# The Estimation of Inventory Holding in Economy as in a Projection Model: Case Study in India

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## I. Introduction

Many economists have studied the role of inventory holdings in an economy. Their main aims were either to analyse the causes of business cycle(1) or to estimate the optimal holding in business firms for plan and project purposes(2) This exercise tries to estimate the parameter of planned inventory holding to output changes, keeping in view the latter type of analysis.

This is a case study for India and the data is primarily based on Census of Manufacturing Spread over 9 years (1950-1959) as first phase cycle. This type of study will be continued in successive period from 1959 to 1966 as second phase cycle and over third phase too. Serial phases of the study may show the effect of international resources crisis in inventory holdings by business firms.

## II. The Relevent Theory on Inventory Investment

"It is a common theory that businessmen attempt to maintain their inventories in a certain ratio to sales (or, in the case of manufacturers, raw mat-

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(1) Moses Abramovitz, *Inventories and Business Cycle*, 1950.

(2) William J. Baumol, *Economic Theory and Operation Analysis*, 2nd Ed., Chapter 1, 1965.

erials and goods in process, in a certain ratio to production). Also, it is true that inventory investment would not vary synchronously and proportionally with changes in sales and production. In other words, inventories tend to lag 6-12 months behind sales and output. Intventory investment tends to reach its peaks and troughs at approximately the peak and trough dates of busness cycles, which are also the turning points of sales and output.(3) As mentioned above, inventories are fluctuated widely. Such sharp fluctuations are a major cause of the short-term variation in the level of business activity.

Nevertheless the long-term trend of inventory investment would be stable. And, it might be moved to upward direction as long as the economy, especially in developing countries, were growing. It is also true that the average inventory investment in year would be maintained in a certain ratio—not a certain fixed ratio—to production without relation to business cycle. In this case, the long term trend of average inventory holding in economy might be changed along the production level mainly rather than the material prices (including carrying cost and re-order cost) and other factors. But inventory investment is not a casual factor of the output but an induced factor of production.

Though "many firms fix their inventory at some constant percentage of sales volume", the optimal inventory by firms is "that inventory should increase only in proportion to the square root of sales. In other words, if sales of some items double, inventory should not be doubled—it should be increased to much less than 200 per cent its original output"(4) Also, it is true that the aggregate inventory holding in economy is not at some constant rate of the output. Therefore, if a certain relative equation between inventory holding and the output—not a certain constant rate to output—the inventory investment to the given outqut could be estimated. We shall try to test this hypothesis by relating inventory holding linearly and exponentially with the volume of output in any sector of the economy.

## III. The Projection Model of Inventory Investment

As was mentioned in Section 2, inventory investment can be simply

(3) Moses Abramovitz, *ibid*, Chapter 15.
(4) William J. Baumol, *ibid*, p. 10.

estimated by a certain ratio to sales or production given. This method has been adopted by Simon Kuznets to estimate the inventory holding. His estimation was divided into two kinds of the sources of inventory holding by firms. One was corporations' book value, the other was non-corporations

**TABLE 1. The Linear Correlation Coefficients by Industries**

| Industries | $R^2$ |
|---|---|
| 1. Food and Beverages | 0.89 |
| 2. Chemicals | 0.99 |
| 3. Tanning | 0.92 |
| 4. Cements | 0.95 |
| 5. Wood and Glass | 0.97 |
| 6. Paper and Matches | 0.94 |
| 7. Textiles | 0.80 |
| 8. Jute Textiles | 0.77 |
| 9. Aluminium, Coppers and Brasses | 0.81 |
| 10. Iron and Steels | 0.91 |
| 11. Bicycles | 0.98 |
| 12. Electrical and Mechanical Engineering | 0.99 |

Note : The foregoing result of linear correlation coefficients show that the inventory holding by industries might be the linear function of the output. Therefore, the inventory holding to the given output by industries can be estimated by the linear regression equation in Table 2. The standard error of each equations are also shown in Table 2.

**TABLE 2. The Linear Regression Equations and Standard Errors by Industries**

| Industries | Regression Equation* | Standard Error | |
|---|---|---|---|
| | | of A | of B |
| 1. Food and Beverages | $Y=0.2498X+30.5284$ | 0.0434 | 163.2260 |
| 2. Chemicals | $Y=0.3639X+28.8609$ | 0.0126 | 11.5172 |
| 3. Tannings | $Y=0.1480X+14.8010$ | 0.0216 | 2.1482 |
| 4. Cements | $Y=0.5876X+47.2991$ | 0.0644 | 18.0776 |
| 5. Woods and Glasses | $Y=0.2602X+12.0363$ | 0.0229 | 3.7296 |
| 6. Paper and Matches | $Y=0.2616X+25.5736$ | 0.0311 | 10.2197 |
| 7. Textiles | $Y=0.2533X+57.3439$ | 0.0658 | 29.4157 |
| 8. Jute Textiles | $Y=0.1288X+20.8742$ | 0.0356 | 52.9097 |
| 9. Aluminiums Coppers and Brasses | $Y=0.1612X+72.8457$ | 0.0390 | 13.2457 |
| 10. Iron and Steels | $Y=0.2803X+10.4640$ | 0.0452 | 41.8160 |
| 11. Bicycles | $Y=0.3618X+1.4047$ | 0.0198 | 1.5163 |
| 12. Electrical and Mechanical Engineering | $Y=0.3221X+12.0656$ | 0.0131 | 155.1300 |

* Y : Average Inventory Holding in Year.
X : Total Output in Year.

holding[5]. Though he divided the sources of inventory holding as two kinds, his method of estimation is no more than adoption of a certant constant ratio to sales or production.

In our present work. after it is assumed that inventory holding in economy are either linearly or exponentially related to output, the goodness of regression line between the inventory holding and the output were tested. The result of the goodness test show a linear correlation in nearly all industries with high relationship between inventory holding and output as Table 1.

## IV. The Testing of Fit by the Linear Regression Equations

In order to test fit of the linear regression equation the estimated inventory holding *Ye* are computed to the given output *Xa* as follows. The comparative table between the actual value *Ya* and the estimated value *Ye* are shown in Table 3. The result of testing fit show that the linear regression equations are proved good.[6] So these linear regression equations, *ceteris paribus*, can be used to forecast inventory holding to the future planned output.

**TABLE 3. The Estimation of Inventory Holding by Industries***

**1. Food and Beverages**

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 3027.4 | 3372.6 | 2864.2 | 2912.8 | 3490.6 | 3815.08 | 4544.5 | 4639.0 | 4578.1 |
| Ya | 720.7 | 919.2 | 844.6 | 66.5 | 856.9 | 1069.2 | 1269.1 | 1080.8 | 1148.6 |
| Ye | 787.4 | 873.7 | 764.6 | 758.7 | 903.2 | 984.3 | 1166.7 | 1190.3 | 1175.1 |

*Xa : Actual Output in Year
Ya : Actual Inventory in Year
Ye : Estimated Inventory in Year
In estimating the value of *Ye* we used the ordinary linear function of type $Ye=a+bXa$, where *a* and *b* are appropriate coefficients of Table 2.

(5) Simon Kuznets, *Commodity Flow and Capital Formation*, Part VII.
(6) The hypothesis of exponential relation between inventory holding and output was rejected by the result of testing fit.

### 2. Chemicals

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 481.3 | 651.6 | 668.1 | 697.9 | 810.7 | 903.8 | 1000.1 | 1241.3 | 1383.6 |
| Ya | 198.3 | 252.5 | 293.6 | 282.0 | 322.0 | 354.4 | 400.7 | 479.4 | 529.4 |
| Ye | 202.1 | 263.4 | 269.4 | 280.1 | 320.7 | 354.2 | 388.9 | 475.7 | 527.0 |

### 3. Tanning

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 79.4 | 104.5 | 73.7 | 85.7 | 95.9 | 112.9 | 123.0 | 125.1 | 94.6 |
| Ya | 26.9 | 30.3 | 25.8 | 26.4 | 27.5 | 32.7 | 32.0 | 33.5 | 30.5 |
| Ye | 26.7 | 30.5 | 25.9 | 27.7 | 29.2 | 31.7 | 33.3 | 33.6 | 29.0 |

### 4. Cements

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 138.1 | 196.1 | 239.3 | 227.2 | 262.3 | 277.3 | 320.2 | 358.2 | 406.6 |
| Ya | 54.7 | 72.3 | 82.4 | 87.7 | 88.0 | 100.0 | 134.8 | 169.6 | 210.0 |
| Ye | 34.2 | 68.4 | 93.9 | 86.7 | 107.5 | 116.3 | 141.6 | 164.0 | 192.8 |

### 5. Wood and Glasses

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 98.7 | 117.6 | 113.5 | 113.7 | 134.4 | 167.4 | 193.7 | 209.8 | 246.3 |
| Ya | 36.5 | 37.1 | 42.5 | 45.4 | 51.7 | 54.2 | 62.5 | 64.2 | 77.6 |
| Ye | 37.7 | 42.6 | 41.6 | 42.9 | 47.0 | 55.6 | 62.4 | 66.6 | 76.1 |

### 6. Paper and Matches

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 195.1 | 242.4 | 254.4 | 254.2 | 277.8 | 323.8 | 361.4 | 400.3 | 519.7 |
| Ya | 60.0 | 86.9 | 90.0 | 96.6 | 97.4 | 112.2 | 129.2 | 119.4 | 150.2 |
| Ye | 76.3 | 88.6 | 91.7 | 91.7 | 97.8 | 109.8 | 119.5 | 129.5 | 160.7 |

### 7. Textiles

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1596 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 3291.5 | 4582.8 | 4250.3 | 4090.0 | 4453.7 | 4614.6 | 5014.1 | 4940.6 | 4731.8 |
| Ya | 1417.8 | 1693.6 | 1730.2 | 1614.3 | 1650.1 | 1568.2 | 1803.0 | 1957.8 | 1849.9 |
| Ye | 1396.3 | 1719.1 | 1636.0 | 1596.0 | 1686.8 | 1727.1 | 1826.9 | 1808.6 | 1756.4 |

**8. Jute Textiles**

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 1488.7 | 2115.0 | 1692.8 | 1129.0 | 1233.6 | 1352.6 | 1427.8 | 1332.4 | 1375.4 |
| Ya | 391.1 | 492.3 | 403.4 | 371.5 | 339.6 | 346.3 | 421.9 | 424.7 | 380.7 |
| Ye | 402.2 | 483.7 | 428.8 | 355.5 | 369.1 | 384.5 | 394.3 | 381.9 | 387.5 |

**9. Aluminiums, Coppers and Brasses**

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 271.9 | 264.7 | 219.6 | 236.1 | 293.2 | 369.5 | 433.1 | 403.5 | 466.0 |
| Ya | 112.2 | 122.9 | 117.9 | 115.2 | 103.6 | 121.4 | 146.9 | 134.6 | 157.7 |
| Ye | 116.4 | 115.2 | 108.0 | 110.6 | 119.8 | 132.0 | 142.1 | 137.4 | 147.4 |

**10. Iron and Steels**

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 558.6 | 611.0 | 702.4 | 724.7 | 862.7 | 925.7 | 1140.0 | 1195.2 | 1289.9 |
| Xa | 235.6 | 297.6 | 202.3 | 336.2 | 342.9 | 370.3 | 411.2 | 383.2 | 517.9 |
| Ye | 261.0 | 275.7 | 301.3 | 307.5 | 346.2 | 363.8 | 363.8 | 439.3 | 365.8 |

**11. Bicycles**

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 17.8 | 20.6 | 30.6 | 43.9 | 62.4 | 77.8 | 99.8 | 104.1 | 135.0 |
| Ya | 7.3 | 8.1 | 16.9 | 17.0 | 20.1 | 28.9 | 38.5 | 39.0 | 51.0 |
| Ye | 7.8 | 8.8 | 12.4 | 17.2 | 23.9 | 29.4 | 37.3 | 38.9 | 50.0 |

**12. Electrical and Mechanical Engineering**

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
|---|---|---|---|---|---|---|---|---|---|
| Xa | 631.5 | 789.7 | 731.0 | 707.5 | 898.3 | 1120.6 | 1425.1 | 1506.5 | 1886.3 |
| Ya | 302.6 | 365.3 | 358.8 | 375.5 | 422.0 | 477.0 | 561.9 | 612.9 | 733.3 |
| Ye | 322.8 | 373.4 | 354.6 | 347.1 | 408.2 | 479.3 | 576.7 | 602.8 | 724.3 |

## V. The Testing of Elasticity of Inventory Holding to Output

The elasticities of inventories to the output by industries were tested in order to show the degree to which inventories respond to changes in output. The testing results of elasticities by industries show that the inventory holding would be changed nearly as the same percentages as did output. The elasticities of many sectors except Tannings, Jute Textiles, and Alum-

inium, Copper and Brasses were closed to unit elasticity as shown in Table 4. But, as these elasticities were computed at average term of inventory and output during 9 years, it would fluctuate more as in a one year term.

**Table 4. The Elasticities of Inventory to Output by Industries**

| Industries | Elasticities=$\epsilon_I$* |
|---|---|
| 1. Food and Bevererages | 0.97 |
| 2. Chemicals | 0.91 |
| 3. Tanning | 0.51 |
| 4. Cements | 1.43 |
| 5. Wood and Glasses | 0.77 |
| 6. Paper and Matches | 0.78 |
| 7. Textiles | 0.68 |
| 8. Jute Textiles | 0.48 |
| 9. Alumintums, Coppers and Brasses | 0.42 |
| 10. Iron and Steel | 0.70 |
| 11. Bicycles | 0.94 |
| 12. Electrical and Mechanical Engineering | 0.74 |

*$\epsilon_I$ were computed as following Formula:

$$\epsilon_I=\frac{dy}{dx}\times\frac{X\bar{x}}{a\bar{y}}$$

where $\frac{dy}{dx}$ is the coefficient of $X$ in linear regression equations.

$x_a$ is average of actual output

$y_a$ is average of actual inventory during 9 years.

## VI. Conclusion

As is evident from the foregoing sections, inventory holding although is likely to be affected by the other factors like as future prospects of material and finished goods, prices, material supply, export and import and so on, it is in fact mainly dependent on the output level rather than the other factors. Furthermore, the avarage inventory holdings by industries were linearly related with output.

Also, as the many developing countries have planned that the production would be increased continuously, the trend of inventory holding in economy as a factor of capital increments would be growing too, without relation to a certain linear cycle.

Therefore, foregoing estimation on the inventory holding in a projection model is useful, *ceteris paribus*, to economic forecasting.