WORKING PAPERS

PRICE AND COST EXPECTATIONS IN AUSTRALIAN MANUFACTURING FIRMS

by

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No. 28 *February 1979*

IN ECONOMICS

DEPARTMENT OF ECONOMICS

UNIVERSITY OF SYDNEY

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National Library of Australia Card Number and ISBN

0 86837 002 9

Acknowledgement is made to the Reserve Bank of Australia for financial assistance from the Economic and Financial Research Fund. I would like to thank Viv Hall, Dilip Madan, John McDonald, Tony Phipps and Ross Williams, for helpful comments on an earlier draft of this paper. Excellent research and computing assistance has been provided by Vicki Le Plastrier, Deborah Egau, Mark Dziegielewski and T.P. Truong. Don Fraser and David Brady from the Department of Industry and Commerce have provided encouragement and helpful advice.

PRICE AND COST EXPECTATIONS IN AUSTRALIAN MANUFACTURING FIRMS

1. Introduction

Whilst expectations play an important role in the determination of many economic variables, the role of inflation expectations has received particular attention in recent years. This has, in part, been due to theoretical developments since the mid-sixties, which place great emphasis on inflation expectations as a determinant of the actual rate of inflation: (Phelps [26] ; Friedman [11] ; Laidler and Parkin [17]). Since the long-run policy implications of these models depend crucially upon the size of the coefficient on the inflation expectations term, the appropriate measure of inflation expectations becomes of major theoretical and policy significance. In addition, in the short-run, the dynamics of the inflation-unemployment model depend upon the way in which expectations are formed, this being true whether or not the possibility exists to permanently reduce the equilibrium unemployment rate. In analysing the role of inflation expectations in structural models of the economy, it is extremely important to specify which inflation rate is being forecast, and which economic agent is forming the forecast. This distinction between different expectations series is particularly important when expectations enter as explanatory variables in structural wage and price models for example. Here the choice of the appropriate expectations variable is crucial and is normally specific to the particular theoretical model under investigation.

This distinction is not as crucial when seeking to explain how a particular expectations series is formed. It does suggest, however, that there is no reason why expectations series which differ in the above regards should be formed in similar ways. The two series with which this paper is concerned are expectations held by firms in the Australian manufacturing sector of future movements in their prices and future movements in their unit costs. These two series differ at least in regard to the fact that the firms have a much greater degree of direct control over the former than the latter. Both series are worthy of investigation because of the effects which they are likely to have on the behaviour of firms. Their own-price expectations will influence their wage offer behaviour, whilst unit cost expectations may exert a considerable influence on current pricing decisions.

Until recently, no direct observations on expected inflation were available. Thus, early studies of the role of expectations in determining the actual rate of inflation proceeded by assuming that expectations were formed in a particular way (e.g. Solow [30] ; Parkin [23]). Typically, these models related the expected rate of inflation to current and lagged values of the actual inflation rate. Thus, if P^*_t represents the expected rate of inflation, formed in time period t and applying to the following time period, and P_t is the actual inflation rate in period t, the general distributed lag expectations model can be written in the form:

$$P^*_t = B(L) . P_t \qquad (1)$$

In this equation, L is the lag operator, $L^n X_t = X_{t-n}$, and B(L) is a general (unconstrained) polynomial in L. This formulation is too general for use in empirical work, where restrictions have been placed on the coefficients (b_i) in the lag polynomial B( )[1]. Three models which have received particular attention are the static expectations model, in which $b_i = 0 (i > 0)$, the adaptive expectations model, in which $b_i = \lambda(1-\lambda)^i$ and in which $0 \leq \lambda \leq 1$, and the extrapolative expectations model, in which $b_o = 1 + \theta$; $b_1 = -\theta$ and $b_i = 0 (i \geq 2)$. The use of these models suffers from the problem that, in the absence of any direct observations of the expected inflation rate, no independent test of the restrictions imposed on the b_i is possible. In this case, there is absolutely no basis for choosing any expectations model in preference to any other, and the nature and role of inflation expectations cannot be determined.

Following papers by Turnovsky [33; 34] and Turnovsky and Watcher [35] in which direct observations on price expectations were investigated, a directly observed expectations series for Australia was derived by Rutledge [27] . The data source was the 'Survey of Industrial Trends', undertaken by the Bank of New South Wales and the Associated Chamber of Manufacturers (NSW-ACM)[2]. Rutledge followed earlier work on this data by Blyth [2] in using Theil's [32] Balance Statistic method in order to derive a quantitative series from the qualitative survey data.[3] Subsequently, four series of the observed expected inflation rate have been derived for Australia. The first two have been discussed and analysed by Jonson and Mahoney [15] . One of these series was based on predictions made by a firm of management consultants (the Shrapnel series), whilst the other (the AFR series) was produced retrospectively by a group of four economists who re-read back issues of the 'Australian Financial Review' and based their expectations upon its contents. A third series has been derived by Danes [6] using the NSW-ACM survey data, but applying the techniques developed by Carlson and Parkin [4], designed to produce a quantitative series from qualitative survey responses. The Danes' series suffers from the same problem as the Rutledge series, in that any conclusions derived from it are dependent upon the appropriateness of the method used to derive the quantitative series from raw survey data which is in qualitative form. Finally, Defris and Williams [8,9] have derived a series based on the quantitative survey responses collected quarterly by the Institute of Applied Economic and Social Research in its Survey of Consumers.

Rutledge, using the NSW-ACM data, found the static expectations model to be preferable to the adaptive or extrapolative models. Danes, however, using the same data but deriving the quantitative series differently, found that both the extrapolative and adaptive models performed well. The parameter restrictions[4] implied by the extrapolative model were satisfied, although the coefficient on the error learning term in the restricted form of the adaptive model was not significant. However, the explanatory power of the adaptive model was greater and this led Danes to prefer this model. Subsequently Davy [7], Valentine [36] and Defris and Williams [9] have all shown the adaptive model to be superior to the extrapolative model. Valentine's work shows the extrapolative model to make no significant contribution to the explanation of either the Shrapnel or the AFR series. There is some evidence of an extrapolative element in the Danes series although Valentine argues that the presence of autocorrelation makes the interpretation of this result problematical. In sum these results suggest that whether it is firms, consumers, or economists who are predicting future inflation rates, all of them place greater emphasis on the use of an adaptive rather than an extrapolative model. In addition to these results Danes, Valentine and Defris and Williams have all found second order error learning terms to be significant, whilst Danes found a significant second order extrapolative term.

Johnson and Mahoney present evidence suggesting that price expectations are influenced by variables other than previous actual price changes. In particular, previous changes in the money supply and in average weekly earnings are both shown to have a significant effect on price expectations. Defris and Williams find that consumer price expectations are significantly affected by money supply growth and a wage indexation variable, equal to zero until the March quarter 1975, and to the percentage increase in wages granted by the Arbitration Commission thereafter. Valentine however argues that the more refined analysis he undertakes of the Shrapnel and AFR expectations series, "do not support the conclusion of Jonson and Mahoney that equations including current economic variables provide a better explanation of the behaviour of price expectations series than equations based on a distributed lag of past price changes" (Valentine [36] , p.397). However, Valentine's estimated distributed lag expectations models exhibit considerable instability when the sample period is expanded, and it is possible that this may be due to variables which have been omitted from these equations.

The aim of this paper is to investigate the extent to which manufacturer's price and cost expectations conform to the findings of previous studies on expectations formation in Australia. The data source is described briefly in Section 2 and Section 3 considers the distributed lag expectations models. Section 4 is concerned with the role of other economic variables in the determination of expectations, and the related question of the rationality of expectations.

2. The Data

The data on which this study is based havebeen collected by the (currently-named) Department of Industry and Commerce in their quarterly 'Survey of Manufacturing Activity' (SOMA). After several pilot surveys, the first results were published in March 1973 and referred to estimates of changes in manufacturing activity in the three months up to December 1972.[5] The June 1973 issue of the SOMA bulletin contains the following explanation:

> The quarterly Surveys of Manufacturing Activity are designed to provide up-to-date information on short-term trends in the manufacturing sector ... Such information should be useful for many purposes, and is an essential aid to the Government's deliberations on economic policy.
>
> (SOMA Bulletin, June 1973, p.2)

The data used here cover the thirteen quarterly surveys from March 1973 to March 1976 inclusive. Whilst information is obtained from firms on past actual, normal and expected future trends in their sales, exports, capacity, overtime, employment, orders, stocks, costs and prices,[6] the latter two are of most relevance here. The relevant questions as asked in the survey are shown in Table 1. The questionnaires are distributed each quarter to between 800 and 900 firms in the manufacturing sector, of whom 700 to 800 respond (a response rate of between 80 per cent and 90 per cent). In terms of both sales and employment, the survey respondents represent over one-quarter of the manufacturing sector. The data have been classified to be consistent with the ASIC sub-divisions and the numbers in each of the resulting twelve industries is shown in Table 2.

TABLE 1: A Section of the SOMA Questionnaire

	Actual % change during three months to 30 Sept., 1974		Expected % change during six months to 31 March, 1975	
	UP	DOWN	UP	DOWN
COSTS Average change in unit costs all items	%	%	%	%
PRICES Average change in unit price (commercial basis) of goods manufactured by this establishment	%	%	%	%

TABLE 2: Sample Size Analysed by Industry

Industry	Minimum Response	Maximum Response	Mean Response	Number of Firms Answering All Thirteen Surveys
Food, Beverages and Tobacco	57	106	83	25
Textiles	27	39	33	13
Clothing and footwear	59	80	71	23
Wood, Wood Products and Furniture	20	29	25	10
Paper and Paper Products, Printing and Publishing	15	22	20	8
Chemicals, Petroleum and Coal Products	51	68	62	24
Glass, Clay and other Non-Metallic Mineral Products	26	31	28	10
Basic Metal Products	59	69	64	30
Fabricated Metal Products	37	56	49	19
Transport Equipment	49	62	56	22
Other Industrial Machinery and Equipment	125	175	159	65
Leather, Rubber and Plastic Products and Manufacturing n.e.c.	36	46	41	16
All Manufacturing Industries	587	756	690	265

Some cross-checking with ABS data has been undertaken in order to establish the reliability of the SOMA data. The two series which were compared were employment and prices. On an employment basis it was clear that the SOMA sample is somewhat over-concentrated, relative to the ABS employment data, on industries in which the average firm size (in employment terms) is largest, and under-represented in industries in which the average firm size is smallest.[7] This bias in favour of large firms is probably desirable from the point of view of analysing short-term industry trends, although it should be clearly stated that the sample is therefore not a truly random selection of firms in the manufacturing sector. The price changes reported in the survey[8] were compared on an industry basis with quarterly percentage change figures derived from the ABS figures for the Price Index of Materials Produced by Manufacturing Firms.[9] For the manufacturing sector as a whole the two series move closely together; the correlation coefficients between the two series is significant at the five per cent level in eight industries, and significant at the ten per cent level in an additional three industries.[10]

Turning to the expectations data themselves, the first problem to be encountered is that the expectations cover a six month period whilst the actual price and cost change data are quarterly. It was decided to work on a quarterly basis throughout, with expectations defined over a single quarter, and hence the expectations data were converted appropriately.[11] Some summary information on the resulting quarterly expectations data is shown in Table 3. Firms' price expectations were on average underpredictions, with the exception of the last quarter of 1974 and the first half of 1975. Cost expectations were on average underpredictions of future cost movements throughout the sample period. In addition, both the mean forecast, and the mean forecast error, were, with one exception, higher for cost changes than for price changes. The tendency for firms generally to underpredict future movements in their own prices is in contrast to the findings of Defris and Williams [8, 9] on the accuracy of consumers' expectations of future movements in consumer goods prices. They concluded that consumers tended on average to overpredict future price movements, particularly since mid-1975. Taken together these findings on firms' and workers' price expectations have important implications for the wage determination process and would at least partly explain why the wage settlement procedures proved so difficult during the mid-1970's, with the resultant increase in industrial unrest and disputation.

TABLE 3: Summary Statistics on Price and Cost Change Expectations

Quarter	Price Expectations				Cost Expectations			
	Mean	Standard Deviation	Mean forecast error (per cent)	Percentage of firms with positive forecast errors (i.e. $P_t - P^*_{t-1} > 0$)	Mean	Standard Deviation	Mean forecast error (per cent)	Percentage of firms with positive forecast errors (i.e. $C_t - C^*_{t-1} > 0$)
Sept., 1973	2.68	2.66	1.27	53.2	3.25	2.60	1.85	73.4
Dec., 1973	3.43	2.68	0.81	50.7	4.03	3.00	2.28	75.5
March, 1974	5.41	3.45	1.23	56.7	6.00	3.57	2.68	71.9
June, 1974	4.35	3.19	3.57	74.6	5.08	2.98	6.24	88.1
Sept., 1974	4.12	2.99	1.59	61.7	4.79	2.77	3.32	79.5
Dec., 1974	3.60	2.74	-0.11	47.8	4.41	2.67	1.77	64.3
March, 1975	4.24	2.59	-0.18	44.0	4.72	2.60	0.80	56.1
June, 1975	3.58	2.43	-0.71	41.4	3.89	2.10	0.38	53.5
Sept., 1975	3.49	2.19	0.32	50.2	3.82	2.11	1.20	65.3
Dec., 1975	3.46	1.88	1.33	72.3	3.60	2.23	0.84	64.0
March, 1976	3.19	1.72	1.41	72.7	3.35	1.73	1.87	77.3

This brief summary of the SOMA data suggests that it is in certain regards non-random, though possibly deliberately so. In the light of this, care must be taken in generalising from the results which follow to the manufacturing sector as a whole. Nevertheless, the survey data represent a rich statistical source which is internally consistent throughout and, more importantly, allows analysis to be undertaken at the individual firm level. This is particularly desirable for testing models of expectations which, if they are to be given any behavioural sense, apply at the individual firm level.

3. Hypothesis Testing: Distributed Lag Models

The aim of this section is to consider how well the price and cost expectations described in the previous section conform to alternative expectations formation models. The analysis will be conducted using expectations data at the individual firm level, and estimating cross-section regression equations. The incorporation of lagged variables into these equations implies that only firms answering successive surveys could be considered. In order not to exclude too many firms, thereby losing too much sample information, the maximum lag was set at two quarters, so that only those firms who answered three consecutive surveys are included in the sample investigated below. Thus the number of firms investigated varied from quarter to quarter from between 506 and 631, with a mean sample size of 571.

As some previous authors (Rutledge, Valentine) have warned, it is a difficult task to choose between alternative expectations models when they are applied separately to the same body of data. The reason for this is that alternative expectations models in many circumstances give similar predictions and hence may fit a given data set equally well. Valentine [36] adopts an approach which combines alternative expectations models into a single equation, leaving it to the data to indicate which model is relatively superior. An amended form of Valentine's approach is used here in an attempt to assess the relative merits of the two most commonly-used and tested expectations models. These two models are the adaptive expectations model and the extrapolative model, which are shown respectively in equation (2) and (3) below.[12]

$$P^*_t = \lambda P_t + (1 - \lambda)P^*_{t-1} \qquad (2)$$

$$P^*_t = P_t + \theta(P_t - P_{t-1}) \qquad (3)$$

All variables are expressed as quarterly percentage rates. The adaptive coefficient (λ) is expected to fall in the range $0 \leq \lambda \leq 1$, whilst the extrapolative coefficient (θ) can be either positive (the extrapolative case) or negative (the regressive case).

These two models were estimated using cross-section data on firms in the manufacturing sector. The estimated equations included intercept terms,[13] *and took the following forms:*

$$P^*_t = \alpha_0 + \alpha_1 P_t + \alpha_2 P^*_{t-1} \qquad (2')$$

$$P^*_t = \beta_0 + \beta_1 P_t + \beta_2(P_t - P_{t-1}) \qquad (3')$$

The restrictions implied by (2) and (3) are, respectively,

$$H_I : \alpha_1 + \alpha_2 = 1 \quad \text{and} \quad H_{II} : \beta_1 = 1$$

These restrictions were rejected strongly for both price and cost expectations in each quarter considered, in favour of the alternative hypotheses $\alpha_1 + \alpha_2 < 1$ and $\beta_1 < 1$. In general the individual coefficients were significant and of the anticipated sign, with the exception of α_1 which was significant and positive in only four quarters for price expectations and eight quarters for cost expectations. The coefficient β_2 was significant and negative in all but one quarter, indicating an element of regressivity in price and cost expectations formation. The explanatory power of both models was quite low, the R^2 falling in the range from 0.03 to 0.30, although it was always higher for the adaptive model.

It is possible that the rejection of the restriction implied by (2) and (3) is due to the fact that by estimating these models for all firms combined, it is implicitly assumed that the coefficients in the models are the same for all firms. As Bierwag and Grove [1] have shown with respect to the adaptive model, the model only applies in the aggregate if all individuals have the same adaptive coefficient (λ).[14] *If this argument is relevant in this case, one would expect to find that the restrictions* implied by (2) and (3) might be satisfied if the analysis were conducted at a lower level of aggregation. In order to check this possibility, equations (2') and (3') were estimated separately for each of the twelve industries shown in Table 2, and the restrictions implied by (2) and (3) were tested separately for each industry, for each quarter. This gives for each hypothesis a total of 132 tests (12 industries; 11 quarters), for price and cost expectations. The number of cases in which the restrictions could not be rejected and in which the individual coefficients in the restricted models had the correct sign and were significant are shown in Table 4. Both null hypotheses were rejected in approximately 90 per cent of cases, and thus the tests at the disaggregated level do not suggest that the poor performance of (2) and (3) at the aggregate level is due solely to the aggregation process itself.

In order to develop an integrated model which takes account of the above results, equation (2) will be written in the form:

$$P^*_t = \lambda\gamma \; P_t + (1-\lambda)\, P^*_{t-1} \qquad (\gamma < 1) \qquad (2'')$$

This can be written in the alternative form used by Valentine:

$$P^*_t - P^*_{t-1} = \lambda(\gamma\, P_t - P^*_{t-1}) \qquad (4)$$

The sum of the weights in this model is equal to γ, which is less than unity. Assuming that a proportion (W_1) of the population form expectations on the basis of the amended adaptive model $(2'')$[15], whilst the remaining $(1 - W_1)$ use the unconstrained extrapolative model (3'), the aggregate expected inflation rate is given by:

$$P^*_t = \theta_0 + \theta_1 P_t + \theta_2 (P_t - P_{t-1}) + \theta_3 (P_t - P^*_{t-1}) \qquad (5)$$

where

$$\theta_0 = W_1 \alpha_0 + (1 - W_1)\beta_0$$

$$\theta_1 = W_1 \gamma\lambda + (1 - W_1)\beta_1 + W_1 (1-\lambda)$$

$$\theta_2 = (1 - W_1)\beta_2$$

$$\theta_3 = -W_1 (1 - \lambda)$$

TABLE 4: *Hypothesis Testing of the Adaptive and Extrapolative Models at the Industry Level*

Hypotheses	Price Expectations: Number of cases in which the hypothesis could not be rejected	Price Expectations: Percentage of all cases tested	Cost Expectations: Number of cases in which the hypothesis could not be rejected	Cost Expectations: Percentage of all cases tested
H_I: $\alpha_1 + \alpha_2 = 1$ in equation (2')	13	9.8	12	9.1
H_{II}: $\beta_1 = 1$ in equation (3')	2	1.5	2	1.5

The model in this form contains both extrapolative and adaptive terms and thus allows one to assess whether either or both expectations models are appropriate. Excluding the intercept term, (5) contains three parameters and five unknowns, so that we cannot identify the individual coefficients in the expectations models. More importantly, we cannot derive an estimate of W_1, which measures the relative importance of the two models. We can, however, derive the following a priori restrictions on the parameters in (5):

(i) $\theta_1 < 1$ (since $\gamma < 1$, $\beta_1 < 1$ and $\lambda > 0$)

(ii) θ_2 has an indeterminate sign which depends upon whether expectations are extrapolative ($\beta_2 > 0$) or regressive ($\beta_2 < 0$)

(iii) $-1 < \theta_3 \leq 0$

Estimates of (5) are presented for price and cost change expectations in Tables 5A and 5B respectively. For comparative purposes the time series estimates are also shown in the last line of the two tables.[16] *In the cross-section results for both price and cost change expectations the individual coefficients are significant and of the correct sign in almost all cases. There is a tendency for the extrapolative term to be less significant than the adaptive term in all cases, and the extrapolative term is not significant in two cases for prices and six cases for costs. In those cases when the extrapolative term is significant, it always indicates an element of regressivity in the formation of expectations. These cross-section results therefore confirm the major conclusion of the time series work previously undertaken, that there is a significant component of error learning behaviour in the formation of expectations, although there also appears to be a significant role for the extrapolative term in particular periods.*

Two further tests confirm the greater importance of the adaptive as compared to the extrapolative element in expectations formation. Firstly, equation (5) was estimated separately for each industry, 132 cases in all, for both prices and costs. . The adaptive term performed much better than the extrapolative term, being significant in 73, as opposed to 37, cases for

TABLE 5A: Estimates of the Integrated Price Expectations Model for Firms in the Manufacturing Sector

$$P^*_t = \theta_0 + \theta_1 P_t + \theta_2(P_t - P_{t-1}) + \theta_3(P_t - P^*_{t-1})$$

Quarter	Number of Observations	θ_0	θ_1	θ_2	θ_3	R^2	F
S 73	380	1.855 (9.45)	0.327 (5.94)	-0.097 (3.16)	-0.242 (3.86)	0.091	12.62
D 73	402	2.102 (10.21)	0.502 (8.84)	-0.084 (2.79)	-0.388 (6.97)	0.165	26.14
M 74	371	3.894 (13.66)	0.478 (7.38)	-0.092 (2.51)	-0.481 (6.96)	0.140	19.83
J 74	394	2.439 (8.79)	0.315 (7.42)	-0.066 (2.40)	-0.208 (5.12)	0.140	21.19
S 74	422	2.422 (8.75)	0.370 (7.94)	-0.019 (1.03)	-0.311 (5.91)	0.134	21.64
D 74	482	1.633 (7.69)	0.449 (11.33)	-0.047 (2.49)	-0.397 (9.74)	0.215	43.54
M 75	478	2.765 (14.16)	0.418 (9.71)	-0.020 (1.08)	-0.391 (9.27)	0.175	33.47
J 75	472	1.382 (7.66)	0.536 (14.40)	-0.086 (4.82)	-0.473 (12.47)	0.312	70.81
S 75	445	2.125 (11.67)	0.363 (8.68)	-0.040 (1.93)	-0.299 (6.84)	0.146	25.16
D 75	305	1.475 (7.07)	0.523 (10.95)	-0.112 (4.67)	-0.373 (6.98)	0.299	42.74
M 76	260	1.328 (7.00)	0.484 (10.99)	-0.067 (2.70)	-0.359 (7.65)	0.323	40.73
J73-M76	12	1.478 (2.88)	0.613 (4.28)	0.074 (0.55)	-0.671 (2.87)	0.705	6.38

Note: t-statistics are shown in brackets.

TABLE 5B: Estimates of the Integrated Cost Expectations Model for Firms in the Manufacturing Sector

$$C^*_t = \theta_0 + \theta_1 C_t + \theta_2(C_t - C_{t-1}) + \theta_3(C_t - C^*_{t-1})$$

Quarter	Number of Observa-tions	θ_0	θ_1	θ_2	θ_3	R^2	F
S 73	407	1.984 (10.65)	0.320 (6.90)	-0.058 (2.77)	-0.168 (3.07)	0.143	22.48
D 73	426	2.463 (9.21)	0.459 (7.26)	-0.021 (0.68)	-0.378 (5.55)	0.112	17.69
M 74	409	4.222 (13.04)	0.443 (7.39)	-0.055 (1.53)	-0.404 (6.75)	0.127	19.64
J 74	435	2.245 (8.33)	0.413 (11.11)	-0.108 (5.51)	-0.259 (6.36)	0.247	47.07
S 74	470	2.510 (9.04)	0.332 (8.11)	-0.029 (1.79)	-0.188 (4.01)	0.169	31.64
D 74	512	1.810 (7.74)	0.472 (12.17)	-0.069 (3.65)	-0.358 (8.71)	0.237	52.59
M 75	512	3.017 (13.17)	0.395 (9.46)	-0.001 (0.02)	-0.438 (10.09)	0.175	35.91
J 75	519	1.896 (10.57)	0.421 (12.79)	0.005 (0.33)	-0.364 (11.15)	0.277	65.72
S 75	505	1.576 (8.82)	0.542 (14.09)	-0.019 (1.09)	0.434 (10.48)	0.290	68.20
D 75	488	1.801 (8.50)	0.437 (9.36)	-0.159 (6.94)	-0.435 (8.06)	0.250	53.75
M 76	461	1.167 (6.67)	0.560 (13.26)	-0.025 (1.24)	-0.457 (9.40)	0.290	62.18
J73-M76	12	1.515 (1.79)	0.611 (2.71)	-0.016 (0.13)	-0.560 (1.70)	0.530	3.01

Note: t-statistics are shown in brackets.

price expectations, and 74, as opposed to 27, cases for cost expectations. In addition the integrated model was re-estimated at the aggregate level, but defining both actual and expected inflation rates over six months rather than three months.[17] The effect of this for both price and cost expectations was to reduce the significance of the extrapolative term, as compared to Tables 5 A and 5 B, whilst having little or no effect on the other estimated coefficients. The extrapolative term remained significant (and negative) in only four cases for both price and cost expectations.

The estimates of the integrated model using aggregate time series data are shown in the last line of Tables 5 A and 5 B. In both cases the extrapolative term is not significant, and to this extent these results are consistent with other studies using time series data, e.g. Valentine [36]. Clearly the conclusions which follow from these equations differ markedly from those implied by the cross-section regressions, in which the role of the extrapolative term is more pronounced.

It is clear from the cross-section results in Tables 5 A and 5 B that the explanatory power of the integrated model is quite low, even though the variables considered are individually (and jointly) significant. This suggests that expectations are also subject to other influences which have not been incorporated in equation (5). Two possible omissions are additional lagged price and cost terms, and other (i.e. non-price and non-cost) variables. The former possibility is now explored, and the latter is investigated in the following section.

In including additional lagged terms into the model developed above, an obvious departure point is to replace the adaptive expectations model with a second order adaptive expectations model of the following form:

$$P^*_t - P^*_{t-1} = \lambda_1(P_t - P^*_{t-1}) + \lambda_2(P_{t-1} - P^*_{t-2}) \qquad (6)$$

This model has been applied to the United Kingdom by Carlson and Parkin [4], Smith [29], and Holden and Peel [14], and to Australia by Danes [6], Valentine [36] and Defris and Williams [9]. In a similar fashion, higher order extrapolative terms could also be included in the model. Consider the following general model of expectations, which contains both autoregressive elements (P^*_{t-1}, P^*_{t-2}) and distributed lag elements (P_t, P_{t-1}, P_{t-2}) as determinants of the expected rate of inflation:

$$P^*_t = \delta_o + \delta_1 P_t + \delta_2 P_{t-1} + \delta_3 P_{t-2} + \delta_4 P^*_{t-1} + \delta_5 P^*_{t-2} \qquad (7)$$

Particular expectations models can now be viewed as special cases of the general model (7), in which parameter restrictions are imposed on the δ_i . Thus, for example, the integrated model considered above imposes the restrictions $\delta_3 = \delta_5 = 0$ on (7), which is then re-written in the following form (which is equivalent to (5)):

$$P^*_t = \delta_O + (\delta_1 + \delta_2 + \delta_4)P_t - \delta_2(P_t - P_{t-1}) - \delta_4(P_t - P^*_{t-1}) \qquad (8)$$

In addition to the general model, the special cases which were considered, and the restrictions they imply on the general model, are shown in Table 6.

The strategy adopted was to test the hypotheses H_1 to H_6 shown in Table 6 against the general model. If all six hypotheses were rejected, then the general model was selected. If only one hypothesis could not be rejected then this model was selected, whilst if a number of hypotheses could not be rejected, that with the highest $\bar{R}^2$ was selected.[18] The resulting model selections are shown in Tables 7A and 7B . The general picture which emerges from these tests is that there is no single expectations model which is consistently selected. For price expectations the estimated coefficients generally have the correct sign, with the most strongly determined variables being the intercept, P_{t-1} and P^*_{t-1} . There is a tendency for the second order terms (P_{t-2} , P^*_{t-2}) to become more significant from mid-1975 onwards, possibly reflecting the effects of the largely underanticipated inflation of 1974. For cost expectations the results are broadly similar, although the current cost term (C_t) is not always of the correct sign. The lags in cost expectation formation appear to be longer than for price expectations, with the second order terms being positive and significant in ten, as opposed to six, cases. Again the second order terms become more significant from mid-1975. Until this time the explanatory power of the first order integrated model is as great, for both price and cost expectations, as the explanatory power of the selected models shown in Tables 7A and 7B . The models selected on the basis of the time series estimates are shown in the last line of the tables. For both price and cost expectations none of the hypotheses tested could be rejected although in both cases the autogressive model was selected on the basis of its higher $\bar{R}^2$.

TABLE 6: A General Distributed Lag Expectations Model, And Some Special Cases.

Model Name	Restrictions Imposed on the General Model	Hypothesis Number
1. General Model (Equation 7)	None	
2. Static Expectations Model	$\delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$	H_1
3. Unconstrained First Order Adaptive Model	$\delta_2 = \delta_3 = \delta_5 = 0$	H_2
4. First Order Integrated Model	$\delta_3 = \delta_5 = 0$	H_3
5. Distributed Lag Model	$\delta_4 = \delta_5 = 0$	H_4
6. Autoregressive Model	$\delta_1 = \delta_2 = \delta_3 = 0$	H_5
7. Unconstrained* Second Order Adaptive Model	$\delta_3 = 0$	H_6

* The second order adaptive model was considered in an unrestricted form only since the restrictions implied by equation (6) were decisively rejected in all cases.

TABLE 7A: Preferred Forms of the General Price Expectations Model

$$P^*_t = \delta_o + \delta_1 P_t + \delta_2 P_{t-1} + \delta_3 P_{t-2} + \delta_4 P^*_{t-1} + \delta_5 P^*_{t-2}$$

Quarter	Expectations Model	δ_o	δ_1	δ_2	δ_3	δ_4	δ_5	R^2	F
S 73	General Model	1.697 (8.33)	-0.021 (0.60)	0.059 (1.74)	0.065 (2.50)	0.208 (3.24)	0.107 (2.04)	0.109	9.11
D 73	Unconstrained Second Order Adaptive Model	2.055 (9.82)	0.028 (0.99)	0.068 (2.04)	0*	0.366 (6.22)	0.066 (1.19)	0.168	19.98
M 74	First Order** Integrated Model	3.894 (13.66)	-0.095	0.092	0*	0.481	0*	0.140	19.83
J 74	Unconstrained Second Order Adaptive Model	2.312 (7.91)	0.039 (1.77)	0.048 (1.56)	0*	0.193 (4.58)	0.090 (1.37)	0.144	16.35
S 74	First Order** Integrated Model	2.422 (8.75)	0.040	0.019	0*	0.311	0*	0.134	21.64
D 74	First Order** Integrated Model	1.633 (7.69)	0.005	0.047	0*	0.397	0*	0.215	43.54
M 75	First Order** Integrated Model	2.765 (14.16)	0.007	0.020	0*	0.391	0*	0.175	33.47
J 75	Unconstrained Second Order Adaptive Model	1.251 (6.54)	-0.019 (0.86)	0.076 (4.14)	0*	0.439 (10.59)	0.079 (2.00)	0.318	54.45
S 75	Autoregressive Model	1.640 (8.50)	0*	0*	0*	0.191 (4.29)	0.251 (6.33)	0.208	58.11
D 75	General Model	1.325 (6.16)	0.023 (0.78)	0.101 (4.13)	0.078 (3.59)	0.356 (6.42)	0.004 (0.08)	0.323	29.9
M 76	Unconstrained Second Order Adaptive Model	1.150 (5.66)	0.055 (1.89)	0.042 (1.54)	0*	0.319 (6.43)	0.119 (2.32)	0.337	32.4
S73-M76	Autoregressive Model	1.668 (2.45)	0*	0*	0*	0.730 (2.16)	-0.186 (0.75)	0.514	4.2

* This coefficient was constrained to zero in the estimation.
** t-statistics are not available on the coefficients on the First Order Integrated Model written in this form.

TABLE 7B: Preferred Forms of the General Cost Expectations Model

$$C^*_t = \delta_0 + \delta_1 C_t + \delta_2 C_{t-1} + \delta_3 C_{t-2} + \delta_4 C^*_{t-1} + \delta_5 C^*_{t-2}$$

Quarter	Expectations Model	δ_0	δ_1	δ_2	δ_3	δ_4	δ_5	R^2	F
S 73	General Model	1.802 (9.37)	0.078 (3.02)	0.030 (1.34)	0.058 (2.89)	0.172 (3.16)	0.064 (2.21)	0.166	16.00
D 73	Unconstrained First Order Adaptive Model	2.496 (9.50)	0.062 (2.05)	0*	0*	0.393 (6.11)	0*	0.111	26.34
M 74	Autoregressive Model	4.184 (13.08)	0*	0*	0*	0.378 (6.68)	0.105 (1.42)	0.126	29.29
J 74	Unconstrained Second Order Adaptive Model	2.073 (7.50)	0.045 (2.44)	0.090 (4.29)	0*	0.231 (5.51)	0.118 (2.50)	0.251	37.29
S 74	First Order** Integrated Model	2.510 (9.04)	0.115	0.029	0*	0.188	0*	0.169	31.64
D 74	Unconstrained Second Order Adaptive Model	1.705 (6.79)	0.045 (2.18)	0.060 (2.95)	0*	0.348 (8.28)	0.045 (1.13)	0.233	39.78
M 75	General Model	2.926 (11.71)	-0.056 (2.78)	-0.010 (0.51)	0.074 (4.25)	0.439 (9.18)	-0.083 (1.87)	0.205	26.12
J 75	General Model	1.604 (8.32)	0.059 (3.30)	-0.027 (1.77)	0.027 (1.88)	0.316 (9.01)	0.103 (2.93)	0.297	43.35
S 75	General Model	1.185 (6.10)	0.085 (4.36)	-0.006 (0.35)	0.049 (3.77)	0.385 (8.58)	0.095 (2.75)	0.321	47.10
D 75	Unconstrained Second Order Adaptive Model	1.458 (6.64)	-0.157 (6.53)	0.134 (5.83)	0*	0.307 (5.19)	0.240 (4.75)	0.283	47.74
M 76	Unconstrained Second Order Adaptive Model	0.987 (5.44)	0.073 (3.58)	0.002 (0.08)	0*	0.393 (7.54)	0.141 (3.28)	0.306	50.31
J73-M76	Autoregressive Model	2.106 (2.21)	0*	0*	0*	0.760 (2.31)	-0.273 (0.97)	0.442	3.16

*)
**) See Table 7A.

It is clear from the estimates in Tables 7A and 7B that the model of expectations, as well as the coefficients of the model (including the intercept) exhibit considerable instability when estimated over different quarters. This suggests that it is not appropriate to apply a fixed model for successive periods, as most time series studies do. The form of the model itself appears to be endogenous. Certainly it is not surprising to find, as Valentine does, that time series expectations models exhibit considerable instability when estimated over different time periods. The results presented here suggest that this conclusion applies even to different quarters in a given time period.

4. The Influence of Other Economic Variables

Even with the inclusion of second order terms, it is apparent that models which include distributed lag variables only have a relatively low explanatory power for manufacturers' price and cost expectations. This suggests that expectations may be affected by variables other than those included in the distributed lag models. Studies by Jonson and Mahoney [15], Davy [7] and Defris and Williams [9] suggest that the most likely variables in the case of price expectations are wage (or earnings) changes, and money supply growth rates. If manufacturers' expectations are affected by variables which have not been included in the distributed lag models, and if the effects of these variables are assumed to be the same for all firms, then it follows that changes in these omitted variables will be reflected in changes in the intercept term in the cross-section regression equations.[19] The results in Tables 5A, 5B, 7A and 7B, indicate that the intercept term, whilst always significant, is susceptible to considerable quarter to quarter variations. The relative and absolute intercept estimates are very similar in Tables 5A and 7A, and in Tables 5B and 7B, and hence only the estimated intercepts in Tables 7A and 7B need be considered.

The other variables investigated were quarterly percentage changes in seasonally adjusted average weekly earnings (ΔAWE), quarterly percentage changes in minimum wage rates (ΔMWR), and the quarterly ($\Delta M3$) and annual ($4Q\Delta M3$) changes in the broadly defined money supply. Each of these variables was lagged one quarter. In the case of price expectations the quarterly expected change in unit costs (C^*), as reported in the SOMA survey, was also *investigated. Each variable was investigated separately because of the short run of time series data, and hence the small number of estimated intercept terms. In order to construct a composite index of the effects of all non-price variables, on the formation of price expectations, I asked several of my colleagues to partake in the following experiment.*[20] *I asked them each to read the* <u>*Diary of Recent Economic Events and Policy Statements*</u> *published in the* <u>*Australian Economic Review*</u> *which covered the sample period. They were asked to specify in qualitative terms what they thought the net effects of the events and statements listed would be on expectations held by manufacturing firms of movements in their prices in the following quarters. They were not told for what specific purpose their replies were required. An index (Z) was constructed using Theil's Balance Statistic Method:*

$$Z = \frac{IN - DC}{IN+DC+NNE+DK}$$

where IN, DC NNE and DK were the number of replies indicating the predicted effects on price expectations would be 'increase', 'decrease', 'no net effect' and 'don't know', respectively.

Each of these six variables was correlated with the estimated intercept terms shown in Table 7A in the price expectations models, and the first four variables were correlated with the estimated intercept terms in the cost expectations models shown in Table 7B.[21] *With one exception the correlation coefficients were low and not significant, the highest non-significant coefficient being 0.28 between the price expectations intercept and Z, and 0.27 between the cost expectations intercept and* $\Delta 4QM3$. *The only significant correlation coefficient, equal to 0.72, was between the price expectations intercept and C*, the (employment-weighted) mean expected unit cost change. The variables were also entered, one at a time, into the selected time-series expectations models shown in Tables 7A and 7B, with the following results. For cost expectations none of the (four) variables tried was significant; the two monetary variables appeared with a negative sign. For price expectations both C* and Z were significant and positive, although the others were not significant, and were all negative. The significant results are shown below:*

$$P^*_t = 0.113 + 0.469P^*_{t-1} - 0.128P^*_{t-2} + 0.596C^*$$
$$(0.20) \quad (2.22) \qquad (0.87) \qquad (3.97)$$

$$R^2 = 0.850 \; : \; dw = 2.88$$

$$P^*_t = 2.505 - 0.145P^*_{t-1} + 0.370P^*_{t-2} + 0.944Z$$
$$(3.54) \quad (0.28) \qquad (1.08) \qquad (2.04)$$

$$R^2 = 0.695 \; : \; dw = 2.40$$

In assessing these equations, it should be borne in mind that they are estimated from only eleven observations and that in both cases the Durbin-Watson statistics fall into the inconclusive region for the test of negative first order serial correlation. In the second equation,the autoregressive terms are no longer significant although the intercept remains significant and positive. Of greater interest is the first equation in which the first order autoregressive term remains significant and the C^* term is highly significant, whilst the intercept becomes insignificant. Both results provide evidence that price expectations are affected by non-price variables, mainly expected cost changes.[22] This makes intuitive sense when one remembers that the prices being forecast are the future prices of the manufacturers' own goods. Since there is a strong relationship between actual price and cost movements (Saunders [28]), it is not surprising to find, as both of the above tests indicate, that in forming forecasts of future price movements, manufacturing firms take into account expected future cost changes as well as past price movements.

Related to the question of whether or not other economic variables affect expectations is the issue of whether expectations can be considered rational in the Muthian sense. A test of the rationality of expectations has been developed by Turnovsky [33] and has been applied subsequently in Australia by Danes [6] and Hall [12]. The test is based on the observation that if individuals do behave rationally, then the predicted value of a variable will equal its statistical expectation. Predictions will therefore be unbiased, i.e., $P^*_{t-1} = E(P_t)$. If this is the case, then we should find $\alpha_0 = 0$ and $\alpha_1 = 1$ in the following regression model

$$P_t = \alpha_0 + \alpha_1 P^*_{t-1} + u_t \qquad (9)$$

Here u_t is a stochastic term which should satisfy the usual assumptions: $E(u_t) = O$, $E(u_t\ u'_t) = \sigma^2 I_t$. This test is, however, a test of the unbiasedness of expectations rather than their rationality. As Mahoney [18] points out, "the test is a poor one since it would be passed by any process which produced unbiased estimates of the inflation rate. Nothing very specific can therefore be deduced about the way agents form their expectations" (Mahoney [18], p.25).

A more rigorous test of the rationality of the expectations recognises that future predictions will depend upon the information set on which they are based, as well as on the way in which individuals process this information. McDonald [19] and McDonald and Woodfield [20] have argued that under certain conditions the optimal extrapolative expectations (OEE) method may be regarded as a useful approximation to rational expectations in situations where individuals do not have full information on the economic structure, and where information is costly to collect and process. Under the OEE method, a time series model of the variable of interest is estimated and used to forecast future movements, which are then taken as expectations. Alternatively, one can argue that non-price variables are likely to affect actual price changes in the full economic model and hence these variables should appear as determinants of future expected rates if individuals are rational. However, it cannot be inferred from the presence of non-price variables in price expectations models that these expectations are rational, since for rationality the non-price variable must be shown to affect both actual and expected prices in the same way. Thus if, in general, prices are determined by past price movements and by past movements in exogenous variables Z_j, we have:

$$P_t = \alpha_O + \sum_{i=1}^{i=n} \alpha_i P_{t-i} + \sum_{j=1}^{j=m} \beta_j Z_j \qquad (10)$$

We then estimate the expectations model:

$$P^*_t = \alpha'_O + \sum_{i=1}^{i=n} \alpha'_i P_{t-i} + \sum_{j=1}^{j=m} \beta'_j Z_j \qquad (11)$$

For rationality,[23] we should find that:

$$\alpha_i = \alpha'_i \ (i = O, 1, \ldots, n); \text{ and } \beta_j = \beta'_j \ (j = 1, \ldots, n)$$

More simply, one can estimate (10), use this to produce a forecast series ($\hat{P}_t$) for the actual rate of inflation, and then estimate the model:

$$P^*_t = \gamma_O + \gamma_1 \hat{P}_t + u_t \qquad (12)$$

Rationality then implies that $\gamma_0 = 0$, $\gamma_1 = 1$ *and* u_t *is generated by a white noise process. This is the kind of test used by Pesando* [25] *and McDonald and Woodfield* [20] *. The rationality test implied by equations (10)-(12) requires the specification and estimation of the structural price (and cost) equations (10). This has not yet been done, although some preliminary results reported in Saunders* [28] *are encouraging. Furthermore, the fact that the above results indicate that price expectations are significantly influenced by cost expectations suggests that the relationship between actual price and cost changes, reflected in firm's pricing behaviour, is also reflected in their predictions of future price movements.*

In the absence of this test, the unbiasedness test based on (9) was undertaken for both price and cost expectations. The cross-section results were generally unfavourable to the hypothesis. The estimate of α_0 *was significantly different from zero in all but one case for price expectations, and in all cases for cost expectations. For both price and cost expectations, the estimate of* α_1 *was not significantly different from unity in five cases. The time series estimates of (9) produced the following results:*

Price Expectations

$$P_t = \underset{(0.76)}{0.745} + \underset{(3.58)}{1.021}\, P^*_{t-1} \qquad R^2 = 0.561 \; : \; dw = 1.39$$

Cost Expectations

$$C_t = \underset{(0.14)}{-0.270} + \underset{(3.15)}{1.481}\, C^*_{t-1} \qquad P^2 = 0.497 \; : \; dw = 0.79$$

In both cases, the rationality hypothesis that $\alpha_0 = 0$ *and* $\alpha_1 = 1$ *cannot be rejected, although there is evidence of first order serial correlation in the cost expectations equation. The results for price expectations produce the same conclusions as Danes* [6] *and Hall* [12] *reached on the basis of the NSW-ACM data.*

5. Conclusions

The results presented here by and large speak for themselves and require little by way of summary. The use of cross-section analysis on this disaggregated data set has contributed to our understanding of the forces determining price and cost expectations in Australian manufacturing firms.

The main conclusions from the cross-section results are that there exists a considerable degree of inter-temporal instability in expectations models, particularly since 1975. This has important implications for the estimation of time-series expectations models, particularly those which extend beyond 1974. Not surprisingly, the conclusions reached on the basis of time-series estimates differ considerably from those derived from the cross-section estimates. Up until mid-1975 both price and cost expectations could be reasonably well explained by a combination of first order adaptive and extrapolative components. From 1975 onwards second order terms also exerted an influence on expectations.

The unbiasedness test of rationality suggested that both price and cost expectations did not satisfy this criterion when the cross-section analysis was employed. However it does appear that firms take account of expected cost changes in predicting future price movements. Whether or not this evidence supports the view that firm's price expectations are rational in the sense implied by equations (10) and (11) has not yet been established. However, given the strong correlations which exist between price and unit cost changes, it is difficult to distinguish between price expectations models which include only lagged price terms, and those which are based on the rational use of a price determination model which includes only lagged cost terms. Cost changes are not under the control of firms and thus it is not surprising to find that firms form cost expectations on the basis of distributed lag models. In the case of price expectations however, it appears that firms do not form expectations of future movements in their own prices independently of their actual price determination behaviour.

FOOTNOTES

1 The polynomial thus takes the general form:

$$B(L) = b_0 + b_1 L + b_2 L^2 + \ldots + b^n L^n$$

2 The Associated Chamber of Manufacturers now comes within the Confederation of Australian Industry.

3 The Balance Statistic (Z) is defined as $Z = (U - D) \div (U + D + S)$ where U, D and S are the proportion of firms indicating that they expected their prices to rise, fall or stay constant, respectively.

4 These models, and their implied parameter restrictions, are specified in detail in Section 3 .

5 The questionnaires are dated 31st March, 30th June, 30th September and 31st December respectively, and request information which covers the period for the three months prior to this date, and expectations covering the six proceeding months.

6 With the exception of capacity, costs and prices, firms are asked to give absolute values of the variables requested. The SOMA Bulletins however, being concerned mainly with providing information on short-term trends, publishes all of the series in percentage change form.

7 The bias in favour of large firms may well be deliberate on the part of the sampling body, in terms of the kinds of firms to which the questionnaires are sent.

8 The SOMA figures were weighted by current sales. Thus they are not strictly comparable to the ABS figures which are on a net sector basis, and weighted by (net sector) production in a base year. In addition, the SOMA figures are collected in percentage change form and generally rounded by the respondents to the nearest whole number whereas the ABS figures are collected in absolute level form, from which the quarterly percentage changes have been calculated.

9 ABS Reference No. 9.14.

10 Since the March Quarter 1975, the SOMA Bulletins have presented estimated standard errors for the quarterly percentage change statistics for each indicator. The estimated standard errors for both the price and cost change series is at most 1% in all of the surveys considered here, and is frequently much less than this.

11 Thus if P^*_6 represents the forecast inflation rate over the next six months, and P^*_3 the implies quarterly forecast, P^*_3 was calculated as follows:

$$P^*_3 = 100 \ [(1 + 0.01.\ P^*_6\ )^{\frac{1}{2}} - 1)]$$

12 The equivalent cost expectations models contain C^*_t and C_t in place of P^*_t and P_t respectively.

13 The interpretation of the intercept terms is discussed in Section 4 below.

14 Bierwag and Grove go on to demonstrate that the aggregate model is a simple unconstrained distributed lag model. Furthermore, "the greater the diversity of expectations in the market, the greater the number of lags in the final form. Some transactors in the market may have identical coefficients of adjustment. If so, these transactors may be aggregated into a set that forms a single pole of opinion .... the number of lagged values .... is exactly equal to the number of poles of opinion in the market." (Bierwag and Grove, 1966, p.830).

15 The intercept term, α_0, has been included in the amended adaptive expectations model.

16 In the time series regressions the individual firm's price change expectations were weighted by sales, whilst the individual cost expectations were weighted by employment. This conforms to the procedure used in the SOMA Bulletins.

17 In this case the six monthly price change ($P_{6,t}$) was calculated in terms of the current ($P_{3,t}$) and previous ($P_{3,t-1}$) quarterly price changes as follows:

$$P_{6,t} = 100 \ [(1 + 0.01.P_{3,t}).\ (1 + 0.01.P_{3,t-1}) - 1]$$

18 It should be noted that in the cases where more than one hypothesis could not be rejected, the $\bar{R}^2$'s for the relevant models were generally extremely close, often differing only on the third decimal place.

19 These effects may also be reflected in the size of the coefficients in the distributed lag models, including whether particular coefficients are zero or not.

20 Those who took part were Robert Brown, Louis Haddad, Peter Kriesler, Tony Phipps, Russell Ross and Judy Yates. I would like to thank them all for their co-operation.

21 The last two variables considered, C* and Z, are relevant only to price expectations.

22 *The respondents referred to in footnote 20 were invited to specify the reasons for their replies if they wished. In most cases it was clear that cost factors were of major importance in determining their responses.*

23 *Note that the test in this form is based on the predictions from a structural equation, and not from the reduced form equation, of the appropriate model.*

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3	N.V. Lam	*Journal of the Developing Economies*, Vol. 17, no. 1, March 1979.
4	V.B. Hall & M.L. King	*New Zealand Economic Papers*, 1976, 118-51.
5	A.J. Phipps	*Economic Record*, September 1977, 297-319.
6	N.V. Lam	*Journal of Development Studies*, Vol. 14, No. 1, October 1977.
7	I.G. Sharpe	*Australian Journal of Management*, April 1976, 85-106.
13	I.G. Sharpe & P.A. Volker	*Kredit Und Kapital* , 1978.
21	R.L. Brown	*Australian Journal of Management*, Vol. 3, No. 1, April 1978, 17-36.
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