CYCLES IN JAPANESE WOOL TEXTILE ACTIVITY AND AUSTRALIAN WOOL PRICES

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PART I: THE THEORETICAL FRAMEWORK

1. The Problem, Method and Setting

THE PROBLEM

This study arose out of a desire to relate fluctuations in wool textile activity to the course of wool price movements at Australian auctions. The immediate purpose of the investigation has been to discover what relationship exists between the various activities of the production chain—output, deliveries, stocks, and prices—from raw wool to sales of clothing to the consumer.

The questions that have been put to the data are several. Are fluctuations initiated by changes in general economic activity, consumer incomes, or retail sales of clothing or are they caused by changing expectations and stockholding at intermediate stages of the production process? Or, is there a combination of both factors operating? If so, what is the time sequence of transmission of fluctuation? Do these factors result in magnification of activity amplitude; if so, from where does the stimulus originate and is it intensified or damped at any stage?

THE METHOD

The plan chosen was a case study of the Japanese wool textile industry in the period 1951-1962. There are many reasons for, as well as reservations against, the study of a single country's fluctuations in

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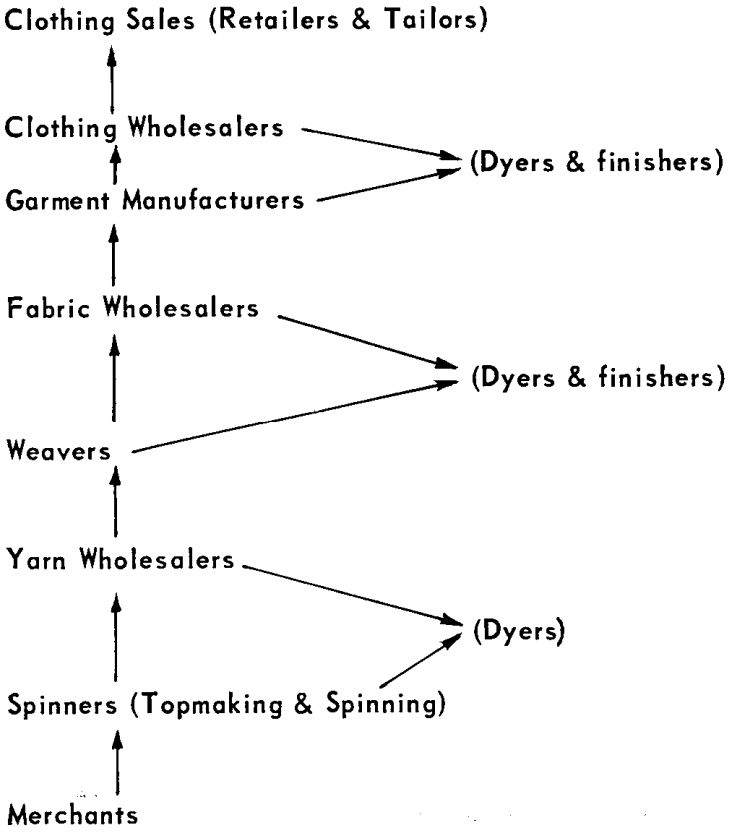
demand in attempting to explain the price of wool in Australia. The main reasons why a Japanese case study was undertaken were: that Japan is now the largest consumer of Australian wool and we can expect her share to increase; that Japan exports only a small proportion, about 10 per cent of total production, so that changes in demand will be largely a product of internal changes; that more statistics are available than for other countries; and that for reasons of economy it was considered more productive to study one sector intensively than to spread resources over many sectors. The difficulties of the method concern: the representatives of the Japanese industry *vis-à-vis* other countries; the relatively short period covered, particularly for some series; gaps in data at the distribution end of the chain; the import restrictions on wool up to 1961; and the fact that, although Japan is a large purchaser of wool, her consumption is still a relatively small proportion of world usage.

The technique used is primarily that of charting deseasonalized or smoothed movements in the selected series over the period of observation, marking off peaks and troughs in each activity and comparing these charts for relative timing of movements. Amplitudes, patterns of fluctuations and timing correlation measures have also been derived where necessary.

The Production Process

The production-distribution chain is shown in the following diagram.



The Japanese wool textile industry appears to have a reasonably high degree of competition.[1] At the end of 1962 there were 445 firms engaged in spinning (or both spinning and topmaking), 4,529 weaving firms and 91 fabric dyeing and finishing firms. There is, however, a high concentration of total output in a small proportion of the firms, in both spinning and weaving. Further, about one-third of worsted and one-quarter of woollen cloth is woven on commission by small specialist firms. Another aspect is the highly integrated nature of the larger firms.

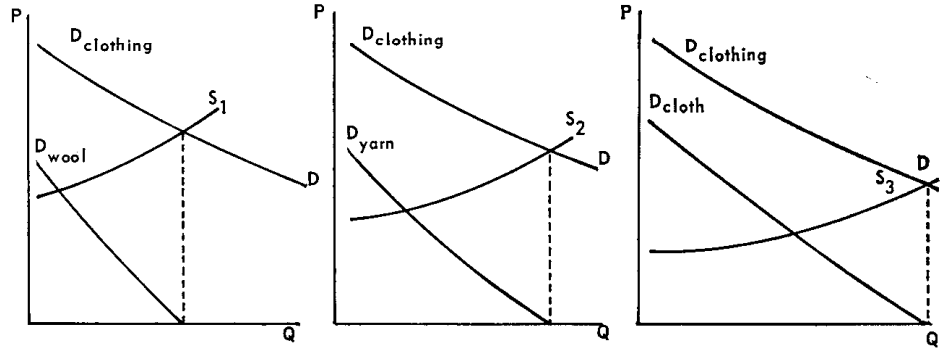
2. The Demand for a Raw Material

The Derived Demand from Consumption

The demand for raw and semi-processed wool is derived from the demand for wool clothing. Following Marshall, the derived demand for a commodity can be obtained by "subtracting from the demand price for each separate amount of the commodity the sum of the supply prices for corresponding amounts of the other factors".[2] The derived demand curve for each product is represented in Figure 1.

Figure 1

Derivation of Demand Curves



In this figure:

S_1 is supply price of labour, capital and materials from raw wool processing to sale of clothing;

S_2 is supply price of labour, capital and materials from cloth weaving to sale of clothing;

S_3 is supply of labour, capital and materials from garment manufacture to sale of clothing.

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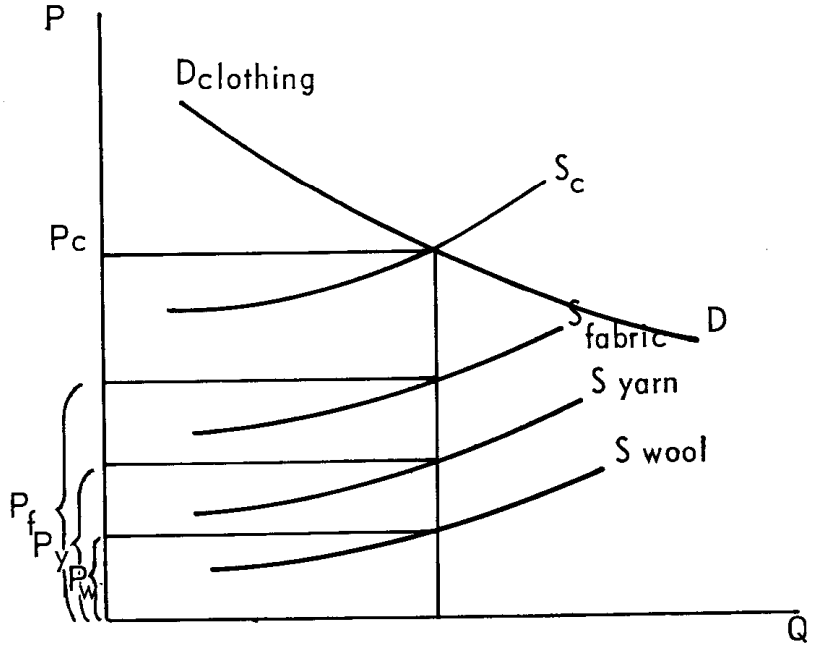
[1] "Wool in Japan", Bureau of Agricultural Economics, *Wool Economic Research Report*, No. 5 (August, 1963), pp. 11-12.

[2] Alfred Marshall, *Principles of Economics* (8th ed.; London: Macmillan and Co., 1961), p. 318. This depends of course on "the suppositions that we are isolating this one factor for separate study, that its own conditions of supply are disturbed . . . ; and that therefore in the case of each of the other factors of production the selling price may be taken to coincide always with the supply price".

In equilibrium the demand price for the separate stages of production is shown in Figure 2.

FIGURE 2

Vertical Equilibrium Prices



In this figure:

P_c is price of clothing;

P_f is price of fabric;

P_y is price of yarn;

P_w is price of wool.

The elasticity of derived demand for a factor will depend on:

(a) whether it is an essential factor;

(b) whether the demand for the finished product is inelastic;

(c) what proportion its cost is of the total cost;

(d) the elasticity of supply of other factors.

Hence, the elasticity of demand of the product of each stage of a given production process will most likely decrease as the amount of processing decreases.

DEMAND FOR CONSUMPTION AND STOCKS

This simple static analysis conceals many of the important factors relevant to this study. The demand for wool is not only the demand for consumption but also for stocks. Assuming no lags in the time transmission of demand, this statement may be put as follows:

The demand for wool in any period (assuming no lags)	=	retail sales of raw wool equivalent in clothing	+	desired inventory investment along the production chain (positive or negative)

Or symbolically, $D_w = R_w + \Delta S_t$ (1)

It is stressed that it is inventory *investment* which is the cause of changes in the output of a commodity due to the holding of stocks. The absolute level of stocks may be important in determining the future direction of output but it has no direct causal relation to output. Inventory investment is the difference between input and output of a commodity, for example, between the receipts and consumption of raw wool or between production and sales of yarn. Inventory investment can then be positive or negative depending on the differential rates of input and output.[3]

The above broad statement can be demonstrated more precisely as follows.

Let R_w be the retail sales of raw wool equivalent in clothing in any period; O_r, O_h, O_w, O_y be the orders placed by (demand of) retailers, by wholesalers (*in toto*), by weavers and by spinners, for raw wool equivalent; S_r, S_h, S_w, S_y be the required changes in stocks of retailers, wholesalers, weavers, and spinners (positive or negative).

Remembering that, with no lags in demand transmission, orders from one stage to another equals demand for that stage's finished product (sales) plus its required investment in stocks.[4]

Then,

$$O_r = R_w + \Delta S_r \tag{2}$$

$$O_h = O_r + \Delta S_h \tag{3}$$

$$O_w = O_h + \Delta S_w \tag{4}$$

$$O_y = O_w + \Delta S_y \tag{5}$$

By progressive substitution in each of the above equations from (2) to (5), O_r, O_h, O_w, cancel out, and there is obtained the relation[5]:

$$O_y = R_w + \Delta S_r + \Delta S_h + \Delta S_w + \Delta S_y \tag{6}$$

Since O_y is the sum of orders (demand) for wool in the markets of the world, (6) is equivalent to equation (1). This relation constitutes the framework within which the rest of the investigation must proceed.

Implications of the Model

This relation poses several questions. The first, a fundamental one, is, how far does this model describe the reality of demand transmission? That is, does consumer demand for clothing in any period rigidly determine the demand for stocks down the production chain or is the sequence broken at some stage by independent movements in demand? Further, is there an intensification of the demand of raw wool equivalent at lower stages of production—an acceleration of derived demand? In other words, is inventory investment at each stage always positively related to changes in demand? If the sequence is rigid, what are the factors causing consumer purchases to change? If it is broken at some stage, what causes it to be broken and to what then does the system react?

[3] The *desired* change in stocks is stressed—how stocks will actually move will depend on the conditions of supply in buying markets.

[4] This relation is elaborated in the first section of Section 4.

[5] Equation (6) is equivalent to the Keynesian income (output) equation $Y = C + I$.

The answers to time sequence of demand transmission must await an examination of the data. At present the unbroken, unlagged sequence of the model will be retained as a working hypothesis and a number of suggestions as to its behaviour will be put forward.

3. Changes in Demand and their Effect on Inventories

Factors Affecting Consumer Purchases of Clothing

The most important factors affecting the demand for clothing and which will cause it to change, are:

(a) movements in disposable income;
(b) changes in price of clothing relative to other prices;
(c) shifts in tastes *vis-à-vis* other commodities;
(d) changes in fashions affecting the relative demand for fibres;
(e) consumer stocks of clothing;
(f) expectations as to future prices.

Determinants of Inventory Changes

Before it is possible to postulate how inventories will move in response to changes in demand, it is first necessary to examine the reasons why stocks are held in the first instance. It is also necessary to classify stocks according to their purpose and their place in the production process of each sector. Finally, it is important to recall that it is the relationship of stock *movements* to changes in demand that is the focus of the discussion.

There are three basic categories of stocks—purchased materials, goods-in-process and finished goods.[6]

Even in a stationary world, with no lags or demand changes, manufacturers would hold stocks. Stocks of *purchased materials* would result from the fact that there are economies of bulk purchasing; that is, the unit cost declines as the number of units purchased increases. These economies result from the presence of fixed costs necessary to place, process and set up orders, and from quantity discounts in purchase or transport. In addition to purchased material stocks held for purchasing economies, a constant quantity of *goods-in-process* will be required, their size depending on the length of the process. Again, there will be a need to hold stocks of *finished goods.* The size of these stocks will depend on whether production is to order and, if not, it will depend on the seasonal incidence of sales. If production is solely to order, stocks of finished goods will be very small—only samples need be kept. If production is to stock, the amount of stocks held at any time will depend on the seasonal incidence of purchases—varying inversely with the rate of sales in any period. Producers need only

[6] This classification is according to individual sectors in the production process. Since the aim of this study is to determine reasons for the movement of stocks as a result of the intelligent adjustment by businessmen to their particular objectives and problems at each stage, this is considered the most appropriate approach.

gear their rate of production to the rate of sales over one year.[7] Since total sales per year are known beforehand, total production will always equal total sales.

If lags are introduced into the situation there will be a further reason for holding stocks of purchased materials. This will result from the time taken for delivery and on the time taken for assembling and preparing stocks in readiness for processing. But, unless this "lead time" is greater than the number of weeks supply held because of purchasing economies, no increase in stocks will be necessary. Also, there exist special cases where the efficient buying of purchased materials dictates that they be bought as they come on the market, agricultural products being a case in point.

Hence it is seen that stocks are not necessarily, in the words of J. M. Clark, "the children of uncertainty".[8] Even under complete certainty purchased material stocks will be held because of purchasing economies and order periods; goods-in-process will be required for the actual process; and finished goods will be held to meet seasonal variations in demand.

Thus far, only a once-and-for-all demand for a constant level of inventories, the static case, has been considered. In the long run they add nothing to the level of effective demand and so have no stimulating or depressing effect on the demand for purchased materials. But if changes in the rate of sales are introduced, the dynamic situation, there comes the need for additions to and decumulation of stocks. This inventory investment becomes very important in giving impetus down the production chain to changes in the demand for the finished products—the acceleration of derived demand.[9] Fluctuations in demand for the finished product of each sector will cause changes in stockholding for a number of reasons, the most important of which result from the uncertainty which changes in sales engender.

Even without uncertainty, changes in the rate of sales will result in an acceleration of derived demand. The economies of bulk purchasing dictate that stocks of purchased materials be increased with the rate of sales and vice versa.[10] Similarly, stocks of goods-in-process will vary positively and fairly closely with the rate of sales. This

[7] Under conditions of fluctuating but certain demand, production will almost certainly be to stock. From the consumer's point of view, he will either desire immediate delivery more than being required to wait or he will be indifferent between the two. Since fluctuating production entails certain extra costs—terminal pay, training outlays, overtime premiums, idle time, impairments of labour relations, productivity—it will be more profitable to maintain constant production if it is profitable to produce at all.

[8] J. M. Clark, "Business Acceleration and the Law of Demand" in *Readings in Business Cycle Theory* (London: Allen and Unwin Ltd, 1944), p. 235.

[9] Abramovitz in his book *Inventories and Business Cycles* (New York: National Bureau of Economics Research Inc., 1950), p. 6, cites that, during five cycles in the United States from 1919-1938, average net changes in inventories contributed to 23 per cent of the change in output during expansions while in contractions inventory disinvestment was responsible for 47 per cent of the changes in total output.

[10] Given the rate of sales, the optimum size will occur when the marginal storage cost becomes equal to the marginal saving per unit of time with increased lot size. The marginal saving per unit of time equals the marginal saving per unit, times the number of units demanded per unit of time. Hence if the rate of sales increases, so does the marginal saving per unit of time, which will then exceed the marginal inventory cost. It will then pay manufacturers to increase the lot size.

association need not be a directly proportional one since manufacturers tend to step up the rate of throughput in periods of high production. Of course, if capacity is filled, there will be no other way of increasing output. Again, finished goods stocks, if they exist at all, will be larger with larger sales since their ebbs and flows with fluctuating seasonal demand will be greater the greater the rate of output, and conversely.

The introduction of uncertainty into the situation shows further reasons why stocks are held and why they fluctuate in consonance with sales in the real world. First, uncertainty *per se* will be dealt with. Uncertainty will result in increased stocks of purchased materials because of the possibilities of delays in delivery and, with a variable rate of production, because of unpredictable variations in the required rate of input. With a higher rate of output, variations in both will be greater and hence stocks will vary positively with sales. Under uncertainty, and with production changing to meet changes in sales, stocks of finished goods will need to be greater to meet variations in demand before production can adjust to the change in demand and are similarly likely to vary in the same direction as sales.

This brings us to the second reason for holding stocks under uncertainty, smoothing of the production flow. This has been mentioned previously in connection with known fluctuations in demand but is given stronger emphasis under uncertainty. There are two ways of smoothing the production flow, production to stock or the accumulation of order backlogs.[11] Whether production will be to stock or to order, and hence how stocks will behave, will depend on a number of factors.[12]

Should the unit cost of production be an increasing function of the rate of production, and there be no other costs, production will be to stock. If this succeeds in completely smoothing the production flow over time, purchased material stocks will need to be only as large as efficient procurement dictates.

Finished goods will vary inversely with changes in demand. Such a policy will mute fluctuations in demand from higher stages to lower stages due to the buffering effect of finished goods. In fact, these finished stocks can be looked on as speculative stocks which smooth fluctuations in price over time.

However, there are countervailing influences which may cause production to order. Should the cost of holding large stocks be greater than the economies of a smooth production flow and should the demand for immediate delivery not be great, it is likely that production will be to order (with delayed delivery). These costs arise first from carrying charges and, much more importantly, from the risks involved. The reasons for risk are:

(a) the product must conform to special unpredictable requirements of different customers;

(b) the product, when processed, is subject to rapid physical or economic deterioration even though it may be made from durable raw materials;

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[11] It is important to distinguish between orders for immediate delivery out of stock and order for delayed delivery which are only produced in response to a definite order.

[12] Victor Zarnowitz, "Unfilled Orders, Price Changes and Business Fluctuations", *Review of Economics and Statistics*, Vol. XLIV, No. 4 (November, 1962), p. 367.

(c) the demand for the product is extremely variable and sporadic and is difficult to predict.[13]

Although production to order also serves to smooth the flow of output through the accumulation of order backlogs in periods of higher demand and their working off in slack times, the smoothing will probably be somewhat less than with production to stock and the effect on stocks will be magnified accordingly. Purchased material stocks will need to be higher in periods of rising demand to avoid interruptions to the production flow. Apart from the direct costs of interruptions to the production flow there will be the further possibility of having to refuse new orders with consequent loss of profits and future goodwill. Hence, under these conditions, stocks of purchased materials will show a positive association with sales.[14] Goods-in-process will also vary with sales and in the same direction. There will be no inventory accumulation of finished goods provided shipment immediately follows output. Hence production to order will result in greater total inventory changes in the same direction as sales *vis-à-vis* production to stock.

As discussed earlier, there may also be some groups of firms where it is appropriate, in view of their costs and the requirements of their customers, to give immediate delivery and to vary their rate of production to meet changes in their sales. In such cases, stocks of purchased materials will have a stronger association with sales than with delayed delivery because uncertainty is much greater. Goods-in-process will also show a much greater change in line with changes in sales since production changes commensurately. Finished goods stocks will be small but will be positively associated with sales since a buffer is required to meet variations in demand before production can be increased to the same extent as the change in sales. With rising sales this buffer will be greater, and conversely.

Besides these factors, there is the very important effect of speculation on stock holding. But first, what is speculation? Primarily, speculation is attempted arbitraging through time.[15] If a merchant or manufacturer expects the demand for a commodity to rise in the future or its supply to diminish, he will buy up the commodity now in the expectation of obtaining a higher price in the later period.[16] This buying now will raise the present price and this selling later will depress the future price and, if expectations prove correct, prices in the two periods will differ only by the price of storage. The converse holds true for an expected decline in demand or increase in supply. If holders of the commodity expect a decline in price in the future they will sell now and the

[13] *Ibid.*, p. 372.

[14] This association will not be very strong however, since, with production to order, there is a "period of option" within which raw materials may be bought before they need enter into process. This period, and hence the strength of association with sales, will vary with the length of the delivery period contracted.

[15] Strictly speaking arbitrage is riskless. But for economy and cogency of exposition, the expression is retained. Boulding uses the same definition without the "attempted" qualification, in his book, *Economic Analysis* (London: Hamish Hamilton, 1948), pp. 82-85.

[16] Excellent discussions of the influence of expectations on price formation are given in P. H. Wicksteed's book, *The Commonsense of Political Economy*, Vol. I (London: Routledge and Kegan Paul Ltd, 1957), pp. 234-248; also in Holbrook Working's, "A Theory of Anticipatory Prices", *American Economic Review, Papers and Proceedings* (May, 1958), pp. 188-208 (including discussion).

consequent price depression will tend to equalise prices in time. Hence, when expectations are that demand will increase in the future, manufacturers will attempt to increase their stocks of purchased materials, and conversely. If expectations bear a close relation to changes in sales, then stock changes will be positively associated with them.

In summary, the reasons for holding stocks are as follows (where P.M. = purchased materials; F.G. = finished goods):

Under certainty

(a) Economies of purchasing (P.M.).

(b) Lead times in ordering (P.M.).

(c) Seasonal variations in demand (F.G.).

Under uncertainty

(a) Delays in delivery to factory (P.M.).

(b) Fluctuations in demand (P.M. and F.G.).

(c) Smoothing the production flow (F.G.).

(d) Hedging against price increases and shortage in supplies (P.M.).

The reasons for restricting stock-holding are:

(a) Costs of storage.

(b) Risk of economic deterioration—obsolescence and price declines.

(c) Physical deterioration.

(d) Tying up of capital which can be used elsewhere.

A scanning of these many considerations produces the following impressions. First, there is no suggestion of a required constant average stock-sales ratio. In some instances there may be desired incremental change but generally the association between sales and stocks will not be a very firm one because the many conditions affecting stocks have no direct connection with rate of sales at all. Smoothing the production flow and efficient buying of materials for the many reasons cited, while they result in changes in stocks, are not concerned with the absolute size of the stock or its relation to sales but with factors centred elsewhere.[17]

Further, the considerations examined suggest that, *in toto*, stocks will often be positively associated with sales.[18] That is, that inventory investment will be positive when sales are increasing and negative when

[17] Nonetheless, manufacturers will still behave "as though" there was some desired stock/sales ratio since the association between the two is often positive. On this point see Franco Modigliani, "Business Reasons for Holding Inventories and Their Macroeconomic Implications", in *Problems of Capital Formation: Studies in Income and Wealth, Vol. XIX* (New York: Princeton University Press), p. 495.

[18] It must not be inferred that the reasons for a positive association of stocks with sales will be strictly additive in their effect on stocks. In fact, stocks for efficiency reasons will mostly simultaneously satisfy the desire for stock for speculative reasons—whichever motive is the dominant one will determine the size of stocks. One of the variables in determining the optimum size of stock is the probability of being sold out. This probability will increase as the number of possible contingencies increases but the probabilities of each separate contingency, taken together, will not be additive.

sales are decreasing. The strength of this association will depend on how each of the three categories of stock is required to move, consistent with economical operation of plant, efficient buying of materials and the need to protect against uncertainties of demand and supply, and on the relative proportions of each category in the aggregate. Raw materials stocks will almost always need to move in the same direction as sales; similarly goods-in-process. The movement of stocks of finished goods will depend on conditions of production governing whether it is more efficient economically to produce to order or to stock. Production to stock may reverse, while production to order may intensify, the positive association of stocks with sales. Gearing the rate of production to the rate of sales will certainly cause stocks to be directly related to sales.[19]

These considerations suggest that, in the original model, when demand is rising, inventory investment at each stage will be positive, that is, each sector is buying more than it is selling or selling less than it is buying. Conversely, with declining demand, inventory investment will be negative. Hence acceleration of derived demand will occur right down the production chain to the raw material stage.

4. A Cycle

Having looked at the considerations which affect the behaviour of stocks with changing demand, it is now necessary to speculate on why demand traces out a cyclical course and how the model might respond to these cyclical changes.

The Mechanics of Production Decision

In order to appreciate fully the models to be presented in the following section, it is necessary to trace out the relationships between production variations, sales, stock movements as they affect the orders issuing from each sector.

There are two different kinds of firms along the chain from raw material to ultimate consumer, distributors and processors. The former category, which comprises retailers and wholesalers, do not engage in physical production, hence their stocks have the characteristics of both purchased materials and finished goods. The latter, who engage in physical transformation of goods, have the three classes of stocks and their production decisions have a profound influence on their accumulation of stocks.

First, the relation between the various activities in which distributors must engage themselves will be considered. At any point of time their orders (O_D) will be a compound of orders to replace stocks depleted by sales (S_D) *plus* a component for investment (positive or negative) in stocks (I_D).

$$O_D = S_D + I_D,$$

therefore

$$I_D = O_D - S_D$$

[19] The content of the preceding discussion owes a heavy debt to Ruth P. Mack's article "The Process of Capital Formation in Inventories and the Vertical Propagation of Business Cycles", *Review of Economics and Statistics*, Vol. XXXV, No. 3 (August, 1953), pp. 181-197; also to that by Modigliani in "Business Reasons for Holding Inventories", *op. cit*, p. 495.

Since, without order backlogs, orders will be equal to receipts (R_D),

$$I_D = R_D - S_D.$$

Thus the component for investment will be positive when receipts (orders) exceed sales and conversely; the sales component is always positive.

With processors the relationships are less simple. Their orders consist similarly of a component for sales plus a component for inventory investment. Orders to *replace* finished stocks depleted by sales, if they are required to be replaced, works at two removes. Production must increase to replace the decrement in finished stocks caused by an increase in sales. This production increase causes stocks of purchased materials to decrease. Orders must then be increased to replace the diminution in stocks of purchased materials. Again orders for *investment* in stocks of finished goods are similarly tied to the actual production process. When stocks of finished goods are required to *increase* in line with sales, production must increase. This increase depletes purchased material stocks to the same extent and the positive investment in finished goods causes an equal disinvestment in purchased materials. Hence an increase in production in response to an increase in sales must be matched by a greater than proportional increase in receipts if inventory investment is to be positive.

The above argument is illustrated in the following:

$$Op = Sp + Ip.$$

Now,

$$Ip = Rm + Fg + Gp$$

where

Op = orders placed by processors;
Sp = sales;
Ip = total investment;
Rm = investment in purchased materials;
Fg = investment in finished goods;
Gp = investment in goods-in-process.

Ignoring goods-in-process, which are to a large extent tied technically to the rate of production,

$$Rm = Rp - Cp,$$
$$Fg = Pp - Sp,$$

where Cp = consumption and Pp = production.

Therefore,

$$Ip = (Rp - Cp) + (Pp - Sp).$$

Now since

$$Cp = Pp,$$

we obtain

$$Ip = Rp - Sp.$$

Hence the net result is the same as with distributors; it is the mechanics which differ.

Should production not be required to increase with increased sales and hence buffer stocks of finished goods be held, the muting of demand acceleration can be seen to operate through disinvestment in finished goods operating via production. When stocks of finished goods can be run down and there is no need to replace them immediately, there will be no need to increase production. Hence there will be no replacement of purchased materials required, thus orders will be so much less than they would have been had finished goods stocks to be maintained.

In the equations:

$$Op = Sp + Ip = Sp + (Rp - Cp) + (Pp - Sp),$$

since purchased materials are not to be increased, $Rp = Cp$, and so $(Rp - Cp)$ is zero; Sp will be greater than Pp since production has not to be increased, so $(Pp - Sp)$ is negative. Hence orders are reduced to this extent compared with the above situation.

(1) A MECHANICAL MODEL

First, the original model with instantaneous and vertical transmission of demand, initiated in the retail sector, will be developed and its implications explored. This immediately raises the question of what causes retail sales of clothing to fluctuate. The most obvious answer to this question is that they respond to fluctuations in consumer income resulting from changes in aggregate economic activity—the business cycle.

Retailers' Behaviour

What then might be the behaviour of each sector down the production chain in response to a change in demand at the retail level? First, what might happen to retailers' demands on the next sector as a result of changes in their own sales? The first thing to be stressed is that the change in demand would be unexpected, since entrepreneurs are unable to forecast future demand. Typically they base their projections as to future demand on the current level of demand with perhaps an adjustment to take account of the trend.[20] In the next period, that is when they next check their inventories, they will find inventories have been depleted to the extent of the increase in sales. Hence they must not only increase their purchases because they are selling more, they must also replace the unexpected depletion of stocks. Most likely they will also wish to increase their stocks in line with the increased sales for the reasons given in the previous section.[21] This is the marginal stock/sales ratio which they wish to maintain and it will be much less than the average stock/sales ratio.[22] This desire to maintain stocks at a constant level or to increase them in line with sales, constitutes the accelerator in the system.

[20] The whole question of retailers' buying is discussed in Ruth Mack's *Consumption and Business Fluctuations: A Case Study of the Shoe Leather Hide Sequence* (New York: National Bureau of Economic Research Inc., 1956), Chs. 8 and 9.

[21] Retailers' stocks have the characteristics of both purchased materials and finished goods. Hence they will need to keep higher stocks both to guard against delays in delivery and shortages of supplies, to achieve economies of ordering, and to meet uncertainties of demand. All will increase with increasing sales and vice versa.

[22] Mack, *loc. cit.*

As demand continues to increase, "planned" investment in stocks will be insufficient to bring inventories to the desired level since further "unplanned" depletion of stocks will have occurred during the period due to further increases in sales. When the rate of change of sales decreases prior to a downturn in output, "planned" inventory investment will decline, although still be positive, in the next period. But "unplanned" investment in stocks will continue to be negative while sales continue to increase and while there remains the inevitable error of forecast. When a downturn in sales occurs, "planned" investment in stocks will become negative. But "unplanned" investment will now become positive due to the fact that "planned" disinvestment is inevitably short of that required while sales continue to decline.

To illustrate and to elaborate, it is appropriate to draw up a model of the reaction of retailers to changing demand and to show the effects of this on the various components of the system.[23] The assumptions underlying this model are:

(a) that retailers have imperfect foresight in planning in period t for sales in period $(t + 1)$.

(b) that there is a lag in adjustment of orders required by change in sales and stocks. The result is that retailers order in period t on a basis of sales in period $(t - 1)$ and on the change of stocks from period $(t - 2)$ to period $(t - 1)$. This lag can be due to both "psychological" and "technical" factors. Psychological factors may result from inertia and uncertainty and technical factors from inability to guage changes in sales immediately they occur, and from the fact that economics of ordering dictate that adjustments only be made with a lag.[24]

(c) that price changes are not used in validating short-term discrepancies between stocks and sales. It is a fact retailers are quite reluctant to restore equilibrium through price changes.[25] Hicks and Abramovitz both ascribe this behaviour to a fear of "spoiling the market", particularly during a downturn in sales.[26] It is inventories more than prices which adjust to changes in demand.

(d) that retailers wish to maintain a marginal stock/sales ratio of 1.5 and that this objective is rigidly adhered to at all times. That is, as sales increase by 1 unit from period $(t - 2)$ to period $(t - 1)$, stocks will be required to increase by 1.5 units in period t. This assumes that purchasing for efficiency reasons will be the dominant motive. As mentioned earlier, buying for speculative reasons will be also served by this change in stocks. That the initial level of inventories is equivalent to a stock/sales ratio of 2/1.

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[23] This model is derived from those developed by L. A. Metzler, "The Nature and Stability of Inventory Cycles", *Review of Economics and Statistics*, Vol. XXIII (August, 1941), pp. 113-129, and that of Ragnar Nurkse, "Cyclical Patterns of Inventory Investment", *Quarterly Journal of Economics*, Vol. LXVI (August, 1941), pp. 385-408.

[24] Nurkse, *loc. cit.*

[25] Mack, *loc. cit.*

[26] J. R. Hicks, *A Contribution to the Theory of the Trade Cycle* (London: Oxford University Press, 1959), and Abramovitz, *op. cit.*, p. 258 and pp. 331-332.

(e) that the rate of change of sales decreases prior to an actual decline.

(f) that the "period" is governed by the interval between which it is feasible for retailers to check their sales and stocks.

The results are shown in Table 1.

TABLE 1

Behaviour of Retailers' Stocks and Orders in Relation to Changing Sales Marginal Stock/Sales Ratio: a = 1.5

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sales†	Changes in Sales	Orders for Sales	Orders for Stock Adjustment	Total Orders‡ (3) + (4)	Passive Inventory Investment	Active Inventory Investment	Actual Inventory Investment (6) − (7)	Inventories
S	ΔS	O_S	O_I	O_T	I_p	I_a	I_r	I
500	0	500	0	500	0	0	0	1,000
550	+50	500	0	500	−50	0	−50	950
622	+72	550	+ 75	625	−72	+ 75	+ 3	953
710	+88	622	+108	730	−88	+108	+20	973
802	+92	710	+132	842	−92	+132	+40	1,013
864	+62	802	+138	940	−62	+138	+76	1,089
890*	+26	864	+ 93	957*	−26	+ 93	+67	1,156
842	−48	890	+ 39	929	+48	+ 39	+87*	1,243*
774	−68	842	− 72	770	+68	− 72	− 4	1,239
690	−84	774	−102	672	+84	−102	−18	1,221
600	−90	690	−126	564	+90	−126	−36	1,185
544	−56	600	−135	465	+56	−135	−79*	1,106
524*	−20	544	− 84	460*	+20	− 84	−64	1,042
556	+32	524	− 30	494	−32	− 30	−62	980
632	+76	556	+ 48	604	−76	+ 48	−28	952*
718	+86	632	+114	746	−86	+114	+28	980

* Signifies peak or trough.

† Successive figures represent consecutive periods.

‡ The table shows orders for stock to be negative. Operationally this cannot be so and the onus will of course be on orders for sales. This is just a way of saying that output is exceeding input.

EQUATIONS:

$$Os_t = S_{t-1}$$

$$O_{I_t} = a\,(S_{t-1} - S_{t-2}) = I_a$$

$$I_{pt} = -S_t$$

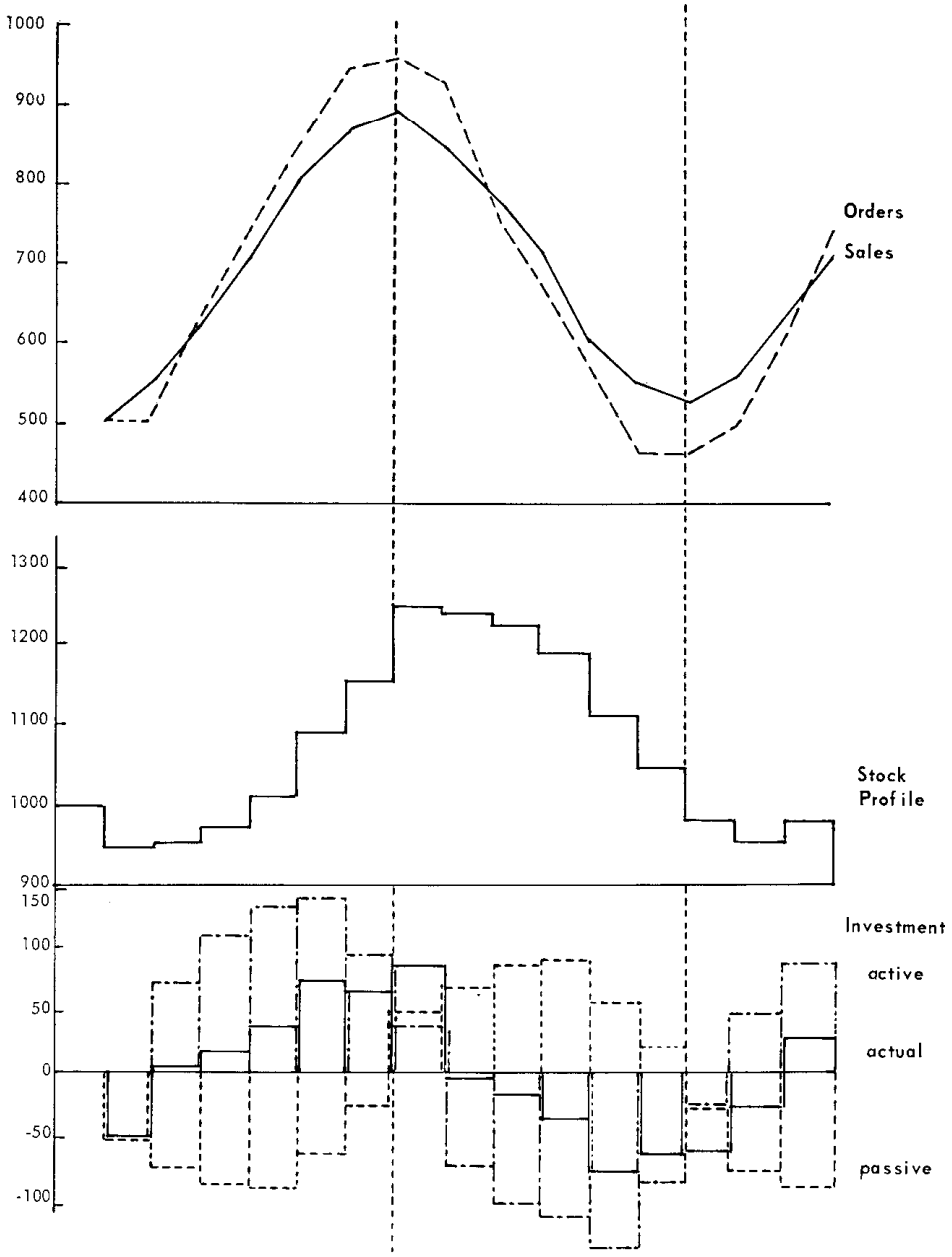
$$I_r = I_a - \Delta S$$

$$O_T = O_S + O_I$$

What emerges from the model? Firstly, and most importantly, there exists an amplitude acceleration of demand as reflected in the order series. Secondly, sales and orders have synchronous turning points under the restrictive assumptions and rates of change of sales used in constructing the model. Third, passive inventory investment remains negative while sales continue to increase and conversely, partially frustrating attempts to change stocks in accordance with the desired marginal stock/sales ratio. Fourth, stocks themselves continue to increase or decrease for a short time after sales have turned down or up. The results of Table 1 are illustrated in Figure 3.

FIGURE 3

Diagram of Table 1



Thus has been demonstrated equation (1) used in deriving the original model. Orders of retailers have moved always in the same direction as sales (there has been no timing acceleration) and orders have been magnified relative to sales due to the need to increase sales in relation to stocks.

As can be seen, this formulation of the inventory cycle is not in accord with the classical acceleration model. This model dictates that investment turns upwards or downwards with the rate of change of sales not with sales proper as in this model. In fact the "active" component of the total does conform with a lag. It is the "passive" component which causes conformity of investment with changes in sales proper. The "passive" component bears a negative relation to changes in sales and, while sales move in the one direction, or move at all for that matter, investment in stocks will continue to be out of line with the desired stock/sales ratio and so further changes in stocks in the same direction as sales will be required.

Wholesalers' Behaviour

In discussing the reaction of wholesalers to changes in sales it should be remembered, in keeping with the original model, that wholesalers' sales are the same thing as retailers' orders, in time as well as in magnitude. Already it has been demonstrated that retailers' orders have been magnified relative to their sales.

What then are the differences between the retailers and wholesalers' *milieux* which might require them to react differently to changes in their sales? Superficially their situation seems similar. Their stocks each have the characteristics of both raw materials and finished goods and they do not engage in physical transformation of raw materials.

The answer lies in a difference in degree rather than kind. Retailers' adjustment to changing demand is governed by the following considerations:

(a) The need to buy more because they are selling more and vice versa;

(b) The need to keep larger stocks with rising sales and conversely;

(c) The need to hedge against price rises and shortage of goods when demand is rising and to liquidate stocks when demand is falling; and

(d) The need to maintain a rigid relation between stocks and sales based on the level of past sales.[27]

[27] Mack, *op. cit*, pp. 240-241. Although this discussion is concerned directly with clothing wholesalers, other wholesalers will be affected by similar considerations.

The response of wholesalers to these considerations relative to that of retailers will result primarily from the somewhat different functions of the two groups. The retailers' forte lies in providing service to consumers while the wholesalers' preoccupation lies mainly in the merchanting function. Hence wholesalers will be influenced mainly by (c) and to a greater extent than retailers. Most likely (a) would exert an equal influence on both. Their response to (b) will probably be less strong than with retailers because a proportion of their orders will be for future delivery; hence, knowing part of their sales in advance, they will not need to keep as large a buffer stock against uncertainty of future demand. Consideration (d) is not likely to be very important with wholesalers. Even if it were, liquidation could be affected, or shortages forestalled, promptly by changing selling prices rather than in changes in buying.

How then to describe wholesalers' reaction to changes in their sales in a quantitative manner? There is apparently no fixed stock objective, so there are no unintended changes in stocks. Hence there can be no accelerator of the kind described earlier. Nonetheless, wholesalers, as speculators, can be expected to react in some definable way to changes in market prospects. These changes in market prospects will most likely be registered in the rate of change of sales and so will be based on the same considerations as that of retailers. Hence their investment in stocks will be generated by a process which operates in a similar manner to the marginal accelerator. Thus their speculative accumulation of stocks can be presented, though with only a low degree of precision, by a marginal accelerator in the same way as before. This is shown as follows:

Retailers' stock changes are based on changes in sales between the two previous periods, multiplied by the marginal accelerator; i.e.,

$$I_t \text{ (active investment)} = b\,(S_{t-1} - S_{t-2}).$$

Wholesalers, as speculators, will need to increase inventories to the extent that they expect sales to increase in the next period. But they will need to react more quickly than retailers. So the extent to which they expect sales to increase will be based on the rate of change of sales between the previous period and the present time, not between the previous two periods. This change of sales will be multiplied by a factor, the marginal accelerator, whose size will depend on the confidence with which they project the recent change in sales. This factor will be called the co-efficient of expectations.[28] So,

$$S_{t+1} \text{ (expected sales)} = (S_t + b(S_t - S_{t-1}))$$

where b is the co-efficient of expectations.

Then

$$I_t \text{ (active investment)} = S_{t+1} - S_t = (S_t + b(S_t - S_{t-1})) - S_t$$

Therefore,

$$I_t = b(S_t - S_{t-1}).$$

[28] This term was used by Metzler, *op. cit.*

This relation is equivalent to that presented for retailers above.

If these requirements are now superimposed upon those of retailers, there can be seen the transmission of retailers' sales in Table 1 into wholesalers' orders to manufacturers, shown in Table 2 and Figure 4.

TABLE 2

Wholesalers Reaction to Changes in Their Sales

Co-efficient of Expectations: $b = 1.5$

Retail Sales	Retail Orders (Wholesale Sales)	Change in Sales†	Orders for Sales	Orders for Stock (Inventory Investment)	Total Orders
S_R	S_W	ΔS	O_S	O_I	O_T
500	500	..	..	..	..
500	500	..	..	..	..
622	625	125	..	..	..
710	730	105	730	158	888
802	842	112	842	168	1,010
864	940	98	940	147	1,087*
890*	957*	17	957	26	983
842	929	− 28	929	42	887
774	770	−159	770	−239	531
690	672	− 98	672	−147	525
600	564	−108	564	− 162	402
544	465	− 99	465	−149	316*
524*	460*	− 5	460	− 8	452
556	494	34	494	51	545
632	604	110	604	165	769
718	746	142	746	213	959

* Signifies peak or trough.

† The first two figures are not typical of cyclical behaviour, starting as they do from a stationary state, and hence are not included.

EQUATIONS:

$S_W = O_T$ (from Table 1)

$Os_t = S_{Wt}$

$O_{I_t} = b\,(S_t - S_{t-1})$

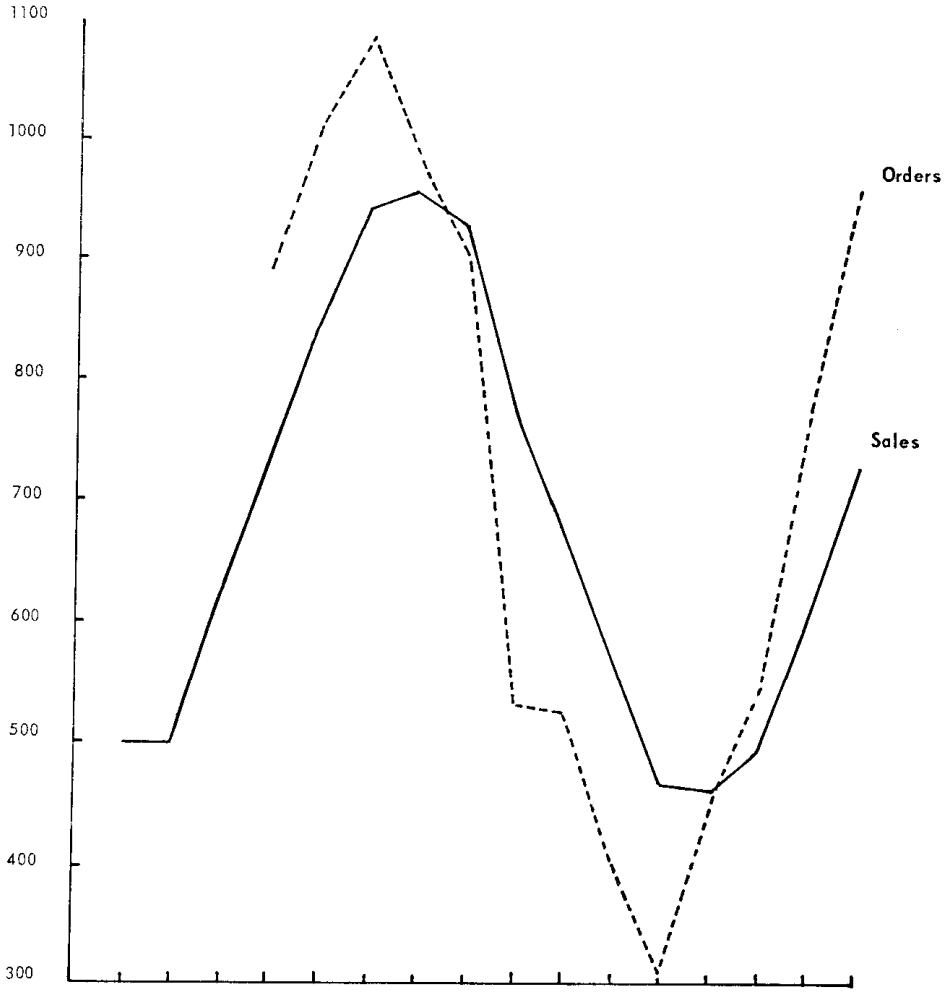
$O_{T_t} = Os_t + O_{I_t}$

The model shows similar quantity acceleration of derived demand due to inventory investment but, in contrast to the retailers' model, orders turn down one period prior to sales. This is more closely akin to the classical acceleration hypothesis which requires that orders turn down coincident with the rate of change of sales.

The lead of orders is inconsistent with the original model of instantaneous demand transmission. Is this a real or only an apparent inconsistency? There is reason to believe that the lead is somewhat

FIGURE 4

Diagram of Table 2



unreal. Many of the wholesalers may not see the decline in activity for what it is but only as an ephemeral levelling off. These dips and rises in activity are quite common along a rising or a falling trend. Hence, if the rate of change declines over only a short period before it actually turns, the growth of uncertainty may be insufficient to cause a lead in orders relative to sales. This does not imply that many wholesalers do not curtail their buying at this time but only that there are enough who don't, to cause the speculative movement to continue its course up to the actual change.

If these considerations are true, the results of the mechanical model must be modified to accord with them. In so doing, the lead of orders will be altered and the lack of smoothness which has developed in them will be removed, while the approximate amplitude will be retained. This produces the series of orders from wholesalers to manufacturers as a result of changes in retail sales shown in Table 3.

TABLE 3

Series of Orders from Wholesalers to Manufacturers as a Result of Changes in Retail Sales

Retail Sales	Wholesale Sales	Wholesale Orders
500	500	500
550	500	542
622	625	626
710	730	738
802	842	870
864	940	988
890*	957	1,020*
842	929	982
774	770	860
690	672	686
600	564	484
544	465	350
524*	460	315*
556	494	366
632	604	506
718	746	692

* Signifies peak or trough.

MANUFACTURERS' BEHAVIOUR

The manufacturer is now confronted consecutively by a time series of orders. The question is, how does he react to these changes in demand? The answer is not simple but it will depend primarily on whether his particular situation dictates that he produce to stock, to order (immediate or delayed) or to a combination of both stock and order. It must also be remembered that there are now three kinds of stocks (purchased materials, goods-in-process, and finished goods) which must be examined in considering how stocks will move and what the net effect of these three separate movements will be on the others emanating from each sector of the industry.

(*a*) *Production to Stock.* First it will be assumed that he is required to produce to stock. In this case the manufacturer will be indifferent in the short run to changes in demand for his product. Variations in demand will be met by running down stocks of finished goods. Stocks of goods-in-process will not respond since production does not respond. Similarly, if efficiency of production is the only criterion for the level of purchased material stocks, these will not change with changing demand. Thus it can be seen that there are no reasons why fluctuations in orders received should be reflected at all in orders placed. Should this be the case, there will be a complete muting of fluctuations in orders received. Hence the acceleration of derived demand generated from above will fail to be transmitted further.

Such an obviously extreme case is, of course, possible. But, unless manufacturers geared their production to the long term trend, they would run out of stocks in that part of the cycle when sales exceeded production and/or they would accumulate excessive stocks in periods when production was greater than sales. Stocks could be excessive in that the risks and costs of holding them would become larger than

the economies of smoothing production. Besides, manufacturers do not know what the long term trend is. In fact the long term trend has no meaning when viewed *ex ante*. It is only relevant to what *should* have been done. Its deduction from past data will be inappropriate should its direction change from the point a decision is made. Hence manufacturers must necessarily base their projections of future demand largely on the present situation. But the present situation is always changing hence manufacturers must change with it. As Robbins has said:

> ". . . though *at every moment* there may be tendencies towards an equilibrium, yet *from moment to moment* it is not the *same* equilibrium towards which there is movement. The future—the apparent future, that is to say—affects the present; but the past is irrelevant."[29]

Hence production will change with changing sales, although not in the same proportion. This will result in a change in the level of purchased material stocks.[30] As soon as the running down of these stocks is imposed there comes the necessity of adjusting them, and possibly of increasing or decreasing them marginally in relation to sales. Also, these changes in the demand for finished goods will induce speculative inventory investment in purchased materials. Similarly goods in process will necessarily be adjusted in line with changing production. Thus, although the accelerator will not be reduced to zero as a result of production largely to stock, it will be considerably damped. Since manufacturers will know the requisite change in their production, they will know the resulting change in stocks; hence they can order to replace stocks as soon as they increase production.

(*b*) *Production to Order*. What then of production to order? Its effect on transmitted demand will depend on the extent to which it smooths the production flow. The extent to which smoothing is permitted will be governed by the costs of varying production, the demand for delivery of varying dates and by the existence of excess capacity.

Suppose first that manufacturers wished, and their customers agreed, to have orders so distributed as to completely smooth the flow of production. In so doing, orders received and not filled in peak demand would be sufficient to make up the deficit of demand, from the trend, in a trough. In this case unfilled orders would perform the same function as finished stocks in production to stock. So the acceleration of demand at higher stages would be completely muted as in pure production to stock. But such an extreme case is most unlikely. It would mean that the manufacturer's customers would then become the holders of stocks instead of the manufacturer. Since the main reason for production to order is that it is too risky to hold stocks of the particular kind of good, it is unlikely that customers would view this risk with any less disfavour than manufacturers. It also implies that their customers are willing to have their stocks of purchased

[29] Lionel Robbins, *An Essay on the Nature and Significance of Economic Science* (London: Macmillan and Co., 1948), p. 62.

[30] With unvarying production raw material stocks will vary from their maximum at the time of ordering to a small quantity at the instant just before the next order is received.

materials vary inversely with sales. In the discussion on stocks no situation has been discerned where this would be good policy—in periods of rising demand, refused orders due to shortage of stocks would mean loss of potential sales; in periods of falling demand, the large stocks would mean large risks and carrying charges. Thus, as with production to stock, there will need to be adjustments in the rate of production as demand changes.[31]

Another possibility is that manufacturers will vary their rate of production to meet changes in their orders, all orders being for immediate delivery. This implies always that there is the possibility of expanding production. But again this situation is somewhat unreal. Manufacturers will not only be physically unable to vary production sensitively enough, but also they will desire to smooth their production. Besides, customers may require delivery dates of varying degree to suit their own convenience or because the article has to be made to exact specifications.

A summary of these different cases suggests the following general behaviour. There will always be some production to stock to meet unexpected changes in demand for immediate delivery.[32] This will vary positively with sales. Nonetheless, a considerable amount of the variation in demand will be met through changing the rate of production. This adjustment will not be complete for reasons of economy and feasibility and so there will be an accumulation of unfilled orders in periods of peak demand.

Given a situation such as this, what will be the result of orders received on production, stockholding and the demand for purchased materials at a lower stage? Stocks of finished goods will be required to change in the same direction as sales, at least in the early stages of an upturn. Production will also vary positively with sales but to a lesser degree on either side of the peak because of accumulation of order backlogs and their fulfilment. This may be due to either peak capacity being reached, to a deliberate attempt to smooth production, or to customers' incorrect anticipations. Goods-in-process will follow the same course as production. Purchased materials will also move in accord with sales for efficiency and speculative reasons. However, the association will not be very strong in periods when order backlogs are increasing because there is a "period of option" between the receipt of an order and its fulfilment in which to purchase the required raw materials.[33]

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[31] However, the tendency to view situations *ex ante* from *ex post* events has again crept into the discussion. At a particular point of time, when demand is rising, customers may be willing to accept delayed delivery because they believe demand will continue either to rise or to stay at the same level. Hence, they expect to sell all they have ordered on receipt of the goods ordered. But inevitably their expectations are confounded. Hence they will accumulate stocks in the same manner as before. So, although the system behaves as if there was deliberate attempt to smooth production by order backlogs, it arises as a result of different circumstances.

[32] This assumes that the risks of carrying stocks are not so great as to preclude any stockholding, or, that a firm produces different kinds of goods, some of which can be produced for stock in small quantities without undue risk.

[33] Mack, *op. cit.* p. 152.

TABLE 4

Response of Manufacturers to Changes in Their Sales When Giving Immediate Delivery†

Finished goods accelerator $a = 0.5$
Goods-in-process accelerator $b = 0.5$
Purchased materials accelerator $c = 1.2$

(1) Wholesaler Orders (Sales)	(2) Production for Sales	(3) Passive Investment in Finished Goods	(4) Active Investment in Finished Goods	(5) Investment in Goods-in-Process	(6) Passive Investment in Purchased Materials	(7) Active Investment in Purchased Materials	(8) Orders for Stock (5) + (7)	(9) Orders for Production (for sales and stock) (2) + (4)	(10) Total Orders (8) + (9)
O_w	P_s	I_{pf}	I_{af}	I_g	I_{pr}	I_{ar}	O_s	O_p	O_T
500	500	. .	0	0	0	0	0	500	500
542	500	− 42	0	0	0	0	0	500	500
626	542	− 84	+ 21	+ 21	− 42	+ 50	+ 71	563	634
738	626	−112	+ 42	+ 42	− 84	+101	+143	668	811
870	738	−132	+ 56	+ 56	−112	+134	+190	794	984
988	870	−118	+ 66	+ 66	−132	+158	+224	936	1,160
1,020*	988	− 32	+ 59	+ 59	−118	+142	+201	1,047	1,248
982	1,020	+ 38	+ 16	+ 16	− 32	+ 38	+ 54	1,036	1,090
860	982	+122	− 19	− 19	+ 38	− 46	− 65	963	898
686	860	+174	− 61	− 61	+122	−146	−207	799	592
484	686	+202	− 87	− 87	+174	−209	−296	599	303
350	484	−134	−101	−101	+202	−242	−343	383	40
316*	350	− 34	− 67	− 67	+134	−161	−228	283	55
366	316	− 50	− 17	− 17	+ 34	− 41	− 58	299	241
506	366	−140	+ 25	+ 25	− 50	+ 60	+ 85	391	476
692	506	−186	+ 70	+ 70	−140	+168	+238	576	814

* Signifies peak or trough. † Assumes orders are received as soon as they are placed.

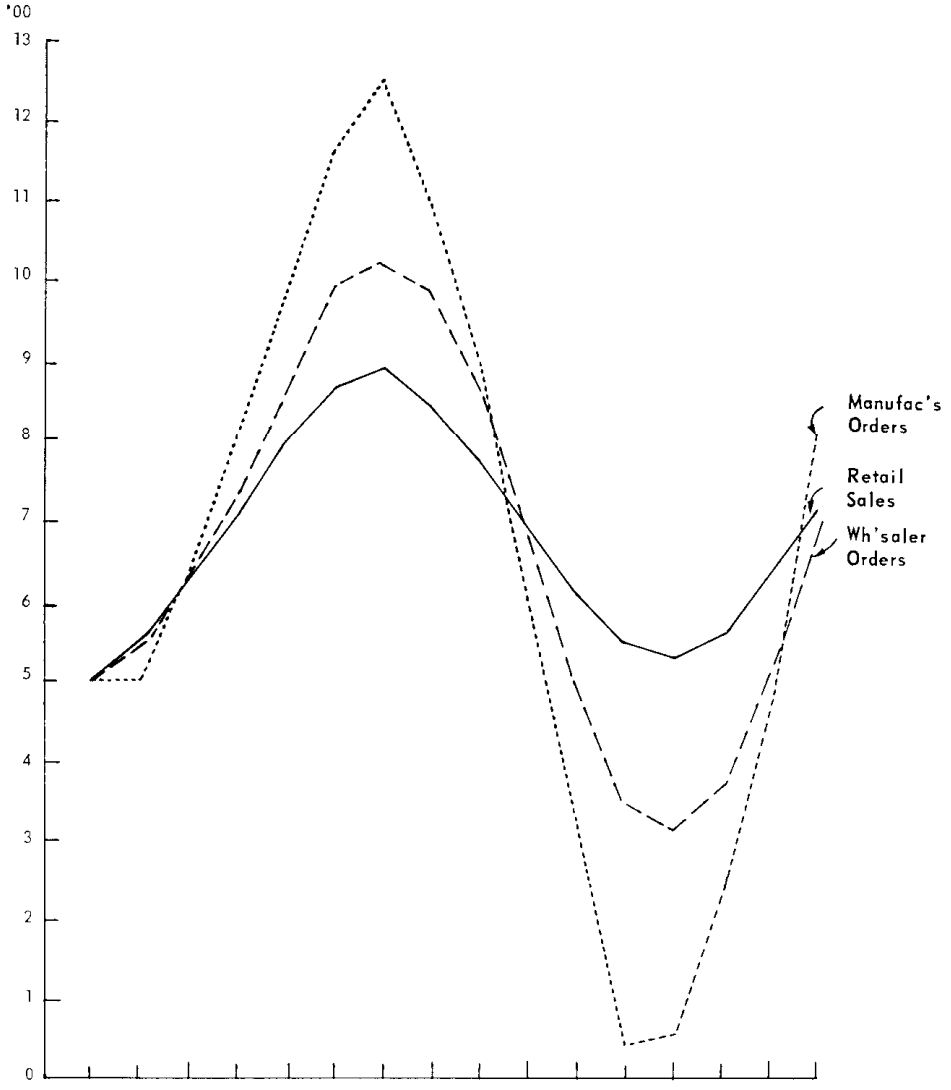
EQUATIONS:

$$P_{s(t)} = O_{w(t-1)}$$
$$I_{pf(t)} = P_{s(t)} - O_{w(t)}$$
$$I_{af(t)} = aI_{f(t-1)}$$
$$I_{g(t)} = b(P_{s(t)} - P_{s(t-1)})$$
$$I_{pr(t)} = P_{s(t)} - P_{s(t-1)}$$
$$I_{ar(t)} = cI_{r(t)}$$

For purposes of exposition, a model will now be drawn up where the rate of production is geared to the rate of demand—orders being delivered immediately. It is not possible to devise a realistic model with order backlogs. In this model, stocks of all types will be assumed to vary positively with sales. It must be remembered that this is again a somewhat extreme case. Nonetheless it is instructive to explore its implications.

FIGURE 5

Summary of Tables 1, 3, *and* 4



The results of this model, given in Table 4 and Figure 5, show a pronounced acceleration of derived demand from retailers' sales to manufacturers. The timing of turns coincides at the peak and leads one period at the troughs. Relaxation of the assumptions to include speculation, as was done with wholesale sales, would probably result in a synchronous timing at peaks and troughs in each activity.

So it can be seen that orders received by manufacturers will be greater or less than orders placed by them depending on whether the nature of the production process and of stocks dictates that production be to order or stock or to provide immediate delivery. In the former case there will be a damping of fluctuation; in the latter there will be an intensification. In both cases there will be approximately instantaneous demand transmission.

In the wool textile industry there are three manufacturing stages. The conditions of production in each will decide whether fluctuations in orders from above will emerge from the particular sector magnified or diminished. In terms of the original model some of the ΔS's will be positive; others may be negative. With a positive ΔS a sector will be buying more than it is selling; with a negative ΔS they will be selling more than they are buying.

(2) A SPECULATIVE MODEL

It now becomes necessary to consider whether such a model as as the previous one describes the actuality of demand transmission and its acceleration. In fact there is another model which will show the same timing and amplification characteristics as this mechanical model. The behaviour of this model is purely a result of speculation at each level in the production process. There are two kinds of speculative models possible—one which will be called a rational long term, the other irrational short term.

(*a*) *Rational Long Term Model.* To have a speculative movement there *must* be a stimulus. The stimulus must ultimately come from somewhere within the economy. This stimulus will have its effect through the fact that businessmen interpret it as an indicator of the future level of their customers' demand. Most likely, then, it will result from changes in the general level of activity as reflected in sensitive indicators which businessmen watch. Hence, as in the previous model, it is the underlying changes in general activity which must set off and uphold waves of over- and under-buying relative to selling.

It must be noted that this type of speculation is different from that delineated for wholesalers in the previous system. It is based not on the direction of past changes in their customers' demand and their projection into the future but on more general expectations as to future demand. Hence it cannot be represented by a model of the kind presented previously.

Synchronous timing will result from the fact that changes in sensitive indicators within the economy will be visible to all sectors at the same time. Since each watches these closely, the timing of turns will be similar at each stage.

Acceleration down the production chain will also be produced by this speculation, provided all sectors are participating. Since speculation implies that a manufacturer is buying more than he is selling (on an upturn), there will be positive inventory investment at each stage and so, as the original equation shows, there will be an acceleration of derived demand. The converse will apply in a downturn.

(*b*) *Irrational Short Term Model.* There is another kind of cyclical process which has its genesis in speculative activity. In some situations it is possible that expectations of speculators may become divorced from their link with consumer demand and become subject to short-term waves of bullish or bearish activity.[34] In this situation, expectations will be dominated by periods of over optimism followed by periods of pessimism. Further, a rise in the price of the commodity will be taken, and rightly so, as a sign that the price will rise further and so buying pressure will be intensified; conversely with a decline in prices.[35] Hence a short-term cycle may be generated from influences not closely connected with ultimate consumer demand but from psychological influences, intensified by participants (chiefly merchants) acting intelligently on a predictable continuity in the direction of a price change.

Taken by itself, however, this is a rather shaky model. It begs the question of causes of change in market expectations and, unless one invokes "nerves, hysteria and . . . digestions" of market participants to explain changes in expectations, the model has no logical foundation.

Be that as it may, it is still possible that waves of over optimism and pessimism do occur in relation to expectations based on consumer demand. For example, when consumer demand begins to rise, expectations may become more optimistic than the uptrend in consumer demand justifies. That is, producers are paying more for their raw materials than they can hope to recoup in their selling prices for the volume they are buying. Demand will then fall. But it may fall further than justified by the underlying trend of consumer demand, and expectations will be revised upwards, again over optimistically, and so the process continues. Nonetheless, expectations will always take into account changes in the direction of consumer demand, the broad trend in market prices following the trend in consumer demand. Hence it is possible that volatility in market expectations may superimpose a short-period cycle process on the longer period cycle in consumer demand.

In each situation there will be vertical acceleration of demand if all sectors participate in the movements.

The question remains as to whether such a process would be transmitted throughout all the sectors and cause simultaneous movements in each. Movements at higher stages would almost certainly be transmitted vertically and synchronously to lower stages. But there is also the possibility that speculative movements at lower stages could

[34] As Keynes has said, in relation to the stock market; "In estimating the prospects of investment, we must have regard, therefore, to the nerves and hysteria and even the digestions . . . of those upon whose spontaneous activity it largely depends"; see J. M. Keynes, *The General Theory of Employment, Interest and Money* (London: Macmillan and Co., 1936), p. 162. For further discussion, see Holbrook Working, "A Theory of Anticipatory Prices", *op. cit.*, p. 188 and "The Investigation of Economic Expectations", *American Economic Review, Papers & Proceedings*, Vol. 39 (1949), p. 158; also F. W. Taussig, "Is Market Price Determinate", *Quarterly Journal of Economics*, Vol., 42 (May, 1921), p. 396.

[35] On this point, Keynes maintains that stock market speculators devote their intelligence to "anticipating what average opinion expects average opinion to be", *op. cit.*, p. 156.

induce waves of buying at higher stages to protect against unfavourable movements in the price of purchased materials. It is difficult, however, to imagine any close relation existing between the turns in output of each sector as a result. Since the lower stage would be acting on more or less irrational expectations, it is not likely that these will be shared by all higher stages in a manner which could cause any conformity in behaviour between each stage. Even if raw material prices are rising, it does not mean that prices of finished goods (the purchased materials of the next stage) will rise. If the next stage believes that demand trends do not justify the current movement in prices they will choose not to buy and the movement will be transmitted no further. Considerations of this kind make it difficult to believe that "irrational" speculative moves could persist for very long, unless shared by higher stages. Participants would quickly find they were buying more than they could hope to sell relative to the buying price and so the buying movement would be curtailed.

(3) A SPECULO-MECHANICAL CYCLE

There is a further possibility that speculative activity may be induced at one of the higher stages of the process, which causes lower stages to react according to the mechanical models delineated previously. The system would move according as the stimulus to speculation, of either kind, waxed and waned.

SUMMARY OF SECTION 4

There have been postulated three mechanisms which could explain the genesis of a cyclical process:

(1) A *mechanical model*, led along by changes in retail sales and given impetus down the production chain by the need to keep stocks in positive relation to sales. The sequences of the production process move in step by means of the order mechanism.

(2) (a) A *long term speculative cycle* at all stages of the production sequence, initiated and curtailed by changing expectations resulting from changes in the general level of economic activity. Turning points are synchronous at each stage because the stimulus to change is apparent to all sectors simultaneously.

(b) A *short term speculative cycle* at all levels of the process resulting from:

(i) waves of "irrational" bearish and bullish activity;

(ii) overoptimism and overpessimism of expectations in responding to changes in consumer demand.

(3) A *speculo-mechanical process* resulting from expectational movements at one stage and accelerated at lower stages by the need to keep stocks positively related to sales. This model requires that orders produce instantaneous demand transmission.

PART II: THE DATA

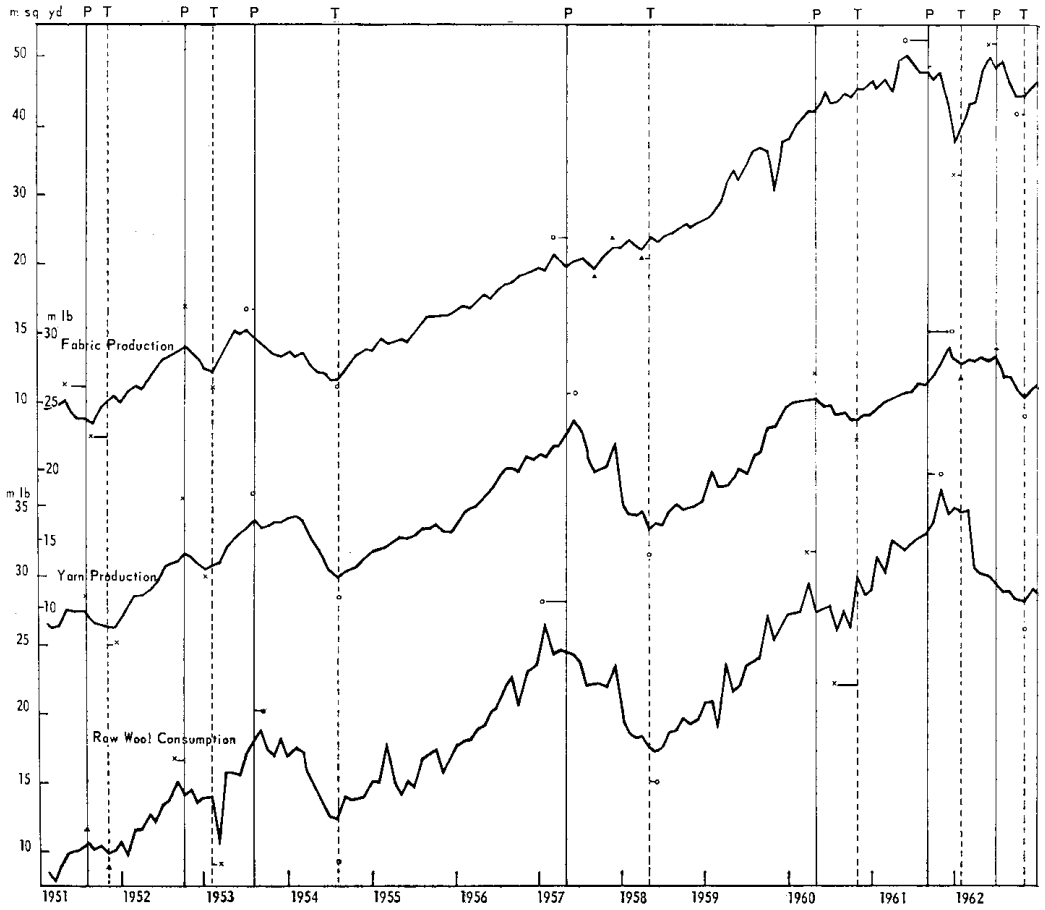
5. Characteristics of the Cycle

THE TIMING OF TURNS IN OUTPUT

In order to have a first look at the time sequence of demand transmission, deseasonalized production data[36] for the first three stages of the production process have been charted in Figure 6.

FIGURE 6

Activity in Topmaking, Spinning, and Weaving Sectors



As can be seen, the three activities have moved up and down at approximately the same time in accord with the hypothesis of Section 4. As a result, it has been possible to construct a reference frame of industry activity against which to measure the movement of other specific activities.[37] It is not, of course, necessary to have a reference

[36] A description of the method of deseasonalising time series data and the rules used in determining turning points are given in A. F. Burns and W. C. Mitchell, *Measuring Business Cycles*, (New York: National Bureau of Economic Research Inc., 1948), pp. 43-50 and Ch. 4.

[37] The peaks and troughs of the reference frame have been chosen at the point where the deviation of the turning points in each series from the reference turning point is lowest.

frame of the sort which has been possible here. However, it is extremely convenient, as well as having considerable significance since it concurs very closely with turning points in activity in each series. One could have arbitrary benchmarks from which to measure other activities or one could measure each activity according to each other activity. But as Burns and Mitchell have said, the latter procedure would be "as clumsy and wasteful as to express the exchange value of each commodity in terms of every other commodity".[38] The former would be equally inelegant.

The conformity of each series to the reference frame is shown in Table 5.

TABLE 5

Conformity Measures of Three Activities to the Reference Frame
Lead (−) Lag (+)

	Raw Wool Consumption*	Yarn Production	Fabric Production
Timing at peaks (months) ..	−0·3	+0·6	−1·3
Timing at troughs (months) ..	−0·2	0	−0·9
Average timing (months).. ..	−0·25	+0·3	−1·1
Percentage of months in unlike phase†.	14	5	20

* Raw wool consumption represents production of tops with a slight lead. This lead is not sufficient to affect the timing measures. Although top production is mainly undertaken in the same firms as yarn production, the two are not mechanically tied to each other since large and variable stocks of tops are maintained.

† This is derived by a tally of the number of months in which the series is expanding or contracting when the reference frame shows a general contraction or expansion, expressed as a percentage of the total number of months covered by the series.

This poses the problem of how is it possible for output at these stages to move synchronously. This problem has been assumed away in the previous model. Given the fact that a particular piece of wool takes from six to twelve months from the raw material stage to its sale to the ultimate consumer, one might presume, at first glance, that there would be an equal lag in the transmission of demand from the consumer to the raw material processor.[39] By the same token, movements at each stage would lag behind changes in sales to consumers successively by the time interval between the entry of the finished product of one sector into the sector above, to its delivery to a further stage in the process. Such would be the case where the production process could not be interrupted at any stage. An analogy is provided by an assembly line of a factory. An increase in final demand on such a line would require an increase in the rate of outflow of goods. This would necessitate an increase in the rate of inflow at the start of the line. Given a fixed speed of the line itself there will be a lag before the increased outflow eventuates, the lag being determined by the speed

[38] The question of the use of reference frame is discussed in Burns and Mitchell, *op. cit.*, pp. 66-76.

[39] A. M. Hermie, *Prices of Apparel Wool*, (United States Department of Agriculture Technical Bulletin, No. 1041), October, 1951.

of the line.[40] But, in a process where the production chain can be broken, there exists the possibility of holding reservoir stocks. *It is these stocks which are the key to the solution of the problem.* An increase in final demand can be met by drawing on stocks of finished goods until the production process can be geared to meet the increase in demand. The possibility of immediately increasing the rate of production is permitted by the existence of stocks of raw materials at each stage, particularly at the initial processing stage. The increased rate of output is achieved in the short-term by using excess capacity.[41] Since each stage holds large stocks, it is possible for each to meet variations in demand from the stage above, first by running down finished goods stocks, and then meeting the bulk of the increase in demand by increasing the rate of production. Each stage is able to increase its rate of production *simultaneously* with each other stage by virtue of the existence of raw material stocks. Hence the lag of registered production changes at any stage, behind changes in demand from the ultimate consumer, will only be as large as the length of the actual production process at any particular stage.[42] Conversely, in a downturn, stocks will increase first, but the brunt of the adjustment will be borne by decreasing the rate of production.

The speed of adjustment in output in response to changes in demand is permitted by the use of the order. In the words of Mack: "Changes in demand at one stage are transmitted via the order to all stages post haste, or, indeed, with the electric speed of the telephone circuit, rather than by the slow and irregular pace of sequential physical operations".[43]

Thus there has been established a synchronism in the vertical transmission of demand from the weaving stage to the consumption of raw wool. This is in agreement with the original hypothesis.

Duration of Cycles

In the twelve year period 1951-1962 there have been three major cycles in activity in the Japanese wool textile industry. The average period of these cycles was approximately four years (see Figure 6). Dates and durations are given in Table 6.

Table 6

Dates of Turning Points in Specific Cycles

Trough	Peak	Trough	Peak	Trough	Peak	Trough
February 1951* (29)	July 1953 (12)	July 1954 (33)	April 1957 (12)	April 1958 (40)	August 1961 (14)	October 1962

* Tentative.

( ) Length of phase in months.

[40] Given the speed of processing, the increase in production will only be possible by increasing the number of assembly lines.

[41] This implies either the utilisation of idle plant or the more intensive use of plant already in use, through working extra shifts.

[42] In either topmaking, spinning or weaving, the production process takes much less than one month.

[43] R. P. Mack, "Notes on Subcycles in Theory and Practice", *American Economic Review; Papers and Proceedings*, Vol. 47, (May, 1957), p. 161.

Periods of expansion in activity have averaged 34 months while periods of contraction have averaged 13 months. It is interesting to note the close similarity of the durations of each of the three major contractions.

In addition to these three major cycles there have been identified four additional movements of much shorter duration. In Figure 6 major cycle peaks and troughs are denoted by circles, shorter cycles by crosses and levelling off movements by triangles. These movements were registered as interruptions to the major cycles, either by a change in the direction of its movement or by a definite levelling off in the rate of change. These short movements, previously dismissed as random, were first recognised as having economic significance by Ruth Mack in her study of the shoe—leather—hide industry sequence.[44] These movements, called "sub-cycles", were later identified in general economic activity in the United States.[45] Details are presented in Table 7.

TABLE 7

Timing of Cyclical and Sub-Cyclical Turns in Activity

Trough	Peak	Trough
October, 1951 (11) ..	September, 1952 (4) ..	January, 1953.
January, 1953† (6).. ..	July, 1953* (12)	July, 1954†.
July, 1954† (33)	April, 1957* (12) ..	April, 1958†.
April, 1958† (24)	April, 1960 (6)	October, 1960.
October, 1960 (10) ..	August, 1961* (5) ..	January, 1962.
January, 1962† (5).. ..	June, 1962 (4)	October, 1962†.

* Cyclical peak.

† Cyclical trough.

( ) Length of phase.

The average of the expansion phase (paraphases) has been 15 months; the average of the contraction phases (counterphases) has been 7 months. The relatively short length of the contraction phase is typical.[46]

Having discovered that the cyclical process is shared synchronously by the first three stages of the production process and that the cycle has a certain average length, the task remains to find the causes for this cycle.

6. The Origin of the Stimulus

In Part I, a number of hypotheses were advanced to describe possible mechanisms which might explain the observed cycle. These were:

(a) a mechanical system derived from consumer demand;

(b) a long-term speculative process initiated by changes in general economic activity;

[44] Mack, "Consumption and Business Fluctuations", *op. cit.*, Ch. 4.

[45] Mack, "Notes on Subcycles in Theory and Practice", *op. cit.*, p. 161.

[46] *Ibid.*

(c) a short-term speculative sequence resulting from "irrational" or excessive expectations;

(d) a speculo-mechanical process akin to a (b) or (c) sequence imposed on an (a) system.

We now submit the implications of three of these models to the test of the data. At the outset it must be noted that the paucity of data from the fabric wholesalers upwards precludes a satisfactory answer to the problem.

(*a*) *A Mechanical System.* This model requires that retail sales or its proxy, consumer expenditures on clothing, trace out the same cyclical path as does the output series and that turns in the two series are either synchronous or show retail sales to lag the reference frame slightly.[47] For these purposes the data are far from satisfactory. Consumer expenditure is related only to clothing *in toto*; the construct for per caput clothing consumption (total) is rather artificial;[48] the series for retail sales of clothing (total) starts only in 1956 and is quarterly; and the department store sales of clothing (total) statistics show a strong upward trend (suggesting that they may reflect little more than the growth in the number of department stores). The series are charted in Figure 7.

The data fail to substantiate the hypothesis. All the series representative of consumer purchases of textile products fail to share many of the cycles in output; they have independent movements not shared by the output series; and the timing of matched turns fails to conform with the requirement of synchronosity, or a slight lag in consumer purchases. Thus the available evidence is inconsistent with the hypothesis of a mechanical relation between consumer sales and output of semi-processed goods down the production chain.

Other investigations have shown varying agreement with this hypothesis. Mack's study of the United States leather industry demonstrated a very close and consistent relation between consumer shoe purchases and the vertical output series.[49] Stanback showed that, in the United States, there was no agreement between fluctuations in total department store sales and mill consumption of cotton.[50] A similar lack of conformity between retail sales of clothing and mill consumption of apparel fibres is suggested by the research of Davis.[51] Hermie's findings in the U.S. wool textile industry were similar.[52] A Japanese study also indicates no conformity between consumer purchases of cotton textiles and cotton yarn production.[53]

[47] Due to a presumed decline in the rate of change of sales prior to the turn with a consequent decline in induced inventory investment and hence a decline in orders to lower stages.

[48] This series is made up of deflated consumer expenditure series of urban and rural sectors from household budget series reduced to a per caput basis and progressively weighted by the changing proportions of total income shares to each sector.

[49] R. P. Mack, "Consumption and Business Fluctuations", *op. cit.*

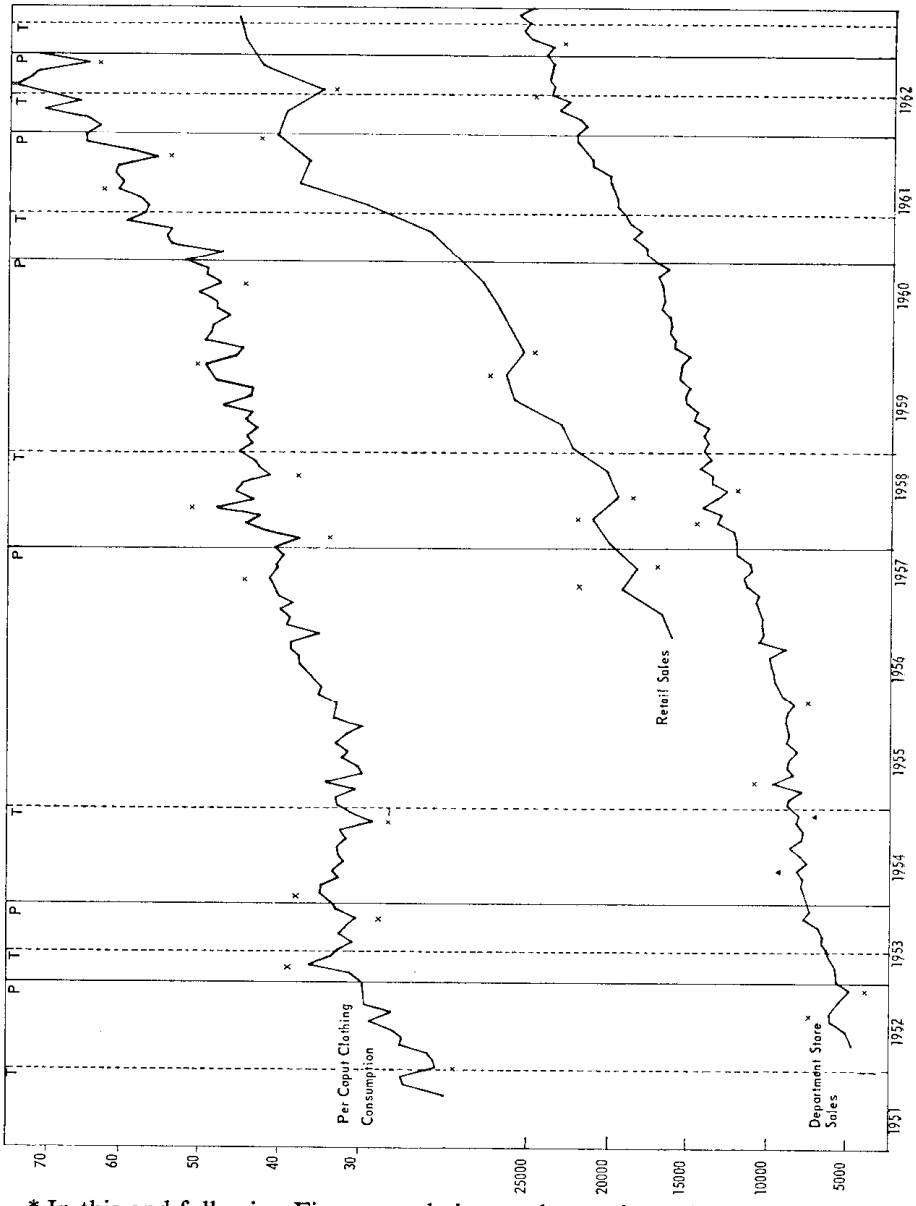
[50] Thomas Stanback, "The Textile Cycle; Characteristics and Contributing Factors", *Southern Economic Journal* (October, 1958), p. 181.

[51] T. J. Davis, "Cycles and Trends in Textiles", *U.S. Department of Commerce Business Defense Services Administration* (1958).

[52] A. H. Hermie, *op. cit.*

[53] Institute for Economic Research, Toyo Spinning Co. Ltd "Cotton Textile Cycles in Japan", *Toyobo Economic Series*, No. 4 (1962).

FIGURE 7
*Measures of Clothing Consumption**



* In this and following Figures, scale is not always given, the emphasis being on turning points rather than absolute values.

(*b*) *A Rational Long-term Speculative Process Related to General Economic Activity.* Since the available evidence fails to give support to the hypothesis of a mechanical model with its genesis in retail sales of clothing, attention must be turned to the alternative hypothesis, a speculative process. Previously it has been shown that the two models will produce the same effects. Hence it remains to investigate the factor or factors, if any, which set off expectations of changes in the direction of sales which sustain them during expansions and bear them down during contractions. These factors are the analogue of retail sales in the mechanical model.

The proximate cause of these changes in expectations must be some indicator or indicators of the direction and extent of future changes in economic activity which producers expect will cause changes in their sales through the resultant changes in consumer income. Ultimately the stimulus to expectations must of course come from exogenous factors which cause activity in some sectors to fluctuate and, with it, producer expectations in other sectors. But this leads on to things outside the scope of this study.

As a broad and incomplete guide to these factors, the measured peaks and troughs of general economic activity—the business cycle—have been taken. A comparison of these with two of the major peaks and troughs of the wool textile cycles exhibits only general agreement, as shown in Table 8.

TABLE 8

Dates of Turning Points in Business and Wool Textile Cycles

	Peak	Trough	Peak	Trough
Wool Textile Cycle ..	July, 1963..	July, 1954..	April, 1957	April, 1958
Business Cycle	Jan., 1954..	Sept., 1954	June, 1957	April, 1958

Source: National Bureau of Economic Research, 42*nd Annual Report* (1962), p. 6.

Since business cycles turning points, as measured, are the central tendency of a number of series with scattered turning points, some series will be still going in the same direction while others will have been in reverse for some time. Maybe it is to one of the earlier turners that the wool textile cycle responds.

For a more sensitive indicator, with a complete coverage, and one which might also explain the subcyclical changes, an index of gross industrial production has been charted in Figure 8.

As is readily apparent, the series fails to conform to what one would expect of an indicator which business watches closely and to which it responds after only a short delay. It lags the turns in the industry cycle and fails to show a definite movement at one cycle.

An examination of average stock prices, a typical leading indicator,[54] shows similar lack of general conformity.[55] This by no means exhausts the range of possible stimuli but, at this stage, it is possible to pursue the matter further.[56] The fact of the matter may be that businessmen

[54] G. H. Moore, "Leading and Confirming Indicators of General Business Changes", *Business Cycle Indicators*, Vol. I, (New York: Princeton University Press, 1961), p. 45.

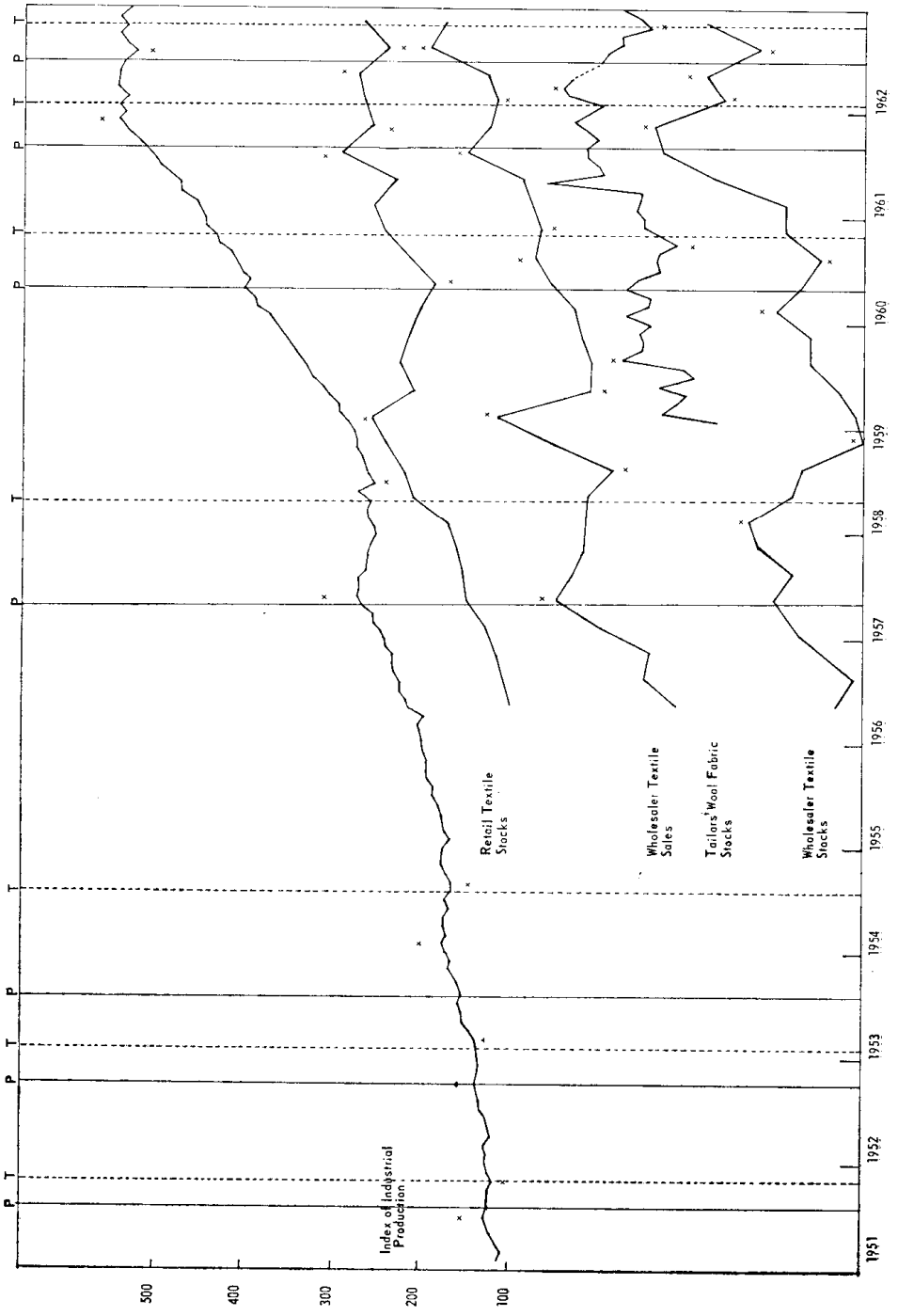
[55] These have not been charted because the series is broken and it is not possible to link the two indexes.

[56] It is interesting to note that in the United States the textile industry is the most volatile of all industries. It has shown the greatest number of cycles, having the greatest amplitude of any group but the heavy durables, despite the fact that the ultimate demand for textile products is not unduly sensitive to cyclical forces; see Stanback, *op. cit.*, pp. 182-183.

do not respond to any one stimulus but to different stimuli in different circumstances. So this very approach would be inapposite from the outset. If such was the case, it would be fruitless to pursue this tack further. Interviews with businessmen themselves would seem to be the only answer to this problem.

FIGURE 8

Indexes of Economic Activity



There is a further side to this issue. Prior to 1955, Japanese purchases were a relatively small proportion of the total as shown in the Table 9.

TABLE 9

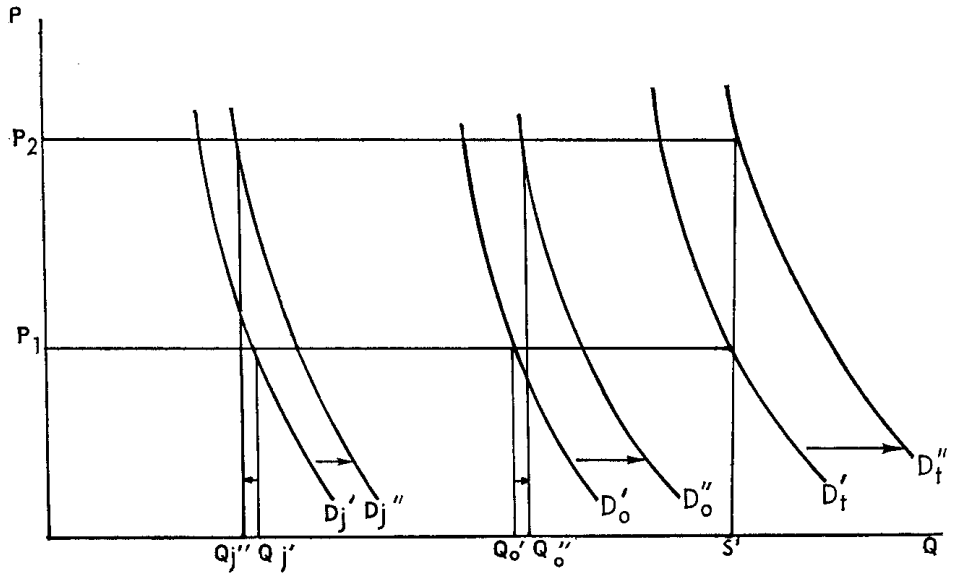
Percentage of Japanese Purchases to the Total Exports of Australian Wool

Year	Japanese Purchases, per cent of Total Australian Wool Exports	Order in Quantities Purchased
1950-51	7·6	5th
1951-52	11·7	4th
1952-53	15·0	3rd
1953-54	9·6	3rd
1954-55	13·0	3rd
1955-56	17·8	3rd
1956-57	19·3	2nd
1957-58	18·8	2nd
1958-59	23·0	2nd
1959-60	25·9	1st
1960-61	32·7	1st
1961-62	31·4	1st
1962-63	..	1st

It is possible that, in the early years covered in this study, that the downturns and upturns in Japanese activity were due to declines and increases in the quantity demand as the price became too high relative to the increase in demand in Japan, or low in relation to the decrease in demand. The situation would be as illustrated in Figure 9,

FIGURE 9

Relative Demand Shifts and Quantities Purchased



in which:

D_o' is the total "other" demand schedule in period 1;
D_o'' is the total "other" demand schedule in period 2;
D_j' is the Japanese demand schedule in period 1;
D_j'' is the Japanese demand schedule in period 2;
D_t' is the total demand schedule in period 1;
D_t'' is the total demand schedule in period 2;
S' is the rate of supply over period;
Q_o' is the quantity purchased by "others" in period 1;
Q_o'' is the quantity purchased by "others" in period 2;
Q_j' is the quantity purchased by Japan in period 1; and
Q_j'' is the quantity purchased by Japan in period 2.

However, from the 1957 peak onwards (with the exception of the 1958 trough), wool prices declined either previous to, or synchronous with, the change in activity. This, supported by the fact that yarn prices persistently lead the downturns in output, indicates that downturns and upturns since the 1957 peak were initiated by changes in the Japanese sector. Apparently the absolute movement in Japanese demand has been greater at these turns than any aggregate countervailing absolute movement in "other" countries.

(*c*) *An Irrational Short Term Speculative Process.* It is possible, as suggested in Section 4, that the sub-cycles in activity are caused by waves of speculative activity unrelated to consumer demand or by transient over-optimism and over-pessimism with respect to consumer demand.

It is not possible, at this stage, to fully explore this hypothesis.[57] Nonetheless, as a first step in this direction, a test for serial correlation in monthly first differences of the price of 64's Av. type wool was made over the period 1952-63. The test showed a non-significant correlation co-efficient.[58] This test excludes speculative activity causing some kinds of behaviour in time series but further tests are required to uncover the possible presence of other speculative influences. As Working says:

> "Because the kinds of structure commonly believed present in future prices and in stock prices are trends and cycles (in a somewhat loose usage of those terms), those kinds of structure were the first looked for as evidence of nonrandomness; and the statistical tests used were familiar ones that had been proved appropriate for revealing structure of those sorts in other data, namely, tests for the presence of simple autocorrelation. Failure of those tests to reveal an appreciable degree of structure in future prices, however, left open the question whether other sorts of structure might not be present."[59]

[57] For a discussion of the techniques and results from some studies in this area, see Holbrook Working, "New Concepts Concerning Futures Markets and Prices", *American Economic Review*, Vol. LII, No. 3 (June, 1962), pp. 431-460; also Working, "A Theory of Anticipatory Prices", *op. cit.*, pp. 188-189.

[58] For techniques and discussion of serial correlation see M. G. Kendall, "The Analyses of Economic Time Series—Part I: Prices", *Journal of the Royal Statistical Society, Series A (General)*, Vol. CXVI, Part 1 (1953), p. 11; also Gerhard Tintner, *Econometrics* (New York: Wiley and Sons, 1952), Ch. 10.

[59] Holbrook Working, "New Concepts Concerning Futures Markets and Prices", *op. cit.*, p. 447.

WHO RESPONDS FIRST?

Although we have failed to discern where the stimulus originates, it is useful to enquire which sector it is that first responds to the stimulus. To this end several series have been examined and superimposed onto Figure 8. Again, the attempt has been plagued by inadequacies in the data, both in representation and extent. For what they are worth, the series do not demonstrate any close relation between the fluctuations in output and activities of retailers in their stockholding or purchases from wholesalers or of wholesalers or tailors in their accumulation of inventories.[60] Wholesalers' textile stocks share all the turns of the output series but the timing—sometimes leading, sometimes lagging—is somewhat inconsistent with what would be expected of a group which was the cause of, or the effect of the same causes of, fluctuations in output. Still, the fact that it conforms in a broad fashion, that it is a quarterly series and thus one cannot derive the crucial investment patterns from it, warn against dismissing it too summarily. The inconsistent timing and unmatched movements in retail textile stocks and in retailers' purchases of textiles (as represented by the wholesaler textile sales) show that any relation between the two is not a firm one. This finding differs from that of Stanback in the United States who demonstrated a close relationship between fluctuations in textile activity and total department store inventories.[61] Tailors' stocks of wool fabrics show almost no conformity to the reference frame.

So the attempt to find the origin of the stimulus has been unsuccessful, as has the attempt to find the sector which responds first. The available data, albeit unsatisfactory, have not shown a relationship between retail sales of clothing and the output series and there has been found no agent that would generate a speculative process—the alternative hypothesis.

7. The Vertical Transmission of the Stimulus

Prior to discussing the vertical transmission of demand it is appropriate to consider again briefly the original models. The first feature of the mechanical model is that it postulates the order as the mechanism of demand transmission. The second is that it is net inventory investment which produces acceleration of derived demand, upwards or downwards. A third point is that acceleration can be produced either from the necessity of keeping stocks in some relation to production and/or sales, or from the desire to speculate on changes in demand.

Since the attempt to find the origin of the stimulus has been unsuccessful, it is convenient to assume, for the purposes of the following analysis, that the stimulus does take effect somewhere between fabric wholesalers and clothing wholesalers. The data will now be examined to see how this fluctuation is transmitted down through the rest of the production process, as regards both timing and amplitude acceleration.

TIMING

As was shown in Section 5 (Figure 6), the original stimulus is transmitted instantly down the production chain, by whatever mechanism, causing output to move up and down synchronously at each stage.

[60] Since three of the four series represent total textiles, any conclusions drawn here relate only to the relation between these and output. The wool component of the series may show quite different conformity, although this is doubtful.

[61] Stanback, *op. cit.*, p. 181.

AMPLITUDE

In order to see whether there was an amplitude acceleration of derived demand from the weaving to the topmaking stages, the amplitudes of the three activities have been measured,[62] and are shown in Table 10.

TABLE 10

Per Month Amplitude of Rise and Fall

Fabric production	1·35
Yarn production	1·58
Raw wool consumption	1·38

These results suggest that there has been an acceleration of demand from the weaving to the spinning stages but this has been muted at the topmaking stage. The figure for the topmaking stage, however, includes one non-conforming cycle. If this cycle is excluded from the calculations, the results show a progressive acceleration of demand transmission. A firmer conclusion must await further examination of the data.

First off, it must be stressed that it is not possible from an examination of the data to discern whether the acceleration of demand is the result of a need to keep stocks in relation to sales or whether it is mainly a result of speculative accumulation or decumulation of stocks in response to changing expectations. As there is a similar mechanism operating in both cases, the prime mover of each will cause inventory investment to rise and fall at all stages at about the same time. The mechanical accelerator operates through changes in inventory investment or disinvestment geared to changes and rates of change of the original stimulus, and is transmitted via orders. Since orders can be transmitted instantaneously throughout the production process, the stimulus to change derived from the primary stimulus will occur in each sector simultaneously. The speculative accelerator operates through expectations governed similarly by changes and rates of change in the primary stimulus; this stimulus will be apparent to all sectors at the same time either *per se* or through its induced effect on other stages of production, hence it will cause a reversal in inventory investment or disinvestment at all stages at the same time. A speculo-mechanical process will have the same timing and acceleration characteristics. Also, it must be remembered that, while inventory investment is positive (negative) at each stage under either process, there will be an acceleration of derived demand down the production chain when output is increasing (decreasing). As discussed earlier, provided there is no disinvestment in finished goods stocks, production will be required to increase when sales are increasing. While production is increasing, stocks of purchased material are being depleted. While stocks are being depleted, attempts

[62] Amplitudes are derived by expressing the sum of the three months centred on the peak and on preceding and following troughs of each phase as a percentage of the average value of the series during the phase; subtracting each trough value from that of the peak; dividing each value obtained by the number of months in the expansion and contraction phase respectively and summing the two. The final figure gives the per month amplitude rise and fall. See Burns and Mitchell, *op. cit.*, pp. 131-141.

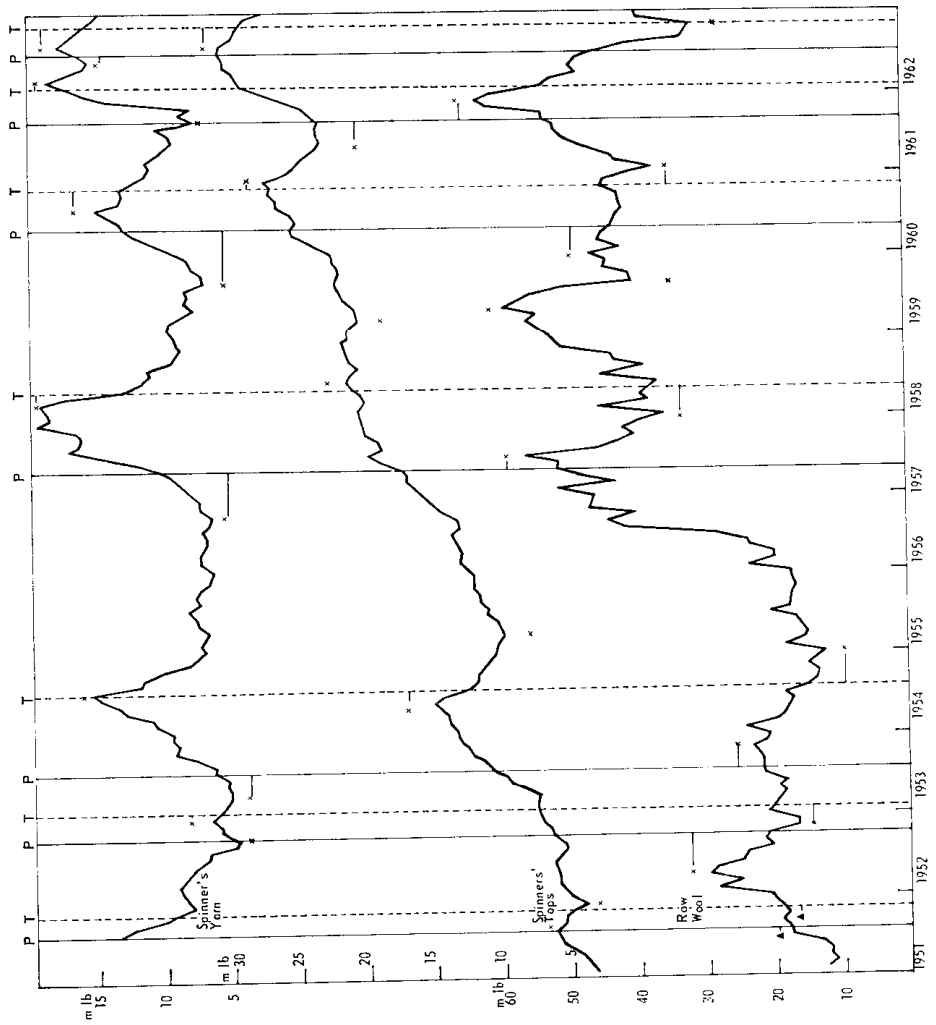
to increase inventories are being frustrated and hence orders will have to be increased so much more to achieve the required increase in stocks. This applies equally to both a mechanical and a speculative process.

The Behaviour of Stocks

As a first test of the original hypotheses of how stocks move in relation to sales, and of how they cause and dampen acceleration of demand at each stage, the data on stocks at each stage have been examined. Monthly deseasonalized data have been charted in Figures 10 and 11 and cyclical stock patterns[63] are shown in Figure 12.

FIGURE 10

Stocks of Yarn, Tops, and Wool



[63] Cyclical stock patterns are a kind of still photograph of the average value of stocks at certain points during each cycle. To derive them, the standing of each at troughs and peaks and at three equitemporal points during expansion and contraction phases is computed. The values are averaged for each cycle and they are plotted on a reference frame which is the average of the duration of expansion and contraction phases. See Burns and Mitchell, *op. cit.*

FIGURE 11

Stocks of Yarn and Fabrics

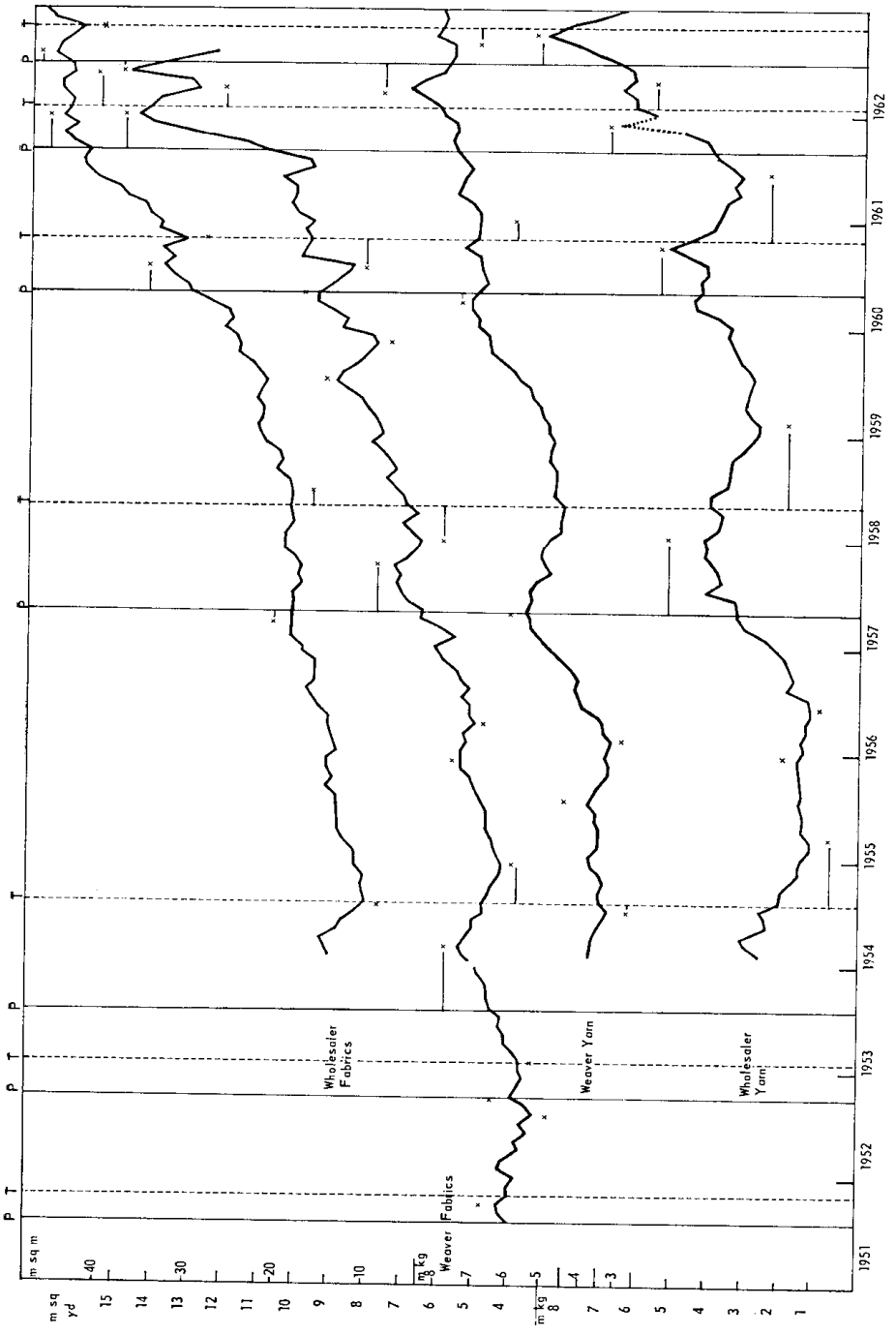
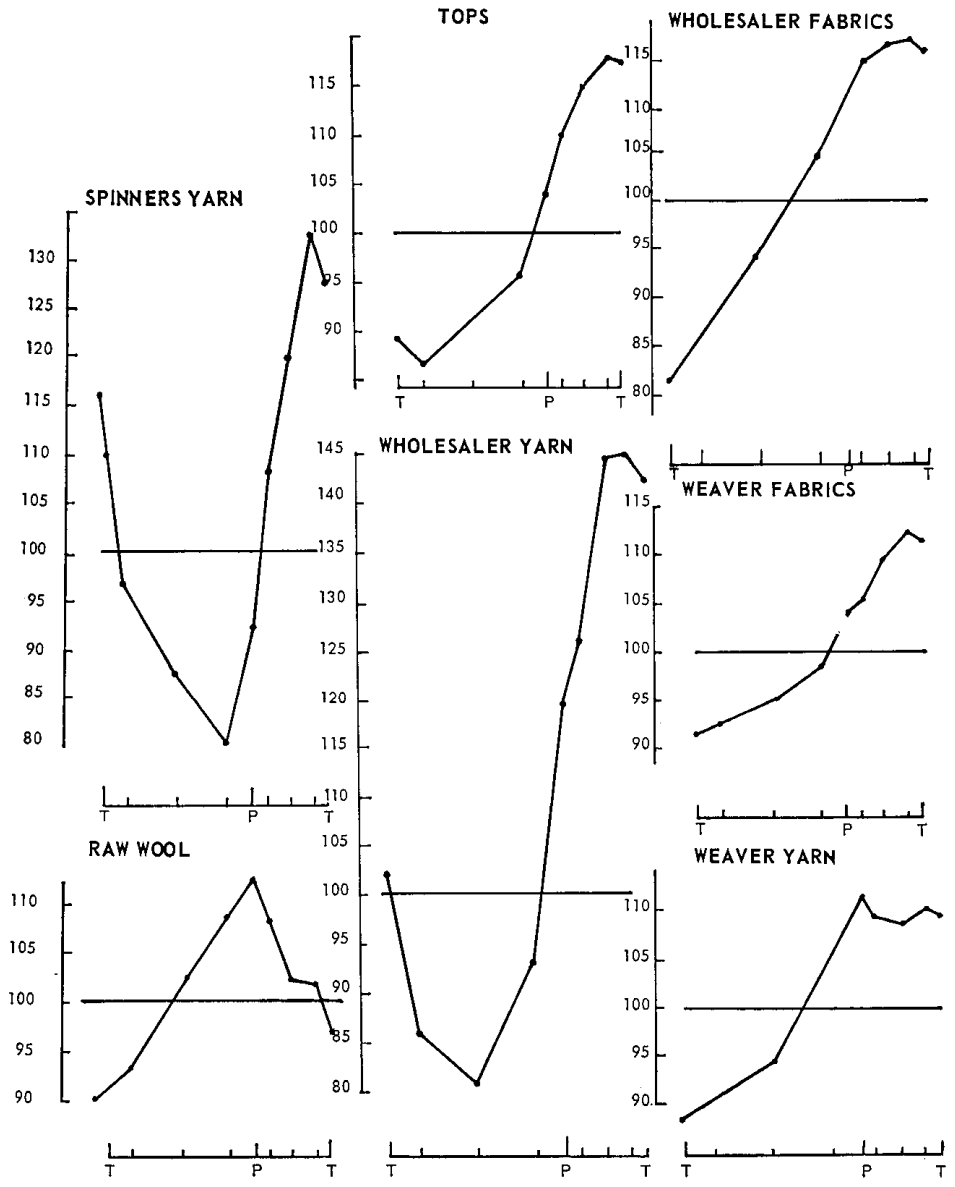


FIGURE 12

Cyclical Stock Patterns



The data are in general agreement with the hypotheses. Purchased material stocks of manufacturers—raw wool and weaver yarns—increase during expansions and decline contractions as was postulated. Wholesalers stocks of both yarn and fabrics also conform positively to increases and decreases in output, but with a strong lag.[64] Spinners' stocks of finished goods move inversely to the reference frame, demonstrating

[64] The reference patterns should be interpreted carefully in view of the method of their calculation. Since they are a percentage of the average value and their trend is rising, the last values will be relatively higher than the first values as measured by the actual data. Hence one must turn them in a clockwise direction to obtain a true picture of their relative standings. See *ibid*, pp. 160-176.

their purpose as buffer stocks to reduce the necessity of increasing production in response to changes in demand. The other finished goods series, weaver fabrics, shows no conformity to the reference frame when measured by cyclical patterns. However, the time series chart shows some tendency of a positive association with sales, suggesting that investment of purchased material stocks is reinforced by a parallel investment in finished goods stocks as a protection against being sold out for immediate delivery.[65] Stocks of tops which are a hybrid of goods-in-process, purchased materials and finished goods show no conformity when measured by reference patterns. Nonetheless, the time series show a strong inverted conformity at troughs and some conformity at peaks with a very long lead. Hence, for a large part of the cycle there is inverted conformity, indicating their function as a buffer to fluctuations in demand on a secular basis.[66] However, their amplitude of fluctuation is very small and hence their buffering effect must be quite low. Timing of each series is shown in Table 11.

TABLE 11

Average Timing of Stock Movements in Relation to the Reference Frame†
Lead (−) Lag (+)

	Peaks	Troughs
Wholesaler fabrics	+1·8	+1·2
Weaver fabrics	+2·5	−0·3
Weaver yarn	−1·3	−0·3
Wholesaler yarn	+4·8	+6·3
Spinners' yarn (inverted)*	−3·2	−1·3
Spinners' tops (inverted)	−14·0	−0·8
Raw wool	−0·5	0

* Peaks matched to troughs and vice versa.

† When considering the behaviour of stocks and of stock investment it must be remembered that *realised* stock movements will not often coincide with the increase in demand which brings these movements about. The presence of unfilled orders may cause stocks to accumulate for some time after the peak demand for them has passed. Delays in delivery due to strikes, transport bottlenecks, natural calamities, etc., will have the same effect. Similarly, imported materials, raw wool for example, will only register an increase in line with increased purchases after a lag sufficient for delivery to be effected in the buying country. Further, and most importantly, there is the factor of "unplanned" investment or disinvestment in stocks due to "planned" investment in stocks being inevitably out of line with changes in sales. As shown in the model of Table 1, this will cause disinvestment in stocks in early stages of a recovery when actual investment is required; it will also cause investment for a period after the peak when disinvestment is required.

[65] A distinction must again be made between two kinds of buffer stocks in finished goods. The first is a secular one to counteract the necessity of changing production and will move inversely to change in output. The second is a buffer against changes in demand in the short term and will vary positively with sales.

[66] It is interesting to note that at the higher stages of processing, weavers' stocks of fabrics are positively associated with sales, while at the lower stages spinners' stocks of yarn and tops show an inverse relation. The apparent reason is that fabrics are more subject to obsolescence (due to fashion changes) than are yarns and tops. Hence spinners can afford to produce for stocks while the weavers cannot.

These stock series permit some conclusions about why the acceleration of demand, as demonstrated in the amplitude data, behaves as it does. Since weavers accumulate stocks of purchased materials in times of rising sales, their receipts and, hence, their orders, must be greater than their production. Conversely with declining sales. Hence their orders to yarn wholesalers, in relation to the orders they have received from fabric wholesalers, are accelerated either positively or negatively, according as demand is rising or falling. Wholesalers stocks in turn move positively in relation to changes in sales, hence they must be ordering more than they are selling when sales are increasing and vice versa.[67] Thus weavers' orders are accelerated at the wholesaling stage. But at the spinning stage, buffer stocks of finished goods are held which move inversely to changes in sales. This must mute the acceleration of demand as it impinges on the output of yarn. However, this muting is not sufficient to cause yarn production to fluctuate less than fabric production. At the last processing stage, stocks of tops move inversely to output for some part of the cycle, and so exert a dampening effect on spinners demand as it affects the topmaking sector. Hence the reduced amplitude of wool consumption derived previously would seem to be correct.

Demand Transmission Through Inventory Investment

Although the previous discussion on stocks was suggestive of why each stage has approximately synchronous timing, the acid test resides in the investment data.[68] The time series and cyclical patterns are presented in Figures 13, 14, and 15.

It can be seen that it is only investment in purchased materials which is being considered. In the original model it was total investment that was discussed. However, for purposes of examining the causes of turning points, the purchased materials data are adequate in this study. It would be inappropriate should a decline in purchased materials investment near the peak be due to an increase in investment in finished goods. In such a case demand for inventory investment need not be declining at all—the contraction of one being offset by the expansion of the other. Similarly an upturn in purchased materials investment at troughs could be due to an intensified reduction in production. But, as discussed earlier, an increase in finished goods investment requires increases in production to be at an increasing rate and conversely. Since first differences in all the output series have almost invariably declined prior to the actual peaks, or increased prior to troughs, (data not shown) the decline in purchased materials investment must have registered a real decline in demand.

The investment patterns (Figure 15) show, in a broad way, the part that stocks of purchased materials play in the acceleration and transmission of the original stimulus. At each stage (including the wholesalers and excluding weavers) it shows a prevailing positive

[67] Since $I = R - S$, $R = S + I$; hence when sales are increasing $R > S$ and when sales are decreasing, $R < S$.

[68] The investment series is derived from first differences in stocks, smoothed by a five month moving average. It is appropriate to point out again that registered changes in stocks will lag variably behind the changes in demand which bring them about.

FIGURE 13

Inventory Investment

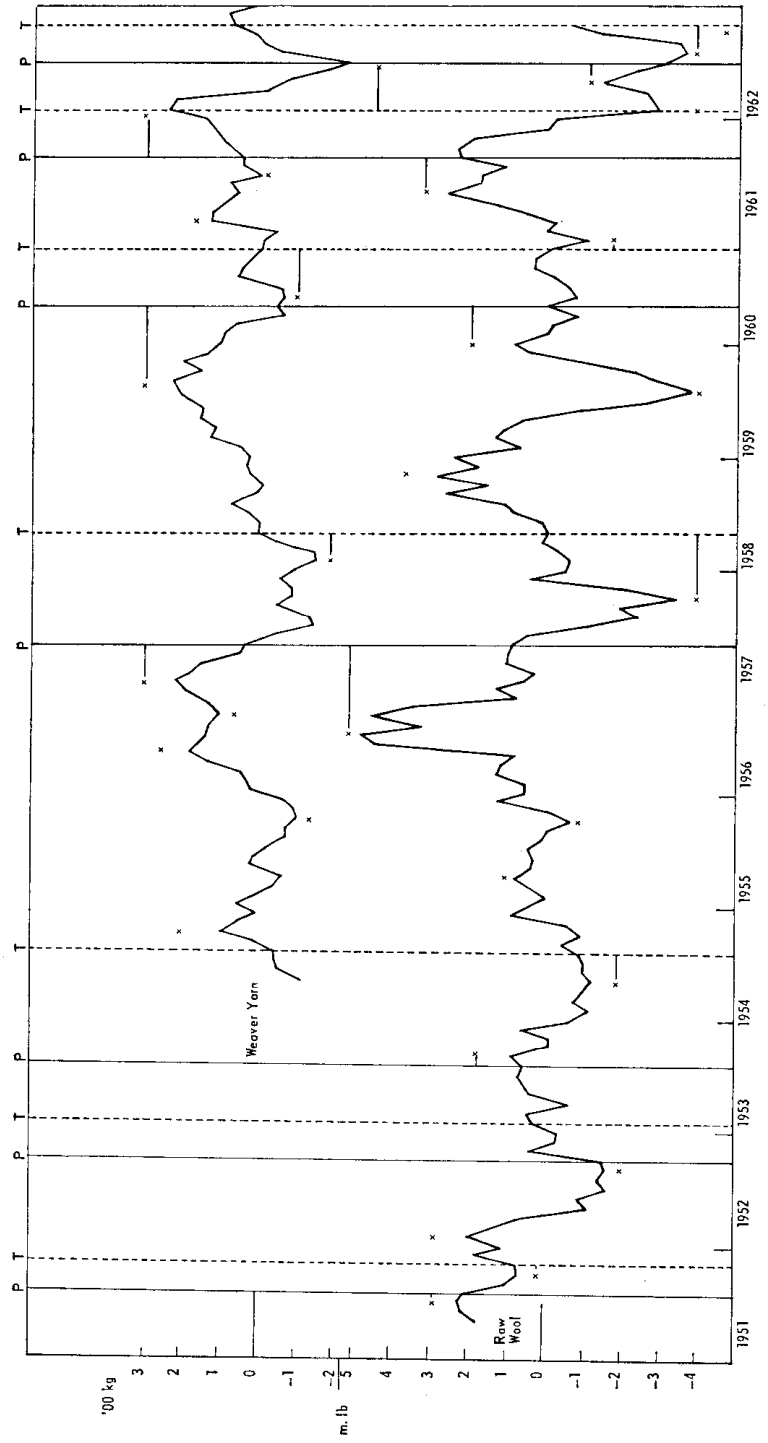
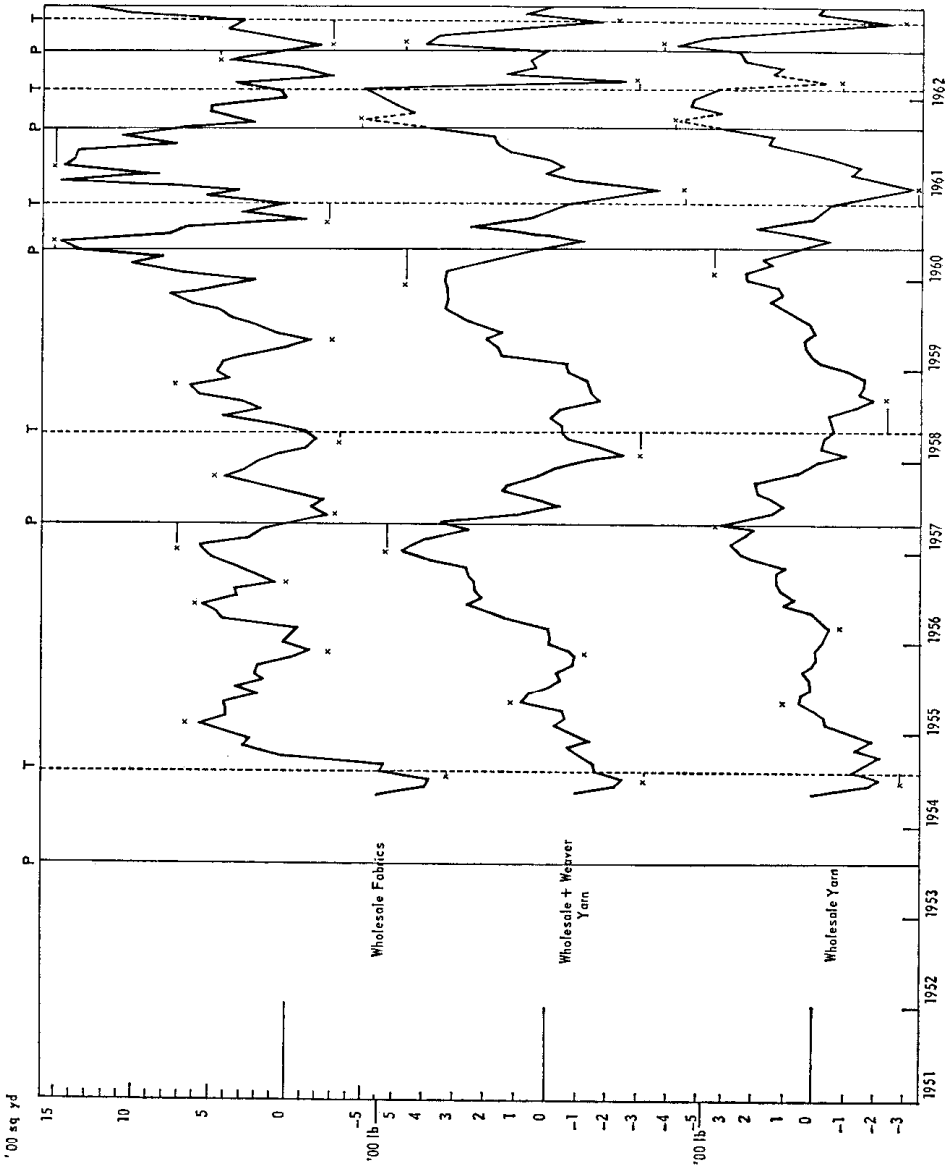


FIGURE 14

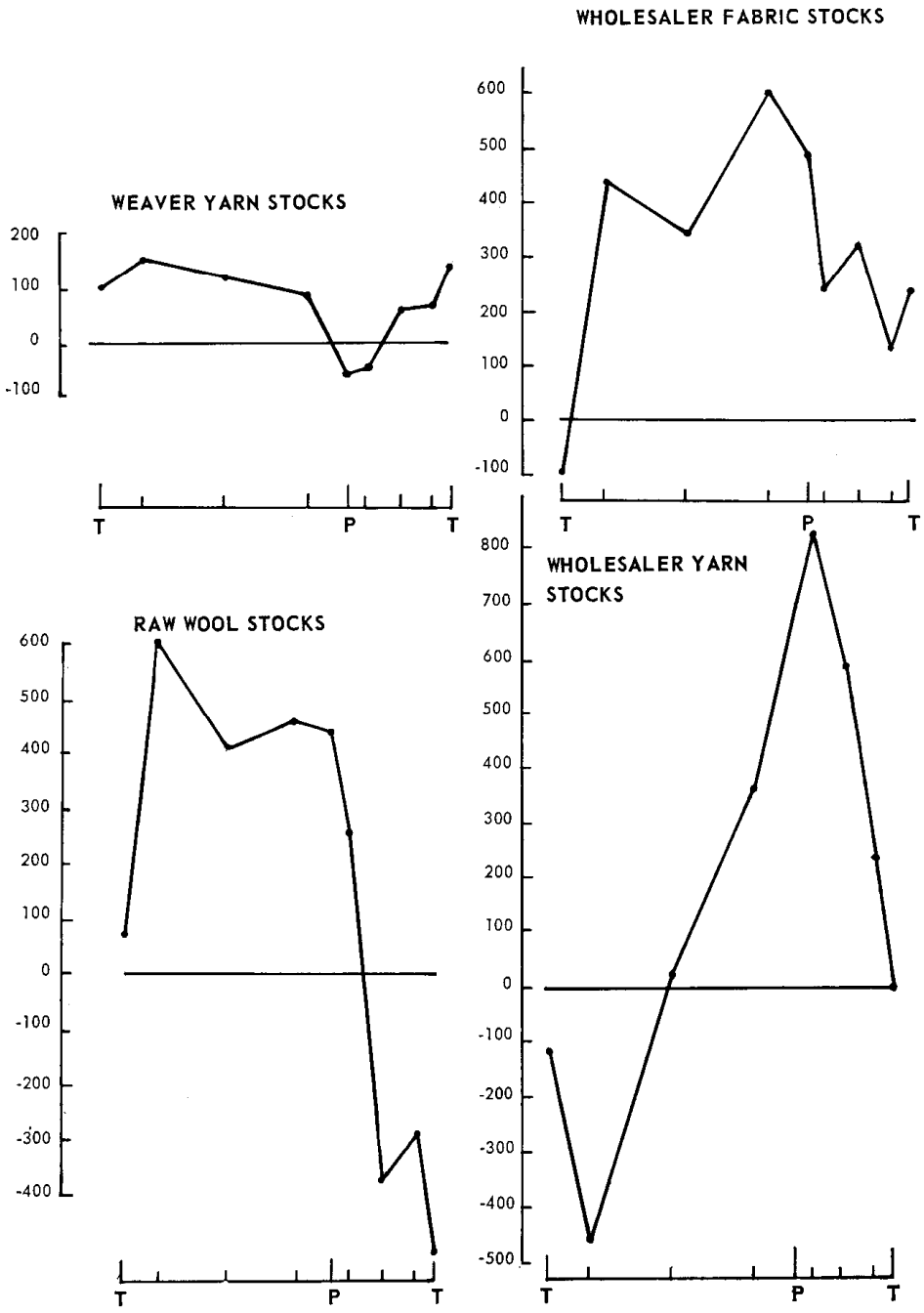
Inventory Investment



conformity with the reference frame, rising during expansions and falling during contractions. However, these investment patterns indicate only general tendencies since they are influenced in timing and magnitude by extreme values. It is to the time series that one must refer to deliberate accurately on the timing of increases and decreases in inventory investment and the consequent turns in output which they cause (Figures 13 and 14).

These series indicate the role of inventory investment in the transmission of the stimulus. At almost every peak and trough of each series of the reference frame, investment in stocks of purchased

FIGURE 15
Cyclical Investment Patterns



materials falls and rises either prior to, or at very nearly the same time as does output. These results show that it is the decline in the demand for inventories at each stage which causes the decline of output at each lower stage. Timing measures are given in Table 12.

Despite the high timing conformity, the presence of extra turns in the investment series which have not produced turns in output is disturbing. This is particularly so of the fabric wholesaler series. In

TABLE 12

The Investment Series Compared with the Reference Frame
Lead (−) Lag (+)

	Peak	Trough	Timing Peak and Trough
Wholesaler fabrics	−2·3	−0·5	−1·3
Weaver yarn	−2·3	−1·0	−1·7
Wholesaler yarn	−0·3	+1·2	+0·6
Wholesaler plus Weaver yarn ..	−1·5	−0·2	−0·8
Raw wool	−3·3	−2·2	−2·8

the other series there is only one extra turn, and this could easily be due to factors mentioned in the footnote 70. Perhaps these factors apply more strongly in the markets in which fabric wholesalers buy and sell. The investment series for raw wool also shows a low conformity to the reference frame. This lack of conformity is not unexpected. Delays in delivery due to the various factors mentioned earlier would account for some of the irregularity. There has been another more important factor operating during most of the period covered by this study, namely, import restrictions. Under this system, which operated for wool up to 1961, there was a twice yearly allocation of foreign exchange with which to purchase imports. This necessitated buying by Japanese manufacturers on credit supplied by buying firms in Australia and storing of purchased wool in Australia. Payment and actual shipment were effected when the necessary foreign exchange became available. A further factor which still results in disparities between quantities purchased and their entry into Japan is the fact that Japanese manufacturers buy types of wool that are in heavy supply at particular times of the year and keep them in store in Australia until they are ready for processing.[69] This period of shortage in Australia due to either or both of these factors may be up to six months. But, more fundamentally, it would be wrong from the beginning to expect stocks of raw wool, whose supply in the short run is quite inelastic, to conform to the movements in demand in one country. The economic problem is to allocate scarce resources to those who require them most. So, in a period of rising demand, wool will be channelled to those consumers whose demand is increasing most, absolutely. Since Japanese demand obviously will not have increased more than other consumers' at all times, the quantity purchased must decline over some periods, while demand for clothing is increasing. Although this slower increase in demand may not result in a decline in the quantity purchased by consumers, it may result in a decline in the quantity demanded for stock accumulation. So investment in stocks would cease while output was still increasing.

So there has been shown an amplitude acceleration of derived demand due to accumulation and decumulation of stocks of raw material at each stage in upturns and downturns. This has been damped, though

[69] Seasonal adjustment of the stock data may have removed this to some extent. But the periods of storage seem to be fairly irregular and hence will have an irregular seasonal pattern.

only to a degree, at the lowest stages of the process due to the holding of buffer stocks of finished goods. The timing of turns in the three output series has concurred fairly satisfactorily with the timing of turns in inventory investment at each stage.

FIGURE 16

Prices of Raw Wool, Yarn, and Serge

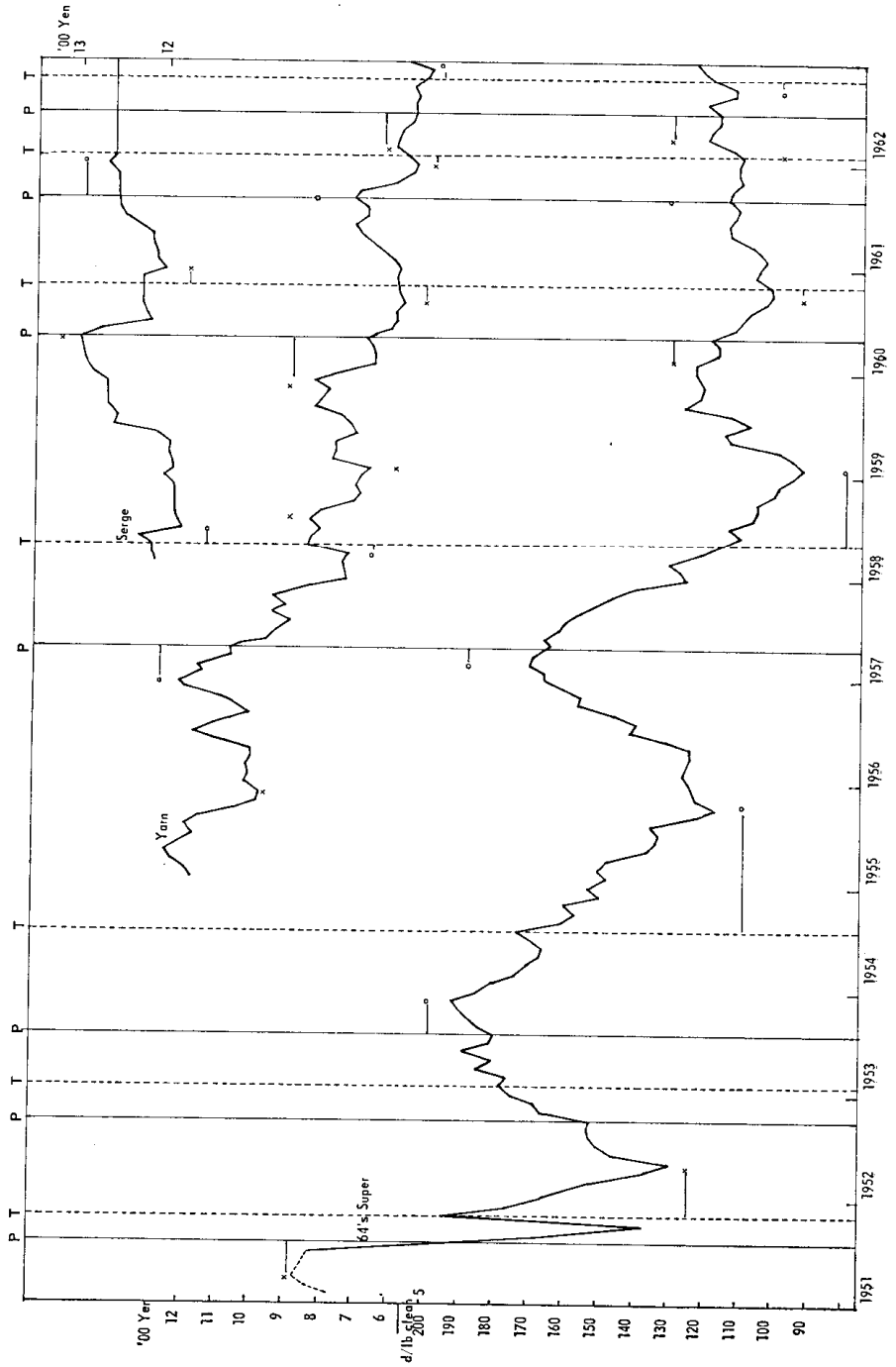


FIGURE 17

Yarn—Inventory Investment and Price

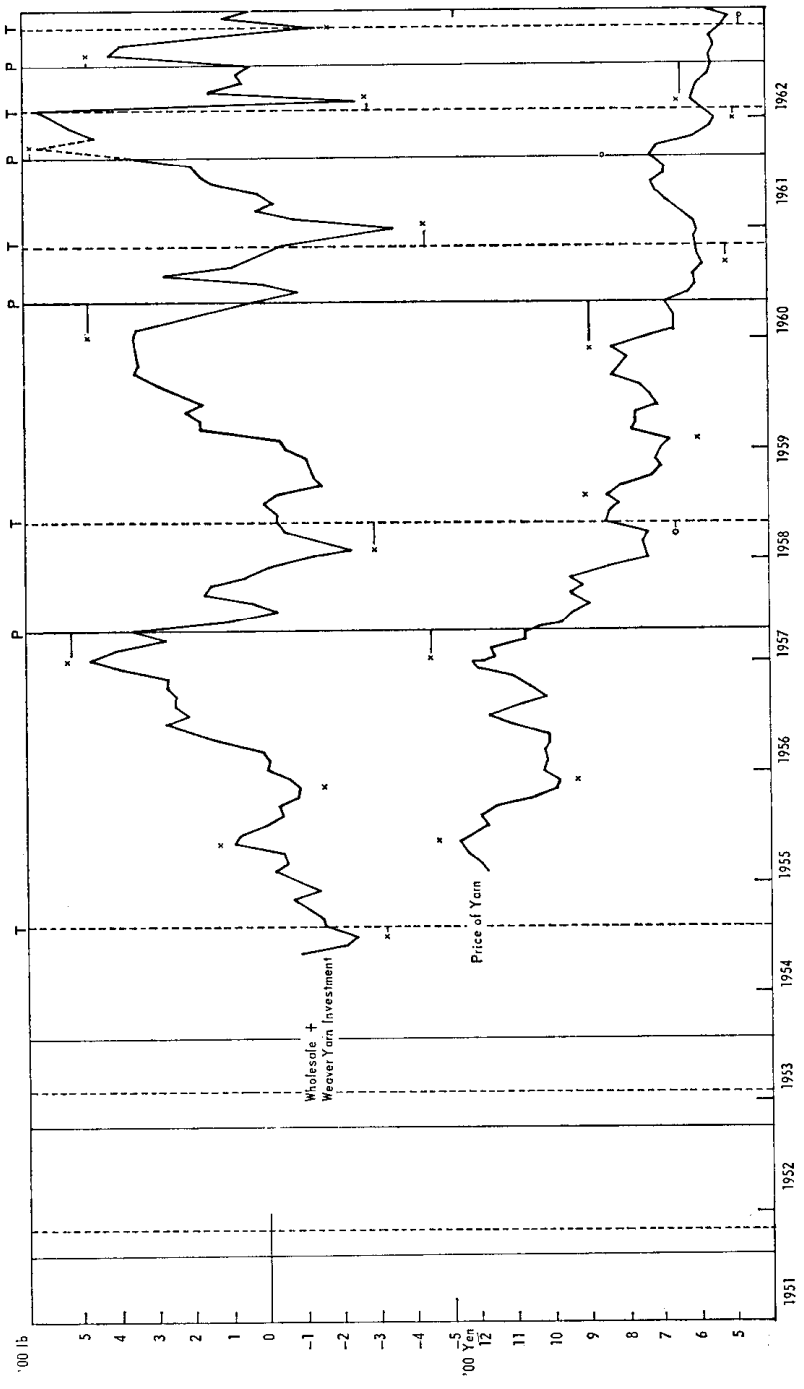
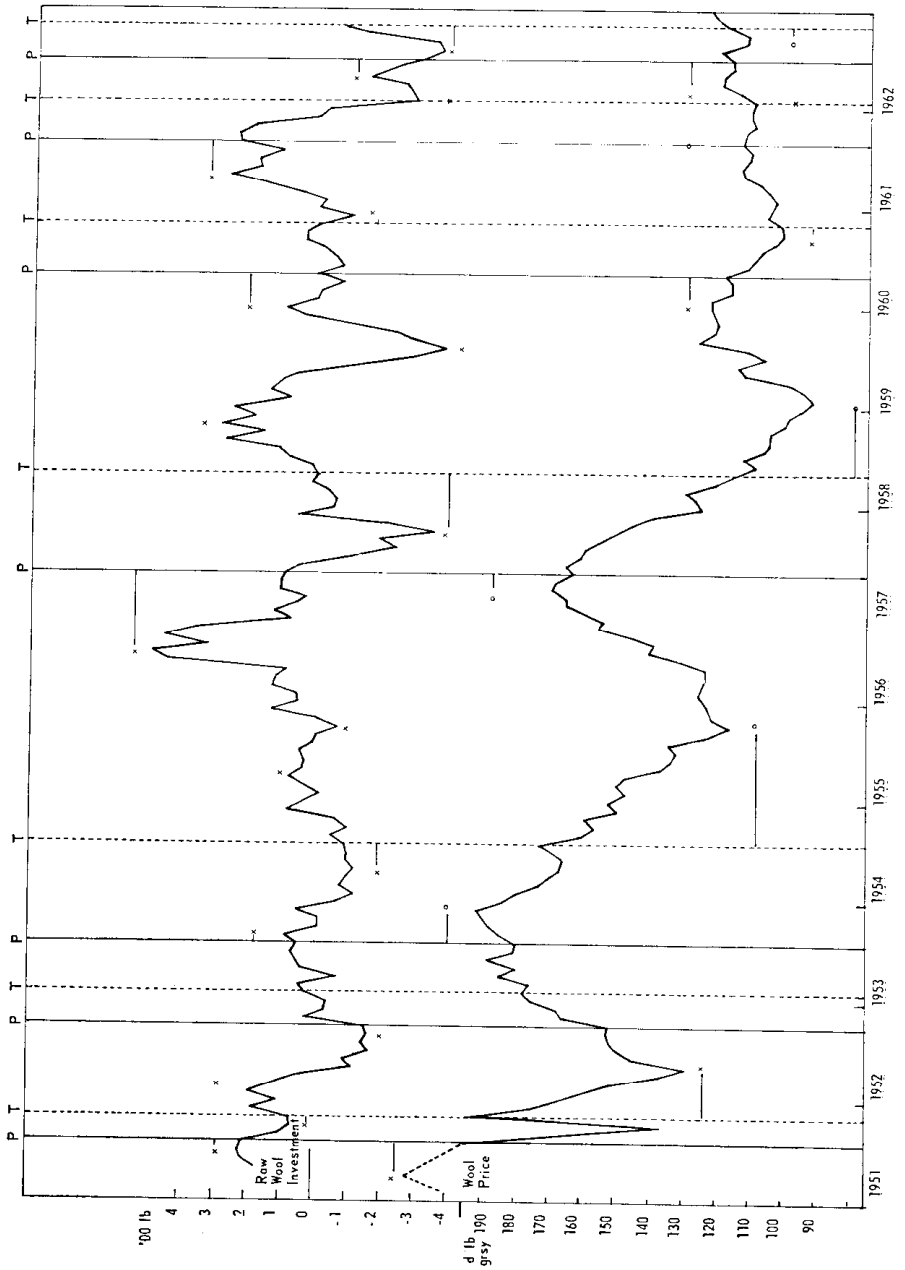


FIGURE 18

Price and Inventory Investment of Raw Wool



8. Prices

The relation of the three vertical price series to the reference frame can be seen broadly in Figure 16 where deseasonalized series have been charted. The average timing of each is given in Table 13.

TABLE 13

Timing of Turns in Prices in Relation to the Reference Frame (Months)
Lead (−) Lag (+)

	Peak	Trough
Raw wool	−1·3	+4·5
Yarn	−3·2	−0·8
Serge	+2·0	+2·0

YARN PRICES

The yarn series shares all the movements of the output series with a fairly consistent lead. This lead is also characteristic of the weaver-plus 1-wholesaler inventory investment series, shown in Figure 17. Hence can be seen the relation between changes in the demand for inventories as registered in the total inventory investment series and the changes in prices which they bring about.

There are a number of extra fluctuations in the yarn prices. But since the price series are based on quotations in the Nagoya Yarn Futures Market, which is given to highly volatile expectations, this is not unexpected.

WOOL PRICES

The raw wool price series shows a high degree of conformity to the reference frame at the peaks, with a slight lead. The conformity to the raw wool investment series, shown in Figure 18, is much less impressive than with the yarn series. Such irregularity between the two series is to be expected. As discussed in Section 7, realised investment in raw wool is subject to various delays and lags and hence it may have no firm relation to the actual changes in demand which causes it to respond ultimately.

Still, the fairly strong leads of the investment data before prices actually decline, especially when one considers the sometimes long delays in receipts after orders for them have been placed, is somewhat disturbing.

The hypothesis requires that the demand for stocks, as measured by inventory investment, should turn down at approximately the same time as do prices. There is a reasonable explanation for this. Should Japanese demand, just prior to the peak, be increasing less relative to that of other countries, then, given a constant rate of supply, Japanese purchases will decline. This situation has already been depicted in Figure 9. Then, after a short time, Japanese demand will begin to decline because the stimulus to demand has weakened. This will cause prices to decline if the leftward shift in the Japanese demand schedule is sufficient relative to the rightwards movement of the total "other" schedule.

Another apparently inconsistent result is the very long lag in prices after the two cyclical peaks. That is to say, prices are decreasing while Japanese demand is increasing, as measured by the consumption and

investment series. A possible explanation is that the increased consumption is a result of a *shift along* a stable demand curve as a result of lower prices than previously. But if it is true that turning points result from changing expectations in the long-term "rational" sense, then, by hypothesis, the demand schedule must be moving to the right. Yet prices are declining while speculative demand is apparently increasing. Is this possible? If speculation is defined rigidly as an arbitraging process in time, it isn't. Japanese speculative demand can be increasing as long as ultimate demand in Japan is increasing, provided most of the finished goods are sold at home, which they are, and that imports of wool goods are restricted. But, this increased demand need not result in a rise in prices while demand elsewhere is declining at a faster rate than Japanese demand is rising.

SERGE PRICES

The short series for serge prices shows fair conformity to the reference frame and to the wholesaler fabric investment series. However there is an inconsistency. The serge prices lag behind yarn prices by about four months.

The only explanation which can be offered for this discordancy with the theory is that serge prices are fixed—most probably by price leadership from a few large firms.[70] Under such conditions it would take a relatively large change in demand to cause a change in serge prices.[71] Slight fluctuations in demand would be ignored, letting quantity bear the adjustment.

Thus has been shown the expected fairly close agreement between prices at each sector and the reference frame due to the accumulation and decumulation of stocks at the stages above each sector.

SUMMARY

In the first section there were postulated two models of a cyclical process: one initiated by changes in retail sales, the other derived from expectations as to future sales. The transmission of the primary stimulus down to the lowest stage of the production process depended on the association between stocks and sales at each stage. When inventory investment was positively associated with changes in sales, the primary stimulus was amplified; when it was negatively associated with sales, the stimulus was damped. The conditions of production and the kind of product were shown to be the determinants of the direction of this stock-sales association. Turns in activity at each sector occurred simultaneously in the mechanical model because orders, the mechanism of demand transmission, passed instantaneously down the production chain, and hence turned for all sectors at the same time. In the speculative model, synchronous fluctuation at each stage was achieved either because the stimulus to inventory investment or disinvestment was apparent to all sectors simultaneously or because it

[70] This view is supported by the fact that absolute *changes* in yarn prices are much larger than those of serge prices. Under perfect competition, and given constant labour costs and technology, *changes* should be equal in each.

[71] It must also be noted that serge represents only a minor proportion of total fabric output and so relationship to the total will not be very definite.

was transmitted to lower stages via the order. It was the presence of stocks in each model which *permitted* this simultaneous change in the direction of output.

In the second section these hypotheses were tested. The cyclical process was shown to be characterised by major fluctuations of a fairly regular periodicity, interrupted by shorter movements. Turning points in the three vertical output series presented showed fairly close synchronism. The search for the primary stimulus to this cyclical activity was inconclusive. The data were at variance with a process initiated by consumer purchases of wool textiles. On turning to the alternative hypothesis, speculation, the quest for a stimulus was similarly unsuccessful, due perhaps to inadequacies of data or, more fundamentally, to the method of inquiry. A study of the part played by inventories in the transmission of the stimulus, whatever it may be, at the final three stages yielded satisfactory results. Stocks of purchased materials were shown to vary positively with the direction of output change, tending to amplify the transmission of demand. This was damped, although only partially, at the yarn spinning stage by inverse movements in buffer stocks of finished goods. At the topmaking stage an actual muting occurred. The inventory investment data on purchased materials at each stage demonstrated very satisfactorily the role of turns in inventory investment in causing turns in output or demand at stages below. The prices series conformed reasonably closely to fluctuations in demand as measured by inventory investment.

APPENDIX

Sources of Data

Index of Industrial Production (1951-62), E.S.J.
Consumer Clothing Expenditure (1952-62), E.S.J.
Department Store Sales of Clothing (1952-62), E.S.J.
Retail Textile Stocks & Sales (1956-62), E.S.J.
Tailors Stocks of Fabrics (1959-62), S.D.W.I.J.
Wholesale Textile Stocks & Sales (1956-62), E.S.J. and S.D.B.J.
Dyers Deliveries of Fabrics (1959-62), S.D.W.I.J.
Dyers Stocks of Fabrics (1959-62), S.D.W.I.J.
Wholesalers Stocks of Fabrics (1954-62), A.S.W.I.J.
Weavers Deliveries of Fabrics (1959-62), S.D.W.I.J.
Weavers Stocks of Fabrics (1952-62), E.S.J. and S.D.B.J.
Production of Fabrics (1951-62), E.S.J. and S.D.B.J.
Wholesalers Stock of Yarn (1954-62), A.S.W.I.J.
Spinners Deliveries of Yarn (1959-62), S.D.W.I.J.
Spinners Stocks of Yarn (1952-62), E.S.J. and S.D.B.J.
Production of Yarn (1951-62), E.S.J. and S.D.B.J.
Stocks of Tops (1951-62), A.G.T.C.
Consumption of Raw Wool (1951-62), A.G.T.C.
Stocks of Raw Wool (1951-62), A.G.T.C.
Prices of Serge (1958-62), S.D.W.I.J.
Prices of Yarn (1955-62), S.D.W.I.J.
Prices of Wool (1951-62), A.W.B.

Abbreviations are as follows:

E.S.J.—*Economic Statistics of Japan*, Statistics Department, Bank of Japan (annual).

S.D.W.I.J.—*Statistical Data on the Wool Industry in Japan*, (Japan Wool Spinners' Association).

A.S.W.I.J.—*Annual Statistics of Wool Industry in Japan*, (Japan Wool Industrial Association).

A.G.T.C.—Australian Government Trade Commission, Tokyo.

A.W.B.—Australian Wool Board, Wool Statistical Service.