Interrelations Between the Sales, Prices, Production and Inventory Behaviour of Firms

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I.

This is the first report on a study of the interrelated sales, production, pricing and inventory decisions of industrial firms, concentrating on price inflexibility, with respect to its extent, and influences bearing on its manifestation.

The question has interested industrial organization scholars over a long period but has recenlty attracted the attention of both micro and macro theorists. Price inflexibility is not considered to fit comfortably into traditional accounts of competitive enterprise, and with our abysmal failure to come up with any sharp results bearing on the behaviour of competitive firms, it is attractive to see whether this area will provide more discriminating tests. For macro economics, with most accepted doctrine under strain in practice, if not in theory, studies of the supposed (relatively) inflexible prices of products of categories of firms might conceivably enable progress to be made on the vexed issue as to whether aggregate monetary flows are more likely to result in output or in price increases.[1/]

For these reasons, which have only come into sharp focus in recent years, and for others, the question has been of theoretical interest to the writer for some time. The absence in any country, as far as is known, of any directly coordinated data prompted the initiation of this study of Australian firms in 1977.

In the next section we shall review arguments on why pricing in competitive enterprise may prove to be fairly inflexible, many of these arguments being derived from the work of others, some having a stronger personal input. While basic theories are merely sketched, an effort is made to spell out the implications that should be capable of refutation, at least in principle.

In the second section we set out the characteristic features of our empirical study, provide some contrast with other approaches, and present results which bear upon some of the central theories referred to.

Finally, we outline some further tests our data collection may be capable of confronting as the work progresses and raise the issue of the directions in which future tests might be developed, given that direct approaches to firms prove very costly both in time and in money.

II.

Theories of Price Inflexibility

Pricing in manufacturing industry was an issue that attracted many of the leading economists in the thirties, and indeed until the fifties when interest seemed to be transferred elsewhere. The celebrated cost controversy[2] was followed by the elaboration of the marginal revenue curve and the books on monopolistic competition by Chamberlin and Robinson.[3] Sweezy and Hall and Hitch[4], via their versions of kinked demand curves, drew attention to a rigidity of pricing in manufacturing, an emphasis that was paralleled by Gardiner Means' empirical study[5] which indicated considerable price rigidity in branches of the manufacturing industry over time. On the cost side, Albert Hart and George Stigler[6] had stressed the attractions of flexible production planning for firms operating under certainty or uncertainty, these to some extent inducing a preference for more shallow trough or flat-bottomed (average) cost curves over steep trough curves where the saving in cost was only moderate. The possibility of production becoming set so as to take advantage of such a limited range for low average costs was considered poor.

Andrews, a keen Marshallian scholar, presented his own theory premised upon a close scrutiny of the British shoe industry[7], but it was the efforts of his former pupils, Farrell and Brunner[8], that drew the attention of the profession to his work through more rigorous presentations. To my mind, Farrell gave the best acceptable version of a kinked demand curve set-up when he postulated that around the ruling price entrepreneurs would foresee that proceeding in isolation, a price rise, unwarranted by cost considerations, would cause major loss in custom over time, even though only minor immediately. The reason for this was that manufacturers mainly sold to a limited range of intermediaries who, with repeated dealing, would remember adversely any attempt

by manufacturers to exploit the market, a central Andrews argument. The long-run demand curve for a manufacturer would hence be perfectly elastic. As Sir Dennis Robertson stressed, such a theory does nothing to explain why price gets set where it is.[9] Here I believe the theories of Modigliani and Sylos-Labini[10] concerning difficulties of entry can be brought to bear to determine equilibrium profit margins. In these theories, the cost side was left relatively unexplored, a horizontal cost curve being often invoked. But it is comparatively easy to link on the Hart-Stigler flexible production planning preference for flat-bottomed cost curves. Indeed, one could go further and emphasize that for firms that expected to grow, there would be anticipation of favourable cost side developments of an external economies nature as other industries developed inputs on favourable terms which facilitated the holding down of costs in the originating product firms with their growing demands. This stress on external economies as the principal form of increasing returns derives from Allyn Young[11] and has always seemed to me compelling. Such an extended analysis then stresses the need for retention of goodwill amongst intermediary buyers on the one hand, and the potential for cost control, and indeed longer-term cost reduction via Stigler, Hart and Young on the other hand. With such a high payoff from orderly expansion, I have argued that firms, for whom inventory holding, as judged by the shapes of the relevant marginal curves, is not costly, may elect to use stocks to counter intrusion into the higher cost ranges in production.[12] Such views have also been expressed by Alchian and by Telser[13]; indeed, the latter has set out in detail the relevant conditions under which this would be an appealing strategy. Neither make a point that seems fundamental. Producers will, for the reasons given, see good cause why they should completely dominate the marketing of their product. To leave such activity in the hands of separately motivated specialists is to run the risk of shorter-term considerations permitting perverse pricing policies.[14]

It seems to me straightforward to argue that views such as these are reasonably consistent with those of Marshall in Book V of the Principles[15/] and that his stress on what Samuelson[16/] has called the Marshallian stability condition both for products, and for factors (in Book VI) can be rationalized in this way. Earlier I had used the same argument to try and rationalize Reddaway's stress on the clearance of labour markets through quantity, not wage rate movements.[17/] The Marshallian stability argument was reinforced by a reading of Leijonhufvud.[18/] Historically, this point may be of interest, for I believe that emanating from Marshall, there was a strong oral tradition in Cambridge in the twenties, and after, that emphasized the role of quantity adjustments and that this influenced Keynes' thinking in significant ways.

To my mind, one of the most important insights of Alchian was to show that price stability is entirely consistent with fully competitive behaviour, though most of the other papers in the same collection seem to find it necessary to rely on some form of monopolistic competition.

A suitable combination of these elements leads to my MARK I model, which was indeed the one I had in mind when funds were sought for the empirical study.

This model emphasizes that price inflexibility over time could occur in the face of erratic sales provided that such fluctuations masked an underlying growth trend. Firms would be observed to run down stocks when demands were unduly high and accumulate them when demands were unduly low, and production would adjust, but more slowly than sales. Implications for inventory-sales ratios we consider later.

This is a good moment to make two important points. The terms 'price stability' and 'inflexibility' are often used interchangeably. The basic reference is presumably to inflexibility, there being a notion that under competitive conditions of shifting supply and demand, prices should move freely over a wide range, each position being stable for given supply and demand conditions. Means is stressing that they do not. In this sense, they are deemed inflexible. But the term stable, or alternatively rigid, has caught on and perforce we shall follow custom though economists usually reserve the term 'stable' for a more precise interpretation.+ Hicks has introduced yet a different term of reference, fix-price as opposed to flex price, and this at least has the merit of keeping definitions under tighter control.

Study of fix-price models has commanded increasing attention thanks to Hicks' work [19], but some qualifications he has made have often been cast aside. This has led to what I choose to dub the Cronkite view -- that's the way it is -- whereby price fixity is stipulated without any consideration at all of the means by which that result is achieved. Price fixity will not occur without a conscious act and subsequent policing. Either queues will form where the price is relatively low, or stocks will be unloaded to prevent this demand from going unsatisfied. A number of the recent highly mathematical models seem to want to have price fixity without introducing the essential adjustments required to ensure it. The Eastern Europeans know well that the posting of prices will not give assurance of supplies, but economists who hold the Cronkite view have still to appreciate this.

+ Though it may be remarked that for Marshall, external economies are consistent with market price stability, whereas for Walras they are not -- a point we have drawn upon.

An alternative explanation of price stability is a direct extension of an analysis already used to explain the patterns of reward for skill over time.[20/] To fix ideas, we must assume that a consumer, or firm, is interested in obtaining certain types of services from goods. There is more than one good, capable of supplying these, and the "productivity" as well as the prices of the goods may differ. How may a choice be made? We use a simple "characteristics" approach.[21/] Let Z_1 be the characteristic, say, bath-cleaning, and X_1 and X_2 the two goods (cleansers). The prices of the goods are p_1 and p_2 respectively. The (user) technologies are of the simple Leontief fixed coefficient variety, time being necessary to obtain the characteristics desired. We assume that there is the same time commitment throughout, regardless of good selected. This is an unnecessary simplification, but serves to highlight the central issue.

$$X_1 = b_1 Z_1 \qquad T_1 = t_1 Z_1$$

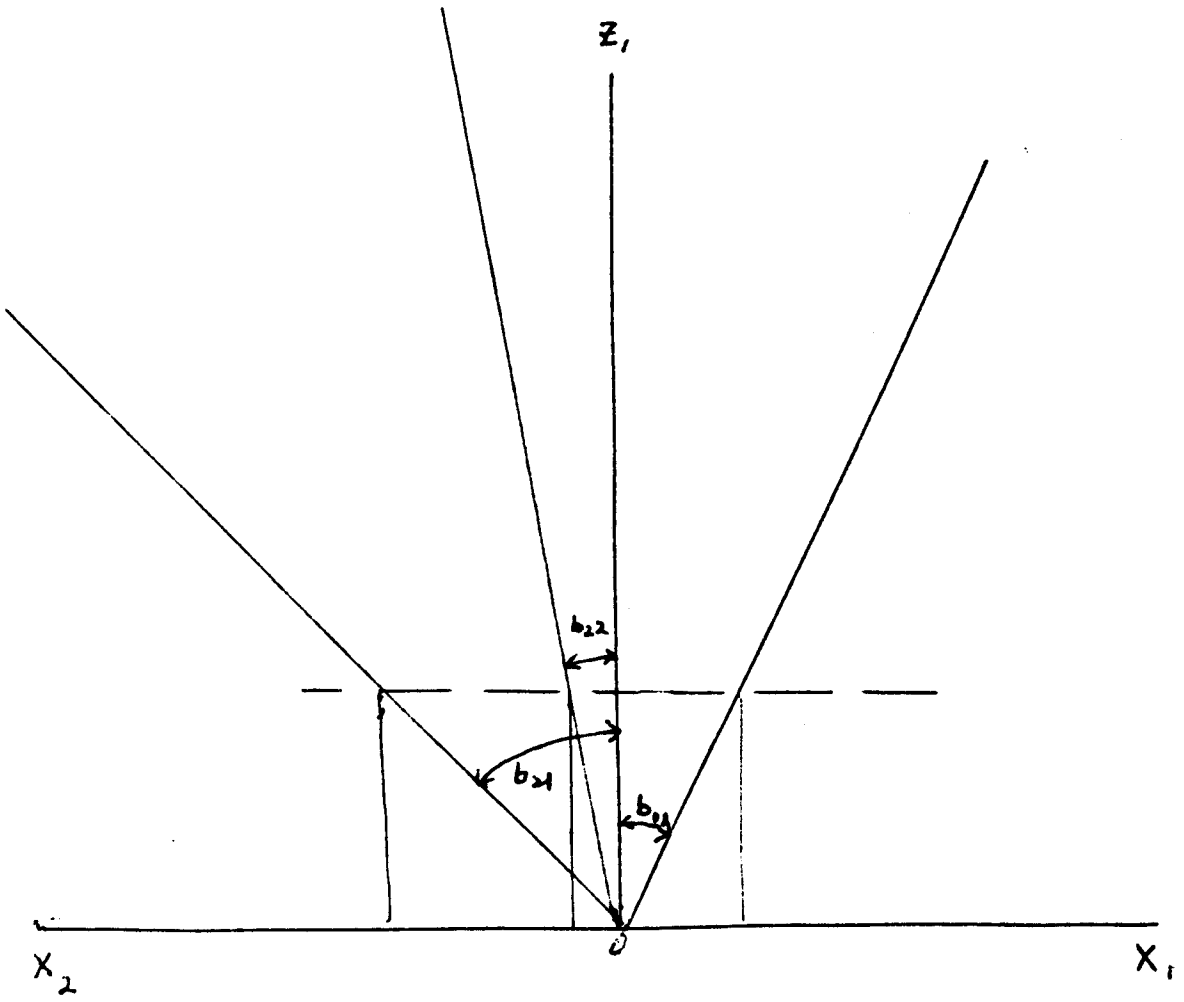
$$X_2 = b_2 Z_1 \qquad T_2 = t_1 Z_1$$

For ease of exposition, we assume the decision-taker is a consumer who has a utility function $U(Z_1, Z_{2..})$, though it could be a purchasing firm. He wishes to maximize utility under constraints of user production technology which extends to cover that of Z_i, total time available and the customary constraint that income is exhausted in the purchase of goods.

It is immediately apparent that selection of the X_1, X_2 combination for Z_1 is either one of indifference if the prices exactly compensate for the efficiency differences or one of dominance. Now assume the problem is made a two-period one, so that Z_i is sought in each of two periods, 1 and 2. Concentrating upon Z_1, let X_1 produce the same efficiency in each period but X_2 be such that, relative to price, it is of lower efficiency in the first period, but such that if it has already been used for a period, one knows how for the same time application the good is capable of giving greater efficiency in the second period.

It would be a case of getting the 'knack of a good' and then, for the same time commitment, being able to produce more. The selection process that will now apply is readily conveyed through the accompanying diagram, in which Z_1 is measured on the vertical axis and X_1 and X_2 on the horizontal axis, but to the right and the left of the vertical through the origin respectively. The bs are measured as angles from the Z axis. For given desired Z_1 we assume that in the first period, X_1 is the more efficient. When price is taken into account, this may not necessarily be so for any particular consumer, though it must be for some consumers. We assume that X_1 is also price efficient for our consumer. If, however, X_2 had been chosen in period 1, the performance the same good would provide if purchased afresh in period 2 would be greater. This would be shown for a prescribed amount of X_2 in the first period, X_{21}, by a narrower angle for line b_2 with respect to the vertical axis in period 2. Indeed, we assume b_{22} will grow steeper the more X_{21} has been selected in period 1. If the consumer desires the same amount of Z_1 in each period, and there is no time discounting involved (a purely simplifying assumption), then it could pay him to use X_2 in both first and second periods and to forego X_1 entirely assuming the prices of the goods remain as known at the start of the first period. The parallel with the question of whether one should invest in skill or remain unskilled in labour economics is complete.

Thus, consumers who "stick" in the market will see advantages in selecting the good that is of lower efficiency in the first period of use but sufficiently higher (through repeated use) thereafter. This says that they choose such a good through time in repeated purchases -- it does not say that they will stick to one producer of the category of good. Since, however, only current or prospective repeated purchasers would see advantage in buying the good, producers will economize on search costs by trying to hang on to past customers, whereas the consumers will see no advantage in changing their sup-


Z1
b22
b21
b11
X2
X1

pliers just for the sake of it. If producers run sufficient risk of losing prior customers, they will be willing to incur costs to keep them. These would tend to take the form of prices 'shaded' in some manner.

Within an industry such 'experience' goods will tend to enjoy a steadier demand over time than the other quality categories of goods, and this will enable their producers to better plan forward unless, when shifts involving Zs occur, the purchasers of the experience goods turn out to be the more volatile. A more regular demand would seem to potentially offer the benefits outlined under Mark 1. If firms incur costs to keep specific customers, this would certainly be the case. In this instance, the shading of price would increase the relative attractiveness to customers of the 'experience' good and producers of the alternative 'non-experience' goods may see advantage in shading their prices also, or at least regularizing them, to offset the fears that their more itinerant customers who note differential price-changing patterns may adjust their user technologies. To do this, they would resort to use of inventories in the manner already described. It is not clear that for the 'experience' good manufacturer it would be necessary to have an active inventory policy at all, the regularizing of demand and the shading of price might be adequate for the purpose. At least the need for such a policy is weaker. Note that in a sense, a discount would be offered by producers of the 'experience' good for regularity of custom to them as individual producers. If they only produce the one type of good, we are unlikely to get an affirmative reply when we ask them whether discount for regular purchases is offered as this will be automatically incorporated already in the price each and all are charged.

As between boom and slump, we might expect that the user of the 'experience' good is the more stable demander. The itinerant buyer is likely to plan short-term, and to disappear more rapidly in slump, so that in any combined index of

of the Z_1 component goods there is likely to be a stronger 'experience' good element in slump, and a relatively weaker one in boom, this implying that the index is likely to be resistant to falls in slump, a feature not far removed from the one Means would seem to be drawing our attention towards.[22] But this result is by no means secure as something depends on the relative movements in price under the influence of shifts and changing elasticities of demand and supply in a manner parallel to that developed with respect to labor markets by Oi.[23]

Mark 2 model attributes price regularities over time in the first instance to a tendency towards evening out demand over time for 'experience' goods. If the supply characteristics of the first section are relevant, price stabilizing pressures are being induced from both sides of the market. It is not clear that the role of inventories is very important for 'experience' good marketing, though they may be for the rival 'non-experience' good producer who caters for the itinerant trade. Regular customer discounting is not likely to be specifically noted by 'experience' good manufacturers; it will be normal pricing for them.

The argument of this section can easily be reinforced by introducing longer across-period experience effects, user time efficiency differences that parallel goods differences in efficiency, durable goods, etc. We have confined our discussion to the simplest case as this makes the essential argument.

There are a number of closely related versions of this model (Carlton, Gould and Fisher)[24] which all rest on the meeting of a market demand for a characteristic, by a separation of customers and firms into sub-classes each dealing in products which differ from one another with respect to at least one attribute. The necessary feature is that a market should be able to be formed for each such that even in the presence of arbitrage, the separation does not

break down. The version we call Mark II seems to have more stability than some of the earlier versions, though this may be more apparent than real. The models of Carlton and Gould require consumers to differentiate between price and the probability of being able to obtain the good. Our empirical material does not permit of such explicit differentiation, so we do not pursue those approaches further now. But there is one point of some immediate relevance. Gould emphasizes that in his probabilistic approach, each firm tends to operate under increasing returns to scale. If then a customer were to come along who would buy the entire output consistent with minimum average cost of production, he should be able to purchase at approximately that price. Thus, he argues there is some motivation for firms to give quantity discounts. This point would seem to follow from our Mark I certainty model also. For each inventory-holding firm would produce under increasing returns to scale to production and hence likewise be willing to enter into a favorable price arrangement for orders that enable it to produce at lower cost and hence resort to less or zero inventory holding. Gould also argues that firms supplying the higher price products, but with their associated lesser risks to customers of stockout, will be likely to give discounts to regular customers (the revenue of low price sellers who are more likely to stockout does not justify this discount). This seems to closely parallel the point made about shaded prices in Mark II.

This leads us on to a discussion of models which we may classify as Mark III. The originating article in this group is probably that of Stigler (1961)[25/] whilst that of Alchian,[26/] who acknowledges that he is building on Stigler's work, belongs here also, even though much of his account is consistent some points made in Mark I and Mark II.

Alchian stresses that price inflexibility is often induced by a desire to economize on search and information costs. Following Stigler, he uses simple

probabilistic models to show how a consumer selecting a good at an array of prices from which he is trying to choose the minimum will, through repeated search from a finite sample, gain access to lower prices but at a diminishing rate the longer (and/or more intensive), and hence the more costly, the search. There is a limit to how far one wants to chase lower price given costs of search, even though one may elect to use specialized agencies for the purpose. For sellers, there are parallel costs of search for the higher price payers. In such situations, there may be advantages for both parties in inflexible prices and letting queues of customers form on the one hand and of producer-sellers holding inventories on the other hand.

The seller could make price more predictable by carrying a larger inventory to buffer the transient demand fluctuations, and customers could reduce search costs with the assurance of a less flexible price if they accepted some costs of waiting in a queue.

Alchian's use of dramatic, yet everyday, examples contributed powerfully to the acceptance of the view that competition, rationing, and inventory holding could co-exist, and that price rigidity over a period was a feasible outcome. Alchian was also very forthcoming on the nature of tests. His analysis allows for coexisting price stability, inventories and declining quality to be an alternative to price flexibility, with constant quality and absence of inventories (cf. the newsboys case). Unfortunately, changes in quality as a result of such policies is something we are unable to check on empirically so that the point is merely noted here.

In general, he argues smaller, and more frequent, random fluctuations in demand, greater search costs, greater value of time, and less burdensome forms of queueing or rationing will increase the incidence of price rigidity. A lower cost of holding of inventories relative to the value of the produce will increase the relative size of inventories, increase price rigidity, and shorten

queues for any frequency and size of random demand fluctuations.

He claims that a discriminatory test would imply underutilization of resources, price stickiness and queueing for all types of resources. If one could detect breaks in patterns of development such that the costs of search or the length and frequency of underutilization of resources change for exogenous reasons, one might be able to frame sharp tests.

There has been a rich outpouring of stochastic theories of search in the last ten years. The outcome relative to potential for empirical testing has been disappointing. I am unable to discover any additional refutable proposition outside those already listed under Marks I and II for which data are available or likely to become available. This should come as no surprise when one thinks of demand theory, to quote but one instance, though the theory of the firm is an even better alternative to quote. Refinements of theory have gone in the direction of presenting propositions that are testable in principle rather than in practice. In my view, the profession should concern itself with presenting theories that consciously cling as close as possible to the borders of observation, though this is easier to state than to achieve. Perhaps the most powerful contribution of Alchian was to augment those sorts of linkage. Certainly the field acquired fresh interest amongst theorists in the aftermath of the Stigler-Alchian contributions.

III.

The Empirical Enquiry

Are prices of industrial products moving in a sufficiently narrow range that they may be said to be inflexible over time? If they are, how is that fix price brought about? Are demand and supply conditions always just changing in a manner to permit this? Or are participants in the market engaged in conscious, but rational, actions to produce this result? In the last section, we have given a number of reasons why they may be doing just that. These consist in the main of actions of demanders to regularize their demands over time. of suppliers to regularize their production over time with possible, but not inevitable, use of deferred delivery dates, or of the accumulation or decumulation of stocks. Indeed, we only cite one case where resort to queueing, or inventory change, is not an essential ingredient of an across-time price inflexibility situation. There may, of course, be others. If, for the moment, we take price inflexibility (inflation apart) as a characteristic of the industrial scene, we should expect in the main to find it coexisting with decumulation or accumulation of orders and/or the accumulation and decumulation of inventories. To see whether this is so, we need parallel information on orders, prices and inventories. Since we are, for the moment, interested in behaviour characteristics of enterprise, it is to firms that we would go for this information. This rules out the use of aggregative time series methods, at least directly. It points to the need for a cross-section study of firms in which information is obtained on the movements of at least these three variables over time.

This stands in substantial contrast from the methods followed by Stigler and Kindahl.[27/] They took the view that firms would choose to be very secretive about prices of their products, and it would be wiser to approach buyers, a

set which in their study included not only many Government agencies, but also a large range of industrial firms. Their study showed the wide diversity in prices for a given product at a moment of time and also over time. It was less clear that it showed that for the same buyers for given products, the price was variable over time, or substantially so. If that is so, we would want to be able to draw on order-inventory information that matched the price situation -- in Stigler and Kindahl's case, that would imply both that we must be able to trace the firm from which purchases were made, and that we must endeavour to build up a picture of the order-inventory behaviour characteristic of the buyer firm or agency.

It becomes clear that both the theoretical and empirical approach of the Stigler and Kindahl study are vastly different from our own and those like Alchian and Telser, who hold related views to ours. Whereas Stigler and Kindahl expect substantial price variation under competition, we can present cases where the converse is likely to be true, thereby querying the traditionally accepted view as to price patterns under competition. Diversity of buyers in Stigler and Kindahl may show the spread of prices for a product grouping at a given time or over time, and yet fail to pick up patterns of underlying stability over time. Moreover, an appeal to buyers' behaviour to get behind list price presentations by producers precludes access to related information on queuing and inventories which we would wish to explore where price amplitudes are small.

Both approaches have their justification. What we want is some fusion of the two, though it is not easy to see how it can be brought about given the costs involved.

In one sense, our study is sufficiently broadranging that in the approach to firms we ask not only about their selling prices but also about their input purchasing prices and associated conditions of contracting. For the producer-

seller there are many types of buyers and contract arrangements may differ from one category to another, even in the absence of discrimination. But the buyer has already been classified as falling within specific categories, and there he will remain so long as his requirements do not undergo change. As Stigler and Kindahl observe, there is a difference between the two sides of the story. Perforce, I would argue that from the producer-seller we will inevitably get much more uniformity in price information, whether at the extreme we are confined to list prices or at the other we are presented with average information relating to a whole series of subcategories for whom different prices are relevant. Such information is bound to be summarized in a way that suggests at least some stability over time -- indeed, it may be fairly stable over time if the relative strengths of the price layers do not change significantly. Stigler and Kindahl's reporters could be picking up information across these price layers and hence their method could tend to emphasize price variability.

Our own enquiry draws upon the behaviour of quoted industrial firms in Australia that are registered in New South Wales. The cooperating portion of the sample which was randomly drawn from COMPASS was then approached personally by the author and his research co-worker in the early stages of collation of information and once a routine was established generally by the co-worker alone. The questionnaire was wide-ranging over the field of production, sales, input purchase and pricing, inventory, and orders of both output and input and asked for quarterly information on these items over the immediately preceding three years. We made an early decision that to extend further was to get involved in substantial product and institutional change situations, and even more pertinently to run into the problem of deficient records. Our guess clearly proved a good one as even within this sample, we were not always able to get information so far back. It is amazing that Stigler and Kindahl were able to secure such support

over ten years and for monthly data at that! In many cases, they were able to get direct access to purchasing dockets. It is doubtful, for reasons they gave, whether equivalent access would be forthcoming for production, sales, and inventory documentation.

In the first instance, we approached the Chief Executive, who sometimes elected to conduct the interview himself, sometimes being joined by specialized officers. On other occasions, we were immediately introduced to representative officers.

Our biggest job was to get an interview at all. Many expressed a desire to see the questionnaire first, and we willingly obliged. Others refused to meet us at all, with or without comment. Of 212 firms approached, we gained interviews with about 80 and have secured workable information over a sufficient array of data from about 60.

The interviews took at least two hours. Firstly, we had to settle on a particular product for scrutiny and upon an input of its manufacture that was critically important both in volume and value. All firms were multi-product, and we endeavoured to concentrate upon a mainstream item. We in no sense were anxious to gain information relevant to the testing of a production function. The questions asked of firms were of two main types -- 'hard' data on items already listed, and these were often supplied after the interview, an advantage in one way but giving opportunity for procrastination and non-delivery. The other type of data was more subjective. Firms were asked the type of clientele they catered for, the number of purchasers, the nature of the product (perishable, etc.), whether production was standard or to order, nature of discounts offered (by categories), location of inventories, use of fixed contracts, time of delay in meeting orders, etc., on the product side. On the input side, questions were asked as to the nature of contracts, frequency of change of suppliers, whether the input is standard or custom-made, discounts forthcoming, delays in delivery, vertical integration, etc.

There were a number of interrelated questions on how the firm would respond to a fall or rise in demand through inventory change or through immediate production change, a feature which had been expected to figure prominently. On the production side, firms were also asked about levels of employment by quarter and resort to overtime hours.

Within a cross-section, one would hope to pick up a large number of firms falling within each major product category, but this demands a high response and a large sample. In its absence, one has to be content with more modest achievements, subdivision by variance within product classes, and across product classes has to be abandoned and one has to be content with the latter alone. In either case, there could be a major problem that has to be squarely faced. In the theoretical discussion we confined ourselves to the competitive case, though it is possible that a number of the firms we sample can be exercising some degree of monopoly power. Many of the points made previously carry over but with little modification to the monopoly case -- indeed, Telser[28] has examined some of them quite extensively. We take a different view here. Perfect competition is essentially a limiting condition. Homogeneity of product, for example, is something no firm seeks for itself; each wants some way of distinguishing itself, and its product, from another firm. The entry of competitors rarely proceeds so far as to produce homogeneity. Thus, concentration on within-product classes can give one a false sense of security in this regard. Moreover, if, at this point, we were to take note of the Austrian view on competition, we would acknowledge that each firm is in some sense distinct -- perfect competition is a legitimate or illegitimate means of concentrating on some central features of competition whilst ignoring others and becomes a matter of judgment. Just recently, Oliver Hart[29] has drawn our attention to a more appealing method of approach that may possibly be adapted to our purpose. For the large economy where every firm is relatively very small, he has shown

that the firm could differentiate its product, and yet conditions approaching those of perfect competition still obtain. Where the number of consumers is large, a firm's elasticity of demand for its product will be close to infinity, whether the good is homogeneous or differentiated. Marginal revenue for a firm equals average revenue time one plus the reciprocal of the elasticity of demand.

$$MR = P + Q \frac{dP}{dQ}$$

The profession has come to accept that MR = P depends on the smallness of quantity, Q, as indeed it may. But it could alternatively depend on the smallness of $\frac{dP}{dQ}$, and for Hart this is the more relevant consideration. This condition may be met in a world of differentiated commodities, whereas the former depends upon a firm's size in a market of firms producing identical products. Now this point of Hart's has correctly been regarded as novel, though as he remarks Schumpeter had pointed out[30/] that as far back as 1838, Cournot was aware of the underlying argument. Hart shows that, for the large economy, even one unit producer capable of exercising monopoly power cannot more than infinitesimally secure any advantage from it. He does add that the presence of close, and, of course, identical, substitutes enables the equilibrium position in the economy to be reached the sooner. Now the appeal to the 'large numbers' case is characteristic of both the traditional and Hart representations. But the difference in emphasis is substantial. Homogeneity of product tends to lose ground and smallness of a producer not in relation to an industry, which is no longer well-defined, but in relation to the economy is elevated in status in the latter. Conclusions for a finite economy in either case are but approximations based upon some vague appeal to continuity from a monopoly case to the fully competitive case, a path known to be irregular. The new slant that Hart's theorem provides would suggest that there is a tradeoff between

homogeneity of product and smallness of producer in relation to the economy at large. The smaller the producer is in relation to the economy at large, the less concerned we need to be about securing approximation to perfect substitution in product. Presumably, in an integrated world economy, traded goods for any one national economy will tend to come to enjoy the benefits of smallness in relation to numbers of customers; hence, a goodly degree of heterogeneity of product can be tolerated. This argument is one of considerable power, for we have in the preceding section been subdividing categories of product into finer and finer subdivisions, within any one of which the conventional assumptions of perfect competition have been stretched to breaking point. If these can now be relaxed, it gives greater credence to the line of attack we have used in relation to both product and factor markets.

On these lines, we may perhaps proceed to treat prices of products and of inputs as parameters.

Our sample of firms relates to different producers and products and dimensionality becomes a major problem. There are a number of ways to proceed, but each requires that across firms any random variable become dimension-free or dimension-common. Proportional changes by quarter will achieve this as will working with coefficients of variation. In this paper we do the latter. The variables we use here are:

Coefficient of variation of sales of designated product;
Coefficient of variation of production of designated product;
Coefficient of variation of prices at producer exit gate of product;
Coefficient of variation of the inventory-sales ratio of product;
Ratio of inventory of product to sales of product.

All but the last are dimension-free and are calculated from the data for each firm across twelve quarters. The last is dimension-common across firms and is measured in units of time, being a stock divided by a flow. It is calculated as the average inventory over twelve quarters divided by four times the average sales

over the twelve quarters.

It might be said that sales, production and inventories are connected by a well-defined relation. This is not exactly so, as orders would have to be taken into account also. In any event, the relation over time would only be taut if one period's levels of inventories were also reckoned in. We work with ratios of inventory to sales so that on no count have we got a subrelation that would exhibit multicollinearity. The data were obtained under strict terms of non-disclosure of source. Cooperation from firms in future for any type of study depends upon respect for this. We have chosen to indicate the product by industry grouping hoping that gives sufficient guidance to the reader while preserving anonymity. The data set used on this occasion are given in the appendix, together with some closely related information that may be interesting to readers and that can be incorporated by dummies at a later date. Firms were interviewed over a period of two years so that the data does not quite relate to the identical three-year range. We have not corrected for this here, but may do so later. In Australia over the period of the enquiry, inflation was generally in the 8-9% range and tending downwards. This data, drawn from the general industrial products price index, would produce a coefficient of variation over twelve quarters of .077 which might be interpreted as the zero base for this period. In the sample, the mean coefficient of variation of the selected variables were as follows:

Sales	.175
Production	.195
Inventory/sales	.278
Prices	.086

Mean inventory-sales ratio as assessed across firms, and aggregated .181. We note that the c of v for prices is not much above the rate of inflation, but the upper and lower values in the table are .015 and .186. There seems to be sufficient variation in the columns for each variable to justify our enquiry.

Some firms do not maintain inventory either because they do not do so as a general rule, or because they are engaged in custom production (to order) as indicated in the table. The lower c of v of sales as compared with production need cause no surprise if change in inventories is sufficiently negatively correlated with production because of the variance of a sum rule.

We cannot be sure how firms chose to measure the price information they gave us. Sometimes it may have been list prices; more often than not, it was average prices over the quarter which were provided. If the makeup of average prices was uniform by quarter, we could hardly ask for better data. But we do not know. The appendix shows that for many firms, discounts for large orders were allowed, so the makeup of the pattern of sales would be relevant to this. Regular customers only occasionally benefitted from discounts, something we rationalized under our Mark II discussion as implying that if repeated purchasers were the rule, firms would see no reason for drawing such a differentiation as it would be meaningless. One or two gave discounts for length of association with the firm. If some firms inevitably rolled their regular custom discount into price, whilst others indicated that they differentiated, and each reported correctly, then the data is in appropriate form for our purposes.

Firms that are going to use inventories very actively in stabilizing prices will, other things equal, need an inventory much more than those who are going to use them but a little. But inventory holding is costly, and in our Mark I theory firms have first to decide to pay the fixed costs of entering the price stabilizing market and, having decided, must assess the degree of their participation by examining concurrently marginal costs on both production and inventory holding curves. Costs consist of warehousing, insurance, price risk, and finance. For these considerations, the inventory-sales ratio is very much a proxy. We would expect it to be high when inventory holding is least costly and vice versa.

Alchian argues that the highest and lowest priced variant of any class of goods will have a longer inventory period...special purpose machine tools should have a longer period in store than general purpose machine tools and widely used types of equipment and their inventory sales ratios should be larger. We do have some pointers that would support the machine tool argument, but no information on price variant categories per se. The very high values of inventory-sales on the list are cases where access to a great variety of product is essential to customers, the costs of the variety at the last stage of production being slight. It is doubtful if ordinary regression processes can give adequate representation to this. It bears a close affinity to another case where the final product of a firm is "to order", but just before that final stage, it is reasonably standard. That is to say, the extra cost and time to provide the variety is very small. In such instances, the inventory is recorded as effectively nil, though we know the bulk of the expense in the production process is entailed in the preparation of a standard product. We have not found a way as yet to deal with that shading.

Perhaps the most difficult procedure question we confront is the choice of dependent variable, given the need to consider interactions between more than two variables simultaneously. Almost any one has a claim to this position. We could perhaps proceed by use of generalized least squares and, given the fact that there are going to be errors in the measurement of each variable, the case for this is strong. At the moment, we adopt ordinary least squares.

Perhaps production has the strongest claim to be dependent variable. Sales will be to a substantial degree exogenous, though price and availability will aid in its determination. With monopoly power price could fill this role, and even under competition with an active inventory policy could be so designated. There seems to be no way out of this impasse other than to look at each variable in turn in this role. None of the Mark I, II or III models provides us with a clear-cut recommendation.

The set of regression results, with each variable in turn being treated as dependent, is given in the accompanying table.

Results of empirical work are rarely immediately cooperative with economic theorizing, and so it proves here. The most striking feature of the table is the repeated significance of the mean inventory-sales ratio, whether as explanatory variable or in relation to other variables in the relation where it is taken as dependent. This is so striking that it must be investigated before we proceed to ensure that we have not introduced a contaminating influence. We already know that the variable can be difficult to handle in theory. A high inventory-sales ratio would be needed if demand fluctuations are large. This may still be positively correlated with prices. A high inventory-sales ratio would suggest that the cost of holding inventory is low, and so inventory can help to moderate price fluctuations. Further very low, possibly zero, inventories are held where the product is a custom good because protective supplies earlier in the productive chain are held in these instances. If custom good firms also exhibit low price flexibility, a strong positive correlation might be encouraged if others exert strong influence. However, in the present instance, it would seem that other explanations are relevant. Looking at the original data, we note at once that high coefficients of variation in prices are associated with high mean inventory-sales ratios across the spectrum of firms. The outliers here are easy to identify and, within the limits of non-disclosure by firm can be accounted for. The highest inventory sales ratio is in the publishing area, where it evidently is essential to keep a large, varied inventory, probably spread over a long span of time. Several others are in the pharmaceutical area. This might suggest that there could be a seasonal problem, but we have averaged the data over calendar years. The problem is that for several of these products, there is a precautionary demand not necessarily associated with seasons per se which justifies retention of large stocks over time. (Perhaps it suggests we should think through

batch production procedures.) It would seem that the same point is relevant for metal products in at least one of the cases listed. This casts doubt on the usefulness as a clear indicator of the inventory-sales ratio, but it does not suggest that the variable is a contaminating influence in our story. It should not be biasing the values derived for other designated variables. Obviously, though, the problem of isolating the interactions we wish to measure is more difficult than we had contemplated.

It is convenient to begin by examining the case where the coefficient of variation of prices is the dependent variable followed by that where the coefficient of variation of inventory-sales ratio fills that role.

In the price-dependent variable equation only one variable is significant at the 5% level, sales, though the coefficient variation of the inventory-sales ratio is nearly so. To say that the firms with the highest values of the coefficient of variation in prices are on balance the ones with the highest coefficient of variation in sales but the lowest in both the coefficients of variation of production and inventor-sales ratios is to present results in harmony with theoretical expectations, save that the coefficients obtained are unreliable, or subject to margins of error that do not exclude positive coefficients.

With the coefficient of variation of inventory-sales ratios as dependent variable, we find a positive association with the coefficient of variation of sales, but a negative one with respect to the coefficients of variation of production and of prices; but again, the coefficient of these last two variables is not significant at any level. Initial pleasure at confirmation of expectations of theory is thus qualified.

In the equation where sales are the dependent variable, all independent variables have significant coefficients and the signs are acceptable. That for prices, however, gives support, at least to some degree, to the Stigler-Kindahl argument that prices do vary positively with supply and demand fluctuations.

After all, we do not deny the conclusions of traditional theory. When such price variations are controlled, the coefficient of variation of the inventory-sales ratio has the correct sign and is significant at the 5% level. But we shall need to probe further in order to discover to what sectors of industry the Stigler-Kindahl price argument or our inflexible pricing argument are the more relevant.

When the coefficient of variation of production is selected as the dependent variable, the coefficient of variation of prices has the correct negative sign, but is barely significant at the 1% level. The coefficient of variation of inventory-sales ratios has the correct sign, but is smaller than its standard error so that we cannot reject the alternative sign. Up to a point, these results are encouraging, but critical results are often too uncertain to support our argument firmly and a fortiori to deny the alternatives. In any event, they bear most directly on Mark I and Mark III.

Perhaps we might say more positively that the coefficient of variation of inventory-sales ratios does exert some influence and that both it and prices serve as adjusters in markets. This seems a minor result, but it is not clear that any such confirmation has been forthcoming previously, at the level of the decision-taking units or even elsewhere. That is a modest result, but valuable. At the least, the role of the variable should not be glossed over in future.

The results as a whole offer limited insight. What can be done to improve on them?

FURTHER TESTS AND RECOMMENDATIONS

Our body of data is quite rich and, as a next step, it is intended to enter some of the other variables, often in dummy form, alongside those used in the previous section. Some attempt will also be made to allow for semi-finished goods inventories of custom goods. We can also correlate information on the coefficient of variations of input purchases and possibly that of the ratio of inventories of inputs to current purchases, though the information here is a little more patchy. Speed of access to inputs may be very relevant to speed in production change. There is some limited information on orders, though most firms denied their relevance and delivery lags were virtually dismissed as perhaps they could be when resources are operating at less than full capacity quite a bit of the time. It is possible, moreover, that inflation has increased uncertainty sufficiently to undermine adherence in use to 'experience' goods, though we do not know how to allow for this. A direct test of Mark II will be difficult to design.

So far we have made little use of the quarter-by-quarter cross-variations in the variables employed. By taking proportional changes in each variable, quarter by quarter, we extend considerably the size of the sample, even though we must introduce seasonal dummies. This would enable us to break down the variation observed in coefficients of variation and attribute it to one influence rather than another. It would give more strength to within-firm variations as opposed to across-firm variations. Most of the more subjective supporting data is only available on a firm basis, however. The study to date would suggest that some form of partitioning the data into different behaviour groups is required. The difficulty is to discover some way, other than one that is purely ad hoc, for carrying this through. The costs of surveys such as this are very heavy. It is clear that with the expectation of poor cooperation from firms, a large sample

must be canvassed. Both the Stigler-Kindahl study and this one would point to the merits of interviewing in the first instance firms that are purchasers of manufacturers' products. If these firms were chosen randomly, perhaps the second half of the survey could consist of interviews with the firms that supplied the inputs. In this way, the movement of inventories across firms could be followed through and both sides of the market examined symmetrically. But before such an expensive course is embarked upon, it would be wise to see if one can sharpen up analyses from such data as is currently being reported upon.

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REGRESSION RESULTS

KEY: X_1 SALES (CV)
X_2 PRODUCTION (CV)
X_3 PRICES (CV)
X_4 INVENTORY-SALES (CV)
X_5 INVENTORY-SALES (MEAN)

DEPENDENT VARIABLE	CONSTANT	X_1	X_2	X_3	X_4	X_5	R	DW	STANDARD ERROR RESIDUALS	F
X_1	.012 (.020)		.843 (.097)				.817		.064	64.21
	-.001 (.021)		.770 (.098)		.097 (.042)		.828		.062	31.32
	-.027 (.026)		.752 (.097)	.356 (.225)	.091 (.041)		.843		.061	25.75
	-.022 (.025)		.756 (.094)	.445 (.223)	.091 (.040)	-.072 (.039)	.843	2.38	.061	25.75
X_2	.063 (.018)	.743 (.085)					.800		.062	39.12
	.053 (.019)	.751 (.085)				.050 (.039)	.806		.062	26.58
	.069 (.024)	.780 (.089)		-.256 (.235)		.061 (.040)	.807		.063	19.64
	.071 (.024)	.801 (.100)		-.256 (.237)	-.021 (.043)	.062 (.040)	.807	2.59	.063	19.64
X_3	.068 (.011)	.105 (.055)					.362		.040	3.32
	.059 (.012)	.112 (.054)				.042 (.025)	.393		.040	2.62
	.065 (.013)	.190 (.090)	-.105 (.096)			.047 (.025)	.393		.040	1.92
	.065 (.014)	.194 (.097)	-.105 (.098)		-.003 (.028)	.048 (.025)	.393	1.43	.040	1.92
X_4	.104 (.061)	.989 (.295)					.452		.217	5.66
	.090 (.067)	1.000 (.298)				.065 (.135)	.458		.219	3.78
	.110 (.093)	1.194 (.500)	-.259 (.532)			.078 (.138)	.458		.221	2.78
	.110 (.093)	1.211 (.531)	-.268 (.546)	-.089 (.854)		.082 (.146)	.458	1.84	.222	2.78
X_5	.073 (.080)			1.250 (.832)			.260		.235	1.59
	.110 (.089)	-.322 (.334)		1.477 (.865)			.340		.232	1.87
	.046 (.010)	-.967 (.535)	.847 (.555)	1.618 (.857)			.349		.234	1.46
	.036 (.099)	-1.070 (.570)	.865 (.561)	1.614 (.864)	.091 (.162)		.349	2.17	.234	1.46

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PRICE FLEXIBILITY STUDY

OUTPUTS									INPUTS				
					1-Consumers 2-Rtlrs. 3-Whslrs. 4-Industrial/Comm.	L-Size T-Time R-Regular E-Exclusive S-Seasonal P-Prompt Payment		2 Yes 1 Little 0 Nil					I = Transfer Pricing T = Time R = Regular N = Negotiated E = Exclusive
COV I/S	PROD.	SALES	I/S	PRICES	DOMINANT TYPE OF PURCHASER	DISCOUNTS	STANDARD(S) CUSTOMER(C)	INVENTORIES HELD BY CUSTOMERS	PRODUCT CLASSIFICATION	INV. OF INPUT TOTAL PURCHASES INPUT	NATURE OF PURCHASE FORWARD(F) INTEGRATED SUPPLIER(S) OR PERISHABLE(P)	CUSTOM(C)	DIS-COUNTS	AGRICUL-TURAL(1)
.750	.216	.226	.177	.114	4	L	S	2	CHEMICAL	.119		0	—	0
.342	.119	.240	.249	.118	4	T	S	2	CHEMICAL	—		0	—	0
.375	.163	.116	.110	.040	2	L	S	1	CHEMICAL	.316		0	—	0
.238	.122	.158	.130	.064	4	LTR	SC	0	CHEMICAL	.653		0	LRTE	0
.185	.083	.107	.061	.096	4	—	S	0	Materials	2.466		0	—	0
.360	.163	.157	.081	.095	4	—	S	0	Construction "	0	S	0	—	0
.153	.129	.171	.425	.101	1	L	S	0	"	.009		0	LE	0
.085	.095	.095	.144	.090	4	LT	S	0	"	0		0	—	0
.396	.383	.352	.149	.029	3	L	S	1	"	—	P	0	L	0
.474	.386	.278	.215	.065	2	LR	S	1	ELECTRICAL	1.081		0	—	0
.000	.207	.208	.000	.025	4	—	C	0	"	.525		0	N	0
.309	.251	.196	.100	.037	4	LE	S	0	"	.078		0	N	0
.903	.167	.252	.077	.090	2	LER	S	0	"	(.324)		0	LE	0
.000	.172	.172	.000	.122	4	—	C	0	"	.454		0	—	0
.128	.094	.096	.020	.114	4	LR	S	1	Metal Prod. Fabricated	.431		0	L	0
.000	.404	.380	.000	.092	4	—	SC	0	"	—	C	0	LER	0
.000	.126	.126	.000	.115	1	—	SC	0	"	—		C	—	0
.130	.203	.135	.288	.073	4	LRT	SC	2	"	1.459		0	—	0
.000	.094	.094	.000	.073	4	L	C	2	"	.616		C	L	0
.113	.139	.066	.499	.063	4	LR	S	0	"	11.609		0	—	0
.062	.104	.104	.291	.030	2	—	S	0	Food, Drink & Tobacco	—	S	C	L	1
.645	.267	.155	.433	.074	2	—	S	0	"	—	P	0	—	1
.525	.188	.163	.031	.118	3	—	S	1	"	.476		C	—	1

PRICE FLEXIBILITY STUDY

OUTPUTS					INPUTS									
					1-Consumers 2-Rtlrs. 3-Whlslrs. 4-Industrial/Comm.	L-Size T-Time R-Regular E-Exclusive S-Seasonal P-Prompt Payment		2 Yes 1 Little 0 Nil					I = Transfer Pricing T = Time R = Regular N = Negotiated E = Exclusive	
COV I/S	PROD.	SALES	I/S	PRICES	DOMINANT TYPE OF PURCHASER	DISCOUNTS	STANDARD(S) CUSTOMER(C)	INVENTORIES HELD BY CUSTOMERS	PRODUCT CLASSIFICATION	INV. OF INPUT TOTAL PURCHASES INPUT	NATURE OF PURCHASE FORWARD(F) INTEGRATED SUPPLIER(S) OR PERISHABLE(P)	CUSTOM(C)	DISCOUNTS	AGRICULTURAL(1)
.000	.079	.066	.000	.088	4	LE	S	0	Food, Drink & Tobacco	---	P	0	---	1
.473	.246	.244	.086	.100	2	LE	S	2	"	---		C	---	1
.593	.054	.054	.179	.023	2	L	S	0	"	0		0	L	0
.111	.212	.062	.146	.015	3	L	S	0	"	1.680		0	---	
.295	.145	.126	.060	.092	2	L	S	2	Lumber Prods.	1.962		0	---	0
.285	.157	.100	.108	.024	2	LR	S	0	Household Prods.	0		C	L	0
.617	.136	.137	.057	.057	4	L	S	1	Lumber Prods.	1.649		0	L	0
.000	.032	.032	.000	.089	2	RT	S	1	Lumber Prods.	1.195		0	---	0
.107	.156	.121	.211	.045	2	LRT	SC	1	Metal Prods.	---		0	RT	0
.000	.280	.212	.000	.070	4	---	SC	0	Metal Prods.	.575		C	---	0
.303	.231	.319	.097	.061	2	LR	S	1	Metal Prods.	---		0	---	0
.155	.217	.140	.258	.134	4	L	S	0	Metal Prods.	---	S	0	I	0
.144	.102	.069	.132	.157	2	LR	S	1	Energy Prods.	.199		0	I	0
.091	.166	.077	1.518	.147	2	L	S	2	Printing & Publishing	1.132		C	LTP	0
.442	.418	.309	.162	.068	3	LR	S	0	Pharmaceuticals	---		0	---	0
.886	.366	.600	.306	.175		RS	S	2	"	1.858		C	---	0
.409	.493	.395	.329	.186	2	L	S	2	"	.906		0	LT	0
.516	.249	.153	.119	.085	2	P	S	2	Glass, Stone, Clay Prods.	---	S	C	I	0
.147	.130	.156	.217	.088	3/4	---	S	2	CHEMICAL	.275		C	---	0
.118	.179	.156	.224	.043	4	L	SC	0	Glass, Stone & Clay	.055		0	---	0
.384	.185	.058	.450	.123	2	L	S	0	Women's Apparel	---		0	L	0
.371	.199	.196	.057	.165	4	L	S	2	Textile Prods.	---	P	0	---	1

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OUTPUTS					INPUTS									
COV I/S	PROD.	SALES	I/S	PRICES	DOMINANT TYPE OF PURCHASER (1-Consumers, 2-Rtlrs., 3-Whlslrs., 4-Industrial/Comm.)	Payment DISCOUNTS (L-Size, T-Time, R-Regular, E-Exclusive, S-Seasonal, P-Prompt)	STANDARD(S) CUSTOMER(C)	INVENTORIES HELD BY CUSTOMERS (2 Yes, 1 Little, 0 Nil)	PRODUCT CLASSIFICATION	INV. OF INPUT TOTAL PURCHASES INPUT	NATURE OF PURCHASE FORWARD(F) INTEGRATED SUPPLIER(S) OR PERISHABLE(P)	CUSTOM(C)	DIS-COUNTS (I = Transfer Pricing, T = Time, R = Regular, N = Negotiated, E = Exclusive)	AGRICULTURAL(1)
.151	.250	.212	.083	.123	2	LR	S	0	Textile Prods.	.308		C	LRT	1
.282	.187	.226	.212	.068	2	L	S	1	Textile Prods.	.052		0	LT	1
.278	.195	.175	.181	.086 = MEAN										