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How do firms react react to surprising changes in demand?: a vector autoregressive analysis using business survey data

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How do Firms React to Surprising Changes to Demand?: A Vector Autoregressive Analysis Using Business Survey Data [+]

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Abstract

The way in which economic agents respond to unexpected changes to demand is a central issue in contemporary business cycle theories. In the new-classical approach, surprising changes to demand cause unexpected changes to prices which in turn cause unexpected quantity changes. In the new-Keynesian approach, which is characterised by sluggish price adjustment, price expectation errors do not play such an important role in the transmission of surprising changes in demand to changes in output and employment in the short run. Although several empirical papers have used macro data to evaluate this issue there are very few results available that have used direct measures of expectation errors from micro panel data. This paper uses micro panel data from a New Zealand quarterly tendency survey to derive expectation errors for nine variables over an unusually long period of 24 years. A vector-autoregressive model is estimated and used to simulate the dynamic reaction of manufacturers to surprising changes to demand. The results suggest that the new-Keynesian approach is a more appropriate characterisation of the behaviour of New Zealand manufacturers. Unexpected changes to demand are important in explaining unplanned changes in output, inventories, labour turnover and overtime. Selling price, cost and employment expectation errors are not particularly sensitive to surprising changes to demand.

Key words: expectation errors, business cycles, micro panel data, vector-autoregessive model.

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1. Introduction and Brief Survey

There are essentially two views in contemporary business cycle theories about how firms react to unexpected changes in demand. In the new-Keynesian approach, which is characterised by sluggish price adjustment, surprising changes in demand result primarily in unexpected changes to the quantity of output and employment in the short run. In the new-classical approach, surprising changes to demand cause unexpected price changes which in turn precipitate previously unplanned quantity changes, at least in the short-run.

Price expectation errors are the crucial link between surprising changes in demand and output in the new-classical model. This link evolved from an attempt by Lucas (1972, 1973) to provide an equilibrium explanation for co-movements of output and prices generally. In the initial models developed by Lucas, imperfect information is the *deus ex machina* to resolve the conflict between the assumption of market clearing and the existence of business cycles. This idea is typically represented by a variant of the model used by Sargent and Wallace (1975), see for instance McCallum (1980):

$$y_t = \alpha (m_t - p_t) + u_t \tag{1}$$

$$y_t = \beta (p_t - E_{t-1}p_t) + v_t \tag{2}$$

$$m_t = \gamma_1 y_{t-1} + \gamma_2 m_{t-1} + z_t \tag{3}$$

Equation (1) is an elementary aggregate demand function. Equation (2) is an aggregate supply function based on the idea that producers cannot accurately distinguish between general and relative price components of prices for their own output. Equation (3) is a policy reaction function describing the generation of the money stock. $E_{t-1}x_t$ denotes the rational expectation of x_i computed using the equations of the model and the values of all relevant variables realised in periods t-i (for i = 1, . .). The symbols u_t, v_t, z_t denote random disturbance terms representing unsystematic forces impinging on the economy. These disturbances are assumed to have zero means and constant variances and to be stochastically independent of variables and disturbances.

Table 1 shows that in this rudimentary new-classical model, price and output expectation errors are both related to contemporaneous stochastic disturbances in the aggregate demand, supply and policy functions. The key assumptions used to derive these relationships are that agents form rational expectations, prices are flexible and markets clear continuously. The last two assumptions are dispensed with in the new-Keynesian approach.

New-Keynesian macroeconomics almost exclusively focuses on explaining the 'sluggish' behaviour of prices and wages and the implications for the business cycle (see Chapters 8 and 9 of Blanchard and Fischer, 1989 for a review). The consequence of this type of nominal price behaviour is that prices are prevented from moving equi-proportionately to nominal demand movements so that real output becomes a residual rather than a choice variable. In particular, if prices are predetermined there need be no systematic relationship between price and output expectation errors - although that will depend on the precise nature of the pricing rule.

This point is easily illustrated by introducing an alternative to the new-classical pricing rule. An example is the pricing rule suggested by McCallum (1982) which is similar to the idea of staggered wage contracts first used in the context of macroeconomic models by Fischer (1977) and Taylor (1979). Prices for period t are set at the end of period t-1 at a level that is expected to make the quantity demanded equal to a weighted average of y_{t-1} and the 'natural' rate of output, $\bar{y}_t$. There are two basic ideas justifying this price setting rule: firms find it optimal to meet all demand at the quoted price; and firms experience adjustment costs whenever y_t differs from y_{t-1} but also suffer opportunity costs whenever there is a discrepancy between y_t and $\bar{y}_t$. If both of these cost functions are quadratic, producers will aim at some value of output between y_{t-1} and $\bar{y}_t$, which can be denoted as $[\lambda y_{t-1}+(1-\lambda)y_t]$, where $0 \leq \lambda < 1$, reflecting the relative costliness of output changes. Consequently, the price level is set to satisfy equation (1) expectationally but with $y_t = \lambda y_{t-1}+(1-\lambda)E_{t-1}\bar{y}_t$, i.e,

$$\lambda y_{t-1}+(1-\lambda)E_{t-1}\bar{y}_t = \alpha (m_t - p_t) + u_t \tag{4}$$

If the log of the natural rate of output is assumed to deviate from its previous value by a random disturbance, e_t, so that

$$\bar{y}_t = \bar{y}_{t-1} + e_t \tag{5}$$

then, as Table 1 shows, output expectation errors will be related to contemporaneous demand and policy surprises but unrelated to contemporaneous price level surprises, which will be zero.

Empirical tests of the relationship between price surprises and real economic activity have taken various forms and produced mixed results. A distinction can be made between macro and micro data based tests. Lucas's (1973) initial macro data tests involved estimating the relationship between inflation volatility and output movements across countries. The rationale is that countries that had experienced volatile demand management would have a volatile price level and producers would not be very responsive to changes in demand, whereas countries with stable demand policies would have more predictable price levels and producers would be more responsive to changes in aggregate demand. This proposition seems to hold only for the more extreme cases; a similar conclusion can be drawn from the reexamination of Lucas's test by Froyen and Waud (1980).

TABLE 1. Predicted Relationship Between Contemporaneous Price and Output Expectation Errors

	$y_t - E_{t-1}y_t$	$p_t - E_{t-1}p_t$
Macroeconomic Model:		
Flexprice/Rational Expectations (New-classical pricing rule)	$\frac{\alpha}{\beta+\alpha}(\beta z_t + u_t + v_t)$	$\frac{1}{\beta+\alpha}(\alpha z_t + u_t + v_t)$
Fixprice/Rational Expectations (McCallum pricing rule)	$\alpha z_t + u_t$	zero

Evidence from estimated structural models using post-war United States macro data is provided by Sargent (1976) and Fair (1979). Sargent reports a negative effect of price surprises on the US unemployment rate, as the theory would suggest, but the magnitude of the effect is weak. Fair reestimated Sargent's model and found that this relationship varied according to the sample period. It has the wrong expected sign for the 1954 - 1977 period, is negative but insignificant for the 1954 - 1973 period, and negative but barely significant for the period 1951 - 1973 that had been estimated by Sargent. Fair's model also estimates the relationship between price surprises and labour force participation. This relationship is not significant over any period.

Since the initial papers by Barro (1977, 1978) there have been several macro studies focussing on the real effects of anticipated and unanticipated money supply changes. Although Barro and subsequent papers by Barro and Rush (1980) and Chen and Steindl (1987) found that for the US only unanticipated money had real effects, studies by Small

(1979) and Mishkin (1983) have contradicted that conclusion. The application of Barro's test to other countries has resulted in similar conflicting results, see for example the application to United Kingdom macro data by Attfield and Duck (1983) and Demery (1984).

A major weakness of most of these macro tests is that the data used to represent the idea of price surprises means they test more than one hypothesis simultaneously. In the absence of direct measures of price or money growth expectations, these expectations have to be modelled. Clearly the estimate of price expectation errors or unanticipated money growth will vary as the postulated expectations function is varied. This point is well illustrated by Small and Mishkin who found that Barro's conclusions rest in part on the form of the money growth forecasting equation chosen to represent what "rational" agents should know. Gordon's (1982) results also contradict Barro's conclusions, although his work is subject to the same criticism.

More recently, results of some micro based tests have been published which circumvent this difficulty by utilising survey data to derive direct measures of individual producers' expectation errors. Koenig and Nerlove (1986) analyse the production and price reactions of French and German firms in response to expected and unexpected changes in demand. They also analyse the effect of demand shocks on deviations of production and prices from their expected values. They found that unexpected changes in prices were associated with unexpected changes in demand but the association is weak. For German firms there is a weak association between price surprises and unplanned changes in production but this is not evident for French firms. The most robust finding is a significant positive association between surprising changes in demand and unplanned increases in production. A similar study by Chizzolini, Nerlove, Pupillo and Ross (1987) analysing the reactions of Italian and United Kingdom firms is even less supportive of the new-classical transmission mechanism. They found no evidence of an association between contemporaneous demand and price surprises nor between contemporaneous price and production surprises but, as in the French and German study, there is a strong positive association between demand surprises and unplanned changes in production.

This paper also uses micro based data obtained from a tendency survey of New Zealand manufacturers. The method used to obtain direct measures of expectation errors is similar to that applied by Koenig and Nerlove and by Chizzolini, *et al*,. However, the approach used in this paper departs from the earlier micro based tests by using a vector autoregressive model to :

(a) evaluate the relationship between surprising changes to demand and price expectation errors;
(b) evaluate the role of price expectation errors in the transmission of demand changes to output changes; and
(c) gain further insights into the 'black box' of reactions of a range of business variables in response to demand shocks.

2. The Data

The data used for this study are all categorical consisting of trichotomous responses by individual firms to a survey questionnaire. These individual firm responses are collected from the New Zealand Institute of Economic Research's quarterly survey of business opinion (QSBO). The QSBO is similar in style to the 'Business Test' of the IFO Institute fur Wirtschaftsforschung, Munich, and surveys undertaken by the Confederation of British Industries and the European Economic Commission. It involves the distribution to business executives of a standard questionnaire that identifies the firm by activity, location and size and contains a standard question asking executives to report their perceptions of the experienced change during the immediate past three months and expected change over the next three months (by reporting "up" or "same" or "down" or "N/A") for several activity variables.

An important feature of this study is that it utilises firm responses to the survey which have been stored on an individual respondent basis since the inception of the full survey in 1964, up to and including 1987 ie. over 24 years, an unusually long period for this type of data. The data set is drawn from two samples: the first commencing in 1964 comprises 220 manufacturers; the second sample was introduced in March 1986 and includes 520 manufacturers and builders, although gradual attrition has reduced the sample to about 500. Both samples have a bias toward large firms. The current sample excludes firms with less than six employees and includes all firms with more than 200 employees. A similar bias applies to the earlier sample.

In terms of persons employed, at the time the samples were constructed the survey covered about 30 per cent of New Zealand manufacturing and building activity. The coverage of the recorded data is considerably less than this since the response rate has been on average about 55 per cent, which is evidently typical of panel surveys of this nature. Non-response is usually temporary but it means that the composition can change from quarter to quarter. Furthermore, there is inevitably a gradual process of attrition in the sample over time.

For the purpose of this study the variable that "drives" the system is not the expected or realised level of demand but rather unexpected changes in demand. Unexpected changes in demand are defined by the entries in the following contingency table relating previous period expectations, $E_{t-1}y_t^d$ and current realisations, y_t^d :

		$E_{t-1}y_t^d$ +	$E_{t-1}y_t^d$ =	$E_{t-1}y_t^d$ -
y_t^d	+	=	+	+
	=	-	=	+
	-	-	-	=

The new variable, called the expectation error, is constructed by comparing the current realisation with the expectation formed in the preceding period. If the realisation is identical to the expectation, the new variable receives the value "=". If the realisation is greater or higher than expected, the new variable receives the value "+" and if it is smaller or lower than expected, the value of the new variable is "-".

These variables are used to construct contingency tables for each quarterly survey by calculating the relative frequency of each type of expectation error. Following Kawasaki and Zimmerman (1986), the frequency distribution is then transformed to derive a measure of over- or underestimation expectation bias, B1, where:

B1 = (overestimation - underestimation) / (overestimation + underestimation)

where:

overestimation = [P(2,1) + P(3,1) + P(3,2)]
underestimation = [P(1,2) + P(1,3) + P(2,3)]

P(2,1), etc. denote the probability that an observation should fall into the corresponding cell in the contingency table used to construct the expectation error variable. Accordingly, $-1 \leq B1 \leq +1$.

The expectations and realisations questions have been regularly included for nine variables since the survey began in 1964. This study analyses the dynamic relationship between the expectation errors for these nine variables (y_n , n = 1,...,9) which are:

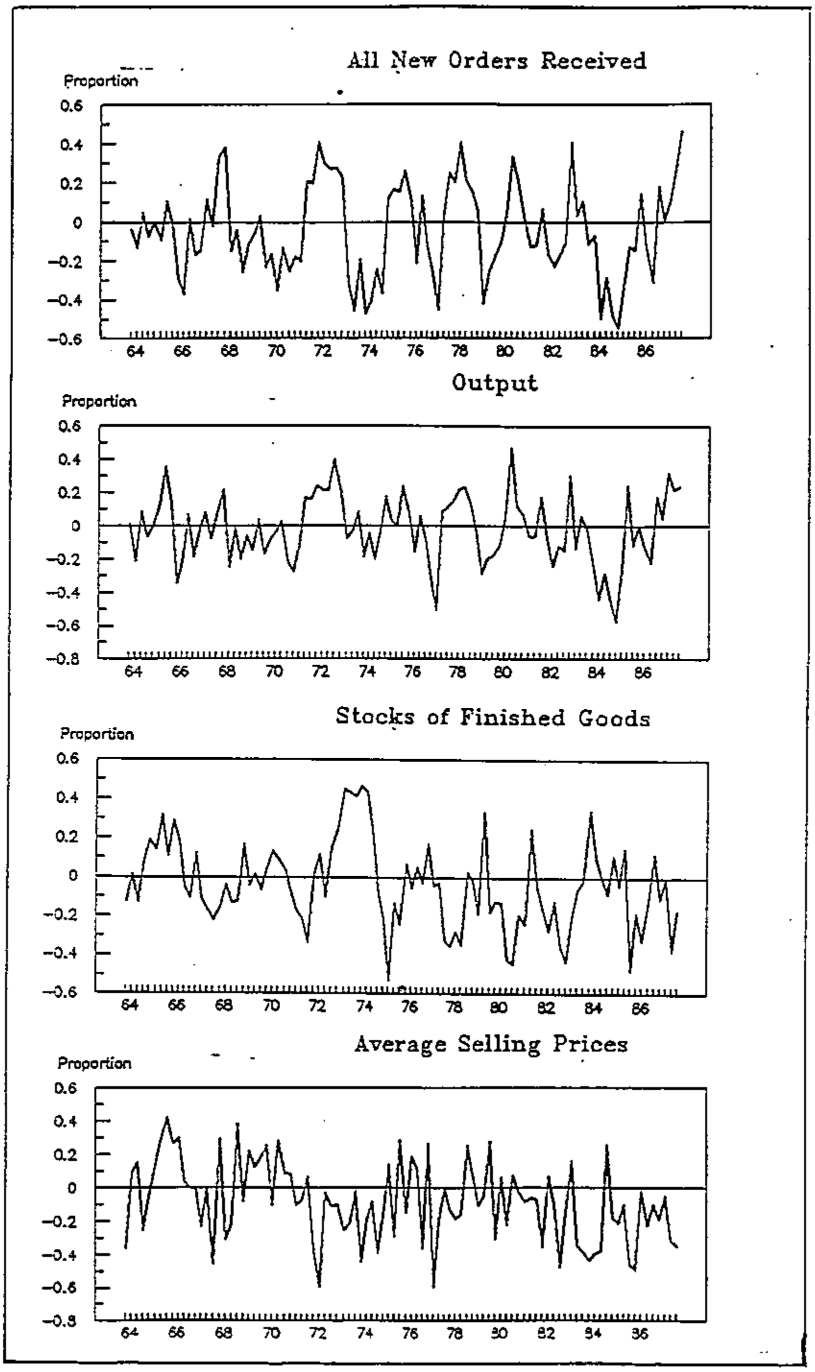
- new orders received (the demand variable),	(y_1)
- output prices,	(y_2)
- average costs,	(y_3)
- output,	(y_4)
- deliveries,	(y_5)
- stocks of finished goods,	(y_6)
- labour turnover,	(y_7)
- overtime worked,	(y_8)
- numbers employed,	(y_9)

This set does not exhaust the full range of business variables that could react to demand shocks but it does allow us to test the reaction of price expectation errors to demand shocks, evaluate the relevance of price errors in the process of transmitting demand shocks to changes in output, etc, and examine the role of other variables, such as inventories, employment and overtime, in enabling firms to adjust to demand shocks.

Quarterly values of B1 are calculated for each of the nine variables. Although the expectation errors of each respondent are the basis for each series, B1 is an aggregate series indicating the predominant type of error i.e. over- or under-estimation bias. Furthermore, each B1 series shows the predominant type of expectation error regarding the direction of change in a variable. For instance, "realised expectations" in the context of these categorical variables is defined as a situation in which respondents correctly forecast the direction of change. In the absence of any order among the categories, each individual expectation is either right or wrong. There is no sense in which one expectation would be closer to what subsequently happened than another. Clearly it is possible, in the context of quantitative variables, for perfect categorical forecasts to be very wide of the mark, and, conversely, for imperfect categorical forecasts to be close quantitatively.

Figure 1 illustrates the behaviour of this measure of expectation error for a selection of variables. An earlier study by Buckle, *et al*, (1990) examining the properties of the expectations of manufacturers covered by this survey drew two conclusions relevant to this paper. The properties of expectations were found to differ across variables, a result which is inconsistent with the new-classical/rational expectations model. Furthermore, contemporaneous expectation errors for the "quantity" variables were found to be correlated whereas, although contemporaneous errors in costs and selling prices were positively correlated, they were not correlated with the "quantity" variables. The fact that some of these expectation errors are contemporaneously correlated is not surprising since some are interrelated instrumental variables of the firm and reflect plans. Some of the variables are closely related via an accounting identity; for example, stocks of finished goods in period t must represent the difference between output and deliveries in that period. Consequently, an error could impact on several variables simultaneously. Somewhat more surprising is the apparent independence of cost and price expectation errors from errors of all other variables, particularly in view of the important role they are purported to play in macroeconomic theories of business cycles. There may, however, exist serial correlation between the errors for the "quantity" and "price" variables. For these reasons the choice was made to evaluate the relationship between these errors by a vector autoregressive modelling approach.

Figure 1
Expectation Errors (B1) for Orders, Output, Stocks and Prices



3. Modelling the Dynamic Responses of Firms to a Surprising Change in Demand

The estimated VAR model can be summarised as

$$y_t = A(L)y_t + \varepsilon_t \tag{6}$$

where y is an n-vector of endogenous variables where n = 9 and the n-vector ε satisfies

$$\begin{aligned} E(\varepsilon_t) &= 0, \\ E(\varepsilon_t \varepsilon_s') &= \Sigma, \; t = s, \\ &= 0, \; t \neq s. \end{aligned} \tag{7}$$

and the moving average process corresponding to (6) is

$$y_t = [I - A(L)]^{-1}\varepsilon_t = B(L)\varepsilon_t \tag{8}$$

A two lag VAR described by (6) was estimated using quarterly data on the B1 variable from 1964 (2) to 1987(3). This provided 94 usable observations with seasonal effects being captured by dummy variables.

In a model such as (6) in which all the variables are endogenous, successive elements of B(L) trace out the response of y_j to an impulse shock in y_i in period zero. We are interested in tracing out the response of y_j to an impulse shock to demand (variable y_1 in the model). In a vector autoregressive model, the contemporaneous correlation between the elements of the vector contains sample period information which should be taken into account when simulating the model. Sims (1980) and Gordon and King (1982) suggest one approach to taking cross-correlations into account in what Sims calls "innovation accounting". That approach gives numerical values which depend on the ordering of the variables in the model. We do not wish to restrict our innovations to any particular ordering of the variables other than to impose new orders as the source of shock. One hypothesis to be tested is the role of price expectation errors as the intermediary through which demand shocks are converted into unexpected changes to output, employment, etc. But we do not wish to restrict innovations to that particular ordering.

Evans and Wells (1983) suggest an alternative procedure which does not necessitate imposing a strict order of causal priority on the variables, yet spells out the sources of the shocks and the expected magnitude of contemporaneous effects. Assuming the disturbances are jointly normal, the conditional expectation function $\varepsilon^*_{t,j}$ specifies the covariance matrix at time t given $\varepsilon_{t,j} = k$. In particular,

$$\varepsilon^*_{0,1} = E(\varepsilon_0 \mid \varepsilon_{0,1} = k)$$

which will be linear and given by

$$\varepsilon^*_{0,1} = \begin{bmatrix} k \\ \alpha_{21}k \\ \cdot \\ \cdot \\ \cdot \\ \alpha_{91}k \end{bmatrix}, \quad \varepsilon^*_{t,1} = 0, t > 0 \tag{9}$$

where $\alpha_{i1} = \sigma_{i1} / \sigma_{11}$, $i = 1, \ldots, 9$. An estimate of (9) is obtained by using the estimated covariance matrix of (6).

The simulation experiment involves

$$\varepsilon^*_{0,1} = (1, -0.022, -2.038, 0.782, 0.773, -7.523, 9.634, 0.672, 0.482)$$

and the model response in the current and subsequent quarters to the impulse shock (9) when k = 1 is provided in Table 2. These quarterly multipliers are calculated on the basis of estimates of innovation covariance matrices and are hence subject to sampling variability. Evans and Wells (1986) have suggested a procedure for providing confidence regions for these multipliers, but their procedure is difficult to implement.

TABLE 2. Model Response to an Impulse Shock to Orders

$\varepsilon^*_{0,1}$	y_1	y_2	y_3	y_4	y_5	y_6	y_7	y_8	y_9
t = 0	1.00	-0.02	-2.31	0.78	0.77	-7.52	9.63	0.67	0.48
1	1.63	-0.47	0.14	0.04	0.58	-3.56	3.60	1.46	0.14
2	2.10	0.33	-0.93	0.51	1.85	-2.62	4.11	1.83	-0.03
3	1.64	-0.10	-0.10	0.48	1.35	-1.75	2.79	1.55	-0.04
4	1.20	-0.07	-0.26	0.42	0.96	-0.90	2.13	1.11	-0.13
5	0.77	-0.12	-0.05	0.27	0.64	-0.45	1.47	0.71	-0.13
6	0.44	-0.11	-0.02	0.14	0.34	-0.16	0.95	0.40	-0.13
7	0.22	-0.09	0.02	0.05	0.16	-0.02	0.58	0.19	-0.11
8	0.08	-0.06	0.03	0.00	0.05	0.04	0.33	0.07	-0.09
9	0.01	-0.04	0.03	-0.03	-0.01	0.06	0.17	0.00	-0.07
10	-0.02	-0.02	0.03	-0.03	-0.03	0.05	0.07	-0.03	-0.06
11	-0.03	-0.01	0.02	-0.03	-0.04	0.03	0.03	-0.03	-0.04
12	-0.03	0.00	0.02	-0.03	-0.03	0.02	0.00	-0.03	-0.03
13	-0.02	0.00	0.01	-0.02	-0.02	0.01	-0.01	-0.02	-0.02
14	-0.01	0.00	0.01	-0.01	-0.01	0.00	-0.01	-0.01	-0.01
15	-0.01	0.00	0.00	-0.01	0.00	0.00	0.00	-0.01	-0.01
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2 immediately highlights one important property of the model which is the lack of any apparent significant contemporaneous positive correlation between the demand shock and price expectation errors. If the Lucas/new-classical transmission mechanism is operative we would expect contemporaneous correlation between these two components of the model for quarterly data. A shock to demand ultimately affects price expectation errors but the response is minimal and has the opposite sign to that which is predicted by the Lucas mechanism. There is a stronger reaction by price expectation errors in the second quarter which gradually tapers off, but the relationship to orders remains the inverse of that predicted by the Lucas transmission mechanism.

A second important property also illustrated by Table 2 is a strong association between the demand shock and changes to several "quantity" variables, including output, in the initial and subsequent quarters. The implication is that the immediate response by firms to a surprising change to demand is to adjust quantities rather than price. The nature of this response over time is better illustrated by observing the evolution of the dynamic multipliers.

The dynamic multipliers resulting from a sustained unit change in unexpected demand are calculated by cumulating the quarterly responses shown in Table 2. These cumulative effects are illustrated in Figure 2. It is clearly evident from Figure 2 that surprising changes in demand generate unexpected changes to output and other "quantity" variables, without any associated positive co-movement in price expectation errors. This particular simulation generates a lower than expected level of demand which causes an overestimation of output, deliveries, labour turnover and overtime hours worked. Subsequent orders are also overestimated as a result of the various linkages within the manufacturing sector. This accentuates the dynamic reaction to the initial shock. Average costs and the level of finished stocks are underestimated. Selling prices are also underestimated but this response is small. Numbers employed are initially overestimated but this effect is ultimately reversed so that the cumulative effect is an underestimation of employment.

For a surprising rise in demand the results can be interpreted as follows. Associated with the surprising increase in demand is a previously unplanned increase in deliveries. This unexpected rise in deliveries is accomodated by an unexpected rise in output and run-down of finished goods stocks. The labour inputs required to realise these previously unplanned adjustments are acquired primarily from an rise in overtime hours worked and therefore a rise in output per employee, a result that is consistent with typical observation that output per employee fluctuates procyclically (see Zarnowitz, 1985 for a summary of

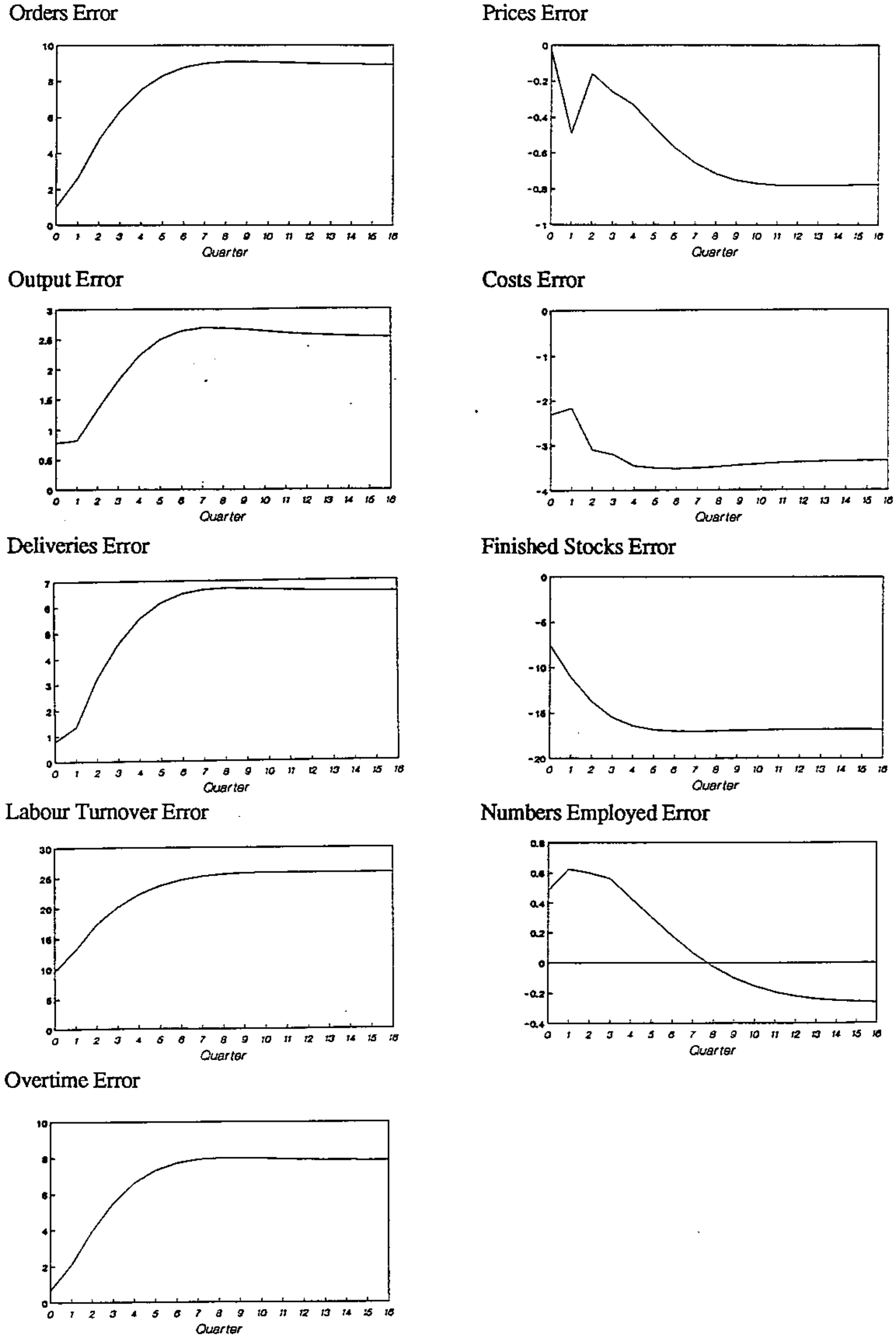
United States research and Marks, 1983 for the New Zealand manufacturing sector) There is an initial unexpected increase in numbers employed but this reaction is reversed by the third quarter from which time there is a tendency to overestimate numbers employed. This pattern of reactions highlights the important buffer role played by finished goods stocks and underutilised labour capacity and are consistent with the procyclical behaviour of inventory investment typically observed in business cycle research, Zarnowitz (1985).

Numbers employed appear comparatively insensitive to surprising changes in demand. There is an initial increase in numbers employed above the expected level. This is eventually reversed and the dynamic multiplier implies that the final change in numbers employed is small compared to what was expected prior to the demand shock. In contrast, the dynamic multiplier for overtime is positive, implying that overtime hours worked is the labour variable that responds to short-run fluctuations in demand for final output.

The reaction of labour turnover is interesting. The consequence of a surprising increase in demand is an unexpected rise in labour turnover in this model. The simulation generated here is equivalent to a generalised upswing in demand across all firms and is generating an unexpected increase in labour demand across firms. The general improvement in employment prospects may trigger a rise in the quit rate thereby causing an unexpected increase in labour turnover. Certainly procyclical fluctuations in the quit rate are commonly observed in business cycle research.

The simulation also generates an interesting behaviour in cost errors. There is a negative co-movement of costs in relation to demand and output expectation errors which persists throughout the simulation. The results suggest that average costs are inversely related to the rate of output. If firms experience an unexpected rise in demand, according to this model, costs will be lower than expected. This result is consistent with firms operating on the negative slope of their average cost functions. In that situation, a rise in output will reduce average costs and so explain the inverse correlation between costs and output expectation errors generated by the demand shock simulation. This may explain the tendency for firms to over-estimate prices when there is an unexpected rise in demand, if some prices are set on the basis of costs per unit of output. The close positive co-movement of cost and price expectation errors is consistent with a cost-based pricing process.

Figure 2
Cumulative Model Response to an Impulse Shock to Orders



5. Conclusions

This paper uses quarterly micro panel data, obtained from a survey of the New Zealand manufacturing sector over a continuous period of 24 years, to analyse the reaction of firms to surprising changes to demand. It is unusual for data of this type to be available over such a long period. From this data set are derived direct measures of expectation errors for the purpose of evaluating two issues of central significance in contemporary business cycle theories: the relationship between unexpected demand and price changes and the role of price expectation errors in transmitting demand shocks to real output and employment changes. These issues were evaluated by means of a vector autoregressive model to account for the possibility of serial correlation and to gain further insights into the dynamic reaction of firms to demand shocks.

The simulation results provide little support for the Lucas/new-classical proposition that price expectation errors are the crucial intermediary between surprising changes to demand and output. Although a shock to demand ultimately affects price expectation errors, the response is minimal and has the opposite sign to that predicted by the Lucas mechanism. The model predicts that from the nine variables considered, the predominant reaction of firms to a surprising change in demand would be unexpected changes to deliveries, output, overtime worked and finished goods inventories, without any associated positive co-movement in price expectation errors. In this respect the behaviour of the New Zealand manufacturing sector, at least over the sample period 1964 to 1987, is closer to the new-Keynesian vision of the business cycle propagation mechanism than to the Lucas/new-classical vision.

The simulation also generated some interesting reactions from the labour and cost variables. The behaviour of overtime hours worked, numbers employed and labour turnover in response to a demand shock appear consistent with the behaviour of these variables observed from business cycle research in other countries. The reaction of average costs to a surprising increase in demand is perhaps more controversial. Average costs appear to be inversely related to the rate of output. One possible interpretation is that on average firms have operated on the downward sloping portion of their average cost functions during the sample period.

From a policy perspective the results highlight the importance of taking account of the industry structure when designing macroeconomic policy. For instance, the response of output and the behaviour of average costs will influence the outcome of a policy of monetary disinflation. Furthermore, the emphasis on price expectations in the recent theoretical literature on the credibility of monetary disinflation policies is not supported by the results in this paper in so far as they apply to the price expectations of manufacturers. That literature emphasises the importance of minimising price expectation errors to avoid a contraction in aggregate output and employment in response to a contraction in nominal demand. Price expectations may be important in the wage setting process and in the transmission of demand shocks to other sectors, but they do not appear to have had a direct role in the transmission of the demand shocks to changes in output and employment in the New Zealand manufacturing sector.

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