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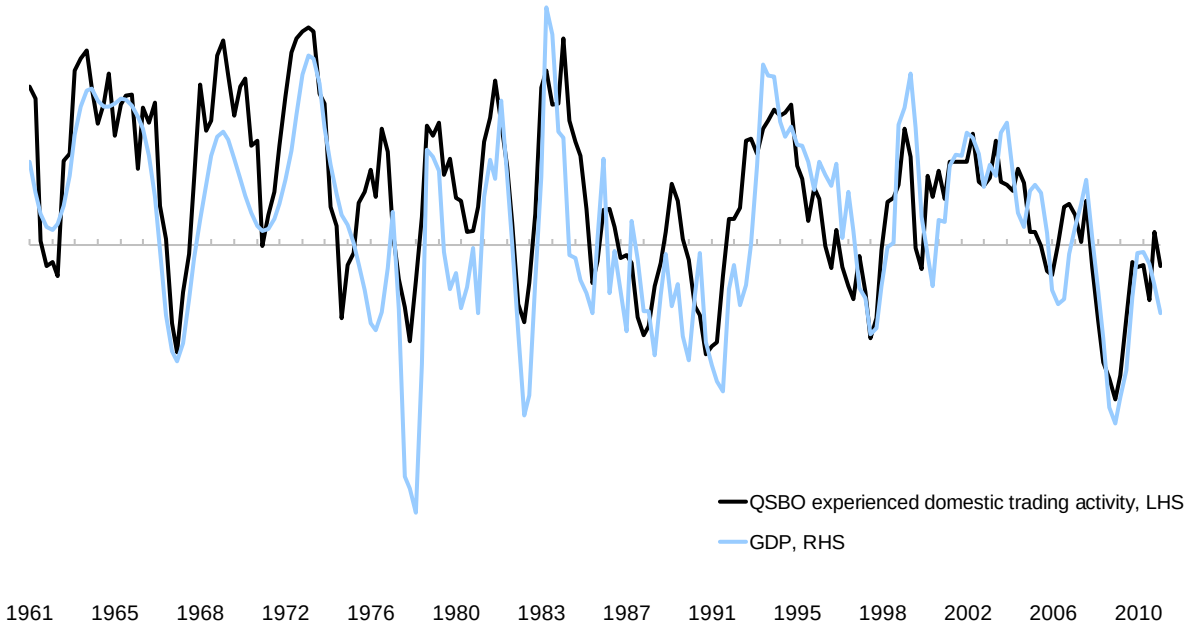

QSBO as a forecasting tool

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About NZIER

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield.

NZIER is also known for its long-established Quarterly Survey of Business Opinion and Quarterly Predictions.

Our aim is to be the premier centre of applied economic research in New Zealand. We pride ourselves on our reputation for independence and delivering quality analysis in the right form, and at the right time, for our clients. We ensure quality through teamwork on individual projects, critical review at internal seminars, and by peer review at various stages through a project by a senior staff member otherwise not involved in the project.

NZIER was established in 1958.

Acknowledgements

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Each year NZIER devotes some of its resources to undertake and make freely available economic research and thinking aimed at promoting a better understanding of New Zealand's important economic challenges. This paper was funded as part of this public good research programme.

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Authorship

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Key points

The Quarterly Survey of Business Opinion (QSBO) has provided robust and timely indicators of economic activity for 50 years.

In particular, experienced 'domestic trading activity' (DTA) is a good measure of the quarter's GDP, while average selling prices provide a good indicator of inflation ahead of official data releases.

This paper investigates using QSBO data to forecast GDP and inflation a year ahead of official data releases using a VAR model and principal component analysis.

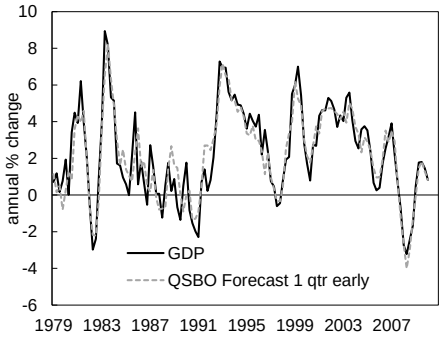
The key finding is that applying such an approach to QSBO data provides robust predictors of GDP and inflation up to a year ahead.

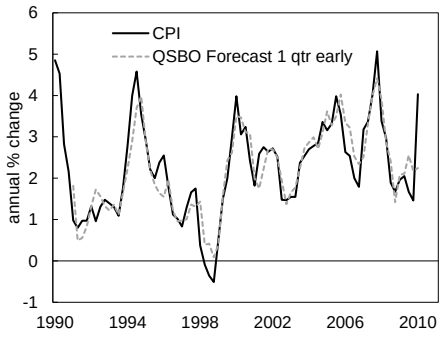
We also find that:

- the QSBO's indicators of the labour market, average costs, and selling prices add the most predictive value in the model
- services sector indicators are strong predictors of GDP growth. This is unsurprising because the services sector represents a large portion of the New Zealand economy.

The charts below show the performance of the models in using QSBO data to forecast GDP and CPI one quarter ahead. But the model also performs well up to four quarters ahead.

These findings illustrate the value of the QSBO to decision-makers in the business and policy sectors.





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1. QSBO as a predictive tool

NZIER's *Quarterly Survey of Business Opinion* (QSBO) contains a 50 year history of business opinion. While its predictive capabilities are well known, there are many more applications that can be pursued using QSBO data. This paper investigates one application, using the QSBO to forecast GDP and inflation up to four quarters ahead of official data releases.

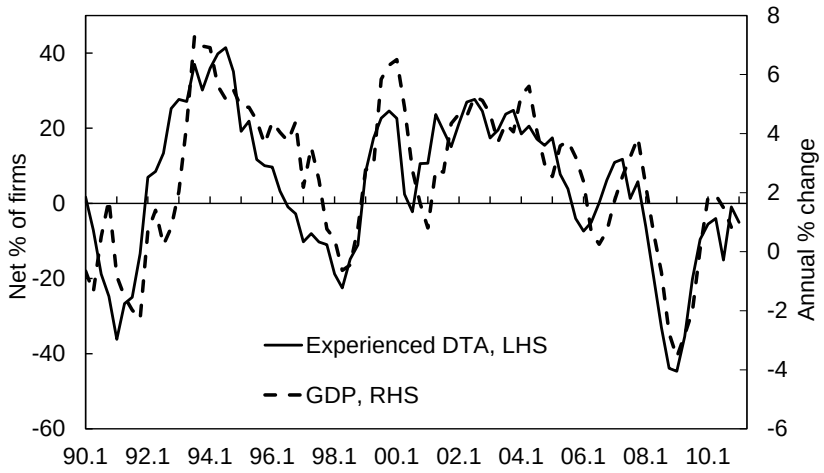
Every quarter 2,200 chief executives are surveyed about the performance of their firm compared to the previous quarter. The survey results produce a vast array of data on business opinion and aggregated results by sector are released to members of NZIER. This includes the net percentages of responses sent in from survey participants.

Relationships have been long established between QSBO data and economic data released from Statistics New Zealand. The QSBO's 'domestic trading activity' (DTA) for the quarter provides a good proxy of that quarter's GDP, while average selling prices provide a measure for inflation. Expected DTA and intentions on selling prices provide indicators of next quarter's GDP and CPI. The relationships have been quite robust over time (Figure 1), but can be improved upon.

There are two limitations of these basic relationships:

- a single series from the QSBO does not fully reflect the quarterly variation
- the relationships can only be used to forecast current and expected quarters.

Figure 1 Domestic trading activity & GDP



Source: Statistics NZ, NZIER

Long-term data series are not common in New Zealand. Those that do span a long time often have inconsistencies where the calculation of the series has changed. The QSBO provides a robust 50 year history – its greatest strength. Questions have run relatively unaltered over the 50 years; a few questions have been added and the responses adjusted for questions identifying characteristics of the firm (see Allen and O'Connor, 2011).

However, like most long term time series, the QSBO is not without limitations. For example, there have been structural changes to inflation over the past 50 years. The last major change was in the late 1980s when inflation targeting was introduced. Since 1991, inflation rates have been low and stable, but are not comparable to inflation rates of the 1970s. This means a model cannot easily be fitted over the full 50 year history. As such we have to limit the data used in our models.

The QSBO contains numerous questions that can be used for understanding economic phenomena and for forecasting.

In this paper we are interested in developing forecasts for GDP and CPI, using series from the QSBO. These series can be highly correlated, and this issue has to inform the choice of method and series. In this paper we seek to include only the key drivers[1] of GDP and inflation. These are:

- labour market conditions: primarily employment, overtime worked, and labour turnover
- general economic conditions: investment intentions, expected overtime worked and profitability
- average cost and selling prices.

Furthermore, these variables can be broken down by sector for their influence on GDP and inflation. The three sectors are manufacturers and builders, merchants and services. Within each sector there are two types of variables, **experienced** changes and **expected** changes. Data can also be disaggregated by firm size and region.

[1] We select series on the basis that they make economic sense and add predictive capability.

2. Methodology

The long term QSBO series enables us to explore the use of VAR (Vector Autoregression)[2] models, as more data points produce better estimates of the long term drivers of GDP and inflation.

In a VAR model, variables are estimated as a linear function of their own lags and other dependent variables in the system. Each model has a similar structure using different time lags for GDP and inflation. All the models were specified as:

$$y_{t+h}^{h} = \mu + \alpha(L)y_t + \beta(L)Z_t + \varepsilon_{t+h}^{h}$$

where h is the forecasting horizon, y_{t+h}^{h} is the projection of GDP/inflation h quarters ahead, $\alpha(L)$ and $\beta(L)$ are lag polynomials, Z_t is a vector of principal components from the QSBO, and μ is a constant.

This approach is not new to forecasting GDP and inflation. Stock and Watson (1999) used this model to forecast inflation in the US, while Marcellino, Stock, and Watson (2003) used this model to forecast GDP growth and inflation in a Euro economy.

Suitability of the model

In order to implement the VAR model, we have to decide the order of integration of the two series: GDP growth and CPI index. In the case of GDP growth, both Dickey-Fuller and Phillips-Perron tests rejected the existence of unit root, so that y_t denotes the growth rate of GDP.

Inflation rates before 1990 are very volatile due to not having inflation targeting, where statistical tests[3] suggest that the inflation series had a structural change between 1986 and 1989. Because of this, we fit the model for inflation using data from 1990. Statistical tests have also rejected the existence of a unit root[4] so that y_t denotes the inflation rate.

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[2] See Stock and Watson (2001), Vector Autogression, *Journal of Economic Perspectives*, Vol 15 (4), 101-115.

[3] Statistical tests suggested by Clemente, Montanes, and Reyes (1998) and Andrews and Zivot (1992). Testing for a unit root in variables with a double change in the mean. *Economics Letters* 59, 175-182.

[4] Matheson (2006) has also forecasted inflation rate as a series with an integration order of 0.

Principal Component Analysis (PCA)

Indicators from the QSBO are highly correlated with each other. This issue was overcome by using Principal Component Analysis (PCA). This reduces the number of indicators by combining the joint (or correlated) effects of these indicators. PCA is widely used in forecasting where there are many explanatory variables.

Before the data can be modelled, variables are transformed into principal components. VAR can then be used to estimate the relationships between GDP growth, the inflation rate and the QSBO's principal components.

PCA is a multivariate analysis technique that was first introduced by Pearson in 1901 (Pearson 1901) and developed independently by Hotelling in 1933. PCA involves a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called principal components. These are linear combinations of the variables that explain the maximum amount of variance in the original variables. The procedure seeks to avoid the problem of collinearity which can result in less precise parameter estimates.

The approach can produce a number of principal components. The first component accounts for the largest portion of the variance in the dependent variable. Then the second component accounts for the largest share of the remaining variance, and so on.

In this analysis we apply PCA to economy-wide, manufacturing, merchants, and services sector indicators separately. The results of the PCA are in Appendix B.

The analysis suggested three principal components among the economy-wide indicators:

- **genpc1:** capturing labour market conditions
- **genpc2:** capturing general economic conditions
- **genpc3:** capturing average cost and selling prices.

There were two principal components for the sectoral breakdowns for domestic trading activity (our proxy for GDP), but only one for average selling prices (our proxy for inflation) as the series are quite similar.

The principal components for domestic trading activity were split into:

- **exper:** capturing experienced changes
- **expect:** capturing expected changes.

The relationship was not as clear for the services sector as for the other sectors, but the same two principal components were retained. The services sector is characterised by a very diverse set of firms, ranging from a large number of small firms to some of the largest firms in the economy. The performance of firms varies between small and large firms, and location (the larger firms tend to be located or centralised in Auckland).

3. Results

We conclude that the QSBO can be used very effectively to provide a robust predictor of GDP and inflation.

Figure 2 shows how well the VAR model is able to predict GDP up to a year ahead of official statistics. Figure 3 shows the modelled results for inflation. VAR analysis results are shown in Appendix A for four quarters ahead of statistic releases.

The modelling revealed several findings on the drivers and best predictors of GDP and inflation from the QSBO series. A summary of the findings are:

- labour market indicators, average costs, and selling prices provide the most predictive value of the general economic indicators
- services sector indicators are strong predictors of GDP growth. This is unsurprising because the services sector represents a large portion of the New Zealand economy
- activity **expectations** of merchants provide a stronger predictor of GDP than **experienced** activity
- "manufacturers and builders" is the weakest sector in predicting GDP
- the activity of merchants was helpful in forecasting inflation in addition to average prices
- merchants and services firms were the best predictors of inflation.

Figure 2 Forecast and actual GDP growth

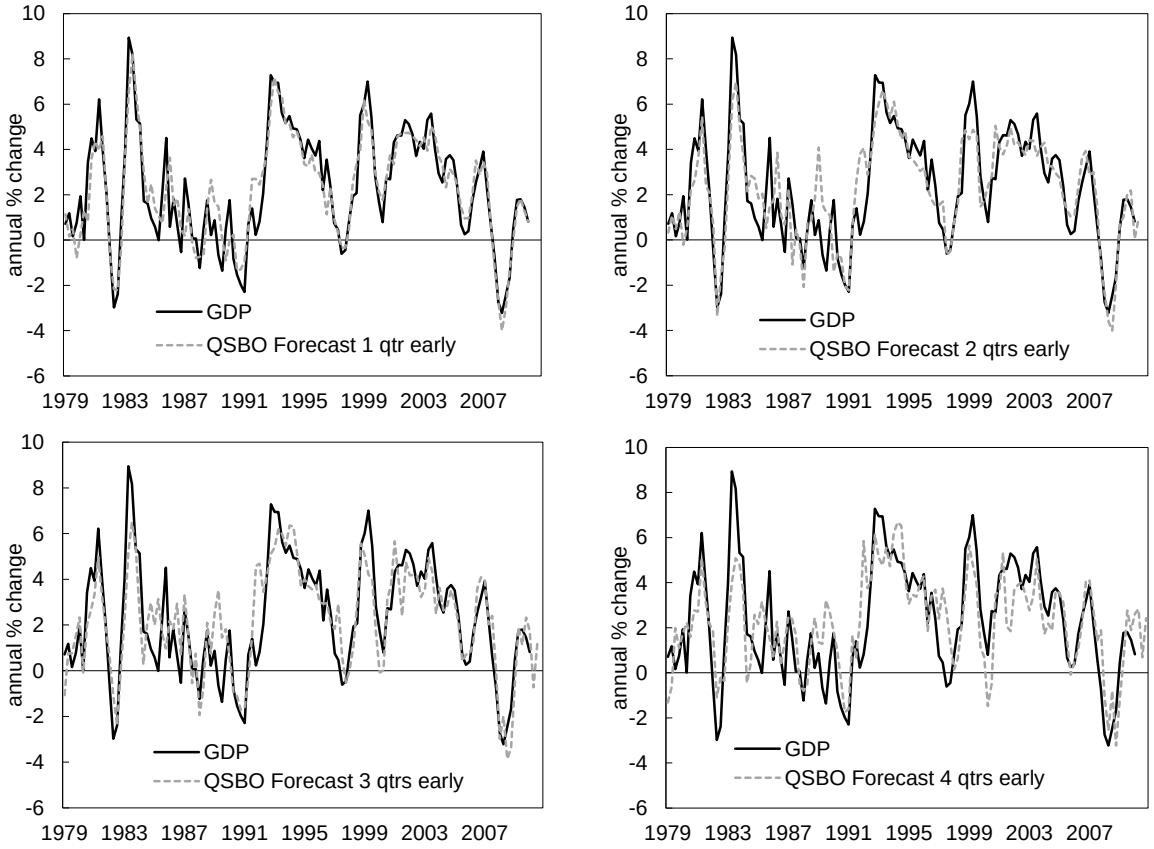
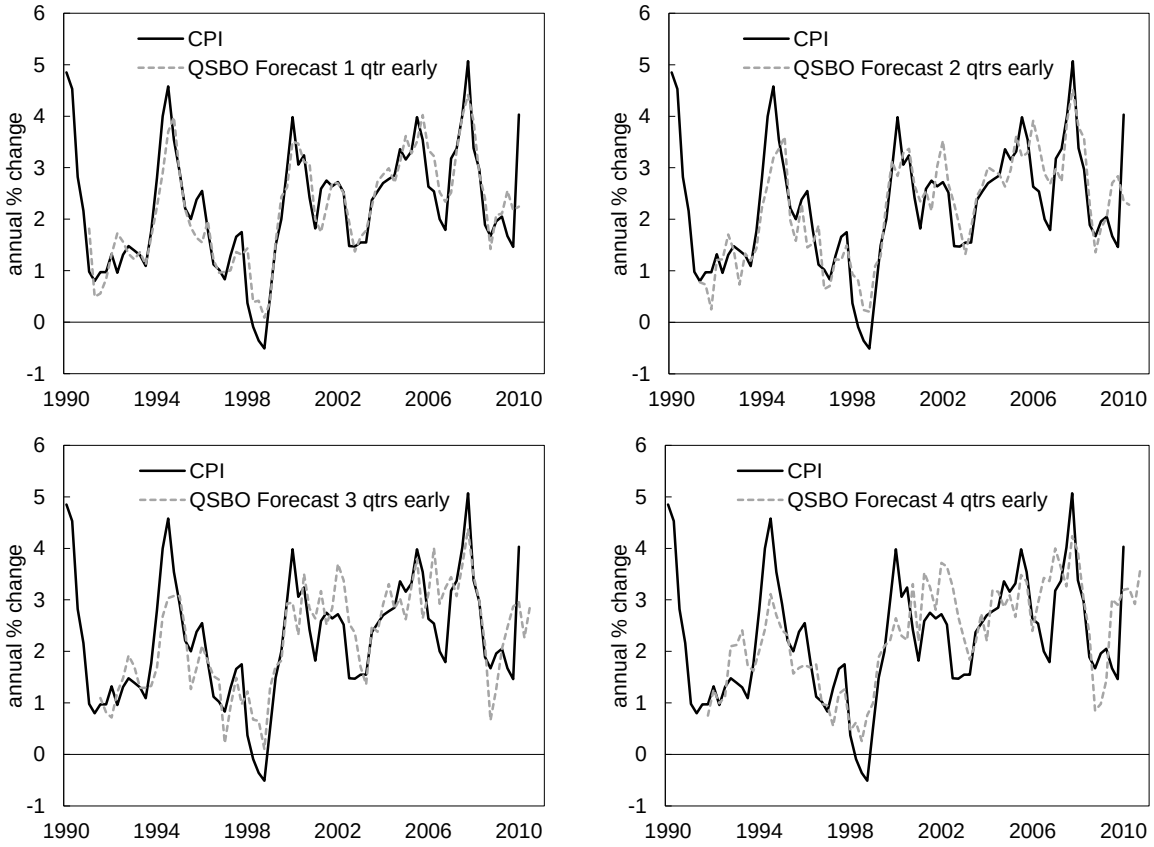


Figure 3 Forecast and actual inflation



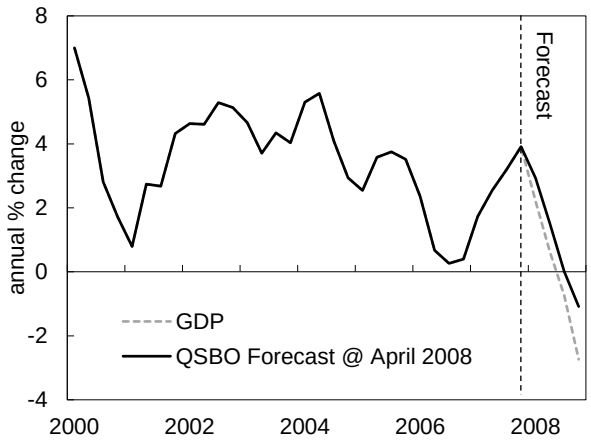
4. Applying the model to recent crises

This section investigates how QSBO data would have forecast some of the more volatile periods of GDP that New Zealand has experienced. For example, the global financial crisis (GFC) provides a unique scenario of a time that was very difficult for forecasters to predict.

QSBO data for the March 2008 quarter was available on 8 April 2008.[5] Figure 4 depicts the QSBO's forecasts for GDP for the March, June, September, and December quarters in 2008, using the April QSBO release. This is compared against actual GDP growth numbers released over the following year.

The direction of the forecasts was accurate with a slight divergence from the actual series. Given the volatile conditions at the time this is a reasonably good prediction. What is astounding is that the QSBO provided a timely and accurate prediction of the extent of the GFC impact a full year in advance.

Figure 4 Actual versus forecast GDP 2008

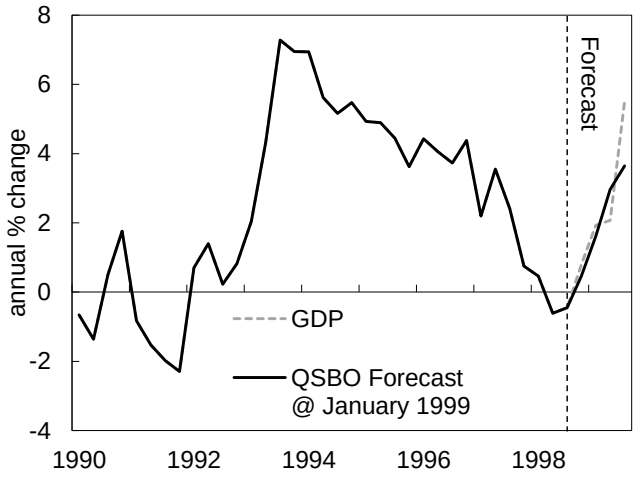


Source: Statistics NZ, NZIER

[5] At this point the most recent GDP data was for December 2007, which had been released on 28 March 2008, two weeks prior to the April QSBO release which covers the March quarter.

Figure 5 depicts QSBO forecasts after a mild recession in 1998, following weak domestic conditions and the Asian financial crisis. This time, the forecast predicted the strength of the recovery a year ahead, despite somewhat uncertain times.

Figure 5 Actual versus forecast GDP 1998-1999



Source: Statistics NZ, NZIER

5. Conclusion

The QSBO provides a strong predictive tool for GDP and inflation. A VAR model estimated with principal components provides a strong modelling framework yielding robust forecasts that have shown to be accurate, even during volatile times.

Forecasts perform well up to a year ahead of statistical releases, with accuracy peaking in the shorter term. Forecasts up to two quarters ahead of data releases provide strong predictive ability; accuracy declines for predictions three and four quarters ahead.

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Appendix A Regression analysis

Table 1 Regression results for GDP

	Current quarter		Next quarter		Two quarters ahead		Three quarters ahead	
	Coef.	P>z	Coef.	P>z	Coef.	P>z	Coef.	P>z
Lag1 GDP	0.616***	0	0.312***	0	0.180*	0.07	-0.405***	0
Lag2 GDP	-0.186**	0.04	-0.061	0.57	-0.517***	0	0.132	0.35
Lag3 GDP	0.015	0.87	-0.475***	0	0.12	0.31	0.077	0.59
Lag4 GDP	-0.182***	0.01	0.251***	0	0.131	0.14	0.054	0.61
genpc1	0.450*	0.07	0.611**	0.04	0.485	0.14	1.009***	0.01
genpc2	-0.395	0.3	-0.222	0.62	0.077	0.88	1.580***	0.01
genpc3	-0.401**	0.02	-0.439**	0.02	-0.719***	0	-1.063***	0
m&bexper	0.707***	0.01	0.574*	0.08	-0.031	0.93	-1.209***	0.01
m&bexpect	0.17	0.54	0.468	0.14	0.257	0.47	-0.709*	0.1
mercexper	0.056	0.81	0.32	0.23	0.431	0.15	0.628*	0.07
mercexpect	0.197	0.33	0.588***	0.01	0.842***	0	0.835***	0.01
servexper	0.560***	0.01	0.536**	0.03	0.843***	0	0.607*	0.06
servexpect	0.344**	0.03	0.337*	0.07	0.659***	0	0.374	0.14
constant	1.480***	0	1.917***	0	2.102***	0	2.210***	0
R^2	0.8301		0.7693		0.7207		0.6107	

Notes: ***, **, * represent the 1%, 5% and 10% level of significance respectively

Source: NZIER

Table 2 Regression results for inflation

Regression analysis of Inflation								
	Current quarter		Next quarter		Two quarters ahead		Three quarters ahead	
	Coef.	P>z	Coef.	P>z	Coef.	P>z	Coef.	P>z
Lag1 CPI	0.742***	0.00	0.654***	0.00	0.764***	0.00	0.194	0.19
Lag2 CPI	0.037	0.78	0.216	0.15	-0.478***	0.01	-0.072	0.73
Lag3 CPI	0.177	0.15	-0.438***	0.00	-0.017	0.92	0.063	0.76
Lag4 CPI	-0.316***	0.00	0.113	0.30	0.154	0.23	0.099	0.51
genpc1	-0.710***	0.00	-0.529**	0.03	-0.889***	0.00	-0.889***	0.01
genpc2	-0.284	0.14	0.017	0.94	-0.426	0.12	-0.368	0.24
genpc3	0.463	0.40	-0.177	0.79	1.012	0.21	2.711***	0.00
m&bprices	0.705**	0.05	0.571	0.20	0.289	0.60	-0.694	0.27
mercprices	0.490***	0.01	0.420	0.07	0.999***	0.00	1.075***	0.00
mercexper	0.154	0.36	-0.099	0.62	0.416*	0.08	0.592**	0.03
mercexpect	-0.821***	0.01	-0.152	0.70	-0.615	0.18	-0.480	0.37
servprices	0.401	0.07	0.914***	0.00	0.739**	0.02	0.239	0.50
constant	1.55***	0.00	1.814***	0.00	2.564***	0.00	3.270***	0.00
R^2	0.8582		0.7954		0.7137		0.6069	

Notes: ***, **, * represent the 1%, 5% and 10% level of significance respectively

Source: NZIER