RESERVE BANK OF NEW ZEALAND
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ANALYTICAL NOTES

Down to business: Which QSBO measures are the best at forecasting?

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Key findings

An investigation into which QSBO measures are best at forecasting key macroeconomic variables up to one year into the future found that over the past decade:

- for **GDP growth**, profitability measures performed the best, followed by domestic trading activity and investment intentions.
- for **CPI inflation,** none of the QSBO variables analysed could reliably reduce the prediction error from our benchmark naïve time-series model.
- for **employment growth**, the domestic trading activity measures provided the largest and most significant improvements in forecast performance.

Introduction[1]

A key challenge for the Monetary Policy Committee (MPC) is that when monetary policy decisions are made the current state of the economy is not known, mainly due to the length of time it takes to gather, process, and publish official economic data. In addition, the Monetary Policy Handbook notes since monetary policy 'affects the real economy and inflation with a lag', the MPC needs to forecast how the economy is going to evolve to make the appropriate decision today (Williams et al., 2019, p. 13).

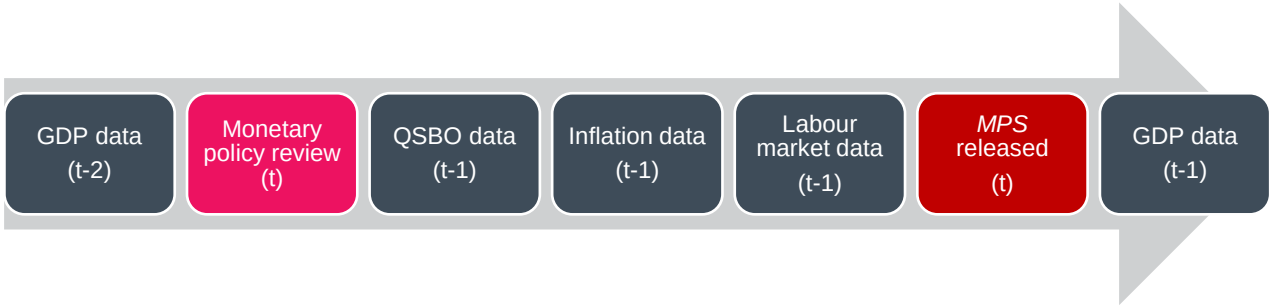
The *Quarterly Survey of Business Opinion* (QSBO), published by the New Zealand Institute of Economic Research (NZIER), is New Zealand's longest running business survey and provides a wide array of timely economic indicators. The survey is published before other key economic statistics are available and is useful to policymakers who need to know how the economy is evolving as soon as possible. Figure 1 shows a simplified timeline for the key data releases between each *Monetary Policy Statement*.[2]

Given the timeliness of the QSBO, it is beneficial to understand which measures provide reliable forecasts of current and future economic activity. We conduct an out-of-sample forecast evaluation to determine which QSBO variables provide the best forecasts and over what horizon.

We find that:

- for **GDP growth**, profitability measures performed best, followed by domestic trading activity measures and investment intentions.

Figure 1: A stylised representation monetary policy decision dates and the publication of economic data



Note: Author illustration. 't' represents the time period e.g. the current quarter.

1 The authors would like to thank Meltem Chadwick, Tom Stannard, Punnoose Jacob, and seminar participants at the Reserve Bank of New Zealand for feedback and discussion.

2 The Bank also monitors other timely business surveys, such as the *ANZ Business Outlook*. However, since these surveys are monthly, rather than quarterly like the QSBO, we exclude them from this analysis. Mixed-frequency data methods may be better at picking up the information content of the monthly surveys for predicting quarterly data.

- for **CPI inflation,** none of the QSBO variables analysed could reliably reduce the prediction error relative to our benchmark time-series model.
- for **employment growth**, the domestic trading activity measures provided the largest and most significant improvements in forecast performance.

What is the QSBO?

The QSBO is a quarterly survey of around 4,300 businesses which has been running since 1961. (Allen and O'Connor, 2011).[3] Consistent data on key macroeconomic variables such as economic activity are available from 1970. Our analysis, however, starts in 1995 as the economy went through large structural changes before this time.

The QSBO covers manufacturers, builders, merchants, and services, but not agriculture directly. Firms in each industry are asked a range of questions, with results available at an economy-wide or industry level (Buckle and Silverstone, 2004). The results of these questions are usually available shortly after the reference quarter ends, providing a snapshot of how the economy performed well before other key data become available.

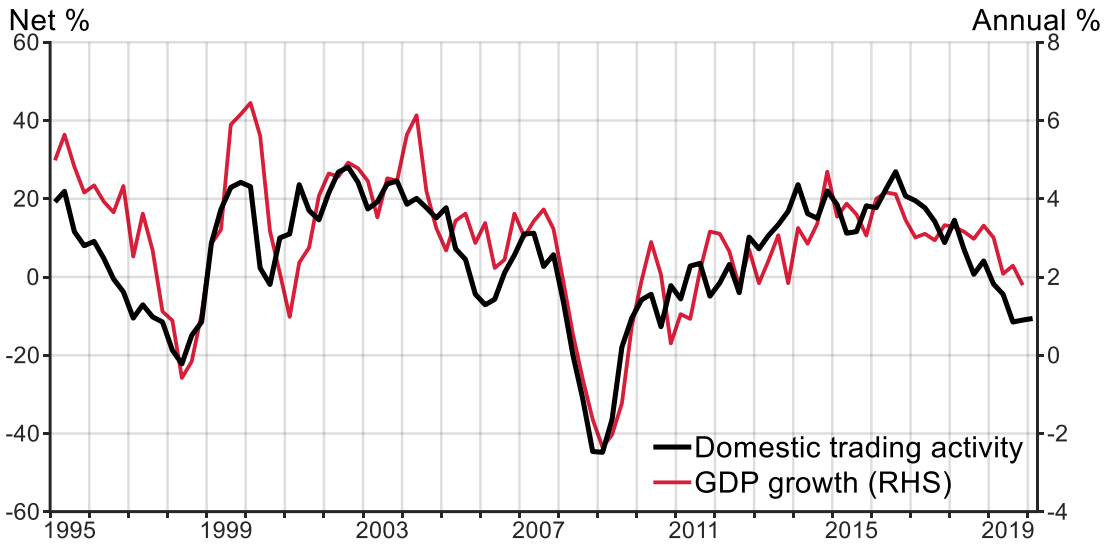
Many of the questions in the QSBO ask whether a variable, such as selling prices, increased, decreased, or stayed the same over the previous three months. Firms are also asked how they expect a variable to move over the next three months. Some questions are structured differently. For example, firms are asked to identify the factor most limiting their ability to increase production. The full list of questions is available in Buckle and Silverstone (2004).

How does the Reserve Bank use the QSBO?

The Reserve Bank uses the QSBO to support its timely estimates of GDP growth, employment, inflation, and other variables before the official data are released by *Stats NZ*.

Figure 2 shows the QSBO domestic trading activity measure provides a reliable signal about economic growth in New Zealand. This measure is available two months before official National Accounts data is release by *Stats NZ*. Since the domestic trading activity measure is based on firms' experiences over the previous three months, it should be – in principle – a reliable indicator of economic growth over this time.

Figure 2: GDP growth and QSBO domestic trading activity (past three months)



Source: Stats NZ, NZIER.

3 See this NZIER press release for the most recent QSBO results (at the time of drafting this *Note*).

What do we already know about forecasting with business expectations?

International findings

An extensive international literature examines the forecast performance of models using information from business surveys. Claveria, Pons, and Ramos (2007) compare the forecasting performance of models with and without business survey data. They find that most models that included survey data do not materially improve the forecasts.

In contrast, other studies endorse the use of survey-based information in economic forecasting. Erkel-Rousse (2009) finds French business surveys provide a significant improvement in GDP forecasts. Lehmann and Weyh (2016) examine 15 countries in Europe and find survey-based indicator models improve employment forecasts, especially one quarter ahead. Garnitz, Lehmann, and Wohlrabe (2019) evaluate whether the World Economic Survey can improve forecasts for GDP growth across 44 countries, including New Zealand. They conclude that for up to three quarters ahead, adding the survey to a benchmark model reduces forecast errors.

Domestic findings

Turning to New Zealand, Green and Beaumont (1993) assess the usefulness of a selection of QSBO measures for forecasting GDP. This was a simple graphical analysis which indicated that the QSBO indicators were useful in forecasting one and two quarters ahead.

Previous research from the RBNZ has shown the usefulness of the business surveys in producing forecasts. Matheson (2010) shows business survey data is particularly useful for forecasting GDP growth in dynamic factor models. The importance of the survey data was found to be mainly due to its timeliness.

More recent analysis of the QSBO measures finds they have strong predictive ability for key macroeconomic variables, including GDP and inflation. O'Connor and Yang (2011) show the QSBO performs well in forecasting GDP growth and CPI inflation up to a year ahead. Their paper highlights the usefulness of the domestic trading activity (DTA) measure as a timely indicator of the current growth rate of the economy. We extend this analysis by testing a range of different QSBO measures' out-of-sample forecast performance for a broader selection of macroeconomic variables.[4]

How do we determine which QSBO measures are the best?

Our approach is to compare the forecasting performance of a naïve time-series forecasting model with the performance of a model that includes a QSBO measure. This exercise will enable us to determine:

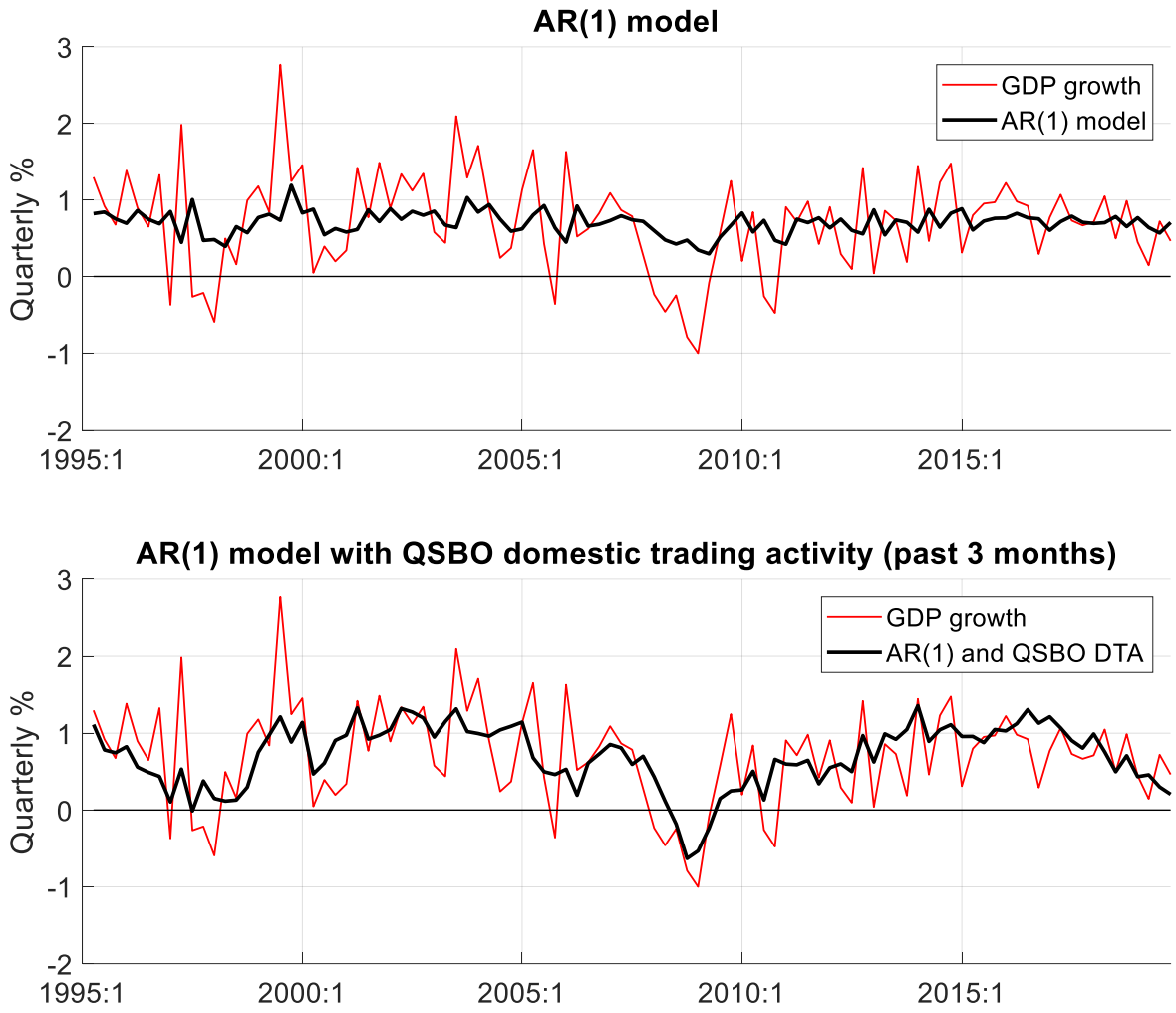
a) whether the addition of QSBO indicators enhances the forecasting performance of a basic time-series model, and;
b) which QSBO indicators offer the largest improvement in forecast performance, at various forecast horizons.

We also include the first principal component of all the tested QSBO measures for each dependent variable in our analysis as an additional variable. While one QSBO variable may not increase forecast performance, a combination of all relevant QSBO variables may provide an improvement.

As a simple example, panel 1 of Figure 3 shows the in-sample fit of an autoregressive model of order 1, i.e. an AR(1) model, which predicts quarterly GDP growth using merely its own value lagged one period. In panel 2, we add the domestic trading activity (past three months) variable to our AR(1) model. We can see the empirical fit appears to improve. We will now verify whether the improvement over the naïve benchmark model carries through to a forecasting exercise.

4 In addition, Coibion, Gorodnichenko, and Kumar (2018) report the results of a quantitative survey of how New Zealand firms form their expectations. They find systematic upward bias in firms' inflation expectations, firms are just as uncertain about current and future economic conditions, firms that face more competitors have more 'informed' economic forecasts (p. 2673), and firms updated their forecasts in a Bayesian manner when given new information, indicating that forecasts may be influenced significantly by new information, especially for inflation.

Figure 3: In-sample prediction of quarterly production GDP growth



Source: *Stats NZ*, author estimates.

Note: Models are estimated on data from 1995 Q2 to 2019 Q4. The first model is given by $y_t = \beta_0 + \beta_1 y_{t-1} + \varepsilon_t$ and the second model is given by $y_t = \beta'_0 + \beta'_1 y_{t-1} + \beta'_2 QSBO_t + \epsilon'_t$ where y_t is the quarterly growth rate in production GDP, and $QSBO_t$ refers (in this example) to the domestic trading activity (past three months) variable from the QSBO.

For interested readers, the methodology is outlined briefly next, with further details and robustness checks available in the technical appendix.

Forecasting models

We use the autoregressive model, where the leads of the variable are only influenced by its own lag, as our benchmark framework. We name this baseline case as Model 1:

$$y_{t+h,1} = \beta_0 + \beta_1 y_{t-1} + \varepsilon_t, \quad (1)$$

where $h = 0,1,2,3$ is the number of quarters ahead we are forecasting, y_t is the variable we are attempting to predict, for example GDP growth, and ε_t is an error term that is drawn from a normal distribution that is centred around 0 and has constant volatility. β_0 and β_1 are regression slope coefficients.

We then compare the forecasts for y_t made by Model 1 with forecasts made when we add a QSBO variable to the model. The augmented model is named Model 2:

$$y_{t+h,2} = \beta'_0 + \beta'_1 y_{t-1} + \beta'_2 QSBO_t + \epsilon'_t \quad (2)$$

Forecasting procedure

We estimate Models 1 and 2, starting with a sample of 1995 Q1 to 2010 Q2, only using the data that would have been available to a forecaster at this time.[5] We generate forecasts from one to four quarters ahead, and calculate the forecast errors of each model. Then, we add the next data point (2010 Q3), generate new forecasts, and calculate forecast errors again. This process continues until 2020 Q1. These forecast errors are squared and the mean is taken to create the mean-square prediction error (MSPE).

We can then compare the MSPE of Models 1 and 2 to find which QSBO variables offer statistically significant reductions in prediction error compared to Model 1, and which models offer the largest improvements for predicting quarterly GDP growth, quarterly CPI inflation, and quarterly employment growth from one quarter to a year into the future.

What are the results of our forecast evaluation?[6]

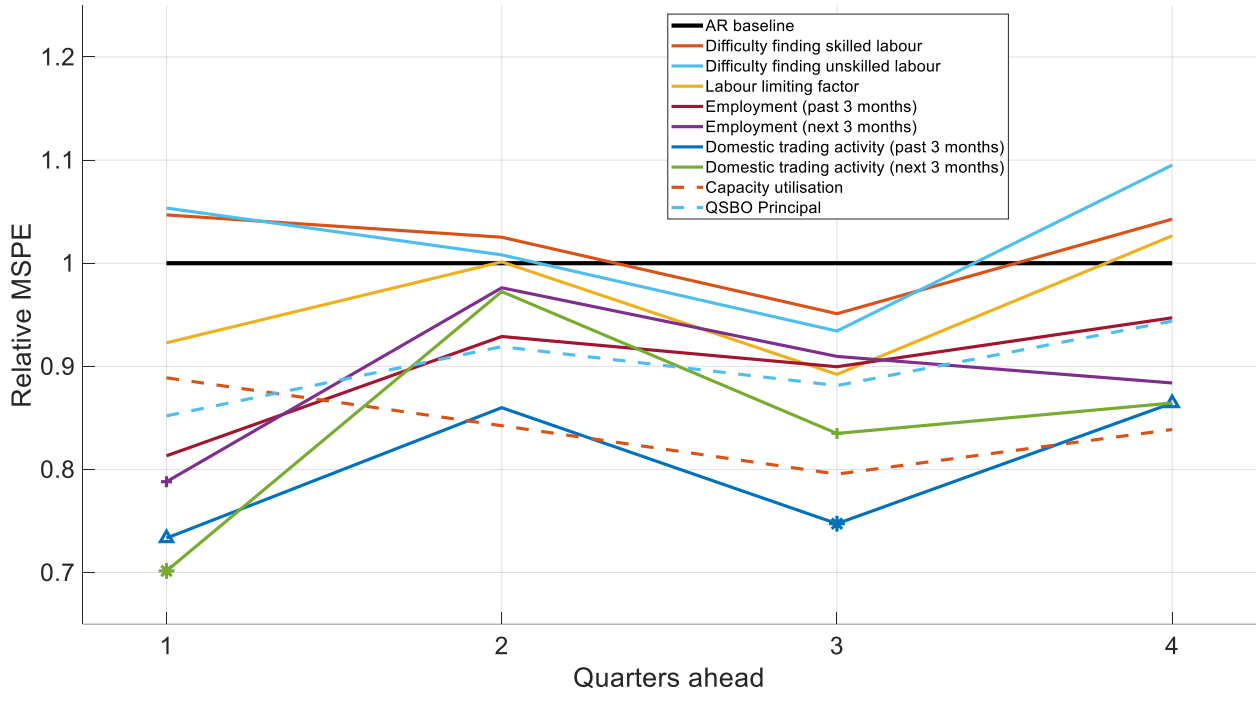
Employment growth

We find many QSBO indicators improve our forecasts for quarterly employment growth, although only a few of these indicators offer a statistically significant reduction in MSPE.

Figure 4 shows the MSPE of forecasting models that include various QSBO measures, relative to the baseline autoregressive model across different forecast horizons. This means that if the relative

MSPE of a model is less than one, it offers an improvement in the forecast performance of the autoregressive model. The significance markers on the figure denote whether the reduction in MSPE is statistically significant.

Figure 4: Relative mean square prediction error for employment growth forecasts



Note: * = 1% significance, ▲ = 5% significance, and ✚ = 10% significance for Clark-West test comparing out-of-sample predictions of two nested models. The dependent variable is quarterly growth in the number of employed people in the *Household Labour Force Survey.* The out-of-sample forecast errors are collected from 2010 Q3 to 2020 Q1.

5 We use the first vintage of the data that would have been available to forecasters trying to predict 2010 Q3 outturns. This is particularly important for GDP data, which tend to be revised heavily after the first release. All seasonal adjustment is carried out in real time. One of the strengths of business survey data is that it tends not to be revised, so aside from changes to the seasonal adjustment, the data we get in the first release of the QSBO is not subject to the same large revisions as other official data.

6 On the principal component, we find that this measure performed well for GDP growth, but was not the best indicator at any forecast horizons. This indicates that combining the information in the QSBO in this simple way did not add anything to a simple indicator regression, using individual QBSBO variables.

We find the domestic trading activity (DTA) measure offers the best improvement in MSPE. The backward-looking measure (past 3 months) offers statistically significant reductions in MSPE for one, three, and four quarters ahead, while the forward-looking measure (next 3 months) offers statistically significant improvements for one and three quarters ahead. The reduction in prediction error from using the DTA measure is economically significant, with a 30 percent reduction in MSPE when we use the forward-looking DTA measure to predict employment growth one quarter ahead.

CPI inflation

The baseline autoregressive model performed well for predicting quarterly CPI inflation up to four quarters ahead. The only statistically significant improvement came from the profitability (next three months) variable for two-quarters-ahead (Figure 5).

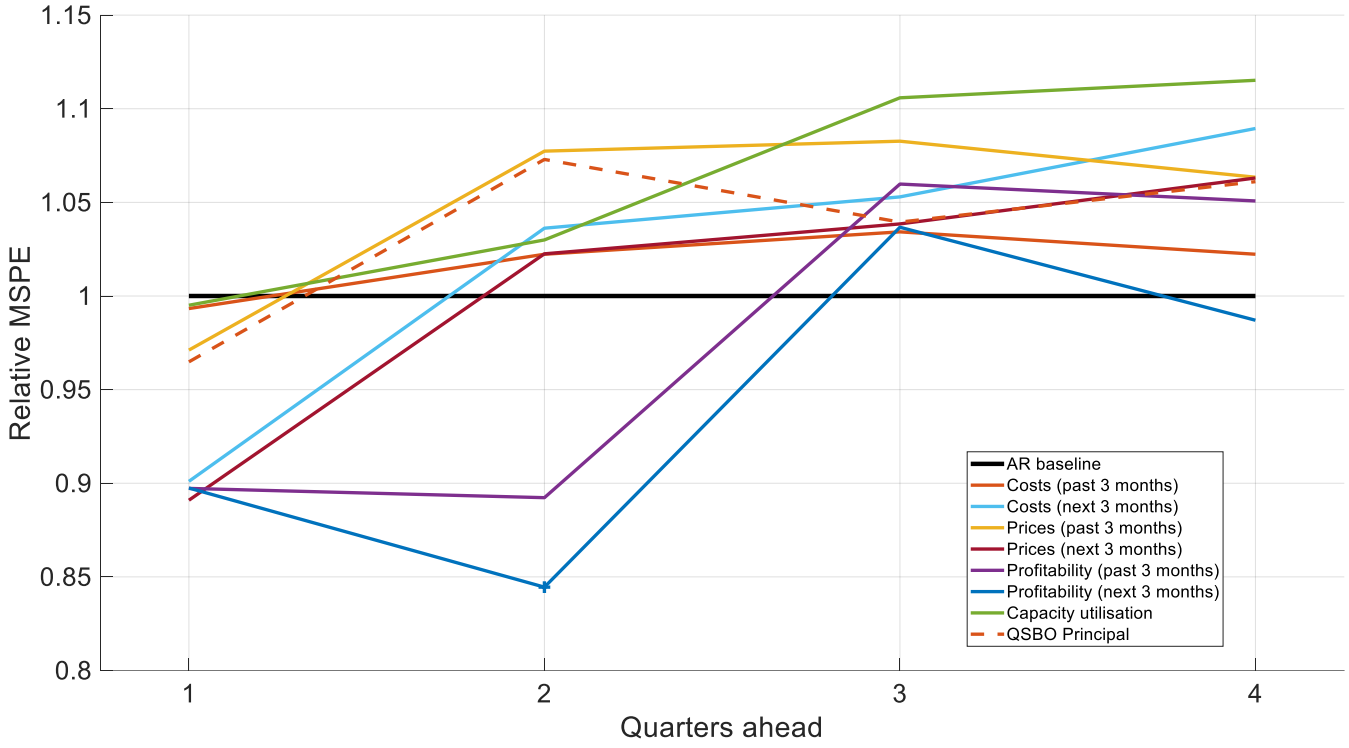
GDP growth

We find the domestic trading activity and profitability measures generate significant improvements in GDP forecasts compared with the benchmark, particularly for the one-quarter-ahead predictions (Figure 6). Interestingly, the business confidence measure (in orange) does not perform very well, despite being a widely reported measure. The business confidence measure only improves the forecast four-quarters-ahead, with the profitability and domestic trading activity (next three months) measures offering substantive improvements at all horizons.

A concern when predicting GDP growth in real time is that GDP data can be revised, especially with the first year after the data are released, when more-detailed annual data are incorporated into the quarterly GDP estimates (*Stats NZ*, 2014).

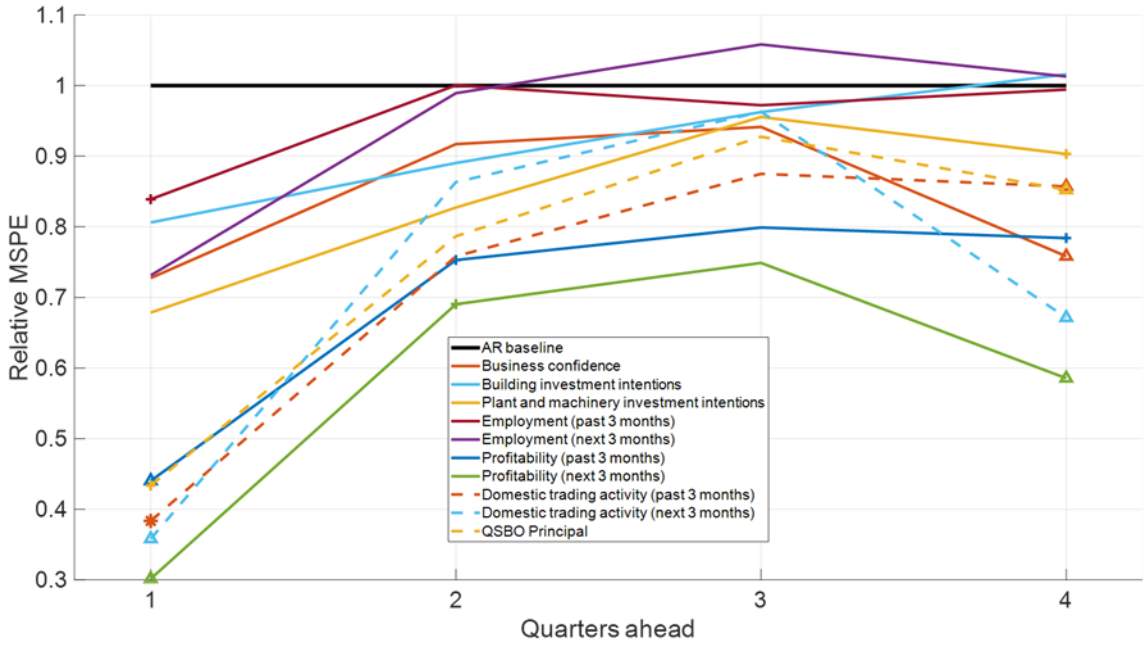
We therefore repeat our forecast evaluation for GDP growth, checking how well the same model predicts the most recently available data.

Figure 5: Relative mean square prediction error for CPI inflation forecasts



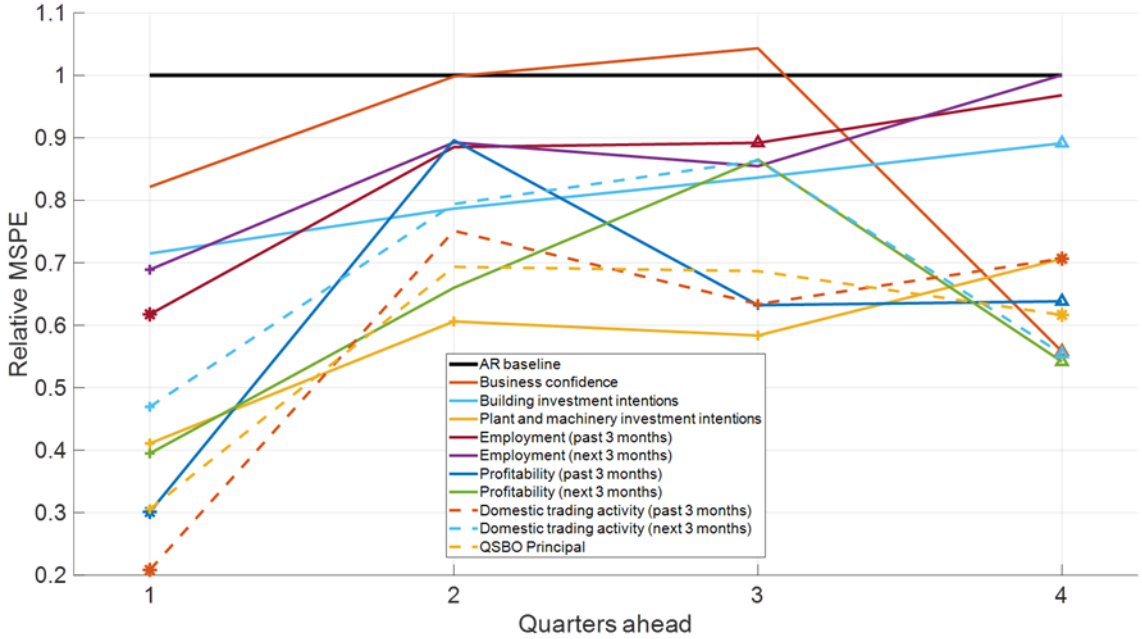
Note: * = 1% significance, ▲ = 5% significance, and ✚ = 10% significance for Clark-West test comparing out-of-sample predictions of two nested models. The dependent variable is quarterly CPI inflation, with an adjustment to remove the one-off impact of the increase in GST in . The out-of-sample forecast errors are collected from 2010 Q3 to 2020 Q1.

Figure 6: Relative mean square prediction error for real time GDP forecasts



Note: * = 1% significance, ▲ = 5% significance, and ✚ = 10% significance for Clark-West test comparing out-of-sample predictions of two nested models. The dependent variable is quarterly CPI inflation, with an adjustment to remove the one-off impact of the increase in GST in . The out-of-sample forecast errors are collected from 2010 Q3 to 2020 Q1.

Figure 7: Relative mean square prediction error for final vintage GDP forecasts



Note: * = 1% significance, ▲ = 5% significance, and ✚ = 10% significance for Clark-West test comparing out-of-sample predictions of two nested models. The dependent variable is quarterly CPI inflation, with an adjustment to remove the one-off impact of the increase in GST in . The out-of-sample forecast errors are collected from 2010 Q3 to 2018 Q3.

This data has been though the annual benchmarking process, and is likely to be a more accurate estimate of GDP. We restrict the out-of-sample exercise to 2010 Q3 – 2018 Q3 to ensure the data we are considering in this evaluation have been through at least one round of benchmarking.[7]

Figure 7 reports the results of this evaluation. While domestic trading activity and profitability continue to offer improvements in our forecasts, we find that investment intentions for plant and machinery is the best predictor of GDP from two to three quarters ahead. Given the lag time on investment projects, it is not surprising that firms are most accurate at anticipating the future path of the economy when considering their own future investment plans.

In Appendix 1, we report which QSBO measures (if any) offered the largest statistically significant improvement in our forecasts, for each forecast horizon.

Potential extensions

This Note evaluated the ability of the QSBO measures to yield accurate near-term forecasts.

The evaluation could be extended in a number of ways. Firstly, alternative model structures could be considered, for example, if we experiment with different lag structures and other control variables. This could provide a sense of whether the QSBO measures improve upon forecast models that utilise a much larger information set.

Secondly, analysing other business surveys, such as the monthly *ANZ Business Outlook* survey, would provide a deeper understanding of the informational content of New Zealand business surveys.

Finally, it may be worth considering whether there are better ways to use the information contained in the QSBO. For example, what is the effect of using the QSBO at a sectoral level, or using machine-learning methods rather than simple single-equation time-series models. Richardson, Mulder, and Vehbi (2019) find machine-learning methods can generate more-accurate real-time GDP forecasts in New Zealand, compared to standard models, such as autoregressive or dynamic factor models. Applying these methods to the QSBO indicators may generate better forecasts than simply adding the indicators individually to an AR model.

What do our results mean for the Reserve Bank?

Our evaluation gives a sense of which QSBO measures are the best at predicting GDP, employment, and CPI inflation. These results mean that when constructing forecasts to support the MPC in their monetary policy deliberations, we know which indicators to give most attention to and which indicators may not improve upon simple statistical models.

7 To clarify this point, we use real-time data to predict first-vintage GDP data in our baseline forecast evaluation. In this extension, we use the real-time GDP and business survey data to predict the final vintage data.

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Table 1: Best performing QSBO indicators at different time horizons

Horizon (quarterly)	**GDP first release**	**GDP latest data**	**CPI**	**Employment**
1	Profitability (next 3 months)	Domestic trading activity (past 3 months)	N.A.	Domestic trading activity (next 3 months)
2	Profitability (next 3 months)	Investment intentions (P&M)	Profitability (next 3 months)	N.A.
3	N.A.	Investment intentions (P&M)	N.A.	Domestic trading activity (past 3 months)
4	Profitability (next 3 months)	Profitability (next 3 months)	N.A.	Domestic trading activity (past 3 months)

Note: The measures included indicate the largest improvement in forecast performance on the baseline AR(1) at each horizon (if any are statistically significant). If no measure is listed, this means that no QSBO measures improved upon the AR(1) model.