COWLES COMMISSION STAFF PAPERS, ECONOMICS NO. 218

February 27, 1948

Manufacturing 1921-41: Preliminary Report

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The purpose of this model is to study the interrelationship between the manufacturing and non-manufacturing sectors of the economy. An equivalent approach is to study the interrelationship between the manufacturing sector and the economy as a whole. I have followed Haavelmo's treatment of the agricultural sector of the economy, and have taken the latter approach (cf. Girshick and Haavelmo, Econometrica, XV (1947), p. 88.).

For the purposes of this model we consider the manufacturing sector as if it were one giant firm buying raw materials (and imported semi-manufactures) and selling the "finished" product. When the product is "finished" does not depend on any physical properties, but on whether it leaves (permanently) the manufacturing sector. Thus gasoline used by the service trades is from this viewpoint finished; similarly exported semi-manufactures are "finished." (Cf. Kuznets, Commodity Flow, p. 22.) We modify this definition to include in finished output of manufacturing all producers' goods, whether bought by manufacturers or not. Otherwise all purchase and sales of semi-manufactures are ignored. This concept is the same as the Department of Commerce "net value of product" (cf. Trac Thompson, Materials Used in Manufactures: 1929). Unfortunately there are no continuous data readily available on this basic

series. Hence it has been necessary to use data which only approximate this ideal. Furthermore, the model makes no attempt to explain manufactured producers' goods. These are lumped together with general private investment, which is considered as exogenous.

Our jointly dependent variables are:

y = disposable money income

p = general price level

$y = \frac{y}{p}$ = real disposable income

x_1^D = demand of consumers (at retail level) for manufactured consumer goods.

x_1^S = supply of same

p_1 = price of manufactured consumers' goods

x_C^D = demand of consumers for all goods

The exogenous variables are

z = real private investment

G = real government expenditure

t = time

We write our complete model as

(1) $x^D = \alpha_0 + \alpha_1 y + \alpha_2 y_{-1} + \alpha_3 t + u_1$

(2) z = exogenous

(3) G = exogenous

(4) $x_1^D = \beta_0 + \beta_1 \frac{p_1}{p} + \beta_2 y + \beta_3 y_{-1} + \beta_4 t + u_2$

(5) $x_1^S = \gamma_0 + \gamma_1 \frac{p_1}{p} + \gamma_2 \left(\frac{p_1}{p}\right)_{-1} + \gamma_3 t + u_3$

(6) $x_1^D = x_1^S$

Equation (1) is a general consumption function. (4) is the consumption function for manufactured consumers' goods; this is assumed to depend on the relative price of manufactured consumers' goods. (5) is the supply function for manufactured consumers' goods. A speculative element is assumed to enter here which does not enter on the consumers' side; hence the dependence of x_1^S on the lagged relative price $\left(\frac{p_1}{p}\right)_{-1}$. In both (4) and (5) there is assumed to be a time trend. (6) states the assumption that there are no undesired inventories accumulating. u_1, u_2, and u_3 represent the respective disturbances of the equations.

Following Haavelmo (ibid.) we first consider equations (1)-(3) separately. Adding them up we obtain:

(7) $x^D + z + G = GNP = \alpha_0 + \alpha_1 y + \alpha_2 y_{-1} + \alpha_3 t + z + G + u_1$

We also have

(8) $GNP = y + R + S - T + D - I$

where R = government receipts, S = corporate savings, T = transfer payments, D = depreciation, and I = inventory revaluation--all in real terms.

Solving out for y from (7) and (8) we obtain

(9) $y = \frac{\alpha_0}{1-\alpha_1} + \frac{\alpha_2}{1-\alpha_1} y_{-1} + \frac{\alpha_3}{1-\alpha_1} t + \frac{1}{1-\alpha_1} \left[z + G - R - S + T - D + I \right]$

Assume that the sum of the terms in the brackets are exogenous, and rewrite this equation as

(10) $y = \delta_0 + \delta_1 y_{-1} + \delta_2 t + \delta_3 \left[z + E \right]$

where

(11) $E = G - R - S + T - D + I = y - C - z.$

Hence z+E equals net private investment -- which is assumed to be exogenous. We have reduced equation (1) - (3) to (10) -- and this is the one that will be used in conjunction with (4) - (6).

The reduced-form (limited information) method of estimation was used, and the following results obtained.

(12) $y = 25.29 + 2.28\ (z+E) + .36y_{-1} + .39t + u_4$

(13) $x_1^D = -6.27 + 0.09\left(\frac{p_1}{p}\right) + .41y + .07y_{-1} + .05t + u_2$

(14) $x_1^S = -274.82 + 4.22\left(\frac{p_1}{p}\right) - 1.10\left(\frac{p_1}{p}\right)_{-1} - .568t + u_3$

These results show that consumers are much less price sensitive than suppliers. They also indicate a strong speculative influence on the behavior of suppliers. Statistical tests showed almost complete independence of the exogenous variables and the residuals. A test for serial correlation of the residuals showed that we would obtain worse results in only 8% of the cases.

There are many factors which make me very seriously question the value or validity of this study. They are enumerated briefly below:

1. I have no idea of the magnitudes of the confidence intervals for the parameter estimated. The basic estimating procedure leads me to believe that they are very large; for the basic procedure consisted of adding and subtracting variables until "reasonable" results were obtained. To handle this type of problem, we must have a much further developed theory of multiple hypotheses.

2. This study was supposed to deal with the manufacturing sector of the economy. Yet no attempt was made to explain the manufacture of producers' goods. This was just thrown in with the

exogenous variables. This procedure was necessary due to the lack of an acceptable theory of investment, and of adequate data.

3. The study treats the manufacturing sector as if it sold directly to the consumers. This is patently a false picture. I am sure some distortion must be present due to this overlooking of the distribution sector of the economy. But I have no idea as to the degree of this distortion.

4. The implication of ~~XXXX~~ equation (6) as to the absence of undesired inventories, seems to be very weak. The difficulty here was in obtaining a measure of undesired inventories. This problem has been discussed in a previous paper ("Manufacturing in the United States" -- multigraphed January 1, 1947).

5. In general, I believe that it is much more difficult to obtain a good model for a sector of the economy, than for the economy as a whole. For each equation that exists in the latter model, there must be two equations in the former: one for the sector under study, and one for all the remaining sectors of the economy. Thus a model which breaks down the economy into sectors is essentially similar to one which attempts to describe international trade. Correspondingly, it must confront all the difficulties arising in the latter: difficulties of bringing out interrelationships; difficulties of obtaining data; and so forth. Thus my personal feelings are that the most important task now is not to apply the model technique to sectors of the economy, but to perfect its application to the economy as a whole.

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February 25, 1948

Appendix

The Time Series and Their Construction

Year	x_1^D	x_1^S	p_1	p	y	z	E	x^D
1920	35.5	181.6	155.9	42.8	5.64			37.1
1921	27.7	128.1	132.0	40.0	1.74			38.3
1922	29.0	120.4	124.8	45.7	4.01			41.7
1923	32.7	123.0	127.1	52.0	6.53			45.5
1924	33.1	122.9	126.2	52.9	4.60			48.3
1925	36.0	129.9	29.4	54.6	5.87			48.7
1926	38.1	126.0	129.6	56.5	5.25			51.2
1927	37.6	122.6	126.6	58.1	5.92			52.1
1928	38.5	125.5	126.9	59.4	5.20			54.2
1929	40.5	123.0	126.4	63.0	6.96			56.0
1930	36.4	114.6	122.1	57.9	4.75			53.2
1931	30.9	100.3	109.8	54.3	4.9			49.4
1932	23.5	89.1	97.2	46.9	2.67			44.2
1933	22.2	89.4	93.7	47.5	2.24			45.3
1934	27.5	100.0	100.0	51.0	3.30			47.7
1935	29.9	107.0	103.8	54.2	3.95			50.3
1936	33.8	105.2	104.4	62.5	5.84			56.6
1937	36.3	111.9	108.7	63.7	6.20			57.5
1938	33.7	104.1	104.2	60.4	4.22			56.1
1939	36.4	101.4	102.6	66.0	5.85			60.1
1940	39.3	103.3	103.4	70.5	7.06			63.5
1941	47.1	113.8	109.3	81.2	12.90			68.3

$x_1^D = x_1^S$: demand (supply) of manufactured consumers' goods in billions of 1934 dollars.

$$x_1^D = x_1^S = \frac{(1)}{(2)}$$

(1) Consumption of processed manufactured goods in billions of current dollars. (1929-1941, Shaw, Survey of Current Business, April, 1942; 1920-1949, Kuznets, Commodity Flow and Capital Formation.) First, total non-manufactured consumption goods was found as the sum of coal at retail prices (p. 289), farm consumption (p.324, line 16), and non-manufactured food (p. 136 -- markup of 200% applied to bring up to retail prices). This total was then subtracted from

total consumption expenditure (p.304) to yield total consumers' expenditure at retail level on manufactured goods. The series obtained was for 1920-1935; and these were made continuous with the Shaw data by free-hand regression.

(2) price level of processed consumers' goods (Mills, Prices in Recession and in Recovery, and Prices in a War Economy, NBER, Occasional Paper No. 12).

p_1: price level of manufactured consumers' goods.

$p_1 = (2)$

p: general price index

$p = (3)$

(3) price index underlying consumers' outlay (Kuznets, National Income and Its Composition, I, 145. Extended by Klein, "Post-Mortem" to 1939-41.)

y: disposable national income in billions of 1934 dollars

$$y = \frac{(4)}{(3)}$$

(4) = disposable national income in billions of current dollars (U. S. Dept. of Commerce, unpublished data)

z + E: private net investment in billions of 1934 dollars

$$z + E = \frac{(5)}{(3)}$$

(5) = private net investment in billions of current dollars (unpublished Commerce data)

x^D: consumers' outlay in billions of 1934 dollars

$$x^D = \frac{(6)}{(3)}$$

(6) = consumers' outlay in billions of current dollars