected, the level of demand is stationary.

8. Pellegrini (1990) confirms this result for different sectorial aggregations and time intervals. In particular, for the period 1953:1 to 1989:4, the value of the Dickey-Fuller test is -2.39, against a critical value of -3.7 at 5%.

The recent econometric literature (Rappoport and Reichlin, 1988, Perron, 1989) has pointed out that the usual tests can lead to incorrect inferences, when the possibility of a break in the deterministic trend under the alternative is not accounted for. This may be relevant in our case, since industrial output growth slows down after 1974. Thus, we have applied the test suggested by Perron, allowing for breaks in both the intercept and the linear trend in 1974:1. The results of the Dickey-Fuller tests are confirmed.

Although both output and labour input are non-stationary, it is still possible that their linear combination is stationary. This result would have deep economic implications, for if a cointegrating vector (1,-1) existed, labour productivity, hence technical progress, would be stationary and output non-stationarity would therefore be driven only by hours and not by technological innovations. For this reason we have conducted an analysis of cointegration on output and hours. The tests used are the Co-integrating Durbin Watson, the Dickey-Fuller and its augmented version. The results are reported in Table 2. Since no cointegrating relationship was found, the idea that non-stationary technical progress drives output is not rejected by the data.

Table 1

Univariate unit root tests
(period: 1965:1 - 1989:4)

VARIABLES	LAGS	MLM1	MLM4	τα	C.V. 5%
		Augmented Dickey-Fuller test			
Relative price of oil	2	0.37	2.49	-1.29	-3.73
Hours worked	2	0.01	1.81	-2.94	-3.73
Output	2	1.24	1.13	-3.17	-3.73
Demand	2	0.56	0.01	-3.17	-2.24
		Perron-test (1) (λ = 0.4)			
Hours worked	2	0.30	1.40	-3.35	-3.72
Output	1	0.21	2.16	-2.89	-3.72
		Perron-test (2) (λ = 0.4)			
Hours worked	2	1.22	2.15	-2.83	-3.94
Output	1	0.26	1.76	-2.90	-3.94
		Perron-test (3) (λ = 0.4)			
Hours worked	1	0.00	1.60	-3.05	-4.22
Output	1	0.39	1.79	-2.89	-4.22

(1) Break in the constant (1974:1)
(2) " " " deterministic trend (1974:1)
(3) " " " constant and in the deterministic trend(1974:1).

Table 2

Cointegration tests
Variables: industrial production and hours worked

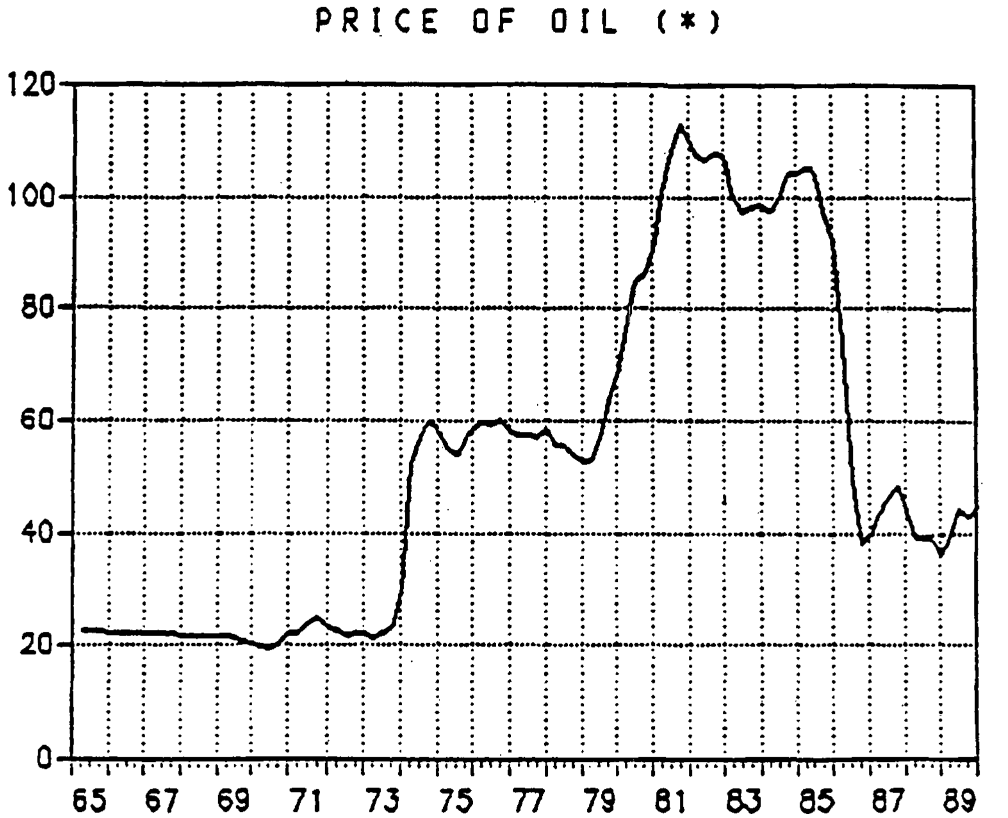
TEST	VALUE	CRITICAL VALUE 5%
Co-integrating Durbin Watson	0.23	0.39
Dickey-Fuller	-3.28	-3.37
Augmented Dickey-Fuller (n. lags = 2)	-2.95	-3.17

3 - Results

We come now to the estimates. Following the methodology outlined above, in the first stage we have estimated an unrestricted near vector autoregression in industrial production, hours worked and aggregate demand. The latter is in levels. The two non-stationary variables are entered as (log) first differences. The sample period goes from 1967:1 to 1989:4. The regressions includes a set of exogenous variables. Their rationale is discussed below.

The price of oil is certainly an important source of fluctuations. We considered extending our model to incorporate oil shocks, but were unable to find a sensible long-run restriction that could be applied in order to separate the effect of oil from that of technology. Shapiro and Watson deal with this problem by including the relative oil price as an exogenous variable in all the equations. As noted by Quah (1989), this leads to an over-identification of the model, in that the oil price is costrained to be unaffected by other variables across the entire lag distribution. Apart from its dubious realism, this restriction seems at odds with the spirit of the entire exercise, since strong exogeneity of the oil price is imposed purely on a priori grounds. If such a route has to be followed for want of better identifying restrictions, it seems more reasonable to use a truly exogenous dummy variable to capture the effects of oil prices. From Figure 4, which plots the ratio of the price of energy raw materials to the price of industrial output, it is apparent that during our sample the oil price's behaviour is dominated by three events: the oil shocks of 1973 and 1979 and the collapse of OPEC in 1986. We have therefore included three sets of dummy variables, from 73:4 to 74:3, 79:2 and from 86:1 to 86:4, in

Figure 4



(*) Deflated by the industrial output price index.

all the equations to account for these events. The coefficients of the dummies appear on the whole to have the right signs. This estimation strategy implies that only major oil shocks can have an impact on consumption and production plans, whereas small swings in the price of oil are assumed to be irrelevant to economic decisions. By including more than one dummy for some events, we allow for some flexibility in the responses of agents and, in particular, asymmetric responses to oil price increases and decreases. However, the dummies capture everything that has occurred in a quarter, which might or might not be related to the oil shock. This is particularly true of the second oil shock, which took place at a time when a demand boom from the investment side was also under way. Because of the definite danger of "overkilling" output variability through extensive use of dummy variables, we have restricted ourselves to a single dummy in that instance. On the other hand, by focussing on only three episodes we still expect to end up underestimating the overall impact of energy prices. Given the likely symmetry between oil and technological shocks, we surmise that the residual effects of the former will be attributed to the latter in our final decomposition. A similar procedure was adopted to net out the effect of four industrial strikes, which occurred in 69:4, 73:1, 74:4 and 76:1. The sum of the coefficients of both sets of dummies is different from zero in the output and hours equations. This is tantamount to imposing permanent effects of the oil price on the two variables.

A further issue arises in the interpretation of labour supply shocks. Unless we are prepared to consider manufacturing and the rest of the economy as completely segmented labour markets, the notion of an industrial labour supply is not uncontroversial. At one extreme, it can be thought of as encompassing the entire labour force; at the opposite end, it may coincide with the manufacturing workers currently employed plus, possibly, those who have recently become redundant. Unfortunately, we found no simple way of endogenising individuals' decisions to work (or wait for work) in the manufacturing sector rather than in the rest of the economy. These decisions will ultimately depend on consumers' tastes regarding manufactured goods, which will be transmitted to the labour market via relative wages. In a competitive equilibrium, a factor price equalisation property must apply. Regrettably, all extensions of our model to more than one sector proved too cumbersome to be implemented econometrically; in particular, we found no way of univocally identifying shifts in consumer preferences between manufactures and other goods and services in the restricted matrix of long-run coefficients. Accordingly, we have resorted to an ad hoc inclusion in the hours equation of the ratio of the wage rate in manufacturing to the average wage rate in services, agriculture and construction. The idea is that the relative wage will partly account for voluntary movements in and out of the industrial sector, with the residual component being identified as the "effective" manufacturing labour force.

The VAR estimates are reported in Table 3 (t-statistics are in brackets)[9]. The results look reasonable. The overall fit is satisfactory for each of the three equations, even though it is often difficult to detect a significant contribution from individual regressors, probably because of the high degree of collinearity among the (six) lags of the explanatory variables. We have experimented with different lag structures: the results are basically unaffected.

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9. If we introduce a constant term in the demand equation of the VAR in order to account for the systematic difference between the mean and the normal level of the ISCO-ME variable, results are almost identical.

V A R   E Q U A T I O N S

Regressors	Dependent variables		
	DH	DY	AD
DH (- 1)	- 0.182 (- 1.49)	0.098 (0.80)	0.201 (0.00)
DH (- 2)	0.009 (0.08)	- 0.011 (- 0.08)	-25.606 (- 0.86)
DH (- 3)	- 0.114 (- 0.87)	- 0.149 (- 1.35)	23.791 (0.87)
DH (- 4)	- 0.119 (- 0.94)	- 0.348 (- 2.80)	54.860 (1.92)
DH (- 5)	0.089 (0.73)	- 0.183 (- 1.46)	-38.481 (- 1.33)
DH (- 6)	0.209 (1.79)	0.059 (0.48)	6.693 (0.24)
DY (- 1)	0.255 (2.05)	- 0.143 (- 1.12)	-40.857 (- 1.39)
DY (- 2)	0.110 (0.80)	0.092 (0.66)	- 9.847 (- 0.31)
DY (- 3)	- 0.034 (- 0.26)	0.170 (1.37)	-44.000 (- 1.54)
DY (- 4)	0.062 (0.48)	0.309 (2.44)	-12.058 (- 0.41)
DY (- 5)	0.010 (0.09)	0.268 (2.20)	43.506 (1.55)
DY (- 6)	- 0.117 (- 1.06)	0.031 (0.27)	10.578 (0.40)
AT (- 1)	0.000 (0.82)	0.002 (4.33)	1.636 (13.47)
AT (- 2)	0.000 (- 0.94)	- 0.003 (- 2.89)	- 0.458 (- 2.21)
AT (- 3)	0.001 (1.16)	0.000 (0.62)	- 0.113 (- 0.55)
AT (- 4)	0.000 (- 0.62)	0.000 (- 0.47)	- 0.281 (- 1.31)
AT (- 5)	0.000 (0.03)	0.000 (- 0.26)	0.002 (0.01)
AT (- 6)	0.000 (0.03)	0.000 (0.91)	0.185 (1.48)
LWR (- 1)	0.216 (0.77)	- -	- -
LWR (- 2)	- 0.335 (- 0.86)	- -	- -
LWR (- 3)	0.206 (0.49)	- -	- -
LWR (- 4)	- 0.617 (- 1.56)	- -	- -
LWR (- 5)	0.200 (0.51)	- -	- -
LWR (- 6)	0.218 (0.83)	- -	- -
DD694	- 0.107 (- 7.21)	- 0.118 (- 7.67)	-10.431 (- 2.95)
DD731	- 0.66 (- 4.13)	- 0.076 (- 4.50)	-16.111 (- 4.14)
DD744	- 0.007 (- 0.36)	- 0.028 (- 1.74)	- 9.682 (- 2.61)
DD761	- 0.017 (- 1.07)	- 0.000 (- 0.02)	- 6.697 (1.79)
D734	0.039 (1.42)	- 0.030 (- 1.14)	8.348 (1.39)
D741	- 0.014 (- 0.49)	- 0.015 (- 0.58)	-11.616 (1.93)
D742	0.030 (0.99)	0.013 (0.49)	- 5.316 (- 0.88)
D743	- 0.004 (- 0.13)	0.020 (0.83)	- 7.185 (- 1.34)
D792	- 0.048 (- 2.39)	- 0.026 (- 1.21)	0.700 (0.14)
D861	0.003 (0.18)	0.033 (1.61)	- 0.908 (- 0.19)
D862	0.022 (1.14)	0.004 (0.19)	5.158 (1.08)
D863	0.007 (0.34)	- 0.007 (- 0.33)	- 2.261 (- 0.47)
D864	0.006 (0.29)	0.012 (0.57)	2.692 (0.56)
S.E.E.	0.018	0.020	4.566
R^2	0.531	0.538	0.959
D.W.	1.605	1.976	2.078
Q [X^2(2)]	22.274	25.106	28.327

DH = change in hours
DY = change in industrial output
AD = aggregate demand
LWR = relative wage
DD694 = dummy variables (equal 1 in 1969 IV and -1 in 1970 I)
DD731 = " " (equal 1 in 1973 I and -1 in 1973 II)
DD744 = " " (equal 1 in 1974 IV and -1 in 1975 I)
DD761 = " " (equal 1 in 1976 I and -1 in 1976 II)
D734 = " " (equal to 1 in 1973 IV)
D741 = " " (equal to 1 in 1974 I)
D742 = " " (equal to 1 in 1974 II)
D743 = " " (equal to 1 in 1974 III)
D792 = " " (equal to 1 in 1979 II)
D861 = " " (equal to 1 in 1986 I)
D862 = " " (equal to 1 in 1986 II)
D863 = " " (equal to 1 in 1986 III)
D864 = " " (equal to 1 in 1986 IV)

The next step consists of identifying the responses of output, hours and demand to a unit shock in technology, labour supply and aggregate demand, respectively[10]. Impulse response functions are plotted in Figures 5 to 7. Let us consider manufacturing output first. A one standard deviation innovation in technology has a strong immediate impact: after one quarter, the level of output is raised by 1 per cent. The response function increases quite steeply for the following four quarters; after a short pause, it resumes gradual growth, reaching around the thirtieth quarter its long run value of 3.2 per cent. The response to a labour supply shock shows a similar, albeit less pronounced, pattern: the immediate effect is relevant (close to that of technology) and positive, and convergence to a long-run elasticity of 1.7 per cent is achieved quite soon. Finally, the response to an aggregate demand shock displays a well-behaved humped shape: the peak (around 1 per cent) is reached after one year, after which it gradually returns to zero. The initial negative value is probably linked to the inventory cycle: firms react to demand shocks by running down inventories, and so the first impact can be very low; only in due course is output increased to meet the extra demand and to replenish stocks. It should be noted that, apart from the long-run restriction imposed on aggregate demand shocks, the values of the remaining elasticities have in no way been constrained during our analysis. The fact that they take both correct signs and reasonable values is encouraging.

The responses of labour input are plotted in Figure 6. A unit impulse in technology causes an immediate reduction in hours worked. This may interpreted as evidence of some displacement of workers brought about by the introduction of new technology. This effect is relatively long-lived: the

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10. As described in the Methodological Appendix, the shocks' variance is normalized to 1.

Figure 5

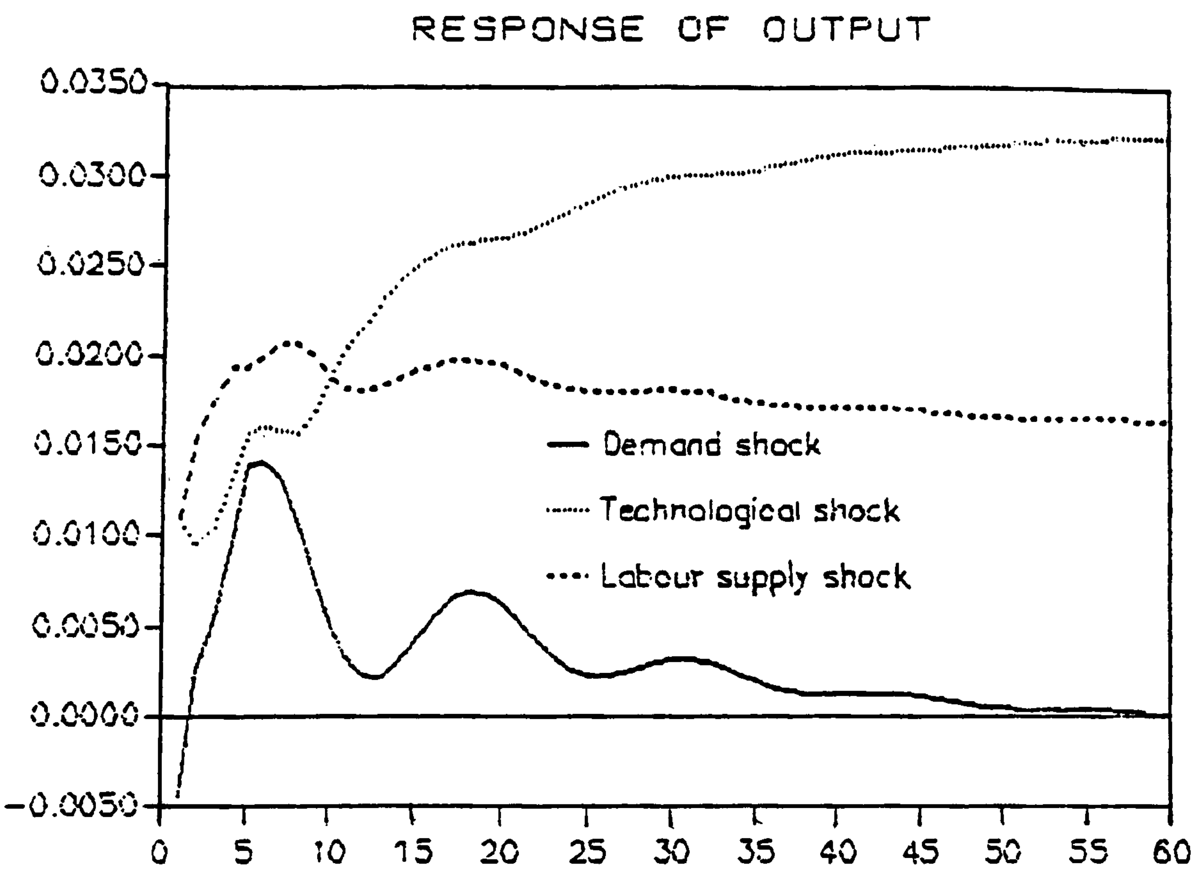

RESPONSE OF OUTPUT
0.0350
0.0300
0.0250
0.0200
0.0150
0.0100
0.0050
0.0000
-0.0050
0
5
10
15
20
25
30
35
40
45
50
55
60
Demand shock
Technological shock
Labour supply shock

Figure 6

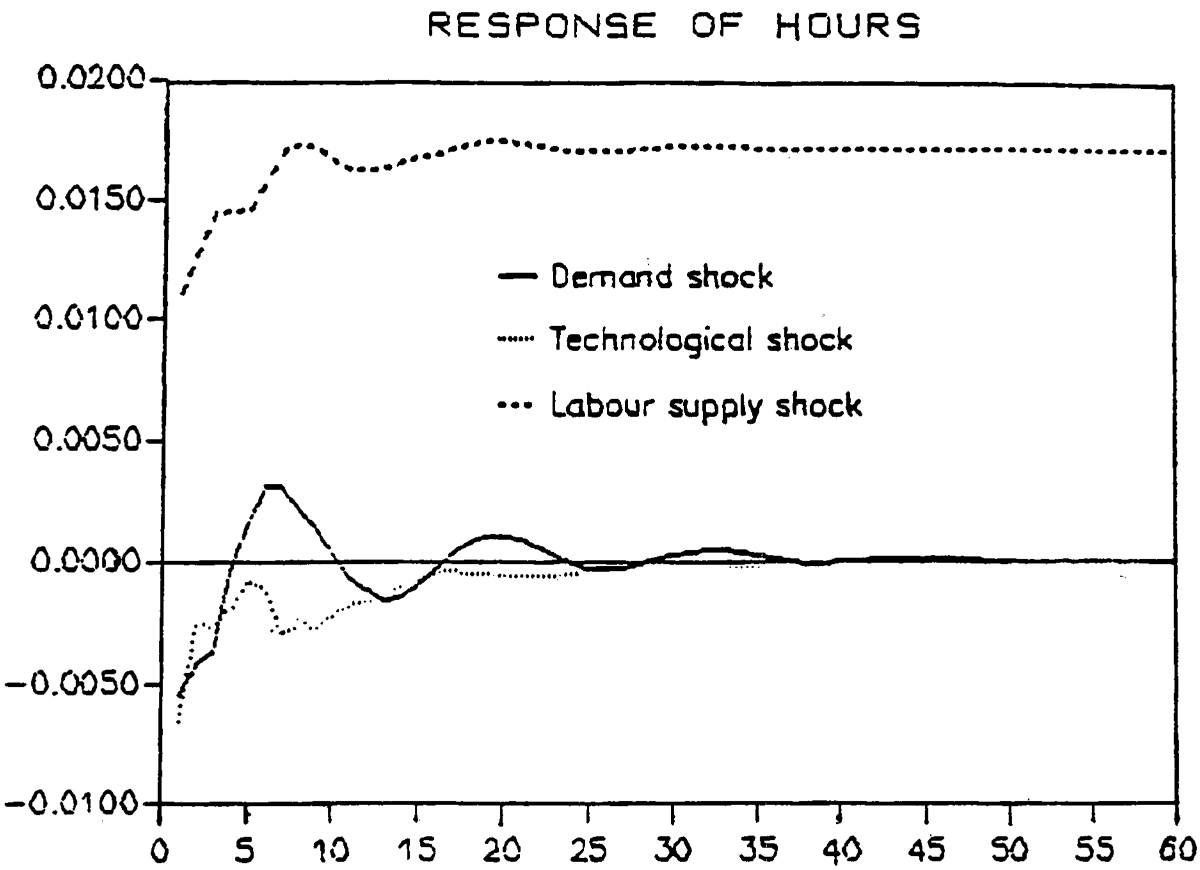
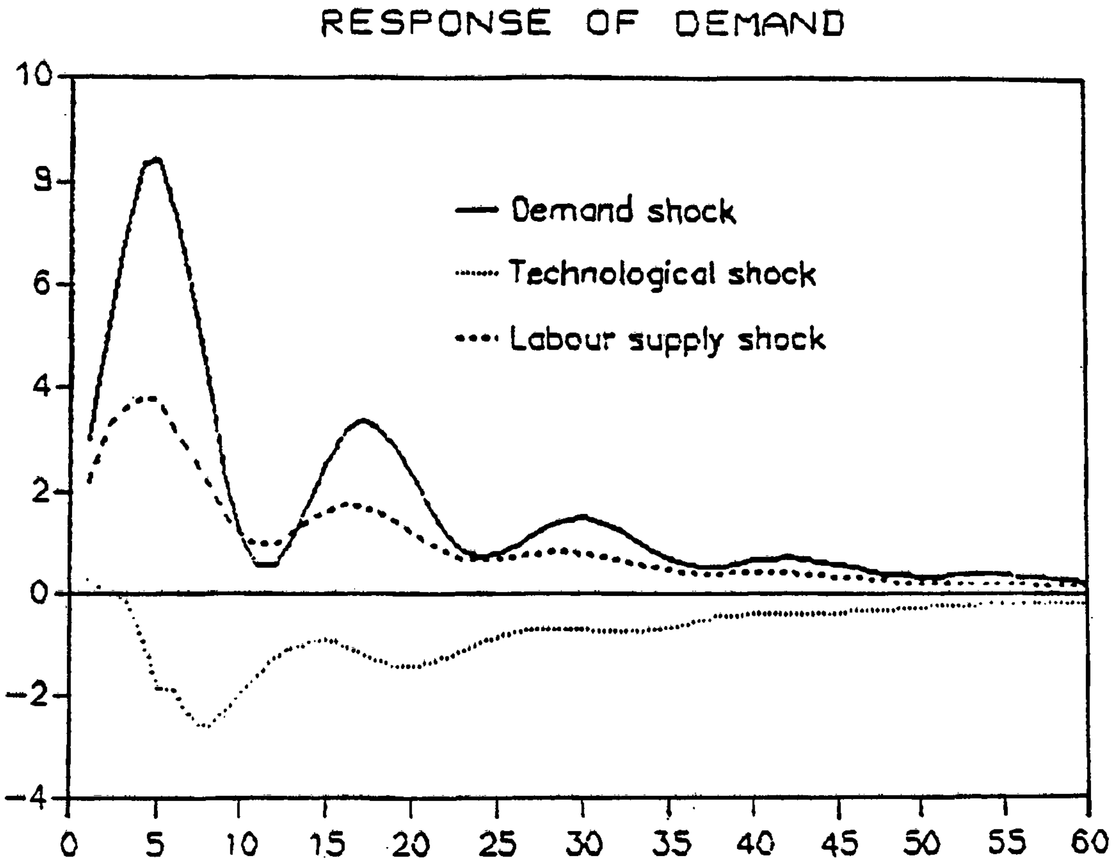

RESPONSE OF HOURS
0.0200
0.0150
0.0100
0.0050
0.0000
-0.0050
-0.0100
0
5
10
15
20
25
30
35
40
45
50
55
60
Demand shock
Technological shock
Labour supply shock

Figure 7



RESPONSE OF DEMAND
Demand shock
Technological shock
Labour supply shock
10
9
6
4
2
0
-2
-4
0
5
10
15
20
25
30
35
40
45
50
55
60

response function displays some waves (always in the negative orthant) and only after more than three years does it go to zero. The quantity of labour adjusts moderately fast to shocks in supply: the impulse function starts off strongly and reaches its long-run value of around 1.7 percentage points in seven quarters. Demand shocks drive down hours on impact. This is a bit surprising: it may be related to the behaviour of inventories or, alternatively, to intertemporal substitution in leisure, if wages react immediately to demand and income effects dominate initially. The impact of a demand shock on hours becomes positive between lags 4 to 10. This sluggish response suggests the existence of a significant degree of labour hoarding in the industrial sector. On the whole, most of the adjustment of labour to its long-run value takes place within two years, which seems a reasonable timing. Only the response to labour supply shocks appears to be on the fast side, as it presupposes a fairly rapid adjustment of wages. A tentative explanation of these results is that, in the face of outside disturbances, firms find it more suitable to make immediate adjustments by relying on the intensive margin, hours, rather than by hiring and firing. This view is consistent with manufacturers' widespread use of overtime and short-time work (which is allowed in Italy under ordinary Wage Supplementation provisions), especially during the eighties; it also accords with most of the recent interpretations of labour market behaviour in Europe, such as those based on efficiency wages, the insider-outsider thesis, hiring and firing costs and fixed technological coefficients, which explain the limited flexibility of the number of workers. By contrast, the number of man/hours worked can be more flexible, provided the marginal cost of an additional hour of work from the incumbent workforce is lower.

Aggregate demand responses to the three shocks are shown in Figure 7. It should be recalled that our variable captures fluctuations around a "normal" level of demand, which we interpret as coinciding with the steady state level of output. The impulse functions of both demand and labour supply disturbances look well behaved: in particular, the latter goes hand in hand with a transitory change in consumption. A bit more surprising is the negative value the response to technology takes for part of the sample. This may be connected with the displacement effect mentioned above.

A different way of looking at the same information as in the impulse functions' is the variance decomposition for a variety of forecast horizons. In Table 4 we present the fraction of forecast error variance which can be attributed to labour supply, technological and demand shocks at different leads. In the Table we do not consider the portion of variance due to deterministic variables. The results suggest that technology shocks play an important role at all horizons. They account for roughly 50 per cent of output variability in the first quarter; the share increases to around 60 per cent over ten years. Their impact on demand fluctuations is modest at the outset, but grows to 10 per cent in the long-run; the opposite occurs for hours, where the impact is strong in the first quarter but falls rapidly afterwards. Labour supply shocks have a dramatic initial effect on the variability of hours (90%); the impact on output variance is of the same order of magnitude as technology's at the beginning, but declines in the long run. Finally demand has a modest impact on the variability of both output and hours, which confirms the findings of the impulse reaction functions.

Having shown the dynamic effects of each type of disturbance, the next step is to assess their relative contributions to output. Basically we try to answer the

Table 4

Forecast error variance decomposition (1)

	Labour supply	Technology	Demand
Hours worked			
1 quarter	62.6	22.2	15.1
5 quarters	87.8	6.2	6.0
10 quarters	95.5	3.5	0.9
20 quarters	97.8	2.0	0.2
40 quarters	99.2	0.8	0.0
∞	100.0	0.0	0.0
Output			
1 quarter	46.8	46.1	7.1
5 quarters	63.6	32.1	4.3
10 quarters	57.5	32.5	10.0
20 quarters	49.6	44.3	6.1
40 quarters	39.2	57.7	3.1
∞	33.6	66.4	0.0
Demand			
1 quarter	35.1	0.5	64.4
5 quarters	22.9	0.3	76.8
10 quarters	20.2	2.9	76.9
20 quarters	21.4	6.7	71.9
40 quarters	21.4	10.6	68.0
∞	0.0	0.0	0.0

(1) Excluding deterministic variables.

following question: what would the level of output have been if demand (or technology or labour supply) shocks had not occurred. In other words, at every time t, the level of output can be represented as a linear combination of current and past innovations, as follows (using the notation of the Appendix):

$$y_t = \mu(t) + F(L)e^{\tau}_t + G(L)e^{l}_t + H(L)e^{d}_t \qquad (16)$$

where $\mu(t)$ includes all the deterministic variables (i.e. the oil price and strike dummies and the relative manufacturing wage, plus a starting value given by the actual ouput in 1966:4). This deterministic trend of output is plotted in Figure 8[11]. The three oil price spikes clearly play a crucial role, by depressing output in 1973 and 1979 and enhancing it in 1986.

Figure 9 shows the contribution of technological shocks. Their cumulative effect is strongly positive for most of the period: it is particularly large after 1981, when the so-called restructuring of the manufacturing sector was near completion (see Barca and Magnani, 1989). Economists have often debated whether technological progress can have an adverse impact on output, in connection with the real business cycles. Prescott (1986) in particular has been a leading advocate of this view. We do not find his arguments convincing, and therefore feel satisfied with our finding of a positive cumulative contribution from technology.

11. Despite the fact that output and the other variables have been reconstructed since 1967:1, all the plots start from 1974:1 in order to let the shocks work their way through most of the propagation lags.

Figure 8

OUTPUT:

CUMULATIVE EFFECT OF DETERMINISTIC VARIABLES

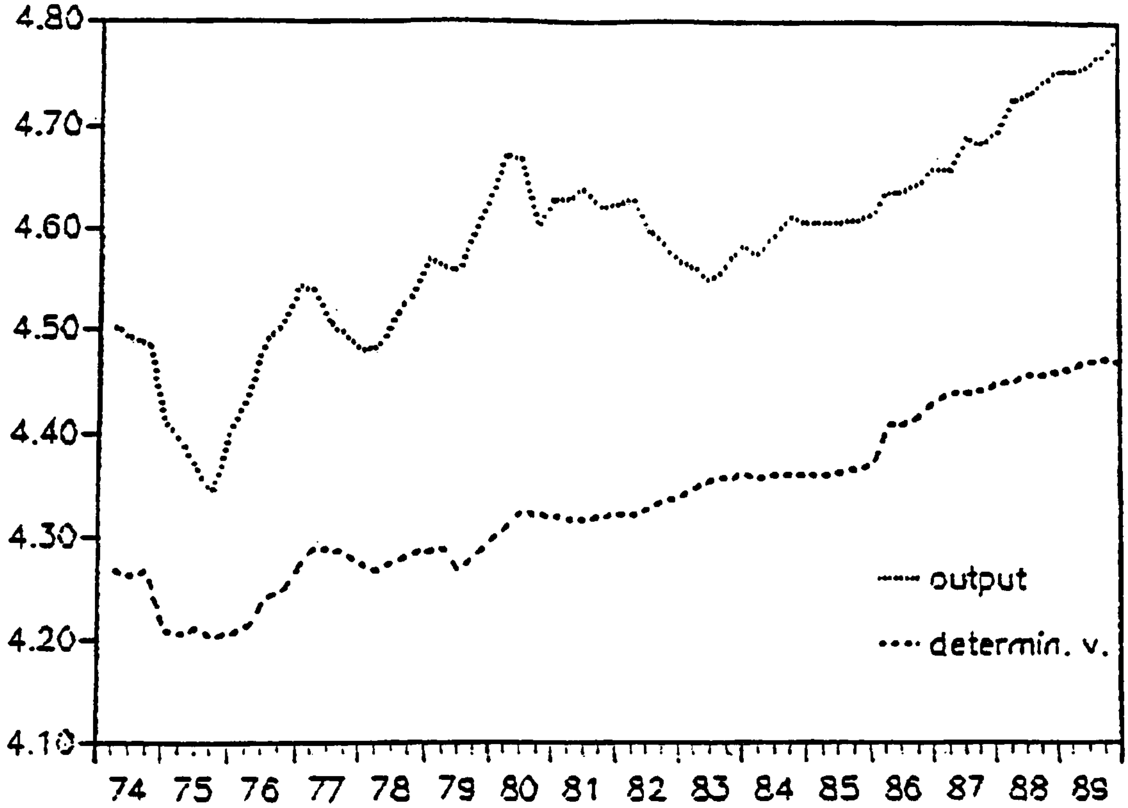


Figure 9

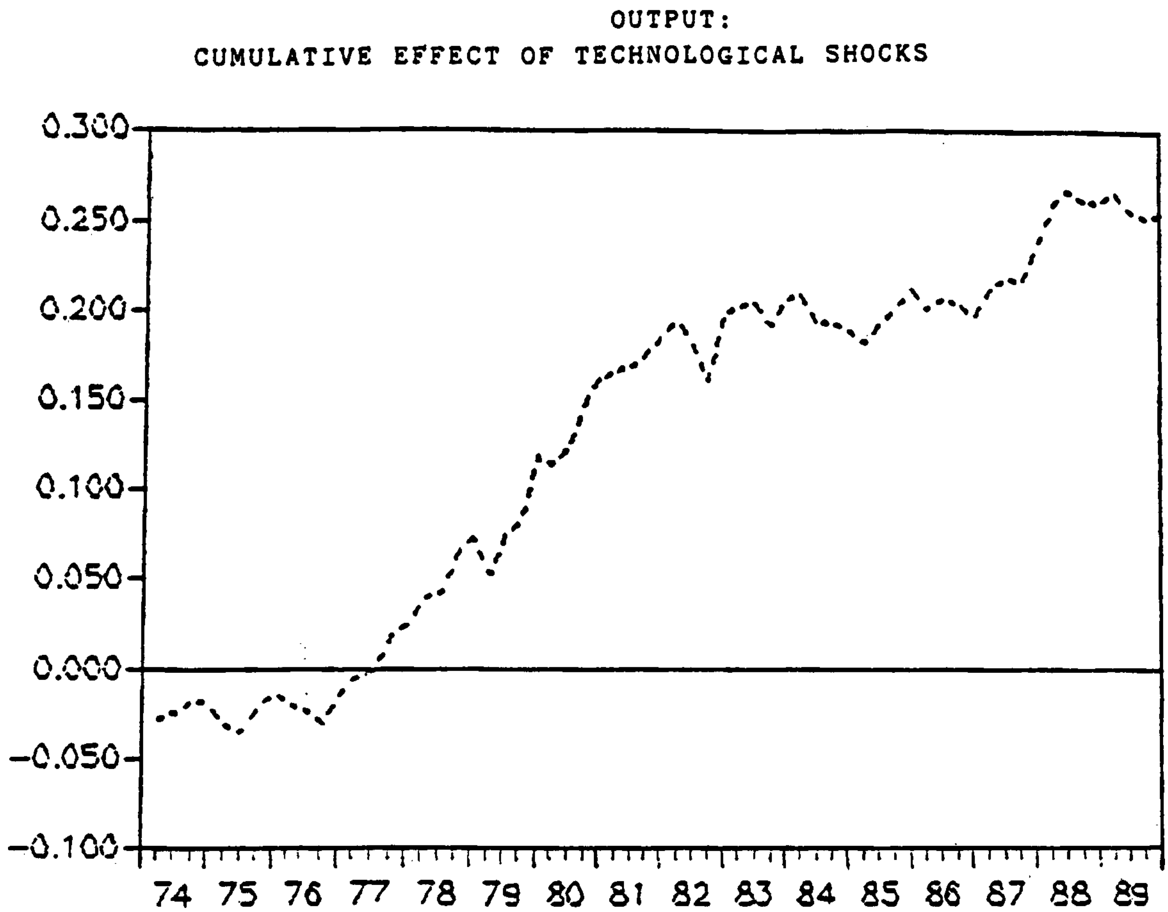

OUTPUT:
CUMULATIVE EFFECT OF TECHNOLOGICAL SHOCKS
0.300
0.250
0.200
0.150
0.100
0.050
0.000
-0.050
-0.100
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89

Figure 10

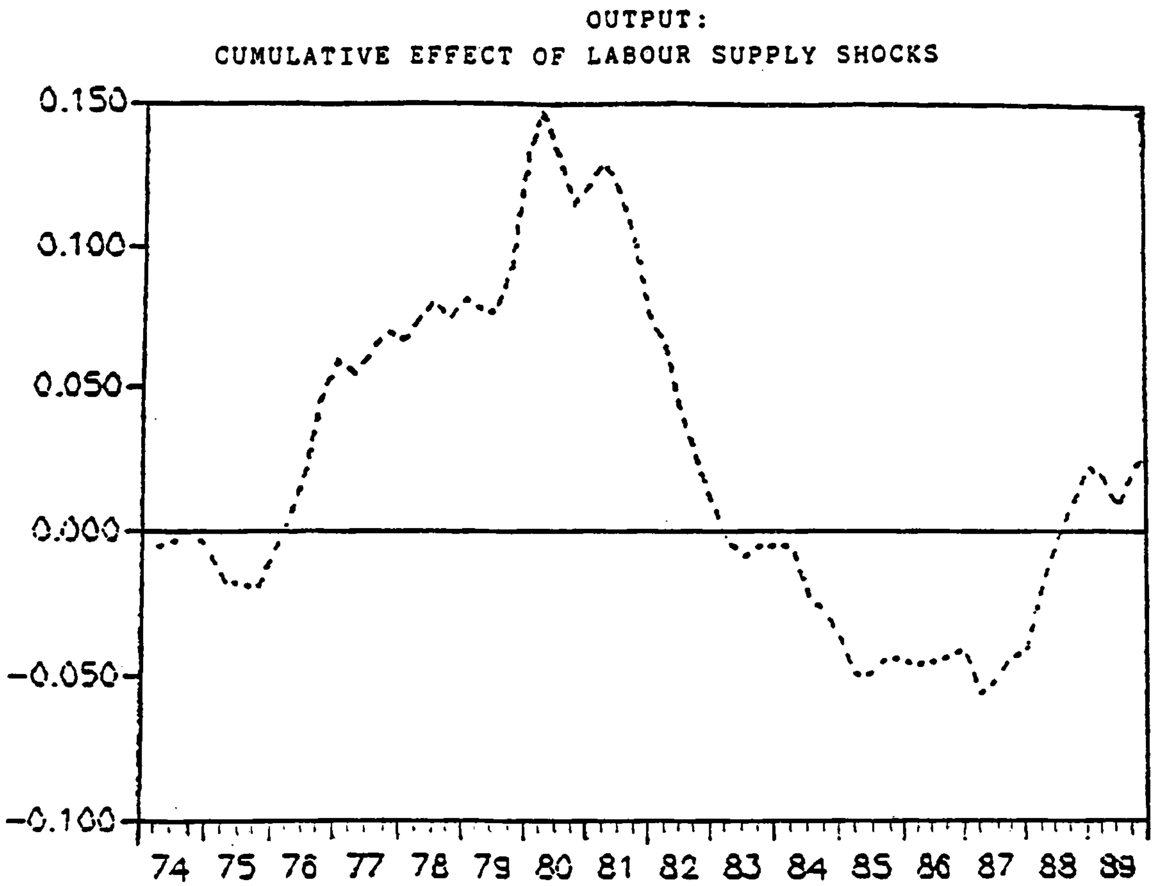
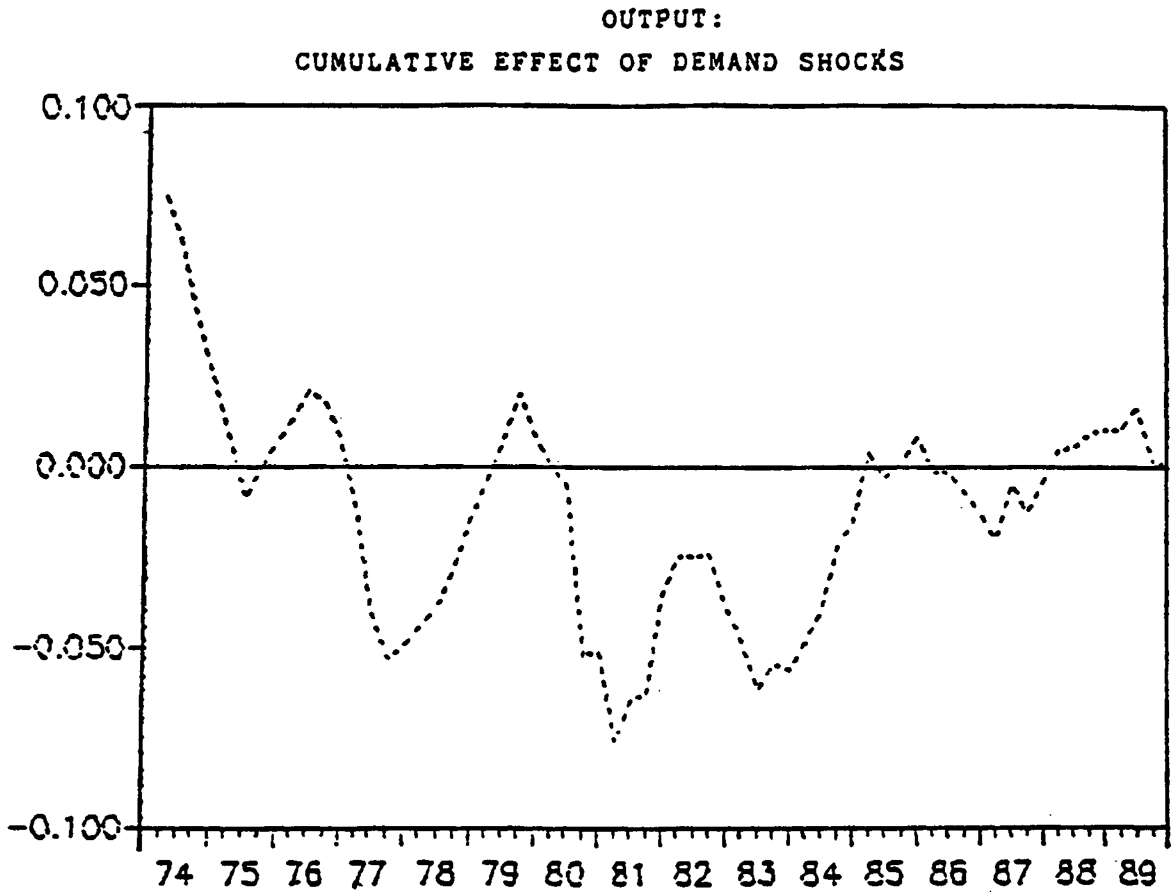

OUTPUT:
CUMULATIVE EFFECT OF LABOUR SUPPLY SHOCKS
0.150
0.100
0.050
0.000
-0.050
-0.100
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89

Figure 11


OUTPUT:
CUMULATIVE EFFECT OF DEMAND SHOCKS
0.100
0.050
0.000
-0.050
-0.100
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89

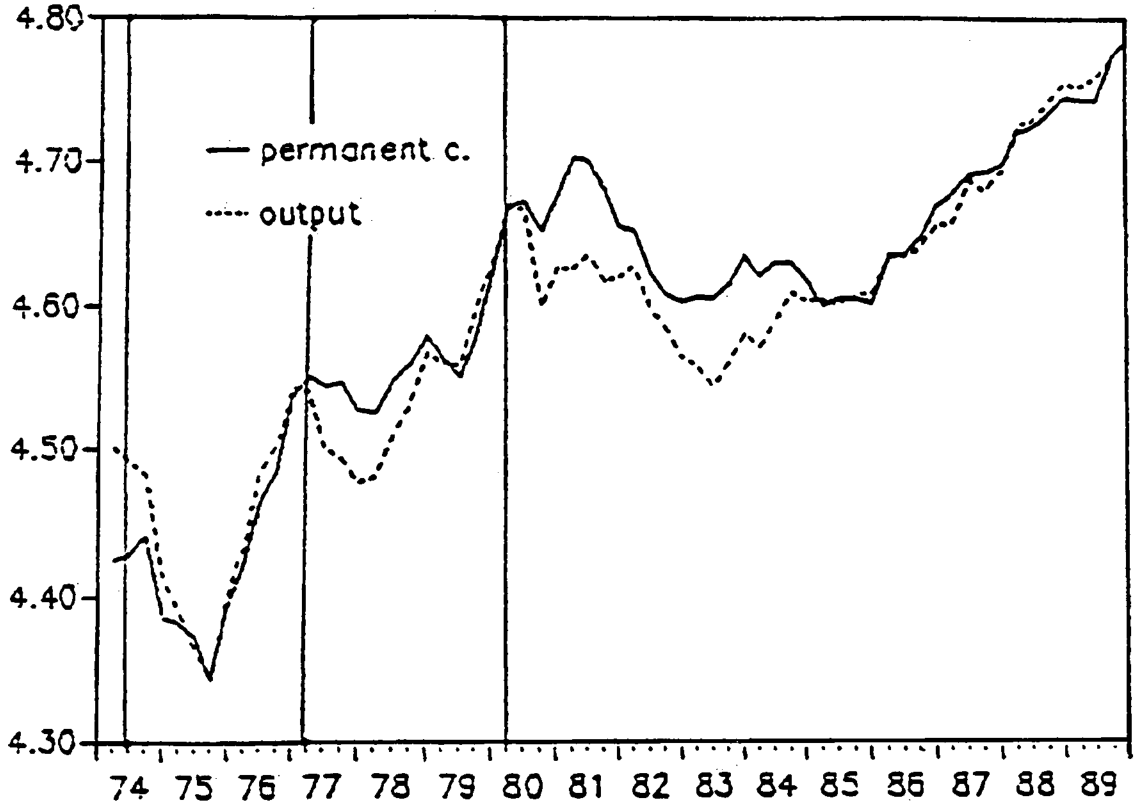
The labour supply contribution is plotted in Figure 10. It is smaller than the cumulative effect of technology. This contrasts with the finding of Shapiro and Watson for the U.S., who attribute most output fluctuations at all horizons to permanent labour supply changes. Apart from the obvious consideration that they are looking at a different country and at the whole of the business sector, the difference may be due to the different estimation technique employed: in particular, as pointed out by Hall (1988), their use of an instrumental variable estimator may lead to an overestimation of the effect of labour supply on output. In the case of Italy, labour supply has a negligible impact on industrial output until 1976. This can be partly interpreted as an overhang of the so-called "Hot Autumn" of 1969, when a sizable reduction in working hours was granted after months of bitter industrial dispute. In our model these events can be interpreted as a permanent restriction on the supply of labour. Only towards the end of the decade, did relations between workers and firms improve (see Giavazzi and Spaventa, 1989). More importantly, at the same time, large numbers of new entrants joined the labour market (the result of the earlier baby boom). These episodes restore a positive contribution of labour supply, which lasts until the end of 1982. Subsequently, negative shocks dominate, with widespread use of the Wage Supplementation Fund to reduce labour input and an exodus from the manufacturing sector. Only in the last two years of our sample did labour supply shocks again have a positive impact. Overall, the labour supply pattern seems to be dominated by demographic factors. However, the pattern in the mid-eighties raises some questions of interpretation: our estimates suggest that a material reduction in the "effective" industrial labour supply took place. In other words, output could have been larger between 1984 and 1988, had more people (or longer hours) been available. This contrasts with the simultaneous existence of a large number of people seeking jobs, especially among the new entrants. A possible explanation is mismatch, which is widely regarded as an important source of supply restrictions. Since we are only dealing with a subset of the economy, we also regard voluntary elements to be important. A part of the decline in manufacturing employment can probably be explained by the voluntary decision to quit industry in order to join the ranks of the civil servants or work in the service sector (often as self-employed). Both positions offer appealing features, such as job guarantee, greater responsability and higher earnings. We have only been able to incorporate a part of these elements in our analysis. Furthermore, even though the methodology adopted should in principle purge the labour supply of Okun-type effects from demand, we cannot be sure this has been accomplished satisfactorily.

By jointly considering the cumulative contributions of deterministic variables, technology and labour innovations, we can determine the permanent component of output, i.e. its stochastic trend, which is shown in Figure 12 and equivalent to

$$yp_t = \mu(t) + F(L)e^{\tau}_t + G(L)e^{l}_t \qquad (17)$$

The difference between this and actual output is the cumulative effect of transitory components, which we identify as demand shocks, presented in Figure 11. One can observe that, in general, the level of output tracks its permanent component quite closely, as is commonly found in this kind of

INDUSTRIAL OUTPUT AND THE PERMANENT COMPONENT



analysis[12]. The latter accounts for over 70 per cent of overall output variability. Demand thus has a moderate impact on output changes[13]. Still, the pattern of booms and slumps emerges clearly. It is worth noting the overheating of industry in 1974 and the negative contribution of aggregate demand to output at the beginning of the eighties.

To further investigate the cyclical pattern of output, we have examined three sub-samples, 1974:1-1976:4, 77:1-79:4, 80:1-89:4, which correspond to the major (peak-to-peak) cycles of the Italian economy, as defined by ISCO. An interesting result emerges: as shown in Table 5, the ratio of the variance of the permanent component's rate of change to that of output is greater in the eighties than in the seventies. It follows that demand played a smaller role in the last decade. There are two possible explanations: either demand shocks were smaller or their impact was largely counter-cyclical, stabilising output around its permanent component (see De Long and Summers, 1988). Probably both motives were important. Italy's participation in the EMS probably reduced the potential for demand management: after 1984 the average impact of demand shocks is in fact zero. On the other hand, the variance ratio of the permanent component in the last period is smaller. This might suggest that demand shocks are of the opposite sign to supply shocks and therefore that demand acted in a counter-cyclical way.

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12. An explanation that do appears not to have been sufficiently investigated is that the authorities have systematically tried to offset demand shocks, by reacting with impulses of opposite sign. If this were the case, the overall effect would be negligible.

13. This contrast with Blanchard and Quah (1989) results.

Table 5

CYCLICAL VARIABILITY OF PRODUCTION

Period	(1)	(2)
1974:2 - 1989:4	74.6	70.8
1974:2 - 1976:4	71.3	92.9
1977:1 - 1979:4	68.8	64.4
1980:1 - 1989:4	79.3	54.0

(1) Variance $(\Delta_1 T)$/variance $(\Delta_1 P)$, where P is the industrial output, and T its permanent component.

(2) Variance ratio, defined as the R^2 of a regression of $\Delta_1 P$ on $\Delta_1 T$.

4 - Conclusions

We have assumed the existence of disturbances of three kinds affecting the variability of industrial output, arising from technology, labour supply and demand, respectively. The first two have permanent effects on output, whereas the latter is assumed to have only a temporary effect. Under these hypotheses, we have argued that:

- output variability is significantly affected by technological innovations at all frequencies. Labour supply disturbances are also important, while demand shocks have a smaller impact on the series; accordingly, the short-run behaviour of industrial production is largely explained by supply side innovations;

- technology has an overall positive impact on output;

- the contribution of the labour supply to output is positive between 1976 and 1982; it is negative or negligible for the rest of the sample period;

- demand innovations play a more important role in the seventies than in the eighties. We suggest this may be due to a more counter-cyclical stance of economic policy during the last decade.

These results need to be interpreted with some caution, however. In particular we have not been able to disentangle the impact of the shift of consumer preferences towards non-manufactured goods. Nor have we been able to explain the decline of industrial employment in a satisfactory way. Both are items for future research.

Methodological Appendix

Going back to our model of section I, output Y and labour input L are non-stationary variables, whereas aggregate demand ad is stationary. The first differences, Δy and Δl, are instead stationary processes. In order to identify the shocks on these variables, we have to make some assumptions about their long-run impact. Blanchard and Quah, in a bivariate case, identify supply and demand shocks by assuming that they are uncorrelated and that demand shocks have only a transitory effect on output, whereas supply shocks affect the level of activity permanently. We will extend their approach.

Let X be a vector of stationary variables. In the above model, we have:

$$X = (\Delta l, \Delta y, ad)$$

The VAR representation of the multivariate process X is given by:

$$V(L)X_t = u_t$$

where the error term $u_t = (u_1, u_2, u_3)$ is i.i.d. with mean 0 and a varince-covariance matrix P. The vector consists of the residuals of the VAR estimates.

V(L) is a polynomial distributed lag of the (invertible) matrices of the VAR coefficients. Since X is stationary, it can be represented as an MA process, using Wold's representation theorem.

$$X_t = A(L)u_t$$

where $A(L) = (V(L))^{-1}$.

Our identifying assumption is that shocks are uncorrelated. This amounts to imposing restrictions directly on variance-covariance matrix P of the disturbances.

Let assume that

$$e = (e^{l}, e^{\tau}, e^{d})$$

is a vector of uncorrelated labour supply, technology and demand shocks.

We want to derive the following representation of the vector X:

$$X_t = C(L)\ e_t$$

where the variance-covariance matrix of innovations e_t, Ω say, is diagonal and, for the sake of simplicity, normalised to be the unit matrix I.

The identifying problem consists in obtaining a C(L) matrix polynomial such that,

$$A(j)u_{t-j} = C(j)e_{t-j} \qquad \text{for all } j.$$

Under the usual normalisation

$$A(0) = I$$

we obtain that:

$$u_t = C(0)e_t$$

and

$$C(j) = A(j)\ C(0) \text{ for all } j \qquad (A.1)$$

with, as a special case:

$$C(1) = A(1)\ C(0)$$

where C(1) and A(1) are the matrices of the long-run coefficients.

The crucial idea is that supply and demand innovations can be identified from a linear combination $C(0)^{-1}$ of residuals u_t, provided a unique lower triangular matrix C(1) is identified. This condition is sufficient for identification. In fact, we have that

$$E(u_t\ u'_t) = E(C(0)e_t)(C(0)e_t)'$$

$$P = C(0)E(e_t e'_t)C(0)'$$

$$P = C(0)C(0)'$$

It follows that

$$C(1)C(1)' = A(1)C(0)C(0)'A(1)'$$

$$C(1)C(1)' = A(1)\ P\ A(1)' \qquad (A.2)$$

where the term on the right-hand side is known.

The C(1) matrix, which has to be lower triangular, results from the Choleski decomposition. In other words, we want to factorise the variance-covariance matrix into the product of an orthonormal triangular matrix and its transpose. The decomposition depends on the order of the equations: it therefore does not deliver a unique solution, in that there are infinite orthonormal transformations of the Choleski factor which satisfy the condition $P = C(0)C(0)'$. In order to achieve identification, we have to "pick out" a unique solution to the decomposition. This is done by way of condition (A.2): by imposing restrictions on the matrix A(1), we determine a unique C(1) out of the factorisation. Once C(1) is identified, C(0) will also be unique. In fact:

$$C(0) = A(1)^{-1}C(1)$$

Finally, we are in a position to identify the shocks from

$$e_t = C(0)^{-1}u_t$$

and the matrix polynomial C(L) from (A.1).

The long-run restrictions we impose on the matrix A(1) are the following:

a) coefficients a_{12} and a_{13} are equal to zero.
b) coefficient a_{23} is zero

Coupled with the condition that the variance-covariance matrix of innovations e_t is equal to the unit matrix, these are sufficient to identify the vector e_t.

Data Appendix

1. Industrial Production Index

The raw index of (narrowly defined) industrial production (1985=100) is published by Istat, in "Bollettino statistico". The index has been adjusted for the number of working days in each year using the method suggested by Denton. Seasonal adjustment for the period 1965-1982 has been obtained using X11-ARIMA on 57 elementary monthly series and aggregating the resulting indeces. For the following years, the X11-ARIMA procedure has been applied directly to the aggregate series. Details can be found in Bodo and Signorini (1985).

2. Hours Worked in (narrowly defined) industry

The total number of hours worked in each quarter is given by the product of per capita hours and the number of employed workers. The former series comes from the Ministry of Labour statistics, referring to all workers in firms with more than 50 employees. This series was discontinued in 1985. Since 1986 we have used the hours worked per capita by manual workers in establishments with more than 500 employees, published by Istat; since 1988 the same series refers to firms (rather than establishments) with more than 500 workers. The Ministry of Labour series (HML) and the Istat series (HIS) have been linked by way of an auxiliary regression over the overlapping time interval 1975-1985. The OLS coefficients are (t-statistics in brackets):

$$\text{(A.3)}\quad HML = \underset{(1.1)}{-13.5} + \underset{(51.8)}{1.3}*HIS + \underset{(5.6)}{0.8}*lag(HML) - \underset{(5.7)}{0.9}*lag(HIS)$$

$R2=0.988$ $DW=2.11$ Durbin $H=0.85$ $SEE=0.81$

The HML equation has been projected for the period 1986-1989 by dynamic simulation.

Employment in manufacturing industry comes from the Quarterly Labour Force Survey. The series has been seasonally adjusted using X11-ARIMA.

3. Demand

The index of total demand for manufacturing industry comes from Isco. Firms answer the survey stating whether the level of demand in the month has been "high", "normal" or "low". We have used the difference between the number of "high" and "low" responses. This amounts to assuming a uniform distribution of answers. Different hypotheses on the distribution lead to very similar results. The series obtained has been seasonally adjusted by X11-ARIMA.

4. Relative price of energy

The relative price of energy is given by the ratio of the unit value of energy imports (in lire) to the industrial output deflator. The former comes from Istat for the period 1980-1989; for previous years it has been reconstructed by Bollino and Caselli (1986) for the period 1970-1979 and by us up to 1970, using the IMF oil price series. The industrial output deflator (1985=100) has been computed by Rubino (1990) on the basis of a set of producer prices and input-output matrices published by Istat.

5. Relative contractual wages in industry

The index has been constructed as the ratio of hourly manual worker contractual wages in manufacturing industry to a weighted average of contractual wages for the rest of the economy (i.e agriculture, construction, trade and transport and communications). The weights for the latter series are given by the number of employees in employment in each sector in 1982 (which is the base year for the series).

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