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ACTUAL AND "NORMAL" INVENTORIES OF FINISHED GOODS: QUALITATIVE AND QUANTITATIVE EVIDENCE FROM THE ITALIAN MANUFACTURING SECTOR

by Paolo Sestito (*) and Ignazio Visco (*)

Abstract

Anecdotal evidence concerning the last decade points to increased flexibility of the production process in Italian manufacturing. We consider its impact on inventory levels and accumulation, taking also account of the higher real interest rates prevailing during the eighties.

In the absence of direct measures for the inventories of finished goods held by manufacturers, we use a qualitative indicator, derived from monthly surveys, that reflects the divergence between actual and "normal" inventories, a proxy of the intended investment in inventories. We estimate a process for this indicator, finding a significant impact of real interest rates and demand. Consistently with the increased flexibility of the production process, we find that during the last decade the intended change in inventories was more geared to the current level of demand than to short-term expectations.

We also obtain an estimate of the actual level of inventories, which shows a gentle downward trend as a ratio to current sales. Estimating the process of inventory accumulation, we find that the traditional production-smoothing model remains a suitable reference point; the disequilibrium signalled by firms has a significant effect on their actual investment.

Contents

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1. Introduction[1]

It is widely claimed that Italian firms gained in flexibility in the eighties, thanks to technological advance (shared with the other industrialized countries) and a reduction of the labour market rigidities that had characterized the previous decade. The increase in flexibility should have led to less reliance upon inventories. A further stimulus in this direction is also likely to have come from the high real interest rates that prevailed in the eighties.

This paper considers the above claim, examining the variability over time of industrial production and sales and the evolution of actual and intended inventories of finished goods. To this end use is made of a qualitative indicator derived from monthly surveys, that serves to reflect the divergence between actual and "normal" inventories of finished goods.[2] A basic problem concerns the measurement of the actual inventory level, which is not directly observed in Italy and cannot be approximated by simply cumulating the difference between industrial production and sales. The index of sales shows a spurious upward trend that has to be removed to take account, as we argue, of the reduction of the degree of vertical integration that has occurred in the Italian industry.

The paper is organized as follows. Section 2 presents a number of measures of the variability of production and sales. Section 3 considers the behaviour of the inventory indicator. Its relationship with the actual change of inventories is used to

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1. This paper has been written for Economic, Econometrics and the LINK: Essays in Honor of Lawrence R. Klein, edited by M. J. Dutta et al., Elsevier, forthcoming.

2. The importance of survey methods and data in the analysis of economic fluctuations has often been emphasized by Lawrence Klein. For an early contibution, see Klein (1954).

obtain a correction of the sales index in Section 4; this allows an estimate to be made of the actual level of finished goods inventories, whose accumulation is examined using the production-smoothing model as a reference. Section 5 concludes.

2. The variability of industrial production and sales

As is well known, comparison of the variability of production and sales may shed light on the process governing inventories of finished goods. Convex production costs (and the costs associated with changing the level of production) tend to reduce its variability vis-à-vis that of sales, while the risk of stockouts and the existence of fixed costs in production work in the other direction. The evidence provided by such a comparison is not entirely conclusive because one would need to identify the properties of the shocks impinging upon both demand and cost functions. Even in a production-smoothing model (based on convex production costs), where the role of inventories is to reduce the variability of production, the latter may exceed the variability of sales because of shocks to the cost function (intertemporal substitution induces firms to produce more in favourable times) or correlation over time of demand shocks (innovations in the demand process lead firms to revise expectations for the near future).[3]

Blinder and Maccini (1991) in their thorough survey of evidence and models of inventory behaviour conclude that the traditional production-smoothing model may have received too much attention in the literature. On the one hand, the bulk of inventories (and inventory changes) is not made up of finished goods in manufacturing, where the model may work best. On the other hand, even in the case of inventories of finished goods,

3. Exact bounds for the comparison between sales and production variability have been derived by West (1986).

several facts seem to work against the production-smoothing model: production seems to be more variable than sales in most industries; sales and inventory changes are often not negatively correlated; and the estimated speed of adjustment to the desired level of inventories turns out often to be implausibly low.[4] As Blinder and Maccini argue, this evidence is quite impressive, even if not conclusive. Notwithstanding their arguments, however, the standard production-smoothing model continues to provide a useful reference point in the literature, especially when finished manufacturing goods are considered and when data availability limits the possibility of testing other specifications. Furthermore, as it will be shown, our preliminary evidence for Italy is not so devastating for this model.

Tables 1 and 2 present evidence on the variability of indexes of industrial production and sales in Italy, separately for the seventies (1973-1980) and the eighties (1981-1991), considering both 19 subsectors and manufacturing industry as a whole.[5] In particular, the following regressions have been estimated

$$\log(X_t) = \Sigma\alpha_s d_s + \beta t + u_t \tag{1}$$

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4. However, the low speed of adjustment may well depend on aggregation bias (see Seitz, 1993) or measurement errors in the construction of inventory data (see Fair, 1989).

5. See the Data Appendix for details about the time series utilized in this paper. The 19 subsectors are: 1) Fuel and power products; 2) Ferrous and non-ferrous ores and metals; 3) Non-metallic mineral products; 4) Chemical products; 5) Metal products (excluding transport equipment), agricultural and industrial machinery; 6) Office and data-processing machines, precision and optical instruments; 7) Electrical equipment; 8) Motor vehicles and engines; 9) Other transport equipment; 10) Meats and other food products (excluding beverages and milk products); 11) Milk and dairy products; 12) Beverages; 13) Tobacco products; 14) Textiles and clothing; 15) Leather, leather and skin goods, footwear; 16) Timber, wooden products and furniture; 17) Paper and printing products; 18) Rubber and plastic products; 19) Other manufacturing products.

Table 1

PRODUCTION AND SALES
VARIANCES (MULTIPLIED BY 100) AND CORRELATION BY SECTOR (1)
(1973-1980)

Sectors	Production		Sales		Correlation (2)
	residuals	seasonals	residuals	seasonals	
1	0.3	0.3	1.2	0.5	0.18
2	0.7	1.5	0.8	3.4	0.53
3	0.5	1.8	0.9	1.8	0.80
4	0.5	2.3	1.0	2.6	0.76
5	3.2	2.5	0.9	5.1	0.54
6	3.2	2.6	2.0	5.0	0.30
7	0.9	8.3	0.9	7.1	0.75
8	2.8	11.3	2.2	3.8	0.64
9	1.0	5.5	3.4	6.1	0.22
10	0.4	3.4	0.3	1.3	0.70
11	0.1	0.8	1.8	0.1	-0.34
12	1.4	2.5	1.2	2.3	0.65
13	0.8	2.4	2.1	2.7	0.21
14	1.0	7.4	0.9	6.6	0.86
15	0.9	10.2	0.9	6.7	0.77
16	1.5	7.3	1.2	5.4	0.76
17	1.0	2.3	1.4	3.4	0.75
18	1.1	11.0	1.8	7.8	0.81
19	2.5	11.2	6.5	5.1	0.53
Total	0.5	2.9	0.5	3.0	0.91

(1) The residuals are obtained from a regression:
$\log(X_t) = \Sigma\alpha_s$ seasonals + βtrend + u_t
where X_t = production or sales.
The seasonal variance is the variance of the estimated α_s.
The residual variance is the variance of the estimated u_t.
(2) Correlation between the residuals of production and sales.

Table 2

PRODUCTION AND SALES
VARIANCES (MULTIPLIED BY 100) AND CORRELATION BY SECTOR (1)
(1981-1991)

Sectors	Production		Sales		Correlation (2)
	residual	seasonals	residual	seasonals	
1	0.5	0.1	0.9	0.7	0.30
2	0.5	4.0	0.6	6.3	0.55
3	0.4	3.3	0.7	3.3	0.92
4	0.2	4.6	0.3	4.4	0.57
5	2.0	3.7	0.4	7.1	0.13
6	2.1	3.6	1.0	7.4	0.61
7	0.6	16.1	0.4	9.4	0.54
8	3.4	32.2	1.9	14.6	0.58
9	1.3	7.6	3.1	8.1	0.10
10	0.3	3.7	0.4	1.2	0.57
11	0.3	0.5	0.2	0.2	0.17
12	0.7	2.9	0.7	2.4	0.27
13	0.8	5.7	1.3	2.4	-0.11
14	0.4	12.5	0.4	9.5	0.53
15	0.4	14.1	0.6	10.2	0.55
16	1.0	13.6	0.8	12.8	0.83
17	0.3	3.2	0.3	3.0	0.45
18	0.5	15.6	0.4	12.9	0.70
19	3.2	14.3	1.2	12.2	0.24
Total	0.2	5.9	0.2	3.9	0.90

(1) The residuals are obtained from a regression:
$\log(X_t) = \Sigma\alpha_s$ seasonals + βtrend + u_t
where X_t = production or sales.
The seasonal variance is the variance of the estimated α_s.
The residual variance is the variance of the estimated u_t.
(2) Correlation between the residuals of production and sales.

where X_t is the monthly index of production or sales, d_s are seasonal dummies, t is a time trend, u_t is a zero-mean residual and α_s and β are parameters. Simple variances of estimated residuals and seasonals have been computed. The contemporaneous correlation between the production and sales residuals has also been computed.

The comparison between the two indexes produces the usual picture that production is not unambiguously less variable than sales, contrary to what a simple production-smoothing model would predict. Moreover, innovations in production and sales (as measured by the residuals of the estimated equations) are positively correlated in almost every case.[6] In particular, the evidence for the 19 subsectors hints that no general pattern prevails, pointing to possible aggregation problems when analyzing the total. This is a caveat to bear in mind when looking at the estimates presented in the next sections, where use is made of aggregates.

Comparing the two periods, there is no clear evidence of higher variability of production residuals in the eighties, but production was generally more variable in its seasonal component. This greater variance of the seasonals during the eighties could be linked with a gain in flexibility by industrial firms. Indeed, there is anecdotal evidence that firms were able to concentrate their cuts in production when a recessionary period was ahead, by lengthening vacations and taking advantage of the Cassa Integrazione Guadagni, a public wage supplementation fund that allows firms to put workers on a temporary layoff scheme.

The reduction in the variability of sales and the lower cyclical turbulence in the eighties may also have played a role in reducing the variance of production residuals. The previous

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6. These results are confirmed when seasonally adjusted data are used directly.

decade was characterized by more pronounced cyclical epysodes,[7] probably leading to more erratic behaviour by both production and sales (Figures 1 and 2).

Besides examining the detrended level of production, the short-term variability of production was also considered, after having accounted not only for a log-linear trend but also for cyclical movements. The hypothesis that, for a given level of cyclical turbulence, production was more flexible during the last decade was examined, looking at the variance of the "irregular" component of production, as measured by the difference between the seasonally adjusted index of production and an estimate of its "trend-cycle", obtained from a 9-term Henderson average produced by the X11 seasonal adjustment procedure (Table 3). For the aggregate index, the erratic component of production is actually more variable in the eighties than in the seventies. This result does not extend, however, to all the subsectors considered.

3. The deviation of actual from "normal" inventory levels

The measures of variability reported in Tables 1 and 2 were not invalidated by the difference in the trends of production and sales, which clearly suggests the presence of a spurious component. The ratio between the production and sales indexes falls from 1 in 1973 to .86 in 1991 (see Figure 3). For any plausible values of the starting inventory level and the production-to-sales ratio in the first year, this divergence would produce negative inventories, obviously a nonsensical result. One possible interpretation is that the sales index was influenced by the restructuring process and by the reduction of the degree of vertical integration of the industrial sector that

7. The reference period for cyclical upturns can be found in Schlitzer (1993).

Fig. 1

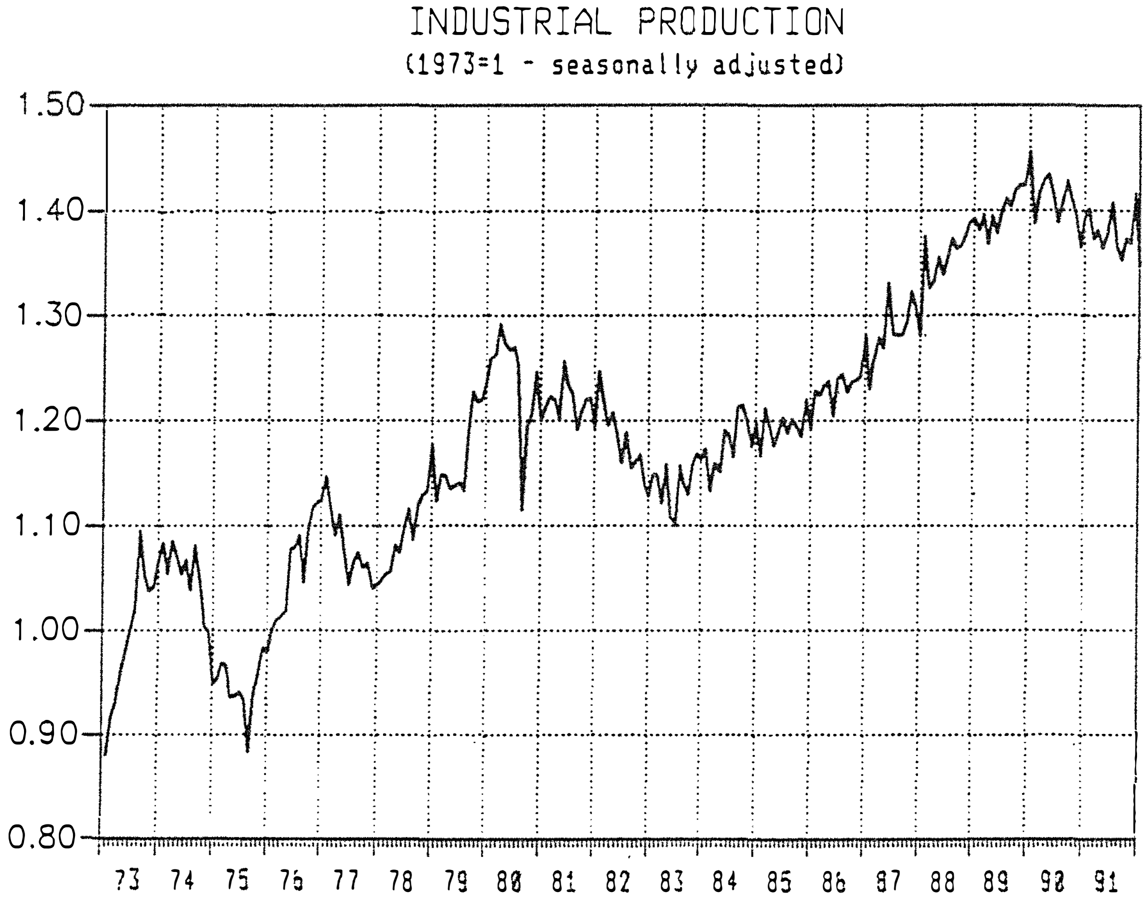
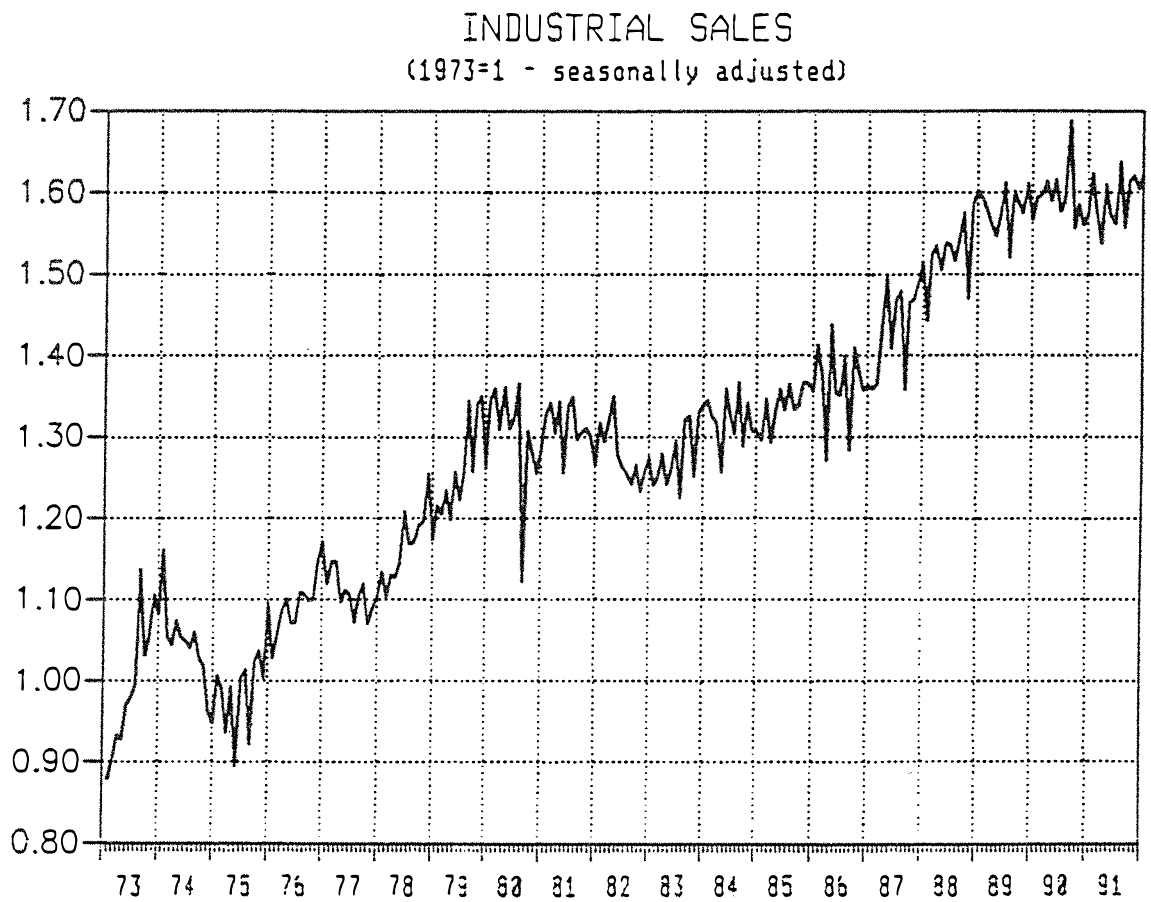

INDUSTRIAL PRODUCTION
(1973=1 - seasonally adjusted)
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91

Fig. 2



INDUSTRIAL SALES
(1973=1 - seasonally adjusted)
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91

Table 3

VARIANCE OF THE IRREGULAR COMPONENT OF PRODUCTION (1)

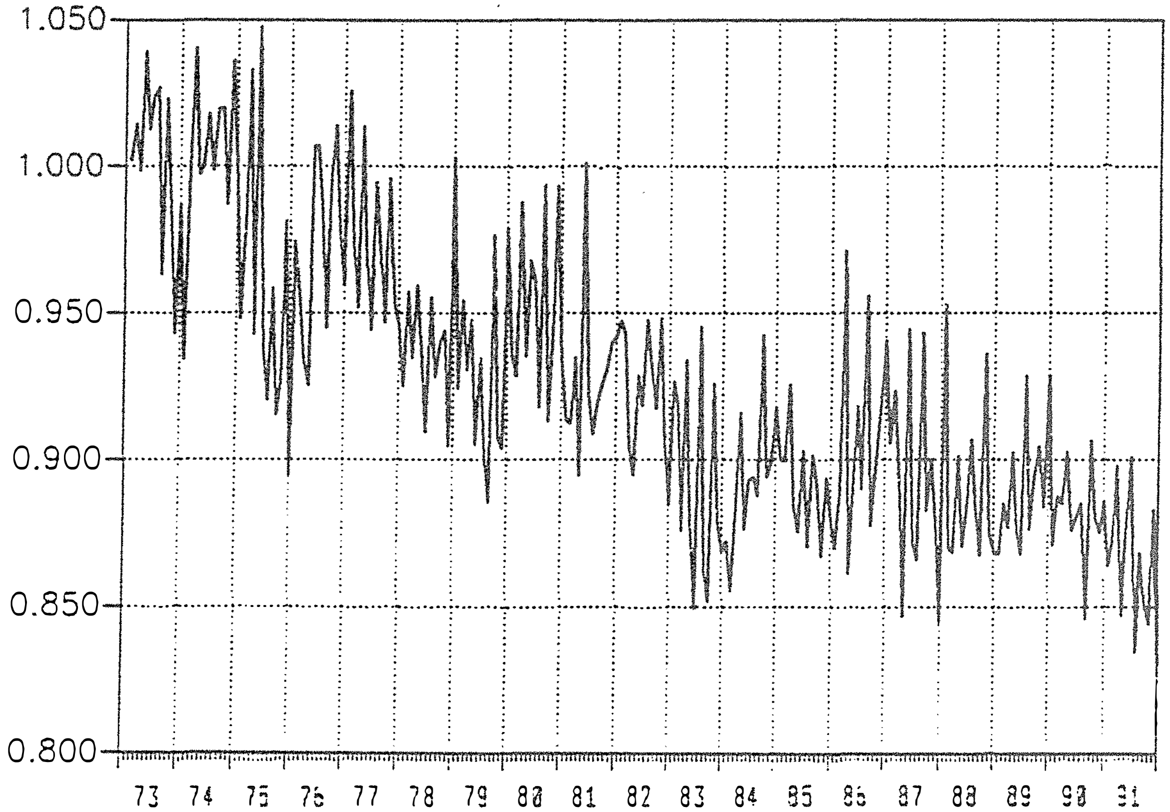
Sectors	1973 - 1980		1981 - 1991		Ratio
	Amount	Share of total variance	Amount	Share of total variance	seventies / eighties
1	4.0	10.9	4.2	5.1	0.95
2	3.6	5.4	3.1	5.2	1.19
3	3.2	4.9	1.7	2.6	1.92
4	2.9	3.3	2.0	1.8	1.47
5	5.4	2.7	12.2	1.8	0.44
6	5.6	2.9	12.7	1.8	0.44
7	4.8	8.5	3.5	1.9	1.37
8	32.1	21.0	9.2	4.0	3.49
9	1.6	1.4	7.3	1.3	0.22
10	3.6	6.6	3.9	5.9	0.93
11	4.2	7.8	4.8	6.5	0.87
12	6.1	10.6	8.8	2.4	0.69
13	6.5	20.3	2.0	1.9	3.19
14	6.2	7.5	4.2	20.2	1.47
15	8.7	15.9	2.7	3.3	3.24
16	4.9	2.5	7.4	6.6	0.66
17	5.0	6.7	6.1	2.6	0.81
18	9.2	12.7	2.7	2.2	3.46
19	35.4	7.6	11.2	2.6	3.16
Total	124.8	57.6	271.6	67.2	0.46

(1) The irregular component is the difference between the seasonally adjusted index and the trend-cycle, obtained from a 9-term Henderson average produced by the X11 procedure.

Fig. 3

RATIO OF PRODUCTION TO SALES INDEX

(1973=1 - seasonally adjusted)



occurred mainly in the late seventies and early eighties. The sales index refers in fact to all the products sold by a firm (including those not directly manufactured), while the production index is a quantity index measuring specific items.[8]

In the absence of a direct measure of stocks in Italy, a correction for the spurious trend in sales has to be made before an estimate of actual inventories can be obtained by cumulating the difference between production and sales. Our research strategy is to exploit the qualitative information on the difference between actual (unknown) and "normal" inventories of finished products in manufacturing, surveyed monthly since 1962 by the Istituto nazionale per lo studio della congiuntura (ISCO), in order to derive an indirect estimate of inventories, given the relationship that must link the time series of industrial production, sales and inventories.

In the ISCO surveys firms are asked about their actual (end-of-period) vis-à-vis "normal" levels of finished goods inventories (taking seasonal factors into account); answers are coded, as percentages, into four groups: "above", "equal" and "below normal", and "no inventories" at all. Assuming a distribution for the continuous (unknown) quantitative responses, a series σ_t can be constructed (following Conti and Visco, 1984, in using the Theil (1952) and Carlson and Parkin, 1975, procedure) such that:

$$- c\sigma_t I_t = (I_t^* - I_t) \qquad (2)$$

where I_t is the actual (end-of-period) level of inventories, I_t^* is the "normal" level and c is a positive constant signalling a threshold value below which there is no perceived divergence

8. Iacoboni and Sestito (1987) have presented evidence of a downward trend for the ratio of sales of own-manufactured goods to total sales, the latter being measured by the sales index currently available.

between normal and actual inventories (i.e. an answer "equal to normal" is given).

More specifically, given the percentages, A and B, of those answering above and below normal, one can write $A=Pr(I \geq I^{*}+\delta)$, $B=Pr(I \leq I^{*}-\delta)$. Assuming that $\delta=cI$, where c defines the boundaries of the normality interval as percentages $\pm cI$, one can obtain estimates of $(I^{*}-I)/I$ for a given form of the distribution of the answers. Under the assumption of a normal distribution, the series σ can be constructed as a function of the abscissa values of the standardized normal Z_1 and Z_2 (corresponding, respectively, to the areas 1-A and B) such that $(I-I^{*})/I=c\sigma$. In particular, $\sigma=-(Z_1+Z_2)/(Z_1-Z_2)$. Assuming instead a uniform distribution, one obtains $\sigma=BAL/(1-A-B)$, where BAL=A-B is the "balance" statistic usually computed in these qualitative surveys.[9] Series of σ have been constructed under both hypotheses; they are very similar and those based on the normal distribution are the ones actually used in what follows. In the computations, the "no inventories" answers have been added to those "below normal". However, ignoring these answers, the pattern of σ over time does not change much. It should also be observed that the simplifying assumption of equal and constant limits for the "equal to normal" class has been made for all firms and all time-periods. This assumption should be among the first to be tested in future work. In fact, measurement errors may be induced by neglecting the heterogeneity (and possible asymmetry) of the scaling factor (and more generally of the "normal" level of inventories) across firms.

As Schlitzer (1993) has shown, the deviation between

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9. For further methodological details, see Visco (1984), especially pp. 65-74. It should be observed that in the case of a uniform distribution the balance statistic would be a reasonable indicator provided that the "equal to normal" class was roughly constant over time: this appears not to be a bad approximation in the present case.

actual and "normal" inventories of finished products coming from the ISCO surveys appears to be strongly correlated to industrial output fluctuations for which it also acts as a leading indicator. Figure 4 shows the behaviour over time of the measure of σ_t, based on the assumption of a normal distribution. Going back to the issue of flexibility in the eighties, it is immediately evident that deviations of actual inventories from the level considered to be normal became smaller, in absolute size, during the last decade.

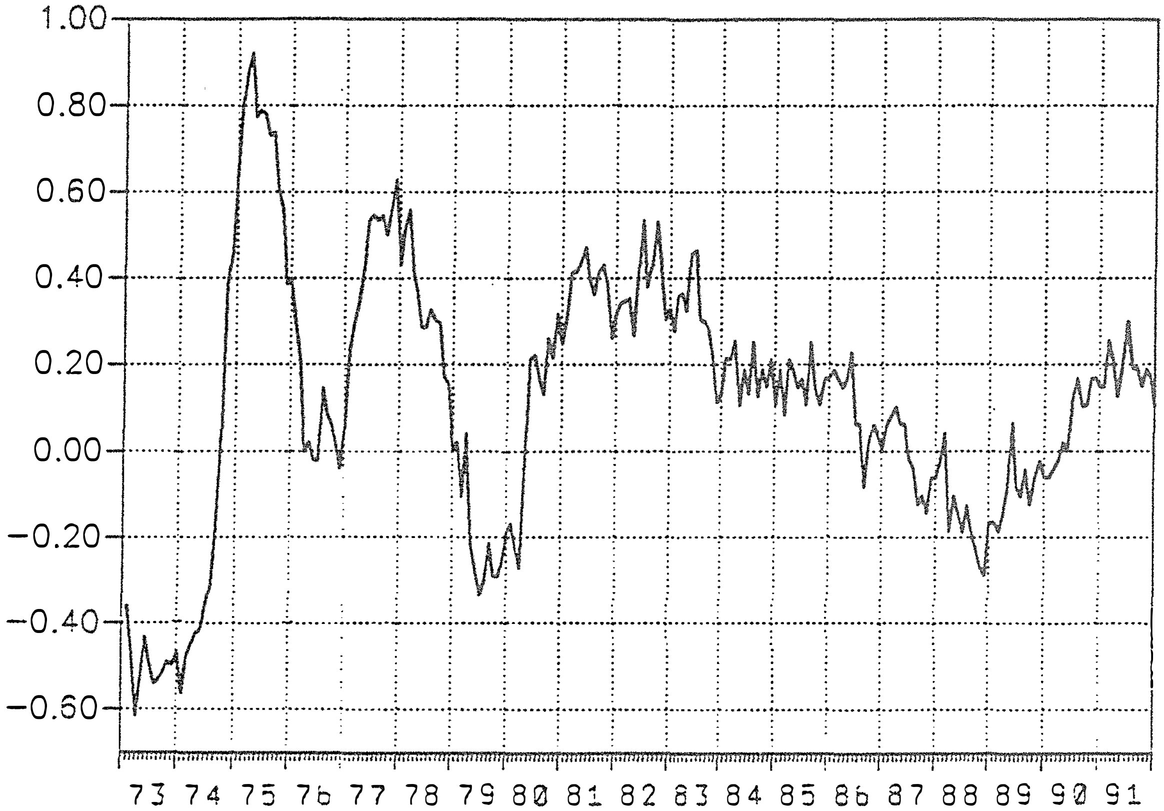
A visual inspection of the ISCO variable shows that the normal level firms have in mind is likely to be neither a long-run target (say the steady-state level) nor a very short-run objective. In both cases this variable would have been much more erratic. In the former case because all the shocks to actual inventories should have been translated, one for one, in that variable. In the latter case because firms would have attempted to promptly eliminate any divergence from the "normal" level, with the result that these differences would again be quite erratic and less persistent.

In searching for the determinants of the discrepancy between actual and normal inventories, the first problem therefore arises from the ambiguity in the concept of the "normal" level of inventories: is it more similar to a long-run or to a short-run target? A direct examination of the normal level is not possible because it cannot be estimated without knowing both the actual level of inventories and the scaling factor c. Accordingly, rather than exaamining the determinants of I_t^* (conditional on some assumption for c and an estimate for I_t),[10] the determinants of the discrepancy between

10. This alternative route was followed by Conti and Visco (1984). For the period they examined, however, the estimate of I_t was likely less subject to measurement errors. Moreover, the heterogeneity across firms neglected in the construction of σ may have been less important in the

Fig. 4

DEVIATIONS OF FINISHED GOODS INVENTORIES FROM NORMAL (*)



(*) The survey answers have been transformed on the assumption of a normal distribution.

normal and actual inventories have been considered, with particular reference to the effects of short-term demand conditions and innovations in real interest rates. Basically, σ_t has been regressed on the deviation of the ex-ante real interest rate (r_t) from its lagged six-term moving average (mr_{t-1}) and other ISCO variables reflecting the expected change of demand in the coming 3-4 months (T_t) and the current level of demand vis-à-vis its "normal" level (L_t).[11] The possibility of breaks in the equation was also investigated, leading to the following estimate:[12]

$$\sigma_t = \underset{(3.43)}{-.028} + (\underset{(29.80)}{.885} - \underset{(3.67)}{.224} d_t)\sigma_{t-1} + \underset{(2.10)}{.0052}\,(r_t - mr_{t-1})$$

$$-\underset{(5.52)}{.313}\, d_t L_t - \underset{(5.30)}{.425}\,(1-d_t)T_t \qquad (3)$$

$\bar{R}^2$=.933, SER=.0742, DW=2.15, h=1.25,

MLM(1)=1.83, MLM(12)=.14, MLM(1-12)=.85,

ARCH(1)=1.41, ARCH(12)=1.76, ARCH(1-12)=7.15

(Continuazione nota 10 dalla pagina precedente)
seventies than in the eighties. In the next section a measure of the actual level of inventories of finished goods is in any case obtained and some preliminary evidence of the determinants of actual inventory accumulation presented.

11. See the Data Appendix for further details also on these time series.

12. Allowing for the lags present in the equation, the sample period goes from July 1973 to December 1991. t-statistics are reported in absolute value in parentheses. Statistical inference would not be much affected by the use of the White procedure to estimate the standard errors. The other reported statistics are: $\bar{R}^2$ and SER, respectively the adjusted R^2 and standard error of the residuals; DW and h, respectively the Durbin-Watson and the Durbin test for autocorrelation of first order in the residuals; MLM and ARCH, respectively the modified Lagrange multipliers and Engle statistics appropriate to test for autocorrelation and autoregressive conditional heteroschedasticity of different order in the residuals.

where d_t is a dummy variable equal to 0 prior to 1978 and to 1 afterwards.

Two interesting results should be noted. First, a significant and strong impact of real interest rates on the intended change in inventories has been obtained. Second, the time break that has been uncovered is consistent with the hypothesis of greater flexibility in the production process: in the more recent period, the autoregressive component of σ_t becomes less important, while the important demand variable appears to be the discrepancy between the current and the normal level of orders rather than the expected change of demand in the near future.[13] This is in line with the interpretation that the flexibility gained in production management allowed firms to reduce the accumulation of inventories with which to meet future movements of demand.

4. Actual inventory accumulation

To examine whether the production-smoothing model works as a reasonable approximation of actual aggregate inventory behaviour in Italian manufacturing, an estimate of actual inventories needs to be obtained. As mentioned in the previous section, a correction for the spurious trend in the sales index needs to be made before an indirect measure can be derived of the actual change in inventories of finished products.

To recover the level of actual inventories, we thus start from the identity:

$$I_t = I_{t-1} + QP_t - QS_t = I_0 + \sum_{i=1}^{t} (QP_i - QS_i) \qquad (4)$$

13. The restriction implied in our treatment of the time breaks is not rejected, with an $F(4,212)=1.42$.

where QP_t and QS_t are production and sales in month t. In (4) we have that $QP_t = aP_t$ and $QS_t = bS_t$, where P and S are the quantity indexes of production and sales and a and b are their values in the base year (1973). We then assume that the proper sales index, S_t, can be expressed as $S_t^* G_t$, where S_t^* is the unadjusted index and G_t is a correction factor assumed to be a simple function of time.

Whatever the determinants and the precise definition of "normal" inventories are, we can further assume that the investment in inventories for period t is somehow related to $(I_{t-1}^* - I_{t-1})$. This implies that whenever σ_{t-1} is (approximately) zero, production and (adjusted) sales tend to be approximately equal to each other. The evolution over time of the correction factor G_t can then be identified by looking at the production-to-sales ratio for those months when σ_{t-1} was approximately equal to zero. In doing so different benchmarks have been used, selecting those months with σ_{t-1} included in intervals from $\pm .05$ to $\pm .20$. The picture does not change much across the different cases (Figure 5). We ended up by using the one with most observations, even if it should be observed that in the last period almost all observations fall in the range.[14]

Considering only the months with absolute values of σ_{t-1} below .20, the ratio between the two indexes in the 1973-1976 period is roughly consistent with the production-to-sales ratio in the average of 1973 (a/b=1.018, i.e. the ratio of the actual values in the base year) as reported in Conti and Visco (1984). This result corroborated our procedure, which provided a value of .889 for the ratio of the two indexes during the 1984-1991 period. A few problems arise for the intermediate period: for the years from 1977 to 1980 there seems to be an intermediate value for the production-to-sales ratio; for the years from 1981 to

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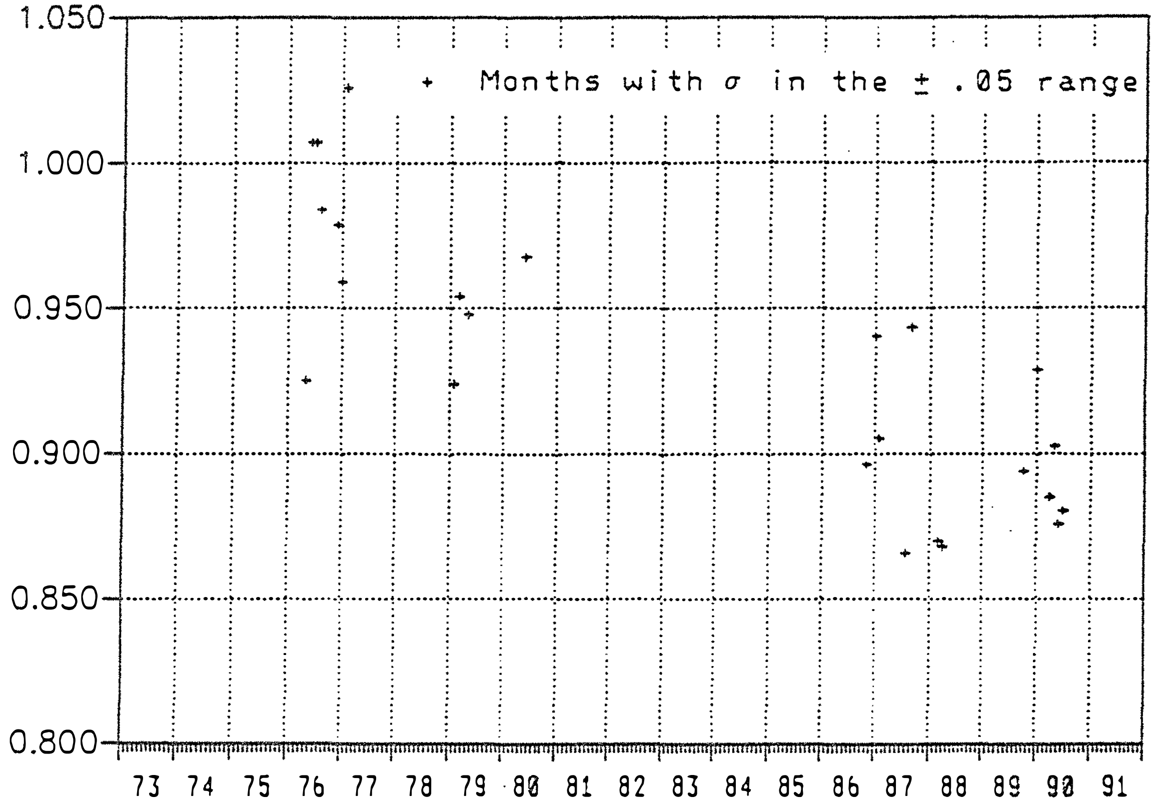
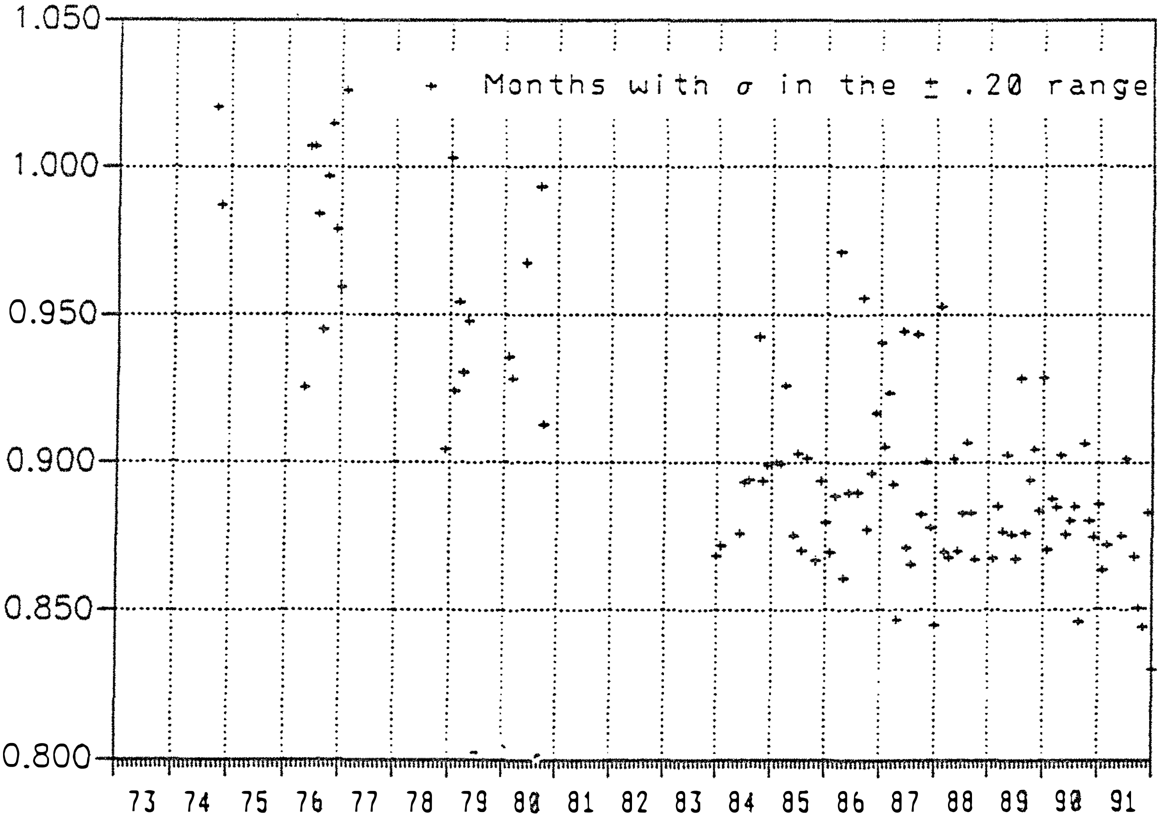
14. Observe that for plausible values of c (say c=.05) $\sigma = \pm .20$ implies $(I-I^*)/I = \pm .01$.

Fig. 5

RATIO OF PRODUCTION TO SALES INDEX IN THE MONTHS WITH NORMAL INVENTORIES APPROXIMATELY EQUAL TO ACTUAL INVENTORIES
(1973=1)





1983 we basically have no observation with σ_{t-1} approximately equal to zero. We therefore decided to assume that G_t followed a linear trend in the years 1977-1983 going from 1 to .905 (obtained from .889 by using the known value of a/b). We ended up with the following values for G_t:

$G_t = 1$ for the 1973-1976 period
$G_t = 1 - .001116\,(t-48)$ for the 1977-1983 period
$G_t = .905$ for the 1984-1991 period

where t is a linear trend equal to 1 in January 1973.

Using then 1.018 for the production-to-sales ratio in 1973 and 1.607 as the starting value for inventories in units of 1973 average sales (also taken from Conti and Visco) the actual level of inventories (also expressed in units of 1973 average sales) can be obtained as:

$$I_t = 1.607 + 1.018 \sum_{i=1}^{t} P_i - \sum_{i=1}^{t} S_i^* G_i \qquad (5)$$

Figure 6 shows that the level of actual inventories of finished goods resulting from (5) presents marked cyclical fluctuations as well as a gently declining long-run trend.

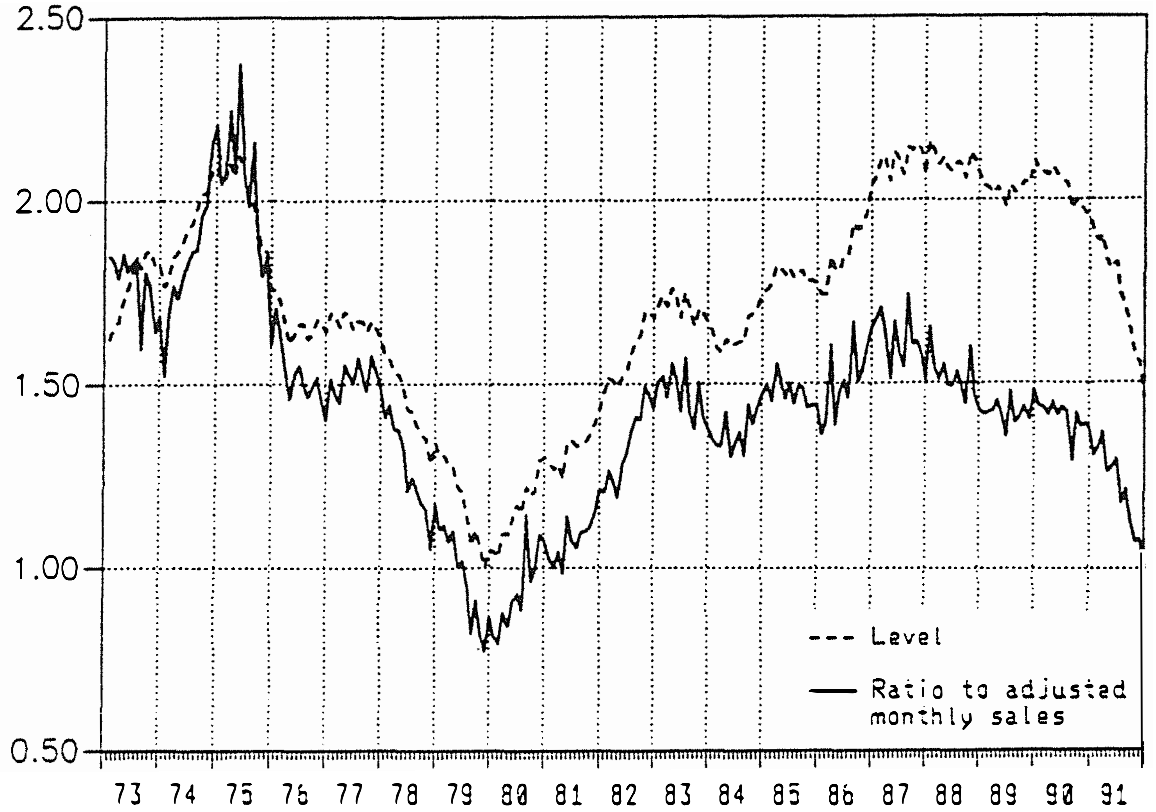
To examine whether production-smoothing reasonably approximates actual inventory behaviour, a very simple specification has been considered, consistent with the way the estimate of I_t was obtained:

$$\Delta I_t = \lambda(I_{t-1}^* - I_{t-1}) + x_t + \varepsilon_t \qquad (6)$$

where x_t summarizes all the elements not included in the level of inventories that firms considered to be "normal" at the end of month t-1 (the buffer role of inventories, news leading to revisions in the planning of inventory accumulation, expectations about cost and demand shocks not already taken into account by

Fig. 6

ACTUAL INVENTORIES (*)



(*) Expressed in units of 1973 average monthly sales.

$I^{*}_{t-1})$[15] and ε_t is a stochastic error.

Recalling that $-\sigma_t I_t=(I^{*}_t-I_t)/c$, equation (6) can then be estimated.[16] Neglecting the x_t component, an estimate of $\lambda c=.01$ is obtained; the fit of the equation is, however, rather low and the t-value of the estimated coefficient is about 1.5. Roughly the same estimate, with a t-value equal to 1.95,[17] is obtained when x_t is simply specified as $\beta\Delta(T_t S_t)$, which proxies the acceleration of expected sales for the near future.

The preferred specification, which completely eliminates the autocorrelation present in the previous estimates, is the following:

$$\begin{aligned}\Delta I_t = \; & \underset{(2.23)}{.035} + \underset{(3.96)}{.013}\,(I^{*}_{t-1}-I_{t-1})/c + \underset{(2.50)}{.073}\,\Delta(T_t S_t) \\ & - \underset{(16.66)}{.705}\,S_t + \underset{(3.45)}{.143}\,S_{t-1} + \underset{(0.78)}{.034}\,S_{t-2} - \underset{(2.26)}{.109}\,S_{t-3} \qquad (7) \\ & + \underset{(3.17)}{.216}\,P_{t-1} + \underset{(1.83)}{.125}\,P_{t-2} + \underset{(4.35)}{.270}\,P_{t-3}\end{aligned}$$

$\bar{R}^2=.668$, SER=.023, DW=2.02,

MLM(1)=.79, MLM(12)=.31, MLM(1-12)=1.10,

ARCH(1)=.78, ARCH(12)=1.3, ARCH(1-12)=14.03

where x_t includes current and past values of sales and past values of production, catching both the buffer role of inventories and the presence of cost shocks not taken into

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15. This reflects the possibility that I^{*} might account for only part of all the relevant short term elements.

16. The sample period goes again from July 1973 to December 1991.

17. 1.98 using the White procedure, which takes account of potential heteroschedasticity.

account by I^{*}_{t-1}.[18]

The significant effect of the past discrepancy between actual and normal inventories provides a remarkable result, given the use of aggregate data.[19] As a caveat one has to keep in mind that the final specification used for x_t is not fully consistent with the way the measure of I_t was obtained because the presence of x_t was neglected at that stage. Moreover, from (7) we only get an estimate of λc, so that it is difficult to evaluate the actual performance of the production-smoothing model unless some outside guess on the unknown scaling factor c is made or some further identifying restriction is introduced. From the estimate of λc in (7) we can nonetheless conclude that, for reasonable values of c, the implied values of λ suggest that a sufficiently rapid adjustment to the desired target is not incompatible with the data. For c=.025, for example, one would obtain λ=.52, so that about eighty percent of the gap between desired ("normal") and actual inventories would be closed in just two months.

An independent estimate of λ could be obtained by putting more structure into our model.[20] Denoting by P^{*}_{t-1} the level of production planned at the end of month t-1 in the absence of adjustment costs and assuming that the actual production process might be described as a simple geometric adjustment to its desired level, we can write:

$$\Delta P_t = \lambda(P^{*}_{t-1} - P_{t-1}) + x_t + \eta_t , \qquad 0 \leq \lambda \leq 1 \qquad (8)$$

---

18. In (7) as well as in what follows the production index P has been multiplied by the production-to-sales ratio in the base year, a/b=1.018.

19. For the bias arising from the use of aggregate data in the estimate of the production-smoothing model, see Seitz (1993), who also relies on survey data of the kind considered in this paper.

20. For a similar derivation, see Fair (1989).

where x_t again summarizes all the elements not included in the desired level of production and η_t is a stochastic error. A simple specification for P^* could be the following:

$$P^*_{t-1} = \gamma S_t + (1-\gamma)\hat{S}_{t+1} + I^*_{t-1} - I_{t-1} \tag{9}$$

where the level of production planned in month t-1 for month t is intended to close the gap between the desired and actual levels of inventories and to meet anticipated demand. Given obvious production lags, the latter is expressed in (9) as a weighted average of the sales that are actually going to take place in month t (presumably known and basically decided by firms at the end of t-1) and those expected by firms for the immediate future (say month t+1). Equations (8) and (9), together with the identity $\Delta I_t = P_t - S_t$, lead to:

$$\Delta I_t = \beta_1(I^*_{t-1} - I_{t-1}) + \beta_2\hat{S}_{t+1} + \beta_3 S_t + \beta_4 P_{t-1} + x_t + \eta_t \tag{10}$$

where $\beta_1=\lambda$, $\beta_2=\lambda(1-\gamma)$, $\beta_3=\lambda\gamma-1$, $\beta_4=1-\lambda$, so that $\beta_2+\beta_3+\beta_4 = 0$.

For a particular specification of $\hat{S}_{t+1}$ in terms of past values of S_t, equation (7) could be parameterized to produce proper estimates of β_2 , β_3 and β_4 , with x_t being essentially a function of ΔP_{t-1} and ΔP_{t-2}. In this case an estimate of λ could be obtained by simply summing the coefficients of the production terms present in the equation, ending up with an estimate near .4, which is not a low speed of adjustment at a monthly level. Alternatively, we have considered the possibility of proxying expected demand as:

$$\hat{S}_{t+1} = S_t(1 + \hat{\gamma}_0 + \hat{\gamma}_1 ds_t + \hat{\gamma}_2 ds_{t-1} + \hat{\gamma}_3 ds_{t-2}) \tag{11}$$

where $ds_t = \Delta S_t/S_{t-1}$ and the $\hat{\gamma}$'s have been obtained from the third-order autoregression (over the 1973.6-1991.12 sample period):

$$ds_t = \underset{(2.52)}{.006} - \underset{(10.99)}{.733}\, ds_{t-1} - \underset{(4.61)}{.365}\, ds_{t-2} + \underset{(1.946)}{.130}\, ds_{t-3} \qquad (12)$$

$\bar{R}^2$=.450, SER=.033, DW=1.99, h=1.10.

Using (11) the following estimate of equation (10) has been obtained:

$$\Delta I_t = \underset{(2.53)}{.039} + \underset{(4.33)}{.014}\,(I^*_{t-1} - I_{t-1})/c + \underset{(2.64)}{.077}\,\Delta(T_t S_t)$$

$$+ \underset{(3.23)}{.219}\,\hat{S}_{t+1} - \underset{(17.83)}{.802}\,S_t + \underset{(9.83)}{.554}\,P_{t-1} \qquad (13)$$

$$- \underset{(5.59)}{.329}\,\Delta P_{t-1} - \underset{(3.97)}{.230}\,\Delta P_{t-2}$$

$\bar{R}^2$=.662, SER=.023, DW=2.01,
MLM(1)=.49, MLM(2)=.17, MLM(1-12)=1.04,
ARCH(1)=.62, ARCH(2)=.05, ARCH(1-12)=15.85.

In the first place it should be noted that the fit, general characteristics and parameter estimates of equation (13) are very similar to those of equation (7). Two points are worth emphasizing. On the one hand, the constraint on the coefficients of $\hat{S}_{t+1}$, S_t and P_{t-1} given by equation (10) is substantially satisfied, with $\hat{\beta}_1+\hat{\beta}_2+\hat{\beta}_3=.04$,[21] and a significant buffer stock role revealed. On the other hand, the estimate of the adjustment coefficient turns out to be about .45, which implies that the production (and inventory gap) appears to be closed at a sufficiently high speed, about two-thirds of the adjustment taking place in two months. From this estimate, and that of the coefficient of $(I^*_{t-1}-I_{t-1})/c$, we

21. The restriction, however, is rejected at the 5 percent level, with a t-value equal to 2.33, pointing to the possible presence of some slight misspecification, as is almost bound to occur in the construction of the expected demand variable.

also obtain an extremely reasonable value for c, slightly above 3 percent. Finally, it should be observed that, through the inventory disequilibrium variable, the gains in flexibility discussed in the previous section obviously also affect the actual inventory accumulation process.

5. Conclusions

In this paper the evolution and determinants of the stock of finished goods inventories held by Italian manufacturing firms have been examined. The only direct information available on inventories, allows a qualitative indicator, that reflects the divergence between actual and "normal" levels, to be derived from monthly surveys. This indicator probably reflects the intended change in the stock of inventories and appears to be significantly affected by changes in real interest rates and demand. Consistently with the increased flexibility of the production process, it turns out that during the last decade the intended change in inventories of finished goods was geared more to the current level of demand than to expectations of change in the near future. The greater flexibility obtained in production management allowed firms to reduce the need to accumulate inventories in advance to meet expected demand.

An indirect estimate of the actual stock of inventories was obtained by cumulating over time the difference between the production and (adjusted) sales indexes. As the latter shows a spurious upward trend, presumably linked to the restructuring process and the reduction of the degree of vertical integration that has occurred in Italian industry, an adjustment was made that also took account of the qualitative information coming from the indicator on the divergence between actual and "normal" inventory levels. As a ratio to current sales, the stock of inventories of finished goods that results from this procedure shows both marked cyclical fluctuations and a gentle downward trend. Estimating the process of actual inventory accumulation, the traditional production-smoothing/buffer-stock model seems to remain a suitable reference point, at least in the case of the stock of finished products; the disequilibrium signalled by firms has a significant effect on their actual investment in inventories and the speed at which the disequilibrium is closed appears to be sufficiently high.

The evidence presented in this paper is certainly preliminary. Even if we believe that the aim of showing the usefulness of survey information in the analysis of inventory accumulation was essentially achieved, a number of steps and assumptions should probably be further analyzed and tested. With only a limited amount of aggregate information, a wide spectrum of issues was put under scrutiny. As the various caveats we advanced should have indicated, it would be especially important to allow for the heterogeneity and asymmetry in the way firms signal the presence of disequilibria in their inventory stock; moreover, as regards the construction of the actual level of inventories, better ways should be found to deal with the spurious trend that plagues the currently available index of sales.

In particular, the use of disaggregated data would probably reduce the measurement problems that showed up in the estimation of the actual level of inventories, since it would allow the identification of industries where the spurious trend in the sales index was either less important or could be corrected by means of available external information. Perhaps more importantly, it could attenuate the impact of some of the simplifying assumptions that have been adopted to transform the qualitative evidence on the discrepancy between actual and "normal" inventory levels into a quantitative time series. Furthermore, it might also make it possible to separate firms producing for stock from firms producing to order, making it possible to compare the performance of the production-smoothing model directly with that of other models of inventory investment.

In any case, to conclude, the evidence presented in this paper supports the idea that, at least in the aggregate, smoothing and buffer-stocks are still important factors in the determination of finished goods inventory accumulation in Italy. An important role for real interest rates has also been identified, and some support has been found for the claim that increased flexibility in production management in the eighties allowed Italian firms to rely less on the accumulation of inventories of finished products to meet short-run changes in demand.

Data Appendix

P: index of production in manufacturing industry; computed by Istat in quantity terms since 1953, adjusted by the Bank of Italy for differences across months in the number of working days and for seasonality, 1973=1 (see Bodo and Pellegrini, 1993).

S^*: unadjusted sales index in manufacturing industry; computed by Istat in nominal terms since 1973, deflated and seasonally-adjusted by the Bank of Italy, 1973=1.

T: expected change of demand in the next 3-4 months; weighted balance of plus and minus answers in the ISCO monthly surveys; seasonally adjusted by the Bank of Italy.

L: level of current demand and orders vis-à-vis a "normal" level; weighted balance of answers above and below normal in the ISCO monthly surveys; seasonally-adjusted by the Bank of Italy.

I: actual level of (end-of-period) inventories of finished goods, obtained by cumulating the difference between production and (adjusted) sales as described in the text and expressed in units of monthly average 1973 sales.

r: ex-ante real rate of interest, computed as $(i-\pi)/(1+\pi)$, where the monthly loan (prime) rate, i, has been computed joining different series elaborated by the Bank of Italy, and π is the rate of change of wholesale prices expected at the end of month t for the next six months by the industrial businessmen participating in the Mondo Economico forum (see Visco, 1984, for the construction of this series from the survey answers); the π series is originally semi-annual and has been interpolated using the qualitative answers to another monthly ISCO question on price changes as indicator.

σ: percentage deviation of actual and normal inventories (divided by an unknown scaling factor) obtained by assuming a normal distribution of the answers to the monthly ISCO surveys.

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