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#### MEASURING INVENTORIES UNDER HIGH INFLATION

Supporting paper submitted by Central Bureau of Statistics, Israel\*

1. In the last 20 years, the methods of measuring changes in inventories in the national accounts of Israel have been revised due to the high inflation and to the lack of reliable data for some of the components. Revised methods were mainly intended to improve the estimates at constant prices and to prepare estimates for shorter periods.

2. A short description of the background and the main methods is given below.

#### Background

3. Since the establishment of the state of Israel its economy has been characterized by high inflation rates: in the years up to 1955 the inflation rate was between 10% to 50% per year; from 1955 to 1970 8-9% in most years. From 1973, inflation accelerated, reaching a rate of close to 400% in 1984. After the implementation of a stabilization program in 1985, inflation quickly dropped to about 20% per annum in the years 1987-1991 and to around 10% or less in recent years.

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4. The high inflation has caused problems of measurement in the national accounts for most of the years. As is well known, at high inflation rates there are problems of aggregation of flows from different periods. The flows at the end of the period will carry a much greater weight than the flows at the beginning of the period, so that the comparisons of flows will reflect development at the end of the period disproportionately. The information derived from annual national accounts at current prices is almost worthless, and estimation of average prices and computation of national accounts at constant prices becomes very problematic. In the beginning of the 1980's, problems of measurement became so large that publication of annual national accounts in conventional ways was considered to be misleading, and new methods of measurement and presentation were developed. Estimates at constant prices became the main series published and most resources were invested in developing reliable quarterly estimates at constant prices<sup>1</sup>.

5. It is worthwhile mentioning that the problems became evident in the single firm as well as in the national accounts. In many firms neither the management nor the shareholders were able to analyze the firm's activity correctly on the basis of annual financial reports - a fact that may have contributed to a slowdown in economic activity during the early 1980's. These problems led to publication by the Certified Public Accountants (CPA) Association in Israel of recommendations for preparation of accounts adjusted for inflation. Since the publication of these recommendations, publication of adjusted reports has become almost universal. The adjustments recommended were simple to apply; to use the consumer price index, which is well-known and easily available, for adjustment, rather than specific price indices, the choice of which would be arbitrary and subjective. The adjustments recommended were mainly adjustments of fixed assets and inventories to the prices of the end of the period.

6. Since measurement of changes in inventories in the national accounts is especially difficult, a number of estimation methods for increases in inventories were developed. These methods are described below, and the impact of the application of the new methods on the national accounts is shown.

#### **Measurement of increases in inventories based on data from financial reports**

7. Even in periods with normal inflation, the evaluation of inventories using financial reports may be problematic, since inventories may be held for long

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<sup>1</sup> A more comprehensive description of the methods for measurements of the national accounts developed was given in a (end of note 1) paper presented at the IARIW seminar held in Cambridge, August 1999.

periods and are evaluated by various methods in financial reports of the firms, which reflect historic prices. The unadjusted increase in inventories will reflect price changes as well as volume changes, and since the volume increase may be minimal compared to the size of the stock, in most cases the major part of the increase in nominal value will reflect price changes. In periods of high price inflation, differences may also be larger in price changes of goods from different branches or types of inventory, so that there is a much greater need to make detailed estimates.

8. In Israel, there are two important methods of evaluation of inventories: FIFO (first in first out) and "moving averages". LIFO (last in first out) is not recognized by the tax authorities, so that almost no firms use this method. Until 1980, a well-known method of adjustment was used to evaluate inventories in the national accounts. Data on inventories in the national accounts, at current or constant prices, were computed by branch, with the simplifying assumption that in all enterprises the method of evaluation was FIFO. The value of the inventory was adjusted assuming a constant ratio between finished goods, raw materials and work in progress in the main branches and weighted relevant price indices were used, taking into account the period inventories were held on average.

9. However, when inflation accelerated at the beginning of the 1980's, improvement of these methods was urgently needed. The method of computation was refined, and, since the prices of different types of inventories vary much more under high inflation, adjustments for each kind of inventory evaluation were made.

10. Information on the method of evaluation of inventories for single firms was gathered regularly in industry surveys. The average time of holding inventories was computed for three kinds of inventories: finished goods, raw materials, and work in progress. Monthly price indices for each kind of inventory were prepared. Since no price indices for raw materials are collected, special indices for raw material were constructed using input-output data. Prices for work in progress were assumed to be the average of the price index of raw materials and the price index of finished goods.

11. For firms evaluating inventories by the FIFO method, the adjustment was made as in the past - but for 3-digit branches and for each quarter. The adjustment was made as follows:

12. If  $V$  is the value reported and  $L$  is the number of months inventories are held then the average price of the inventories at time  $t$  is:

$$P_{\text{fifo}} = \frac{\sum_{j=t-L}^{t-1} P_j}{L}$$

and the values of the inventories at the prices of the period  $t$ :

$$V * P_t / P_{\text{fifo}}$$

13. If the inventories are finished goods,  $L$  is computed by dividing the value of the inventory by the value of sales per month. If the inventories are raw materials,  $L$  is computed by dividing the value of the inventories by the value of purchases of raw material. Since the correct value of the inventory is the value after adjustment, a number of iterations are made before  $L$  is obtained.

14. For firms evaluating inventories by the "moving average" method, a new model of adjustment was developed. Using the "moving average" method means that the average price of the inventory is recalculated each time a new purchase is made. The withdrawal of inventory is made at the average price. The adjustment model developed takes into account the weight of new purchases (or newly produced finished goods) since the weight of each price index in the average price of the inventories depends on the weight of the purchases of that month.

15. The price of the inventories will be:

$$P_{\text{mn}} = \sum_{j=t-F}^{t-1} W_j * I_j$$

where  $I_j$  is the price index at  $j$

$t-F$  is the first month taken into account - simulations showed that using  $F=48$  makes the weight of the first month close to zero.

The proportion of new purchases is inversely related to the length of time inventories are held (equals  $1/L$ ).

16. An approximation to the weight  $W_t$  is obtained by:

$$W_t = (1 - e^{-1/L}) * (e^{-1/L})^{t-1}$$

17. The values of the inventories at the prices of the period  $t$ :

V\*Pt/Pmn

If L is smaller than 0.7 the adjustment of FIFO is used.

18. Though the data on inventories are measured at a point in time, due to the problems mentioned above with comparisons of flows and the computation of average prices under high inflation, it is important to estimate increases in inventories for shorter time periods. However, since data on inventories in individual enterprises could only be obtained quarterly (even these data were only obtained with difficulty), estimates of increases in inventories were prepared each quarter.

19. The improvement of the adjustment of inventories was of major importance for the national accounts. For instance in 1988, under a relatively low inflation rate of 17%, the size of the adjustment for manufacturing inventories reached 11% of the product of the manufacturing industry.

20. In the table below inventories before and after adjustment are shown. The ratio of unadjusted inventories of finished goods to adjusted inventories at 31.12.89 amounts to 1.08 and the nominal increase in inventories is 2.8 times higher than the increase at constant prices.

**Value of inventory in manufacturing before and after adjustment, 1990**

	Before adjustment for price changes			At constant prices (average 1990 prices)		
	Inventory at 31.12.89	Inventory at 31.12.90	Nominal increase in inventories	Inventory at 31.12.89	Inventory at 31.12.90	Increase in inventories
Total	8,184	9,431	1,247	8,801	9,241	440
Finished goods	2,372	2,761	389	2,544	2,619	75
Work in progress	2,059	2,162	103	2,134	2,147	13
Raw materials	3,753	4,508	755	4,123	4,475	352

**Measurement of increases in inventories based on quantity data**

21. Part of the inventories, such as inventories of agricultural produce, fuel, and other vital products, such as meat and fodder, are measured using quantity data and price data. Due to the problems with comparisons of flows and the computation of average prices under high inflation, the main problem is to obtain suitable prices. Data on quantities could only be obtained quarterly, but for the computation of the increase in inventories at current prices, monthly prices were used and weighted according to assumptions about the change of inventories during the quarter. Especially in agriculture, the change in inventories is not smooth, and monthly data on production were used to estimate the increase in inventories each month. The computation of estimates at constant prices is more straightforward.

**Measurement of increases in inventories using production and sales data - the example of the diamonds branch**

22. For a small part of inventories no reliable data are available on inventories, and other data are used to derive the increase in stocks. As noted above, in periods of high inflation estimates for short periods and for detailed items are needed, so that more elaborate methods need to be developed.

23. The most important example is the inventories in the diamonds branch. The diamond industry imports rough diamonds, cuts and polishes them. Most of the sales of this industry are exports. Diamond exports amount to about US\$5 billion in recent years, or almost 20% of exports of goods to abroad. On the other hand, imports are only slightly lower than exports, and the value added in the diamonds branch is a relatively small share of exports. From the early 80's, no reliable data on inventories for this branch have been available, and data on value of exports seem to be less reliable than import data.

24. Since the local market for diamonds is very small compared to the export market, change in inventories is estimated for the exports market only.

Using the equation:  $GVA = Exports + Change\ in\ inventories - Input$   
change in inventories may be derived from data on imports and exports.

25. As mentioned above, it is especially important to obtain reliable estimates at constant prices, so the computation at constant prices is performed separately for each kind of diamond. The rough prices of diamonds vary according to carat, color, clarity and cut, and the diamonds are classified into 10 different categories.

26. Data on input are obtained from import statistics - since unpolished diamonds only come from outside Israel. Data on both the value of imports of unpolished diamonds and on the quantity in carats for each type of diamond are collected. Information on the proportion of polished diamonds obtained from unpolished diamonds ("technical coefficients") for each type of diamond is also collected. The technical coefficient for different types of diamonds differs widely so that it is very important to perform the detailed estimation.

27. For each type of diamond, change of inventories in carats may be computed:

$$\text{Change of inventories} = \text{Imports} * \text{TEC} - \text{exports}$$

TEC - technical coefficient

28. Since the data on value of exports seem to be less reliable, a special computation has to be made to obtain the value of the change in inventories.

29. As a simplifying assumption, it was assumed that the imported diamonds were polished within the quarter, so that no unpolished diamonds are held as inventory. Since value added is relatively small the assumption does not lead to serious distortions.

30. The price of a polished diamond PP:

$$PP = (PUP/TEC) * (1 + CE) * (1 + SUR)$$

PUP - price of unpolished diamond

CE - ratio of compensation of employees to cost of unpolished diamonds, varies for each type of diamond

SUR - ratio of margin, assumed similar for all types of diamonds

31. In many periods, PP has been much higher than the price per carat of exports reported - an indication that export data probably are not reliable, and recently when other indicators also showed that the exports data were unreliable, it was decided to add an estimate of unreported income to exports.

32. In the table below, an example of the computation of inventories of diamonds is given. As explained above, the computation is made for short periods - preferably months, due to the problems with inflation. To minimize the bias due to inflation the whole computation is made in US\$ (as is the entire balance of payments for the same reason), so the problem of inflation is mainly relevant for the last step of translation of the flow into Israeli currency.

**Example of estimation of change in stocks of diamonds- first quarter of 1999**

Type of diamond	Imports in million US\$	Imports in thousand carats	Price per imported carat (\$)	Technical coefficient	Price per exported carat (\$)
Stones 5+	261.4	200.8	1,324	0.46	3,208
Stones 2, 4-5	191.3	261.2	772	0.42	2,049
Spots, Kappes, Cubes	111.7	499.9	231	0.35	736
Fantasy	80.3	417.8	197	0.27	488
Clivage	109.2	1,552.2	72	0.28	297
z-11	163.0	407.4	422	0.47	1,001
5+11-	0.5	3.0	164	0.49	373
Spots (large)	79.9	189.6	428	0.35	1,363
Total	897.2	3,532.0	254		

**Annual estimates in base years**

33. Another important problem during high inflation is the adjustment of annual estimates. As is well known, the sum of estimates at average prices does not always equal the sum of estimates at current prices in a given year. As a result, the annual estimates at current prices in base years may differ from the estimates at base year prices for the same year. The size of the difference depends on the distribution of the flows during the year and on changes in prices during the year. During periods of high inflation, the problem becomes of such a dimension that if the differences are added proportionally to each sub-period, the changes shown between quarters may be substantially distorted. If one adjusts the estimates at current prices, the quarterly price changes will be distorted, and if one adjusts the estimates at constant prices (average prices of the year), the quarterly volume changes will be distorted. In the case of the estimates of increase in inventories, the distortions were especially large. Since the measurement of volume changes was perceived as more important, it was preferred to adjust the current estimates in base years to the estimates at average prices and to preserve the volume changes as measured. For recent years, after Israel adopted the SNA93 recommendations, and obtain volume changes using estimates for each year at the previous year's prices, the adjustments have to be made each year.

**Conclusion**



34. The experience with accounting under high inflation in Israel has shown that it is important to use detailed basic statistics for periods that are as short as possible to obtain estimates of inventory increases.

35. Preparation of estimates at constant prices are given priority and due to the large differences in price changes between products from different branches and different types of inventories, estimates at constant prices should be made for detailed items and for each type of inventory: finished goods, raw materials, work in progress.

36. The problem of adjusting annual data in base years is very important under high inflation, and no single satisfactory solution seems to be available. However, since the volume changes probably are more important for the users of national accounts data under high inflation, in Israel it was chosen to adjust the data at current prices to the data at average prices.

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