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INVENTORY ACCOUNTING AND PROFIT EVALUATION

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In an inventory model with exogenous sales, FIFO and LIFO criteria are formalized and compared with national account estimates for intermediate and finished good products. The model is simulated by utilizing manufacturing input and output prices for Italy (1970–88). LIFO and national account estimates of inventory are usually close and also imply reliable measures of output level and changes which can be shown by solving the quantity model. Conversely, FIFO exhibits larger profits and leads in real terms to unsatisfactory estimates of output changes.

I. Introduction

The value of inventories in an inflationary environment reflects the accounting criteria adopted by firms which rarely coincide with national accounts (NA). Since macroeconomic figures usually stem from collecting a large amount of self-reported microdata, both flow and stock estimates of NA inventories need to be corrected. This is so because stock appreciation not only characterizes FIFO (First In-First Out), but also regards the much more popular LIFO (Last In-First Out) when volumes are reduced.

What ever accounting criteria a firm may select, it is obvious that NA observe only the reported values. The quantities have to be discovered by trying to replicate the firm's criteria. Symmetrically, the firm knows the quantity, but not the nominal value of its inventory which is also calculated on the basis of its fiscal goals.

To clarify these issues, I will illustrate FIFO, LIFO and NA methods using a simple model. I will apply them to a hypothetical, aggregate, economy to show their differences and consequences on the business cycle. The second purpose of this article is to link the inventory evaluation with functional income distribution. This has, in turn, several implications to the meaning and estimate of taxable income.

II. Quantity Relations

Let me assume that a manufacturing economy produces a single storable good and buys from abroad or from other sectors a single, storable, intermediate product. Unfilled orders are ignored and inventory stock has no physical depreciation. I assume also that it is constituted by intermediate and finished goods only. The latter cannot be used as input. Work-in-process stocks are either ascribed to materials or to finished goods, depending on their stage of completion. Finally, intermediate purchases include raw materials and any other physical input which has not been completed, in this case services being irrelevant.

Note: I am indebted to D. D. Hester and to an anonymous referee for constructive criticism. Views and remaining errors are mine.

Defining the stock at the end of period t ($t = 0, 1, \dots$), let me denote the following variables in real terms:

h = Inventory stock

hm = Intermediate good stock

hf = Finished good stock

qi = Inflows into the warehouse

qo = Outflows from the warehouse

ip = Intermediate purchases

ic = Intermediate consumption

s = Final sales

y = Output.

Let me now introduce the following price indexes:

p = Price index of inventory stock

pm = Price index of inputs

pf = Price index of final sales.

The corresponding nominal variables are in capital letters:

Y = Output

S = Final sales

H = Inventory stocks

HM = Intermediate good stocks

HF = Finished good stocks

IP = Intermediate purchases

IC = Intermediate consumption

CS = Cost of sales

VA = Value added

W = Labor compensation

PR = Gross profits.

Denoting by D the first difference operator, I define inventory changes as the net difference between the inflows and the outflows of the warehouse:

(1) $$Dh_t = qi_t - qo_t.$$

By cumulating (1), I obtain two equivalent expressions for the stock level:

(2) $$h_t = h_{t-1} + (qi_t - qo_t),$$

and:

$$(3) \qquad h_t = h_0 + \sum_{i=1}^{t} Dh_i \equiv h_0 + \left(\sum_{i=1}^{t} qi_i - \sum_{i=1}^{t} qo_i \right),$$

where $h_0 > 0$ indicates the initial volume of the stock. Note that in physical units, the stock at the end of the year must be identical to the stock at the beginning of the next year ${}_oh_t$:

$$(4) \qquad h_{t-1} \equiv {}_oh_t.$$

I link inventory and production accounting using the following relations:

$$(5) \qquad y_t = s_t + Dhf_t$$

$$(6) \qquad ic_t = ip_t - Dhm_t$$

$$(7) \qquad qi_t = ip_t + y_t$$

$$(8) \qquad qo_t = ic_t + s_t.$$

Equation (5) defines output as the sum of final sales and changes of finished (and semi-finished) good stocks. Equation (6) can be renormalized to show that changes in the intermediate good stock are the difference between supply and demand of nonlabor inputs:

$$(9) \qquad Dhm_t = ip_t - ic_t.$$

Equation (1) then amounts:

$$(10) \qquad Dh_t = (ip_t - ic_t + y_t - s_t) \equiv Dhm_t + Dhf_t.$$

Likewise, the overall stock will be:

$$(11) \qquad h_t = hm_t + hf_t,$$

except for commercial units which hold finished goods only.

III. Nominal Relations and Accounting Methods

In physical terms, inventory evaluation does not present any particular problem. Problems arise, however, in nominal data because of different assumptions about the timing of releasing materials and products.

Here I will formalize both FIFO and LIFO criteria and compare them with NA estimates which typically evaluate changes in stocks at the average price of the period (United Nations, 1968; Eurostat, 1979). Before discussing each method in detail, let me establish the following nominal relations:

$$(12) \qquad Y_t = S_t + DHF_t$$

$$(13) \qquad VA_t = Y_t - IC_t$$

$$(14) \qquad IC_t = IP_t - DHM_t$$

from which value added is obtained in terms of the total nominal inventory changes $DH \equiv DHM + DHF$:

$$(15) \qquad VA_t = S_t - IC_t + DH_t.$$

Value added can be defined as the sum of labor compensation (W) and gross profits (PR) which then correspond to:

$$PR_t = S_t - CS_t \tag{16}$$

in which the cost of sales (CS) can, in turn, be defined as the difference between opening stock, current costs ($IP + W$) and closing stock:

$$CS_t = [H_{t-1} + (IP_t + W_t) - H_t]. \tag{17}$$

Combining equations (16), (17), (6) and (11), I express profits as the value of sales plus finished good inventory changes less the relevant costs of production:

$$PR_t = S_t - (IC_t + W_t) + DHF_t. \tag{18}$$

By applying equation (6), gross profits are also obtained as the difference between sales plus inventory changes less the cost of purchasing labor and intermediate inputs:

$$PR_t = S_t - (IP_t + W_t) + DH_t. \tag{19}$$

Hence we easily obtain an expression for the cost of sales:

$$CS_t = IC_t + W_t - DHF_t \equiv IP_t + W_t - DH_t. \tag{20}$$

In equation (18) it should be noted that profits are increased by positive variations of finished good stocks that constitute a potential for future sales which do not require extra costs.

This mechanism is most relevant to an understanding of how to deflate the finished-good stock regardless of the accounting method. If, in fact, the stock of finished products is considered a component—even if not synchronized—of sales, the price deflator should be the same as the sales deflator, it being impossible that a dollar of stock corresponds to a different quantity of a dollar of sales (West, 1983) as happens when finished goods are deflated by a cost index (Herman-Donahue-Hinrichs, 1977; Hinrichs-Heckman, 1981). This same objection can be raised for the accounting practice or civil law tradition which in many countries prescribes the evaluation of the stocks of finished goods at the lower-of-cost-or-market and, therefore, in most cases, at the cost of production.

III.1. *Accounting Methods*

FIFO

FIFO assumes that the goods that have been purchased or produced first are utilized or sold first. In an inflationary environment this implies an appreciation of the stock since each outflow leaves in the warehouse a higher number of recent products or materials. The aggregate equation for the stock can be stated as:

$$H_t = p_{t-1}h_{t-1} + (p_t qi_t - p_{t-1} qo_t), \tag{21}$$

where p is the weighted average of intermediate product and finished good prices. Assuming that the price of input (pm) applies equally to intermediate purchases or consumption, the expression for the relevant stock becomes:

$$HM_t = pm_{t-1}hm_{t-1} + (pm_t ip_t - pm_{t-1} ic_t). \tag{22}$$

Similarly, for finished good stocks we have:

$$HF_t = pf_{t-1}hf_{t-1} + (pf_t y_t - pf_{t-1} s_t), \tag{23}$$

where a price (the same for output and sales) not a cost index is used to deflate the stock.

In FIFO the remaining stock appreciates because of inflation and then exceeds its previously estimated value (H_{t-1}):

$$H_{t-1} < p_{t-1} h_{t-1}. \tag{24}$$

Setting, in fact, $h_{t-1} = h_0 + \sum_{i=1}^{t-1} Dh_i$, equation (21) becomes:

$$H_t = p_{t-1}\left(h_0 + \sum_{i=1}^{t-1} Dh_i\right) + (p_t qi_t - p_{t-1} qo_t), \tag{25}$$

where the initial stock (h_o) appreciates just as a result of inflation.[1]

Combining equations (20) and (21) I obtain an expression for FIFO profits (PRF) that exceeds the amount implied by equations (18) and (19). This appears clearly in:

$$PRF_t = PR_t + (p_{t-1}h_{t-1} - H_{t-1}) + (S_t - S_t^0) + (IC_t - IC^0), \tag{26}$$

where the terms in parentheses denote inventory appreciation, increase in the value of sales and of intermediate consumption, respectively.

What should be noted in equation (26) is that FIFO may account for gross profits even when $PR = 0$, the other terms on the right hand side being positive as a result of inflation. FIFO accounting then implies capital gains (CG) on the stock at hand:

$$CG_t = PR_t - PRF_t \tag{27}$$

that are not found in the fix-price case or when LIFO is used instead. This fact has produced wide discussions on the meaning of income and, thus, of taxable income for which I refer the reader to the specialized literature (Parker and Harcourt, 1969).

LIFO

In treating LIFO it is necessary to distinguish between null or positive inventory changes on one side and decumulation of the stock on the other. In the first case it is possible to match current demand for goods or inputs with the last layer of inventory, i.e. without reducing the level of the stock.

In the second case the firm will actually utilize LIFO just for that part of its final demand or input requirement that can be satisfied by the last inflow of materials or products. The remaining part will be matched by drawing inventories from previous layers of the existing stock.

[1] In fact when $p_{t-1} > p_0$, the stock increases even though the quantities do not change: inserting equation (20) in (21), noting that $pm_t ip_t \equiv IP_t$, $pm_t ic_t \equiv IC_t$, etc., defining $pm_t ic_t \equiv IC_t^0$, $pf_t s_t \equiv S_t^0$, it is easy to see that $IC^0 < IC_t$ if $pm_t > pm_{t-1}$ and also that $S_t^0 < S_t$ if $pf_t > pf_{t-1}$.

The first case can be formalized as:

$$H_t = H_{t-1} + p_t(qi_t - qo_t), \; qi_t \geq qo_t. \tag{28}$$

while the second corresponds to:

$$H_t = H_{t-1} - \left[\sum_{i=1}^{k} w_i p_{t-i}(qi_{t-i} - qo_{t-i}) \right], \qquad qi_t < qo_t, \tag{29}$$

where:

$$\alpha_t qi_t = qo_t, \qquad 0 \leq \alpha_t < 1 \tag{30}$$

is the part of inventory outflows provided through current inflows. The residual part appears in brackets in equation (29) and is obtained by a sequence of withdrawals, weighted according to the time of entering the warehouse and priced conformably for those lots which have not been exhausted. The sum of the weights is unity. These can be expressed as:

$$w_i = [(qi_{t-i} - qo_{t-i})/qo_t(1-\alpha_t)], \qquad qi_{t-i} > qo_{t-i}, \quad \forall i \tag{31}$$

Since two types of stocks are involved, the rise (reduction) of the first may coexist with the reduction (rise) of the second. Thus we have to consider four different cases:

$$HM_t = HM_{t-1} + pm_t(ip_t - ic_t), \qquad ip_t \geq ic_t \tag{32}$$

$$HM_t = HM_{t-1} - \left[\sum_{i=1}^{k} w_i pm_{t-i}(ip_{t-i} - ic_{t-i}) \right], \qquad ip_t < ic_t \tag{33}$$

$$\alpha_t ic_t = ip_t, \qquad 0 \leq \alpha_t < 1 \tag{34}$$

$$w_i = [(ip_{t-i} - ic_{t-i})/ic_t(1-\alpha_t)], \qquad ip_{t-i} > ic_{t-i}, \quad \forall i \tag{35}$$

$$HF_t = HF_{t-1} + pf_t(y_t - s_t), \qquad y_t \geq s_t \tag{36}$$

$$HF_t = HF_{t-1} - \left[\sum_{i=1}^{k} w_i pf_{t-i}(y_{t-i} - s_{t-i}) \right], \qquad y_t < s_t, \tag{37}$$

$$\alpha_t s_t = y_t \tag{38}$$

$$w_i = [(y_{t-i} - s_{t-i})/s_t(1-\alpha_t)], \qquad y_{t-i} > s_{t-i}, \quad \forall i. \tag{39}$$

Equations (32) and (36) correspond to the cases in which inflows into the warehouse are at least equal to the outflows. When a decumulation occurs as in equations (33) and (37), expressions (34) and (38) denote the intermediate consumption matched by the last purchase and that portion of final sales which equals current output respectively.

The cost of drawing previous stocks will then be evaluated in each case according to the weights (35) and (39) which apply again to those lots which have not been exhausted before.

It is easy to show through equations (18), (19) and (29) that in LIFO a rising or stable level of inventory does not imply an appreciation of the stock. This also means that LIFO, unlike FIFO, does not reveal any profit resulting from inflation (Tobin, 1988), capital gains being signalled by this method solely when stock volume is reduced (Shoven and Bulow, 1975).[2]

In fact, by evaluating cost of sales, I obtain an expression for capital gains which is similar to FIFO equations (26) and (27):

$$CG_t = PR_t - PRLF_t = (S_t - \bar{S}_t) - (IP_t - \bar{IP}_t), \tag{40}$$

where $PRLF$ denotes profits due to stock appreciation and $\bar{S}$ and $\bar{IP}$ denote the corresponding flow components.

IV. A Simulation Experiment

IV.1. *Microeconomic Assumptions and Data Generation*

To generate a consistent set of data, I adopt a simple model where a single storable good is produced according to the following short-run technology:

$$y_t = A + b * ic_t = {}_{t-1}s_t^e, \ b > 0 \tag{41}$$

that utilizes a variable amount of physical input (ic) and a constant stock of labor (n) which is linearly related to A, a scale factor:

$$A = K + c * n, \qquad c > 0. \tag{42}$$

In equation (41) output is planned to equal the volume of sales that the agents, at the end of period $t-1$, predict for period t (${}_{t-1}s_t^e$). Assuming that goods and factors are sold in competitive markets, sales, prices and wages can be considered exogenous. The requirement for intermediate consumption will then be:

$$ic_t = \alpha + \beta * {}_{t-1}s_t^e, \qquad \alpha \equiv -b^{-1}A, \qquad \beta \equiv b^{-1}. \tag{43}$$

Usually, intermediate purchases are not utilized in the same period in which they are available so as to anticipate possible rises in costs and to ensure continuity of production. It is then reasonable to assume that also intermediate purchases depend on expected sales. However, this expectation should be formed earlier than output plans are originated because of the delivery lags and of the fact that production takes time.

Assuming that both sources of lags amount to one period, intermediate purchases are expressed in terms of sales prediction for time t which has been formed two periods before:

$$ip_t = \alpha + \beta * {}_{t-2}s_t^e. \tag{44}$$

Combining equations (43), (44) and (9), we can see how inventory changes for intermediate goods are proportional to the revision of expectations occurring **within** these two forecasting periods:

$$Dhm_t = \beta({}_{t-2}s_t^e - {}_{t-1}s_t^e) \tag{45}$$

while finished good inventory changes can be interpreted, given equations (5)

[2]When prices are reduced, LIFO reveals profits that do not appear in FIFO. This case is, however, less frequent.

and (41), as a buffer between supply and final demand:

$$Dhf_t = \delta({}_t s^e_{t-1} - s_t), \qquad (\delta = 1) \tag{46}$$

that will be the stronger the less flexible are production plans.[3]

To produce a numerical example, it is necessary to determine the value of relevant parameters and exogenous variables, under the constraint that both inputs and output are nonnegative and that the share of inputs will be positive but less than 1. Both requirements are satisfied if ${}_{t-1}s^e_t > A$ and $b > 1 - A/Y$.

The selected values are: $A = 230$, $n = 100$, $b = 0.6$; the volume of sales is arbitrary but has been chosen so as to roughly mimic the cyclical fluctuations of several OECD economies since 1970. The volume of sales predicted one step ahead (${}_{t-1}s^e_t$) has been obtained by an $AR(2)$, while the sales predicted two steps ahead (${}_{t-2}s^e_t$) have been obtained by regressing actual sales on their lagged value two periods before, this being the information set in this case.

The initial stock of both finished and intermediate goods have been set equal to 100. To be concrete, I have used as input (pm) and output prices (pf) the corresponding annual indexes of Italy's manufacturing (1970-88) which can be considered approximately exogenous as they belong to a small open economy importing most of its raw material requirement.

In order to assess value added and the role played by inventory accounting in profit measurement, I have used the same index for nominal wage and output price which implies that the real (product) wage is constant over the simulation period. Of course, this assumption will affect profit estimates, but in a way which is independent of inventory accounting and which may then appear irrelevant for my purposes.

IV.2. *Results*

Combining the accounting model (1)-(11) with the microeconomic assumptions (41)-(46), the balance of physical output consistent with the selected parameters is displayed in Table 1.[4]

Output and sales grow at about the same rate and with about the same variance. Altogether, the quantity variables displayed in Table 1 seem adequate to mimic the cyclical behavior of a real economy and constitute a reasonable starting point to shape nominal variables and to compare profit shares.[5]

Another result of these simulations is the possibility of obtaining from exogenous sales—given equation (5)—a measure of the real output level consistent with each accounting method. Deflating, in fact, the estimated levels of nominal production by the relevant price index (pf), I obtain the criterion leading to the best estimate of physical output, whose "true" value is shown in Table 1.

Generally speaking, all results show a close similarity between LIFO and NA, FIFO simulations being quite different from the others. This is also true for

[3]There is no need to hold finished goods if supply is perfectly flexible ($\delta = 0$). When $\delta = 1$, production plans are perfectly inflexible since markets clear through inventory adjustment only.

[4]More detailed data and results are available from the author on request.

[5]The implied output percentage changes are fairly well correlated with actual changes in real GDP for such countries as Italy (0.78), Germany (0.63) and France (0.56).

TABLE 1

INVENTORY, OUTPUT AND SALES IN REAL TERMS FOR AN ARTIFICIAL ECONOMY

Period	*ip*	*ic*	*dhm*	*hm*	*y*	*s*	*dhf*	*dh*	*hf*	*h*	*h/s*
0	—	—	—	100.0	100.0	—	—	—	100.0	200.0	—
1	133.1	130.5	2.6	102.6	308.4	300.0	8.4	11.0	108.4	211.0	0.70
2	142.3	128.5	13.8	116.4	307.2	305.0	2.2	16.0	110.6	227.0	0.74
3	140.9	136.5	4.4	120.8	312.0	308.0	4.0	8.4	114.6	235.4	0.76
4	148.0	141.1	6.9	127.7	314.8	320.0	−5.2	1.7	109.4	237.1	0.74
5	152.3	160.1	−7.8	119.9	326.2	332.0	−5.8	−13.6	103.6	223.5	0.67
6	169.5	178.8	−9.5	110.4	337.4	317.0	20.4	10.9	124.0	234.4	0.74
7	186.3	154.2	32.1	142.5	322.7	325.0	−2.3	29.8	121.7	264.2	0.81
8	165.0	167.7	−2.7	139.8	330.8	334.0	−3.2	−5.9	118.5	258.3	0.77
9	176.3	181.7	−5.4	134.4	339.2	340.0	−0.8	−6.2	117.7	252.1	0.74
10	189.1	190.9	−1.8	132.6	344.7	367.0	−22.3	−24.1	95.4	228.0	0.62
11	197.6	233.8	−36.2	96.4	370.4	378.0	−7.6	−43.8	87.8	184.2	0.49
12	235.9	250.2	−14.3	82.1	380.2	370.0	10.2	−4.1	98.0	180.1	0.49
13	251.5	236.8	14.7	96.8	372.3	365.0	7.3	22.0	105.3	202.1	0.55
14	240.2	229.2	11.0	107.8	367.7	353.0	14.7	25.7	120.0	227.8	0.65
15	233.1	210.3	22.8	130.6	356.3	368.0	−11.7	11.1	108.3	238.9	0.65
16	216.1	234.8	−18.7	111.9	371.0	371.0	0.0	−18.7	108.3	220.2	0.59
17	237.3	238.9	−1.6	110.3	373.5	377.0	−3.5	−5.1	104.8	215.1	0.57
18	241.6	248.4	−6.8	103.5	379.2	384.0	−4.8	−11.6	100.0	203.5	0.53

Legenda: See Section II.

the stock/sales ratio (see Table 1) which is actually better estimated in Table 2 by FIFO than by LIFO and NA.

As LIFO and NA measures ignore or underestimate capital gains, they impart a downward bias to the nominal stock/sales ratio which is amplified over time by the persistence of inflation. Therefore this ratio should **not** be considered an indicator of physical stock that firms desire to hold for a given volume of sales, unless capital gains corrections are introduced.

The average level of FIFO stocks in Table 2 is about three times larger than the corresponding LIFO figure which, in turn, exceeds the estimated NA value. Similarly, the average level of inventory changes is much higher in FIFO than in other cases, confirming the idea that the bigger FIFO scale incorporates an inflationary trend which makes it difficult to disentangle quantity from price changes.

As shown in Table 2, inventory changes in LIFO and NA are remarkably similar when i) changes are positive and when ii) a mild inflation occurs. This happens in one case because LIFO and NA do not allow for stock appreciation unless inventory is reduced and in the other because if the annual inflation rate is low, the half-period price cannot be too different from the end-of-period index.

Inventory changes so obtained lead to an estimate of profits that fully conforms with theoretical expectations in equations (26) and (27). Indeed, FIFO profits—with the exception of period 17 when (see Table 3) prices of inventory stock fall—always exceed LIFO estimates because of the different definitions of cost of sales which have been discussed before. Thus in FIFO estimates the ratio of profits to sales is, on the average, about 30 percent while in LIFO and in NA it is 14 percent and 13 percent respectively.

TABLE 2

STOCK/SALES RATIO, INVENTORY STOCK, INVENTORY CHANGES AND GROSS PROFITS IN NOMINAL TERMS

	FIFO				LIFO				NA			
Period	*H/S*	*H*	*DH*	*PR*	*H/S*	*H*	*DH*	*PR*	*H/S*	*H*	*DH*	*PR*
1	0.75	231.5	36.4	106	0.68	211.4	11.4	81	0.68	211.0	11.0	81
2	0.77	252.3	34.8	104	0.69	227.5	16.1	86	0.69	227.8	16.8	86
3	0.81	293.3	50.2	133	0.66	237.2	9.7	92	0.66	237.1	9.3	92
4	0.90	426.0	153.3	251	0.51	241.9	4.7	100	0.51	239.4	2.3	100
5	0.90	584.8	228.1	362	0.34	224.3	−17.6	110	0.33	215.2	−24.2	110
6	0.83	564.3	107.6	195	0.38	257.8	33.5	109	0.35	236.5	21.3	109
7	0.99	857.7	342.2	417	0.39	343.6	85.8	151	0.36	312.3	75.8	151
8	0.86	855.5	127.3	313	0.33	329.1	−14.5	168	0.30	295.2	−17.1	168
9	0.83	943.8	158.9	357	0.27	312.0	−17.1	178	0.24	275.1	−20.1	178
10	0.82	1,259.9	408.9	676	0.17	268.3	−43.7	176	0.12	184.4	−90.7	176
11	0.71	1,342.3	351.1	636	0.10	183.3	−85.0	68	0.00	4.6	−217.5	68
12	0.74	1,672.0	688.2	691	0.10	231.1	47.8	−30	0.03	61.5	−32.6	−30
13	0.70	1,760.6	592.2	496	0.16	392.8	161.7	58	0.09	215.1	153.6	58
14	0.78	2,104.0	646.6	567	0.22	596.6	203.8	114	0.15	408.6	193.5	114
15	0.78	2,434.3	619.8	703	0.23	720.3	123.7	192	0.17	516.6	108.0	192
16	0.62	1,981.3	−150.8	228	0.17	545.8	−174.5	207	0.11	344.3	−172.3	207
17	0.49	1,538.3	−413.8	36	0.16	504.6	−41.2	407	0.10	301.1	−43.2	407
18	0.50	1,889.8	137.2	591	0.12	412.5	−92.1	357	0.06	204.7	−96.4	357

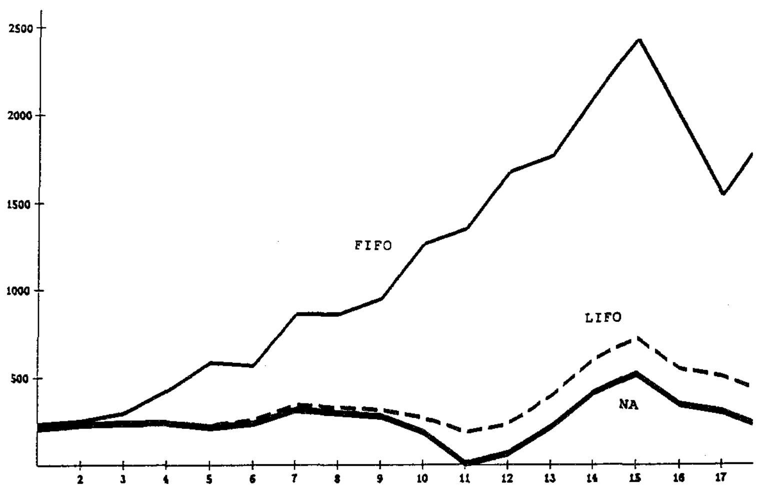

Figure 1. Inventory Stock at Current Prices

A final, but not minor, result of this study is the ability of each method to obtain an accurate estimate of output level and changes. This is essential, in business cycle analysis since inventory changes are a small but highly volatile component of demand which may affect to a large extent (De Leeuw, 1982) the short-run performance of the economy.

From Table 3 we can see how NA estimates are still the best criterion for evaluating physical output and, implicitly, real GNP. However, if we also include

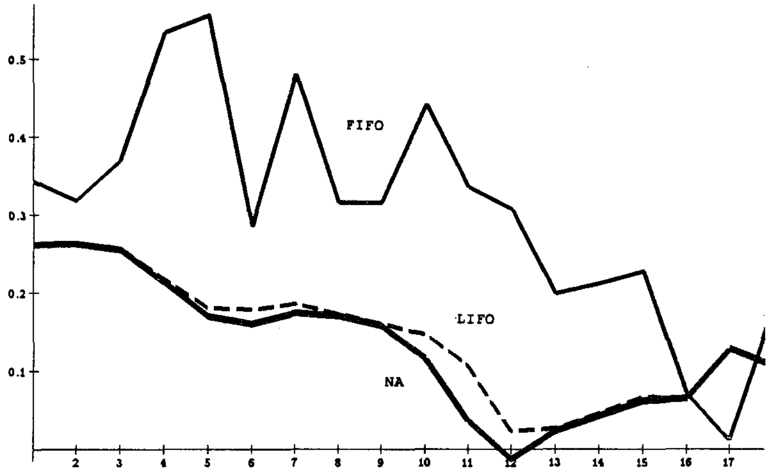

Figure 2. Profit/Sales Ratio at Current Prices

TABLE 3

TRUE AND SIMULATED OUTPUT PERCENT CHANGES

Period	True	NA	LIFO	FIFO	Prices (*)
2	−0.4	−0.3	−0.7	−2.2	4.2
3	1.6	1.5	1.9	5.6	8.9
4	0.9	1.1	1.3	·12.6	25.5
5	3.6	3.7	4.1	7.8	33.4
6	3.4	2.9	2.6	−10.7	9.7
7	−4.4	−4.1	−4.2	5.5	24.0
8	2.5	2.5	2.6	−5.5	11.3
9	2.5	2.5	2.3	3.1	12.1
10	1.6	2.3	5.4	11.3	25.1
11	7.5	7.0	5.2	3.9	20.5
12	2.6	2.2	1.0	2.3	21.1
13	−2.1	−2.0	−2.1	−7.1	12.5
14	−1.2	−1.3	−1.2	−2.4	11.2
15	−3.1	−2.7	−2.8	−2.8	10.7
16	4.1	4.0	3.8	−3.0	2.5
17	0.7	0.7	0.8	−4.6	−2.8
18	1.5	1.6	1.7	8.4	3.8
mean	1.19	1.19	1.20	1.23	13.7
var.	7.97	7.02	7.18	42.81	189.0
corr.	1.00	0.99	0.91	0.10	—

(*) Percent changes in price index of final sales.

output variance in our comparisons, it should be noted that NA smooth out the cyclical pattern more than LIFO, a fact which is not surprising because averaging prices is indeed a moving average filter.

Looking at levels, FIFO overestimates output mean and introduces spurious cycles into first differences that are barely correlated (0.10) with true observations. Conversely, LIFO estimates are much more accurate in predicting levels and changes of output and are just slightly less reliable than NA estimates. In terms of variances, both LIFO and NA underestimate the true parametr by about 10 percent, while FIFO still appears the worst criterion because of its inability to isolate price from quantity changes.

V. Conclusions

Inventory changes are a major source or indicator of the business cycle. This variable, however, is one of the most difficult to measure because of inflation and its effects on stock evaluation.

This problem cannot be confined to short-run diagnosis alone since it also involves a number of fiscal and distributional issues. Since inflation is much lower now than it used to be a decade ago, it might seem unimportant to treat such an issue. This would be a rather superficial conclusion given that stocks are held to perpetuate wealth and do perpetuate inflation for a long period by imparting random shocks to income distribution.

One reason that makes it normally difficult to estimate real inventory changes for the national economy is that firms measure their stocks according to a variety of methods that usually differ from NA. This would not **per se** be a serious problem if a link between microeconomic theory, NA and inventory accounting were fully developed. This is not the case. This paper constitutes a first effort in this direction.

These criteria are then simulated for an artificial economy where inventory adjustment occurs, its prices replicating Italian inflation since 1970. While the quantitative results are country-based, their qualitative nature is general and can be easily extended to other countries or periods.

My principal findings are:

(i) Except in the case of FIFO, current ratios between stocks and sales have little to do with corresponding measures in real terms. Persistent inflation causes a strong downward bias in the nominal stock/sales ratio which is not reliable as a cyclical indicator.

(ii) It is hard to decide if the extra profits that FIFO accounts for, are instead hidden by LIFO, being a form of capital gain bound to disappear when the firm faces higher costs to replace its stock. This point has some logic as far as raw materials are concerned, but is less convincing in the case of finished good outflows which are final sales presumably priced as a mark-up on costs.

(iii) NA provides an estimate of gross profits which is more conservative not only than that of FIFO, but also than that of LIFO. NA appears to be the best criterion to estimate output in physical terms. LIFO ranks second, being still fairly reliable and FIFO is very inadequate in everything but the estimate of the stock/sales ratio.

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