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Assessing the Business Outlook Survey indicator using real-time data

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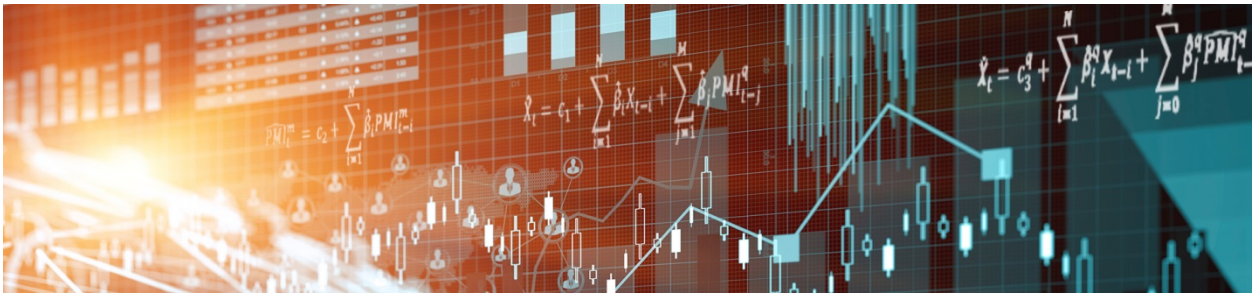
Staff Discussion Paper/Document d'analyse du personnel 2017-5

Assessing the Business Outlook Survey Indicator Using Real-Time Data



by Lise Pichette and Marie-Noëlle Robitaille

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Assessing the Business Outlook Survey Indicator Using Real-Time Data

by

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Abstract

Every quarter, the Bank of Canada conducts quarterly consultations with businesses across Canada, referred to as the *Business Outlook Survey* (BOS). A principal-component analysis conducted by Pichette and Rennison (2011) led to the development of the BOS indicator, which summarizes survey results and is used by the Bank as a gauge of overall business sentiment. In this paper, we examine whether data vintages matter when assessing the predictive content of the BOS indicator and individual BOS questions and whether the BOS is a better indicator of revised or unrevised macroeconomic data. As an indicator of business sentiment in the context of monetary policy, the reliability of the BOS is essential, and it is crucial to understand whether the signals it sends are best interpreted for early-released or revised data. For this purpose, we use different methods of forecasting that take into account the real-time perspective of the data. Results from the different methods show that the BOS content is informative regardless of data revisions. However, in real time, the BOS indicator and individual BOS questions are found to produce better nowcasts of first-released data or partially revised data than of latest-available data. This is particularly important in the case of growth in real business investment. In fact, because revisions to real business investment are more volatile than revisions to real gross domestic product (GDP), the choice of data vintages when assessing the ability of the BOS to forecast growth appears to be more important for real business investment than for real GDP.

Bank topics: Business fluctuations and cycles; Regional economic developments
JEL codes: C53; C82; E37

Résumé

Chaque trimestre, la Banque du Canada effectue, auprès d'entreprises d'un bout à l'autre du pays, une enquête dénommée « enquête sur les perspectives des entreprises ». Une analyse en composantes principales réalisée par Pichette et Rennison (2011) a mené à l'élaboration d'un indicateur qui résume les résultats de l'enquête et auquel la Banque a recours pour évaluer la confiance globale des entreprises. Dans la présente étude, nous cherchons à déterminer si les cuvées de données utilisées importent dans l'estimation de la valeur prédictive de l'indicateur et des questions de l'enquête prises isolément, et si l'enquête est un meilleur indicateur des données macroéconomiques révisées ou non révisées. Comme l'enquête est un indicateur de la confiance des entreprises dans le cadre de la politique monétaire, sa fiabilité est essentielle, et il est crucial de comprendre si elle

fournit de meilleurs signaux pour prévoir les données initialement publiées ou les données révisées. Pour y arriver, nous utilisons différentes méthodes de prévision qui tiennent compte de la perspective en temps réel des données. Les résultats des diverses méthodes montrent que le contenu de l'enquête est instructif en dépit des révisions des données. Nous constatons toutefois qu'en temps réel, l'indicateur et les questions de l'enquête prises isolément produisent de meilleures prévisions pour la période en cours en ce qui concerne les données publiées initialement ou les données révisées partiellement qu'en ce qui a trait aux dernières données disponibles. Ce constat est particulièrement évident dans le cas des données sur la croissance des investissements réels des entreprises. En effet, comme les révisions des données relatives aux investissements réels des entreprises sont plus volatiles que celles des données portant sur le produit intérieur brut (PIB) réel, le choix de la cuvée de données semble revêtir plus d'importance pour évaluer la capacité prédictive de l'enquête à l'égard de la croissance des investissements réels des entreprises que de l'expansion du PIB réel.

Sujets : Cycles et fluctuations économiques; Évolution économique régionale
Codes JEL : C53; C82; E37

1. Introduction

Monetary policy decisions are made in a context of economic uncertainty. Jenkins and Longworth (2002) discuss different sources of uncertainty that monetary authorities are facing. To deal with economic uncertainty, the Bank of Canada uses various strategies, one of them being to consider a wide range of information, including industry contacts across the country. Every quarter since the autumn of 1997, the Bank of Canada's regional offices have conducted the *Business Outlook Survey* (BOS), which consists of consultations with businesses. These consultations are structured around a survey questionnaire. Responses to qualitative questions are used to provide insights on specific macroeconomic variables. Moreover, to provide a broader view of business sentiment, the Bank developed the BOS indicator (Pichette and Rennison 2011), which extracts common underlying variations among selected BOS questions.

Pichette and Rennison (2011) compare the predictive content of the balance of opinion on future sales growth to that of the BOS indicator for growth in real GDP. They replicate the same exercise using the balance of opinion on investment in machinery and equipment to nowcast growth in real business investment. For this purpose, they use a pseudo out-of-sample measure of predictive content, which, as described in Stock and Watson (2003), exclusively involves the most recent vintage of historical data available for real GDP growth and for growth in real business investment. However, the macroeconomic series provided by Statistics Canada are frequently revised to reflect either more complete sources of data or improved methodology to construct the data. As such, the latest-available data for a given quarter are sometimes significantly different from their first release. Many researchers have shown that forecasting models should be evaluated using real-time data instead (e.g., Diebold and Rudebusch 1991; Stark and Croushore 2002; Orphanides and van Norden 2002). Using the latest-available vintage gives the model a considerable advantage, as it is based on data that have been revised and that could not have been anticipated at the time the forecasts would actually have been produced. In fact, Kozicki (2002) argues that survey forecasts, which are similar to the BOS responses in the sense that they are never revised, should not be compared with the latest-available vintage since this vintage includes information that was not available when forecasters provided their expectations.

In this paper, we address this issue by using real-time analysis methods suggested by Koenig, Dolmas and Piger (2003) and by Stark and Croushore (2002) to examine whether data vintages matter when assessing the predictive content of the BOS and whether the survey is a better indicator of revised or unrevised macroeconomic data. Since the BOS is used by the Bank of Canada to monitor business sentiment for the conduct of monetary policy, its reliability is essential, and it is crucial to understand whether the signals it sends are best interpreted for early-released or for revised data. This paper contributes to the literature by testing the forecasting accuracy of survey results in real time, taking advantage of an in-house real-time database. To our knowledge, no real-time analysis has ever been conducted in the Canadian context using business-survey data. Moreover, Pichette and Rennison (2011) conducted their analysis using a limited sample period. Taking into account the real-time perspective of the data and using an extended sample period allows us to validate their results.

Our results confirm that the BOS provides useful signals to forecast the growth of real GDP and business investment, regardless of the vintage of data used. In real time, it is found to produce better nowcasts of early-released data than of revised data. The choice of data vintage is found to be more important for real business investment growth than for real GDP growth, because of the larger revisions encountered by investment data. Pichette and Rennison (2011) find the BOS indicator to be a weaker predictor of real GDP growth than the balance of opinion on future sales growth, but a better predictor of growth in real business investment than the balance of opinion on investment in machinery and equipment. In real time and with a longer sample period, we find that the BOS indicator has similar explanatory power for real GDP growth and growth in real business investment to the balance of opinion on future sales growth and the balance of opinion on investment in machinery and equipment, respectively. In the case of real GDP growth, this different conclusion appears to be caused by the extended sample period, since Pichette and Rennison (2011) estimate the equations based on the 2001Q4–2011Q2 period, while our research covers the 2001Q4–2016Q4 period. For growth in real business investment, data revisions seem to be the most important factor explaining this new conclusion.

This paper is organized as follows: The next section describes the data with a focus on the BOS data set, including the BOS indicator. It also examines data on the growth in real GDP and in real business investment, since the BOS indicator was found to be helpful in nowcasting these two macroeconomic variables. Revisions to these series are investigated. In Section 3, an empirical analysis is undertaken to compare the estimation results of the forecasting models with and without real-time data. Tests are conducted to highlight the predictive performance of the BOS indicator and individual BOS questions using out-of-sample forecasting exercises with different vintages of data. Section 4 provides some concluding remarks and avenues for future research.

2. The Data

This section describes the BOS data set and the two macroeconomic variables of interest: growth in real GDP and growth in real business investment. More specifically, it examines revisions affecting these series given that the importance of revisions is closely related to the vintage-sensitivity in a forecasting assessment exercise (Kozicki 2002). A good understanding of the properties of revisions is helpful to make appropriate assumptions regarding the real-time methods used to analyze the data, as will be seen in Section 3.

2.1. The BOS indicator

For analytical and communication purposes, responses to most BOS questions are expressed in terms of a balance of opinion, which aims at gathering an indicator of momentum or growth, or as a proportion of respondents.[1] To statistically evaluate the survey's information content and its ability to predict real economic variables, Pichette and Rennison (2011) use principal-component analysis (PCA) to extract common movements from the various BOS variables and construct a summary index, referred to as the

[1] For a detailed description of the survey questions, see Martin (2004) and Bank of Canada (2008).

BOS indicator. In addition to capturing a common source of variation, the BOS indicator provides an appealing alternative to using all survey questions in a forecasting exercise, since it conserves degrees of freedom and lessens concerns about issues of multicollinearity. The BOS indicator includes 10 survey questions that are published by the Bank in the quarterly publication of the BOS.[2] These questions are presented in Table 1.[3] While data for most indicators are available from 1998Q3, the questions on credit conditions, on the ability of firms to meet an unexpected increase in demand and on the intensity of labour shortages were added later. Extracting information from all 10 indicators therefore limits the sample to the period from 2001Q4 to 2016Q4.

Although responses to BOS questions are never revised, the BOS indicator is revised every quarter because of the methodology used to estimate it. In fact, coefficients of the PCA are re-estimated as new observations are available. However, revisions to the BOS indicator are very small, and they tend to get smaller as the sample of the BOS grows. As shown in Chart 1, revisions to the BOS indicator were larger at the beginning because results from each survey question are normalized before being treated through PCA. Therefore, adding one observation to a small sample had a relatively big impact on the mean for each BOS indicator. The blue band shows the range of the BOS indicator values as recorded in different vintages (2004Q1–2016Q4).[4] The chart shows that, through time, this band becomes almost indistinguishable for the values recorded in the latest-available vintage (2016Q4). The 2008–09 recession greatly affected the average of the BOS responses and, thus, the PCA coefficients. The revisions then quickly returned to a minimal level after the recession, and we expect that they will remain small in the future, since the sample has become long enough to include at least one full economic cycle.

2.2. Real GDP and business investment: Properties of revisions

Pichette and Rennison (2011) showed that the BOS indicator and the balances of opinion on future sales growth and on investment intentions on machinery and equipment provide useful information in forecasting real GDP growth and the growth of real business investment. These macroeconomic variables are in chained 2007 dollars, seasonally adjusted at annual rates, and estimated by Statistics Canada on a quarterly basis as part of the expenditure-based accounts. Their growth is calculated on an annualized quarter-over-quarter basis. As with most economic data, these macroeconomic variables are revised repeatedly as Statistics Canada gets new or better information. Statistical revisions incorporate the most recent information, such as quarterly and annual surveys, taxation statistics, public accounts and censuses. The revision process is as follows: Two months after the end of a quarter, Statistics Canada provides a first estimate of the expenditure account. Data are revised when estimates for

[2] The BOS indicator excludes the question relating to firms' expectations regarding consumer price index inflation over the next two years, since it does not pertain to firms' views on their own business situation or plans.

[3] Initially, the BOS indicator included only nine survey questions. Since 2015, a new question on the intensity of labour shortages has been added to the BOS publication (Bank of Canada 2015) and therefore was included in the BOS indicator. Its inclusion did not change the general trend of the indicator.

[4] Because a minimum number of observations is necessary to estimate the principal components, vintages of the BOS indicator were obtained from 2004Q1 to 2016Q4 only.

subsequent quarters of the same year are published. Annual revisions going back three to four years are also conducted and released in the first quarter of each year. From time to time, Statistics Canada revises the expenditure account more than four years back to incorporate conceptual or methodological changes (Statistics Canada 2016). This means that the sample period is important and may affect the results of the real-time analysis, since a longer sample period may include not only more revisions but also methodological changes. In this section, we examine revisions to growth in real GDP and business investment because, as pointed out by Kozicki (2002), the vintage-sensitivity of forecasting models is closely related to the importance of revisions. Chart 2 and Chart 3 show the growth in real GDP and in real business investment as recorded in data vintages from 2002Q1 to 2016Q4. Investment, in particular, was heavily revised during and after the global financial crisis.

Table 2 summarizes some key statistical properties of cumulative revisions of the growth in real GDP and in real business investment.[5] It shows the mean, the absolute mean, the standard deviation, the noise-to-signal ratio (which is the ratio of the absolute mean revision to the absolute growth rate of the first release) and the standard deviation ratio between the revision and the first release. Mean revisions to the growth in GDP and in business investment are slightly tilted to the upside, implying minor downward biases in the first estimates. However, none of these biases is found to be statistically significant. The noise-to-signal ratio indicates that revisions are more important for investment than for GDP. The size of absolute mean revisions to investment represents 24 per cent to 70 per cent of the size of the first release of growth in real business investment (in absolute terms), as measured by the noise-to-signal ratio. For real GDP growth, this ratio stands between 12 per cent and 39 per cent. Standard deviations can be used to measure the volatility of revisions compared with growth rates. Revisions to investment seem more volatile than revisions to GDP. For example, the standard deviation for the eighth revision to investment represents 55 per cent of the standard deviation for investment growth, while this ratio is 42 per cent for GDP. Based on the relative sizes and volatility of the revisions, we can expect that our forecasting model for growth in real business investment will be more vintage-sensitive than that for real GDP growth.

In Table 2, the sample period for the latest-available revision is truncated after 2014Q3, even if the latest vintage itself includes historical data up to 2016Q3. This restriction guarantees that each observation has undergone at least eight revisions (i.e., two years of revisions). This hypothesis, which is based on the idea that the data must be close to final after eight revisions, has been used in the literature (e.g., Jacobs and Sturm 2004), and it seems appropriate given Statistics Canada's revision process. In fact, Chart 4 and Chart 5 show that the first revision (after one quarter) is the most important one and that the mean absolute non-cumulative revision tends to get smaller with each revision.[6]

[5] Cumulative revisions are defined by the difference between the *i*th release and the first release, while non-cumulative revisions are defined by the difference between the *i*th and the *i*th - 1 release for a given quarter.
[6] In the charts, the sample diminishes as *i* increases. For the 20th revision, it ends in 2011Q3.

Researchers have suggested that revision processes may consist of *adding news* or *reducing noise* (Croushore 2011). If data revisions add news, it means that the initial releases of data were optimal (efficient) forecasts of the revised data. In this case, revisions to the initial release of the data are unpredictable using data available at the time it was issued. In contrast, if data revisions reduce noise, each release includes a measurement error, and revisions are predictable. The nature of data revisions was found to vary from one variable to another and from one revision to another (Croushore and Stark 2003; Mankiw and Shapiro 1986; Patterson and Heravi 1991). Mincer and Zarnowitz (1969) suggest testing the noise content of data revisions by regressing the revisions on a constant and on the final release. The null hypothesis that revisions are independent of the true values (i.e., the noise hypothesis) may be tested with a Wald test. A similar news test regresses the revisions on a constant and the first-release data. The null hypothesis now tests whether revisions are independent of the initial value (i.e., the news hypothesis) and thus whether the revisions are unpredictable. Results of these tests for revisions to both growth in real GDP and growth in real business investment are presented in Table 3. Whether the latest-available vintage or the data set with eight revisions is used as a proxy for final data, revisions to our macroeconomic data appear to consist of news rather than noise.[7]

3. Empirical Analysis

This section presents empirical results to assess the information content of the BOS for growth in real GDP and in real business investment, taking into account the real-time perspective of the data. First, the forecasting equations presented by Pichette and Rennison (2011) are re-estimated using the conventional method, which relies only on the latest-available vintage. Then, the same specifications are estimated using the method proposed by Koenig, Dolmas and Piger (2003), which uses the first-release data. Then, various forecasting performance exercises, similar to those presented by Stark and Croushore (2002), are conducted, using different sets of data vintages. The objective of these exercises is to examine whether data vintages matter when assessing the predictive content of the BOS and to determine whether the BOS is better at forecasting revised or unrevised data of the growth in real GDP and in real business investment.

In their work, Pichette and Rennison (2011) present the following forecasting models to nowcast growth in real GDP and in real business investment.

Real GDP growth:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \varepsilon_t \tag{1}$$

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 BOSUI_t + \varepsilon_t \tag{2}$$

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 FS_t + \varepsilon_t \tag{3}$$

[7] The news hypothesis is rejected at the 10 per cent significance level using the latest-available vintage as a proxy for final data. However, it appears to be an artifact of the sample ending in 2014Q3, since the news hypothesis is most often not rejected in longer or shorter samples.

Growth in real business investment:

$$inv_t = \beta_0 + \beta_1 inv_{t-1} + \varepsilon_t \quad (4)$$

$$inv_t = \beta_0 + \beta_1 inv_{t-1} + \beta_2 BOSUI_t + \varepsilon_t \quad (5)$$

$$inv_t = \beta_0 + \beta_1 inv_{t-1} + \beta_2 M\&E_t + \varepsilon_t \quad (6)$$

In this setup, y_t, inv_t, $BOSUI_t$, FS_t and $M\&E_t$, respectively, represent real GDP growth, growth in real business investment, the BOS indicator, the balance of opinion on future sales growth, and the balance of opinion on investment in machinery and equipment at time *t*. These equations, along with a host of other models, are currently used by the Bank to monitor the growth in real GDP and in real business investment. Koenig, Dolmas and Piger (2003) suggest that for an optimal use of the real-time data, each equation should be estimated with the first-release data on the left side of the equation and real-time data on the right side. In the context of the equations developed by Pichette and Rennison (2011), it means using only the first-release data for the purpose of estimation.[8] The argument supporting this method is based on the assumption that the revisions consist of news instead of noise (as shown in the previous section) and, as such, that the first-release data are an efficient estimate of subsequent releases. Let $X_{t,v}$ represent the realization for *X* in period (or quarter) *t* as reported in vintage *v*. Since the first estimate for *y* or *inv* in period *t* is released in the following period (quarter), the equations can be rewritten as follows:

Real GDP growth:

$$y_{t,t+1} = \beta_0 + \beta_1 y_{t-1,t} + \varepsilon_t \quad (7)$$

$$y_{t,t+1} = \beta_0 + \beta_1 y_{t-1,t} + \beta_2 BOSUI_{t,t} + \varepsilon_t \quad (8)$$

$$y_{t,t+1} = \beta_0 + \beta_1 y_{t-1,t} + \beta_2 FS_t + \varepsilon_t \quad (9)$$

Growth in real business investment:

$$inv_{t,t+1} = \beta_0 + \beta_1 inv_{t-1,t} + \varepsilon_t \quad (10)$$

$$inv_{t,t+1} = \beta_0 + \beta_1 inv_{t-1,t} + \beta_2 BOSUI_{t,t} + \varepsilon_t \quad (11)$$

$$inv_{t,t+1} = \beta_0 + \beta_1 inv_{t-1,t} + \beta_2 M\&E_t + \varepsilon_t \quad (12)$$

[8] If there were more than one lag of the dependent variable on the right side of the equation, the inclusion of subsequent releases of data would be required.

3.1. Reassessing the information content of the BOS for the growth in real GDP and business investment

In this section, the equations presented by Pichette and Rennison (2011) are re-estimated using both the conventional method (i.e., using only the latest-available vintage) and the method suggested by Koenig, Dolmas and Piger (2003), which relies only on first-release data. The first four rows in Table 4 and Table 5 present the estimation results using the conventional method, over the period from 2001Q4 to 2016Q3. In the forecasting equations for real GDP growth (Table 4), the coefficient of the BOS indicator is positive and significant and the adjusted R^2 of equation 2 is higher than that of equation 1, which includes only the lagged real GDP growth. Consistent with Pichette and Rennison (2011), results for equation 3 indicate that the balance of opinion on future sales growth continues to outperform the BOS indicator for real GDP growth, with a higher adjusted R^2.

Estimation results for the growth in real business investment are shown in Table 5. As in Pichette and Rennison (2011), the adjusted R^2 is improved when the BOS indicator is included as an explanatory variable, which suggests that the BOS indicator provides information for growth in real business investment beyond what is contained in its past values. The survey question on investment intentions in machinery and equipment (equation 6) is also found to have significant explanatory power for business investment. The adjusted R^2 indicates that the BOS indicator continues to outperform the single BOS question on investment intentions.

However, there is a general deterioration of the adjusted R^2 in Table 4 and Table 5 compared with Pichette and Rennison (2011), suggesting that the forecasting performance of the BOS indicator and the BOS questions has deteriorated. This deterioration could have different causes. One possibility is that the BOS indicator may be more useful to predict turning points. Since Pichette and Rennison (2011) estimate the equations on the period from 2001Q4 to 2011Q2, the global financial crisis of 2007–09, if well forecasted by the BOS content, may have weighed a lot on the impressive estimation results compared with our sample covering the period from 2001Q4 to 2016Q3. This explanation appears to be important for real GDP growth, since the adjusted R^2 is similar to that in Pichette and Rennison (2011) when it is calculated with the latest-available vintage over the period from 2001Q4 to 2011Q2, but it deteriorates when the sample is extended to 2016Q3. Another explanation is data revisions. In fact, for growth in real business investment, revisions seem to play an important role since adjusted R^2 deteriorates drastically when we estimate these equations with the same sample period (2001Q4–2011Q2) but different vintages.[9] This is consistent with the point made by Kozicki (2002) regarding the sensitivity of the results to the chosen vintage when revisions are important.

Table 6 and Table 7 report estimation results for the approach proposed by Koenig, Dolmas and Piger (2003). The results are qualitatively similar to the previous exercise, which is reassuring and suggests that the BOS content is informative for the growth in real GDP and in real business investment

[9] These estimation results are not shown, but they are available from the authors upon request.

regardless of the vintage of data used. The adjusted R^2 is generally closer to that obtained with the 2016Q4 vintage than in Pichette and Rennison (2011), regardless of the sample period considered.

3.2. Out-of-sample forecasting

Both estimation methods presented above rely on a single set of historical data. In the case of the method used by Pichette and Rennison (2011), this set of data is the latest-available vintage, while in the case of Koenig, Dolmas and Piger (2003), it is the first-release data. Therefore, the forecasting performance of these equations can be tested using a typical pseudo out-of-sample forecasting exercise, in which each equation is estimated for a sample spanning the period from 2001Q4 to 2007Q1, and a forecast is produced for 2007Q2. One observation is then added to the estimation period for the next-quarter forecast, and this is repeated up to 2016Q3.

The real-time out-of-sample forecasting exercise presented by Stark and Croushore (2002) requires a wider range of vintages and historical data. To be used in the real-time forecasting exercise, the equations presented by Pichette and Rennison (2011) can be rewritten as follows:

Real GDP growth:

$$y_{t,v} = \beta_{0_v} + \beta_{1_v} y_{t-1,v} + \varepsilon_t \tag{13}$$

$$y_{t,v} = \beta_{0_v} + \beta_{1_v} y_{t-1,v} + \beta_{2_v} BOSUI_{t,v} + \varepsilon_t \tag{14}$$

$$y_{t,v} = \beta_{0_v} + \beta_{1_v} y_{t-1,v} + \beta_{2_v} FS_t + \varepsilon_t \tag{15}$$

Growth in real business investment:

$$inv_{t,v} = \beta_{0_v} + \beta_{1_v} inv_{t-1,v} + \varepsilon_t \tag{16}$$

$$inv_{t,v} = \beta_{0_v} + \beta_{1_v} inv_{t-1,v} + \beta_{2_v} BOSUI_{t,v} + \varepsilon_t \tag{17}$$

$$inv_{t,v} = \beta_{0_v} + \beta_{1_v} inv_{t-1,v} + \beta_{2_v} M\&E_t + \varepsilon_t \tag{18}$$

The real-time out-of-sample forecasting analysis described in Stark and Croushore (2002) is similar to the conventional pseudo out-of-sample forecasting exercise to the extent that the process also involves a series of one-step-ahead forecasts for each equation. The only difference is that each time the estimation sample is extended by one quarter, a new vintage of data is used to estimate the forecasting model and to compute the out-of-sample forecast. In the context of this paper, data vintages from 2007Q2 to 2016Q4 are used to conduct the real-time out-of-sample forecasting exercise.

A key point in the real-time out-of-sample forecasting analysis is the choice of "actuals" from which forecast errors are calculated. Stark and Croushore (2002) and Kozicki (2002) suggest a few alternatives.

In the context of this paper, the latest-available vintage, the first-release data, and the data with eight revisions are considered. The latest-available vintage appears to be a logical choice since it contains all the information to date. However, its drawbacks are that each observation has been revised a different number of times and that some observations are not final, especially for the quarters at the end of the sample. The first-release data set is also interesting for its timeliness, although it probably includes measurement errors and is missing information. The data set with eight revisions is appropriate based on the assumption that most revisions usually occur in the two years following the first release.

3.2.1 Pseudo out-of-sample forecasting using the latest-available vintage

Table 8 presents the results of the pseudo out-of-sample forecasting exercise using the latest-available vintage.[10] For each equation, it shows the mean error (ME), the mean absolute error (MAE) and the root-mean-square error (RMSE). As in Pichette and Rennison (2011), these results suggest that, for both GDP and investment, information from the BOS (equations 2, 3, 5 and 6) improves the forecast compared with equations 1 and 4, suggesting that the BOS provides information beyond what is contained in the past values of the macroeconomic variables. However, based on the test for predictive accuracy for nested models developed by Clark and West (2007), only the inclusion of the balance of opinion on future sales growth (equation 3) improves significantly the forecast for real GDP growth compared with the benchmark equation (equation 1). In contrast, the test for predictive accuracy developed by Diebold and Mariano (1995) suggests that equations 2 and 3 share a similar predictive accuracy. This contradictory information prevents us from drawing conclusions about the superiority of the balance of opinion on future sales growth to forecast real GDP growth compared with the BOS indicator. In the case of growth in real business investment, the Clark-West test reveals that the inclusion of both the BOS indicator (equation 5) and the balance of opinion on investment intentions (equation 6) significantly improves the forecasting performance of the models compared with the benchmark equation. Contrary to Pichette and Rennison (2011), the Diebold-Mariano test shows that the BOS indicator no longer significantly outperforms the single question on investment in machinery and equipment for forecasting growth in real business investment.

3.2.2 Pseudo out-of-sample forecasting using the first-release data

Table 9 presents the results of the pseudo out-of-sample forecasting exercise using the first-release data (i.e., the method suggested by Koenig, Dolmas and Piger 2003). According to Clark and McCracken (2009), complications arise when testing the differences between forecasts produced with real-time data that have undergone a different number of revisions. However, the authors note that, under the method used by Koenig, Dolmas and Piger (2003), which relies exclusively on the first-release data, predictability tests developed for unrevised data can be applied. This is the strategy used by Ravazzolo and Rothman (2013) to compare the forecasting performance of different models taking into account the real-time perspective of the data. Using this strategy, we find the same results from the Clark-West

[10] The results are reported based on the period up to 2014Q3 to include only data that have been revised at least eight times.

and Diebold-Mariano tests as in the pseudo out-of-sample forecasting analysis using the latest-available vintage.

3.2.3 Real-time out-of-sample forecasting using the latest-available vintage as actuals

The real-time out-of-sample forecasting process using the latest-available vintage as actuals provides roughly the same results (Table 10). One could have thought that using the latest-available vintage to forecast the latest-available vintage, as in Table 8, would have given better results than using real-time data to forecast the latest-available vintage. This intuition is described by Stark and Croushore (2002), who consider the latest-available vintage to have two advantages in this situation: (1) it contains revisions that reduce the measurement error in the data, and (2) it includes methodological and benchmark changes that were not available in real time. However, Stark and Croushore (2002) and Kozicki (2002) also obtain these surprising results. They note that the relative performance of the different out-of-sample forecasting processes depends on the size of the sample and on the importance of revisions.

3.2.4 Real-time out-of-sample forecasting using the first-release data as actuals

Table 11 shows results from the same real-time out-of-sample forecasting exercise as in Table 10 except that forecasts are assessed against the first-release data. Interestingly, all MAEs and RMSEs are lower than those of the pseudo out-of-sample forecasting exercise (Table 8) and the real-time out-of-sample forecasting exercise (Table 10) using the latest-available vintage as actuals. These differences are particularly important for growth in real business investment. These findings are consistent with the results obtained by Kozicki (2002), who suggests that the larger the revisions, the more likely there will be a difference between pseudo and real-time out-of-sample forecasts. These findings also suggest that the choice of vintage may be more important for the growth in real business investment than for real GDP growth. Comparing the RMSEs in Table 10 with those in Table 11 shows that the BOS indicator and the individual BOS questions provide better information about first-release data than about revised data. Given that these variables are based on a business survey, one can expect that firms' perspectives might have been different had they been given the additional information contained in the latest-available vintage. However, in real time, these businesses had to form their expectations based on the information that was available at the time. Since they cannot change their answers as they obtain additional information, it is likely that their answers better reflect economic conditions as measured in real time.

It is reassuring to see that, at least qualitatively, forecasts are similar in the different out-of-sample processes. In fact, the MAEs and RMSEs in all these tables indicate that the best forecasting models are those with the balance of opinion on future sales growth for real GDP growth, and those with the BOS indicator for growth in real business investment. The BOS indicator provides accuracy gains in the order of 24 per cent for forecasting growth in business investment in real time (Table 11), which is even higher than the 19 per cent accuracy gains obtained with the pseudo out-of-sample forecasting using the latest-available vintage (Table 8). Similarly, the balance of opinion on future sales growth provides

accuracy gains of 9 per cent for forecasting real GDP growth in real time (Table 11) compared with 10 per cent with the pseudo out-of-sample forecasting using the latest-available vintage (Table 8). This confirms that those model specifications are robust to the choice of data vintage.

3.2.5 Real-time out-of-sample forecasting using the data with eight revisions as actuals

Table 12 presents the results of the real-time out-of-sample forecasting exercise using as actuals the data that have gone through eight revisions. The RMSEs are higher than when the first-release data are used as actuals (Table 11), but lower than when the latest-available vintage is used as actuals (Table 10). Since data in the latest-available vintage have been revised at least eight times (because the sample ends in 2014Q2), this confirms that the BOS indicator and individual survey questions provide more information about data that have undergone fewer revisions. One explanation is that the latest-available vintage is likely to include more methodological changes than the data with eight revisions and we cannot expect the BOS indicator and individual survey questions to explain methodological changes.

Clark and McCracken (2009) show that the asymptotic behaviour of tests of predictive accuracy for non-nested models is maintained when revisions are adding news. However, these tests require corrections if data revisions reduce noise. As shown earlier, for growth in real GDP and in real business investment, revisions appear to add news. Thus, the Diebold-Mariano test can be applied to the different real-time out-of-sample forecasting exercises (tables 10–12), as done by Heij, van Dijk and Groenen (2011). The same results are obtained as in the pseudo out-of-sample forecasting exercise.[11]

4. Discussion

This paper finds that the BOS provides useful signals to forecast the growth in real GDP and business investment, regardless of the vintage of data used. Pichette and Rennison (2011) find the BOS indicator to be a weaker predictor of real GDP growth than the balance of opinion on future sales growth, but a better predictor of growth in real business investment than the balance of opinion on investment in machinery and equipment. In real time and with a longer sample period, we find that the BOS indicator has similar explanatory power for real GDP growth and growth in real business investment to the balance of opinion on future sales growth and the balance of opinion on investment in machinery and equipment, respectively. Given the volatility of business investment and the relatively small sample size of the BOS, it is particularly useful to consider and compare forecasts obtained using the question on investment intentions and forecasts provided by the BOS indicator.

Our analysis of the revisions showed that revisions to GDP and business investment are non-negligible and that they are more important and more volatile for investment, suggesting that the choice of data vintage, when choosing a forecasting model for growth, is more important for real business investment than for real GDP (Kozicki 2002). Information from the BOS is found to be most useful to forecast unrevised or partially revised values of growth in real GDP and in real business investment. This is likely

[11] Results of those tests are not shown, but they are available from the authors upon request.

because firms had to form their expectations based on the information that was available at the time of the survey. Since they cannot change their answers as they obtain additional information, it is likely that their answers better reflect economic conditions as measured in real time. Moreover, over time, Statistics Canada has implemented some methodological changes that are incorporated in the latest-available vintage data but not in real-time data. One cannot expect the BOS indicator to explain methodological changes contained in the latest-available vintage when using real-time data to estimate models and using the latest-available vintage as actuals.

This paper is subject to some limitations. In particular, statistical comparisons of the real-time out-of-sample forecasts were conducted only for non-nested models using the Diebold-Mariano test. As explained by Clark and McCracken (2009), this test is valid under the assumption that data revisions consist of news instead of noise. However, we do not compare nested models through statistical tests in the context of the real-time out-of-sample forecasting. Clark and McCracken (2009) discuss this issue, explaining that tests of equal mean squared error for nested models may not have the same asymptotic distribution when using data with different degrees of revisions. However, the solutions suggested by Clark and McCracken (2009) in this context rely on the use of a range of different tests and corrections, which is beyond the scope of this paper. To overcome this problem, we apply the Clark-West test to the pseudo out-of-sample forecasting exercise using the first-release data to take into account the real-time perspective. The results obtained were similar to those of the pseudo out-of-sample forecasts using the latest-available data, suggesting that they may be qualitatively the same regardless of the vintage used.

Other avenues of research are considered for future work. First, it might be interesting to assess whether the information content of the BOS remains helpful for nowcasting the growth in real GDP and in real business investment when other macroeconomic indicators are considered. For example, Statistics Canada releases monthly indicators, such as estimates of GDP at basic prices, which could be used to improve the nowcasts. In this case, however, more advanced econometric tools, like mixed-frequency regressions, should be utilized. Second, given that the BOS indicator includes a question on the intensity of labour shortages, which is highly correlated with various measures of the output gap at the Bank of Canada (Bank of Canada 2015), it would be appropriate to do similar analysis with the output gap, especially since this variable is subject to important revisions over time. While having an estimate of the output gap is important for the proper conduct of monetary policy, there is significant uncertainty surrounding it since it is unobservable. The BOS indicator could likely shed some light on this uncertainty or be used as an additional tool to refine the Bank's estimates of the output gap.

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Table 1: *Business Outlook Survey* questions used in principal-component analysis

Survey question	Horizon
Balance of opinion[a] on past sales growth	Past 12 months
Balance of opinion on future sales growth	Next 12 months
Balance of opinion on investment in machinery and equipment	Next 12 months
Balance of opinion on employment	Next 12 months
Ability to meet an unexpected increase in demand[b]	Current
Percentage of firms facing labour shortages	Current
Balance of opinion on input prices	Next 12 months
Balance of opinion on output prices	Next 12 months
Balance of opinion on credit conditions	Past 3 months
Balance of opinion on labour shortage intensity	Current

Notes:
a. Percentage of firms responding "greater," "higher" or "more" minus percentage of firms reporting "lesser," "lower" or "less."
b. Percentage of firms responding "some" or "significant" difficulty.

Table 2: Summary statistics of cumulative revisions to growth rates

	For the 1st revision 2001Q4–2016Q3		For the 8th revision 2001Q4–2014Q3		For the latest-available revision 2001Q4–2014Q3	
	GDP	Investment	GDP	Investment	GDP	Investment
Mean	0.05	0.28	0.12	0.35	0.11	1.76
Absolute mean	0.28	1.70	0.67	3.72	0.98	4.90
Standard deviation (SD)	0.35	2.17	0.89	4.95	1.19	6.71
Noise-to-signal ratio	0.12	0.24	0.27	0.53	0.39	0.70
SD ratio	0.17	0.24	0.42	0.55	0.56	0.75

Note: The sample period changes throughout the table to ensure a sufficient number of revisions.

Table 3: Results of the Wald news and noise tests (sample: 2001Q4–2014Q3)

	Using the latest-available vintage as final		Using the data with 8 revisions as final	
	GDP	Investment	GDP	Investment
Noise test	13.38***	17.17***	11.85***	14.73***
News test	0.75	3.00*	0.92	1.14

Notes: F-statistics are reported under the null hypothesis of noise or news.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 4: Estimation results for real GDP growth (quarter-over-quarter, annualized) using the latest-available vintage (sample: 2001Q4–2016Q3)

Variables	Equation 1	Equation 2	Equation 3
Constant	1.15*** (3.08)	1.51*** (4.16)	-0.02 (-0.04)
GDP growth $_{t-1}$	0.44*** (3.71)	0.23* (1.81)	0.44*** (4.26)
BOS indicator $_t$		0.49*** (3.23)	
Balance of opinion on future sales $_t$			0.07*** (4.20)
Adjusted R^2	0.18	0.29	0.36

Notes: t-statistics are in parentheses.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 5: Estimation results for real business investment growth (quarter-over-quarter, annualized) using the latest-available vintage (sample: 2001Q4–2016Q3)

Variables	Equation 4	Equation 5	Equation 6
Constant	1.02 (0.82)	1.72 (1.59)	-3.25* (-1.91)
Business investment growth $_{t-1}$	0.63*** (6.14)	0.31*** (2.75)	0.42*** (3.78)
BOS indicator $_t$		2.97*** (4.71)	
Balance of opinion on investment in machinery and equipment $_t$			0.36*** (3.40)
Adjusted R^2	0.38	0.55	0.48

Notes: t-statistics are in parentheses.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 6: Estimation results for real GDP growth (quarter-over-quarter, annualized) using the first-release data (sample: 2001Q4–2016Q3)

Variables	Equation 7	Equation 8	Equation 9
Constant	1.07*** (3.33)	1.40*** (4.45)	-0.02 (-0.04)
GDP growth $_{t-1}$	0.45*** (3.90)	0.20 (1.48)	0.44*** (4.26)
BOS indicator $_t$		0.39*** (3.24)	
Balance of opinion on future sales $_t$			0.07*** (4.20)
Adjusted R^2	0.19	0.31	0.36

Notes: t-statistics are in parentheses.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 7: Estimation results for real business investment growth (quarter-over-quarter, annualized) using the first-release data (sample: 2001Q4–2016Q3)

Variables	Equation 10	Equation 11	Equation 12
Constant	0.67 (0.65)	0.35 (0.46)	-3.91*** (-2.86)
Business investment growth $_{t-1}$	0.52*** (4.60)	0.09 (0.86)	0.25** (2.21)
BOS indicator $_t$		2.93*** (7.27)	
Balance of opinion on investment in machinery and equipment $_t$			0.37*** (4.49)
Adjusted R^2	0.25	0.61	0.44

Notes: t-statistics are in parentheses.
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.1

Table 8: Pseudo out-of-sample forecasting using the latest-available vintage (sample: 2001Q4–2014Q3)

Equations	ME	MAE	RMSE
GDP equation 1	-0.27	2.19	2.95
GDP equation 2	-0.43	2.16	2.85
GDP equation 3	-0.83	1.91	2.65
Investment equation 4	0.16	7.35	11.32
Investment equation 5	-0.25	6.67	9.16
Investment equation 6	-0.90	6.83	10.26

Table 9: Pseudo out-of-sample forecasting using the first-release data (sample: 2001Q4–2014Q3)

Equations	ME	MAE	RMSE
GDP equation 7	-0.35	1.64	2.18
GDP equation 8	-0.33	1.63	2.11
GDP equation 9	-0.67	1.45	1.96
Investment equation 10	-0.91	6.49	8.67
Investment equation 11	0.97	5.55	6.74
Investment equation 12	-2.12	6.16	7.57

Table 10: Real-time out-of-sample forecasting using the latest-available vintage as actuals (sample: 2001Q4–2014Q3)

Equations	ME	MAE	RMSE
GDP equation 13	-0.14	2.12	2.83
GDP equation 14	-0.25	2.16	2.77
GDP equation 15	-0.59	2.05	2.68
Investment equation 16	1.11	7.38	11.63
Investment equation 17	0.38	6.56	9.49
Investment equation 18	-0.33	6.37	10.16

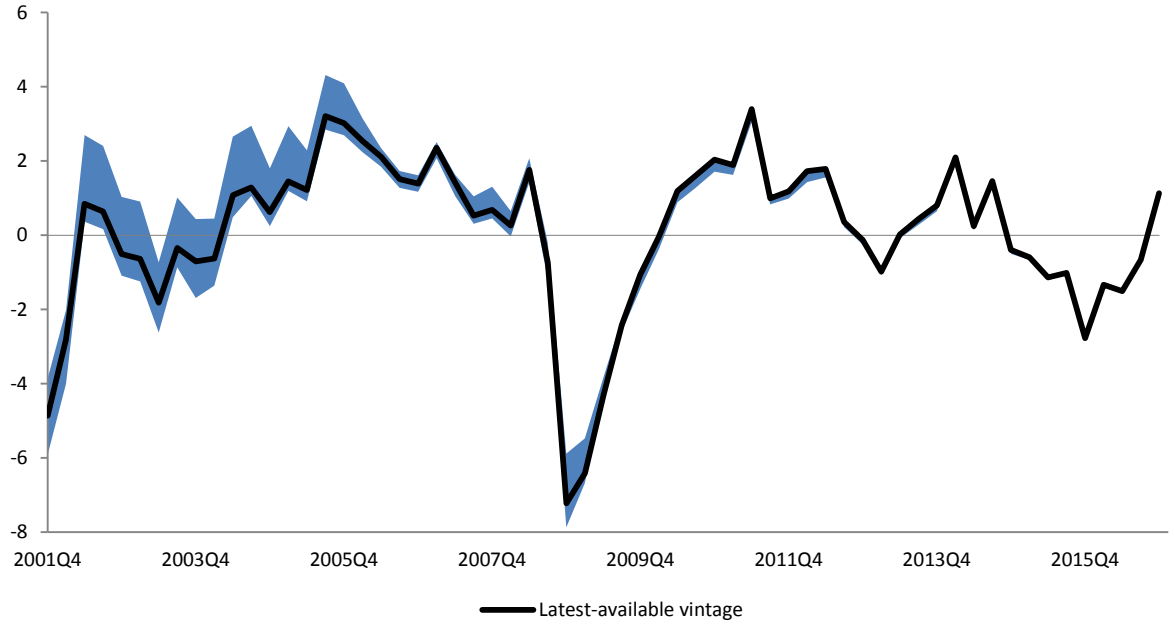
Table 11: Real-time out-of-sample forecasting using the first-release data as actuals (sample: 2001Q4–2014Q3)

Equations	ME	MAE	RMSE
GDP equation 13	-0.33	1.65	2.16
GDP equation 14	-0.43	1.67	2.18
GDP equation 15	-0.78	1.48	1.97
Investment equation 16	-0.98	6.37	8.35
Investment equation 17	-1.71	4.87	6.38
Investment equation 18	-2.42	5.59	7.36

Table 12: Real-time out-of-sample forecasting using the data with eight revisions as actuals (sample: 2001Q4–2014Q3)

Equations	ME	MAE	RMSE
GDP equation 13	-0.34	2.06	2.69
GDP equation 14	-0.44	2.12	2.65
GDP equation 15	-0.78	1.88	2.50
Investment equation 16	-1.51	6.90	10.47
Investment equation 17	-2.24	6.02	8.24
Investment equation 18	-2.96	6.59	9.39

Chart 1: The BOS indicator as recorded in different data vintages



Note:

1. The blue band shows the range of the BOS indicator values as recorded in different vintages (2004Q1 to 2016Q4).

Chart 2: Real GDP growth (q/q, annualized) as recorded in different data vintages

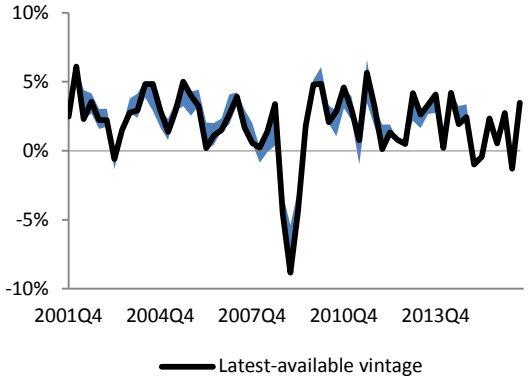
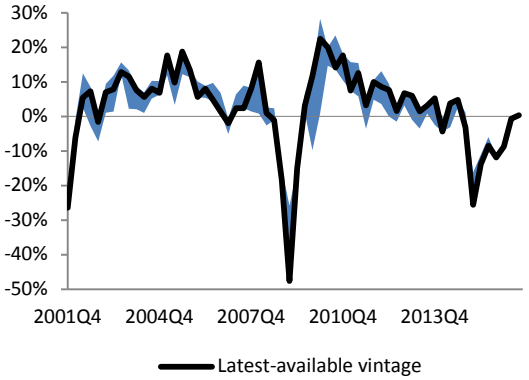


Chart 3: Real business investment growth (q/q, annualized) as recorded in different data vintages



Notes:

1. The blue band shows the range of values for real GDP growth and real business investment growth as recorded in different vintages (2000Q1 to 2016Q4).
2. q/q stands for quarter-over-quarter.

Chart 4: Mean absolute value of the 1st to the 20th non-cumulative revision to real GDP growth (p.p., 2001Q4–2016Q2 to 2001Q4–2011Q3)

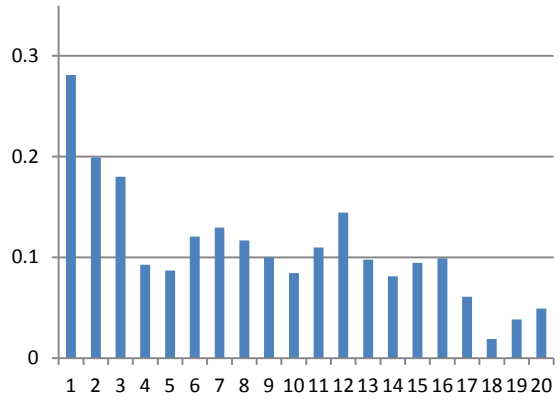
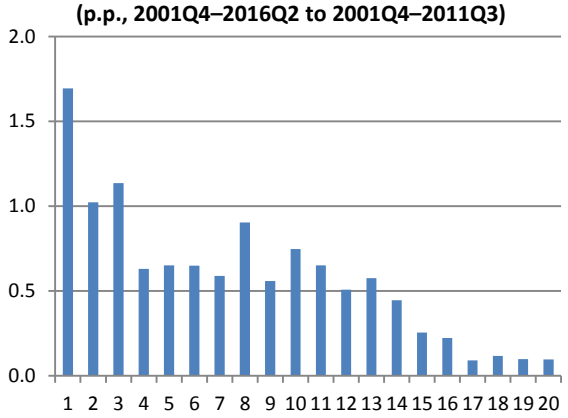


Chart 5: Mean absolute value of the 1st to the 20th non-cumulative revision to real business investment growth (p.p., 2001Q4–2016Q2 to 2001Q4–2011Q3)



Notes:

1. p.p. stands for percentage point.
2. Real GDP growth is calculated on an annualized quarter-over-quarter (q/q) basis.