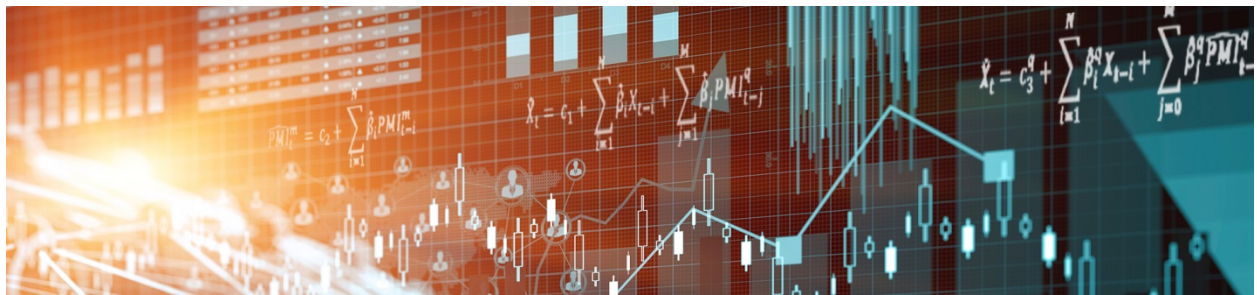


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GDP by Industry in Real Time: Are Revisions Well Behaved?



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Abstract

The monthly data for real gross domestic product (GDP) by industry are used extensively in real time both to ground the Bank of Canada's monitoring of economic activity and in the Bank's nowcasting tools, making these data one of the most important high-frequency time series for Canadian nowcasting. This note documents the series' real-time properties using the reference period August 2007 to September 2017. It shows that revisions to headline GDP-by-industry growth are generally well behaved; that is, they have a zero mean and low variance and are not revised predictably. Therefore, the signal for overall growth from the first GDP-by-industry release can be received with a good deal of confidence. This analysis suggests, however, that while this result is true on average, there are times when revisions can be important. Two examples discussed are when the economy begins to contract or expand and when end-of-quarter revisions are made. Further, revisions to the industrial sectors are not as well behaved. Revisions to some sectors do not have a zero mean and are generally much larger and more volatile than those for headline growth. In addition, revisions for most sectors exhibit predictability. As a result, the monthly signal from the sector data should be considered more cautiously than should the headline growth series.

Bank topics: Central bank research; Econometric and statistical methods; Business fluctuations and cycles

JEL codes: C53, C82, E01

Résumé

La Banque du Canada recourt abondamment aux données mensuelles sur le produit intérieur brut (PIB) réel par branche d'activité afin d'asseoir sa surveillance de l'activité économique et d'en faire usage dans ses outils de prévision pour la période courante. Cela en fait l'une des plus importantes séries chronologiques de haute fréquence pour effectuer des prévisions dans l'immédiat concernant l'économie canadienne. La présente note analytique décrit les propriétés d'immédiateté de la série, à partir de la période de référence allant d'août 2007 à septembre 2017. Elle montre que les révisions de la croissance du PIB global par branche d'activité sont généralement fiables; de fait, elles affichent une moyenne nulle et une faible variance, et elles ne sont pas prévisibles. Par conséquent, on peut se fier dans une bonne mesure à la croissance globale dont fait état la première estimation du PIB par branche d'activité. Selon cette analyse cependant, les résultats sont valides en moyenne, mais les révisions peuvent parfois être importantes. Les deux situations suivantes ont été étudiées, notamment : lorsque l'économie commence à se replier ou à prendre de l'expansion, et lorsque les données sont révisées en fin de trimestre. De plus, les révisions concernant les secteurs d'activité ne sont pas aussi fiables. Les révisions visant certains secteurs ne présentent pas une moyenne nulle, et elles sont en général beaucoup plus importantes et plus volatiles que les révisions apportées à la croissance globale. Qui plus est, les révisions touchant la plupart des secteurs revêtent un caractère prévisible. Il faut donc considérer l'indication mensuelle que fournissent les données sectorielles avec plus de prudence que l'indication donnée par la série permettant d'estimer l'expansion globale.

Sujets : Recherches menées par les banques centrales; Méthodes économétriques et statistiques; Cycles et fluctuations économiques

Codes JEL : C53, C82, E01

1. Key takeaways

- Revisions to monthly headline GDP growth are well behaved; that is, the revisions to the headline series are not significantly different from zero, they have a small variance, and they are not predictable.
- The first revision after initial publication is the largest, and the marginal revision decreases in size with each subsequent estimate. Revisions that occur at the end of a quarter are especially important.
- Revisions around the time of the Great Recession were larger than in the rest of the sample, even when accounting for the larger absolute growth rates published initially. Growth was overestimated during the contraction and underestimated during the subsequent recovery.
- Revisions to industrial sectors' growth are not as well behaved. Revisions for some sectors do not have a zero mean, and most sectors' revisions exhibited high variance and predictability.

2. Motivation and methodology

Data on monthly gross domestic product (GDP) by industry are arguably the most important source of information on how the economy is evolving between publications of the national accounts. GDP-by-industry data factor heavily in both the Bank of Canada's monitoring of the Canadian economy and our nowcasting tools.¹ As with most economic data, GDP by industry is repeatedly revised as Statistics Canada receives more information. There is little cause for concern if revisions are well behaved, meaning they are not significantly different from zero, have a small variance and are not predictable. If revisions are not well behaved, however, there can be important implications for monitoring the economy. In general, the usefulness of the timely signal sent by the first growth rate published by Statistics Canada is inversely related to the size of subsequent revisions.

Statistics Canada began publishing vintages of the GDP-by-industry data toward the end of 2015. Fortunately, vintages of this data have been stored in the Bank's database since November 2007, providing a large enough sample to analyze revisions to the GDP-by-industry data. This note analyzes the magnitude and behaviour of these revisions to better understand their implications and whether there is a need to adjust how forecasters use these series in real time. Revisions between the first publication and later releases as well as incremental revisions between subsequent releases are examined. The longest revision interval considered below is three years. It is reasonable to limit the revision interval given

¹ These include Canada's Short-Term Indicator (Binette and Chang 2013), a dynamic factor model (Chernis and Sekkel 2017) and the platform for averaging nowcasting models (Chernis and Sekkel 2018).

that the more time passes, the less likely it becomes to expect that a revision incorporates new information about the economy. At longer intervals revisions are more likely to be triggered by other causes, such as changes to methodology or updates of seasonal adjustment factors, though seasonal factors are adjusted even in shorter intervals.

Although it is generally understood that new GDP-by-industry data are subject to revision, this is the first publicly available analysis of Canadian GDP-by-industry revision behaviour. The sample used for this note includes the growth rates for August 2007 up to September 2017, inclusive.² In addition to headline GDP-by-industry growth, the analysis examines revisions to the major sectors and subsectors (simply referred to as sectors hereafter) of the economy as well as some subsamples.

The methodology used in this paper is similar to that used in Aruoba (2008) and Flodberg and Österholm (2017). Revisions are considered well behaved if they have a zero mean and a low variance and are not predictable.

A revision (R) is the difference between a later estimate of a series (L) and an earlier estimate (E). Revision intervals are represented below in the format L_E, where L, the later estimate, is replaced with either the letter M (month) and a number or the letter Y (year) and a number to reflect how many months or years after the first publication the vintage in question is released. The earlier estimate, E, usually represents the first publication, F, but would be an M or Y in the case of marginal revisions. For example, Y1_F is the revision calculated as the release published one year after the first publication minus the first publication. Similarly, M5_M4 is the marginal revision calculated as the release published five months after the initial publication minus the release published four months after the initial publication.

The indicators used in this note are summarized as follows:

Mean revision (MR): The average of the revisions for a given interval of time indicates whether early estimates (E_t) are biased relative to later estimates (L_t). If the MR is positive (negative), then the earlier releases are underestimated (overestimated) on average. To check the first criterion for well-behaved revisions, we use Newey-West heteroskedasticity and autocorrelation-consistent standard errors to test the significance of the means (Newey and West 1987).

$$MR = \frac{1}{n} \sum_{t=1}^n (L_t - E_t) \quad (1)$$

² The original GDP-by-industry table in CANSIM was terminated and replaced in 2013. The sample uses the original table for months not available in the current table.

Mean absolute revision (MAR): Given that large revisions of opposite sign offset each other in the MR, we look to the MAR for information about the size of revisions. Summing the absolute value of the difference between later and earlier estimates avoids this offsetting.

$$MAR = \frac{1}{n} \sum_{t=1}^n |L_t - E_t| \quad (2)$$

Relative mean absolute revision (RMAR): This measure puts the MAR into context by dividing it by the average absolute value of the first published growth rates. The RMAR is a measure of the robustness of the published data. It can be interpreted as the share of the earlier estimate that can be expected to be revised over the revision interval, or as the ratio of noise to the signal of the earlier release.

$$RMAR = \frac{\frac{1}{n} \sum_{t=1}^n |L_t - E_t|}{\frac{1}{m} \sum_{t=1}^m |E_t|} \quad (3)$$

Volatility ratio: This indicator divides the standard deviation of the revisions (R_t) by the standard deviation of the later release of the original series. The volatility ratio puts the variance of revisions into context, allowing for judgment of whether our second criterion of low variance holds.

$$Volatility\ ratio = \frac{\sigma_{R_t}}{\sigma_{L_t}} \quad (4)$$

Mincer-Zarnowitz: Our third criterion for well-behaved revisions is that they are not predictable.³ We would say that the revisions have an element of predictability if the initial release gives us information about the subsequent revisions. An example of predictability would be large positive growth rates tending to be followed by downward revisions. If revisions are not predictable, then the coefficients of the following Mincer-Zarnowitz equation would not be statistically significant (Mincer and Zarnowitz 1969).

$$R_t = \alpha + \beta E_t + \varepsilon_t \quad (5)$$

The Mincer-Zarnowitz statistic reported in the tables below is the Wald test p-value obtained by testing the hypothesis $H_0: \alpha=\beta=0$ in (5).

³ One point to note, as discussed in Faust, Rogers and Wright (2005), is that because data construction methods are constantly being revised, it is unclear whether past predictability is evidence of future predictability.

3. Behaviour of GDP-by-industry revisions

Headline growth

First we consider headline GDP-by-industry growth, which reflects all industries in the economy, since we are principally concerned with the economy’s headline growth each month. **Chart 1** plots the first published growth rate against the growth rate published five months later. In general, the two series are quite similar. Many months are revised only moderately, with some notable areas of exception. February 2015 is an example of a relatively large revision. The first release of February 2015 data signalled that the economy had grown marginally in the month at a pace of 0.02 per cent. Five months later, the small growth had been revised into a contraction of 0.14 per cent, a consequential change. In terms of annualized quarterly growth rates, the revision to this month translates into an added drag of 0.4 percentage points on the quarter. **Chart 2** extends the revision interval to the vintage published three years after the first release. The two series remain relatively similar with a perceptible increase in revision size compared with **Chart 1**.

Chart 1: Growth as first published versus growth five months after first publication

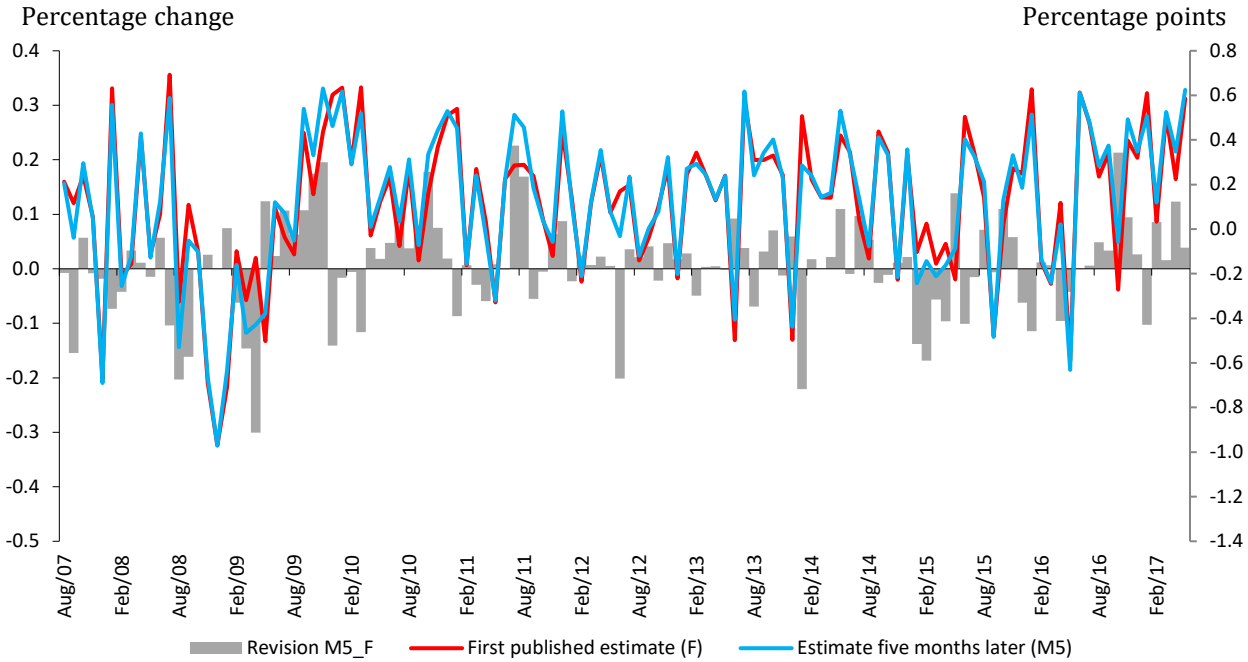
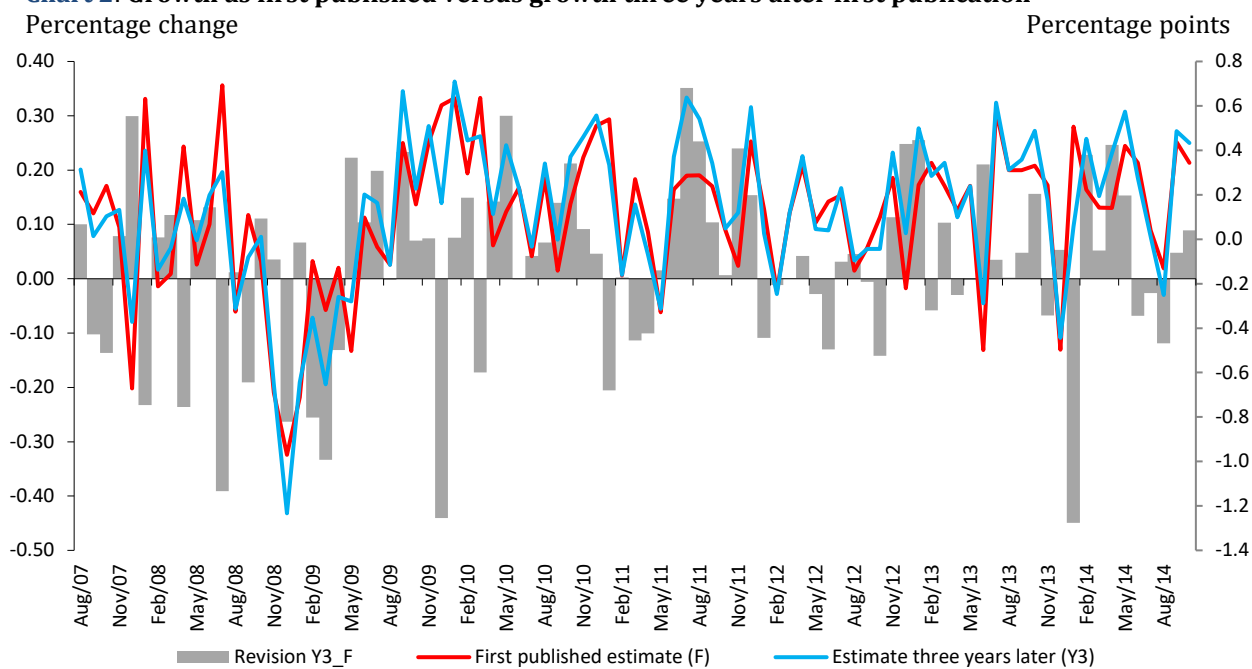


Chart 2: Growth as first published versus growth three years after first publication



Below we consider whether short-run data revisions for headline GDP by industry are well behaved. **Table 1** reports the summary indicators for cumulative GDP-by-industry revisions, and **Table A1** in the Appendix reports the summary indicators for marginal revisions.

Table 1 : Summary statistics for cumulative revisions of headline GDP-by-industry growth								
	MR	MAR	RMAR	Std Dev	Volatility ratio	Min	Max	Mincer-Zarnowitz
M1_F	-0.001	0.04	0.13	0.05	0.15	-0.15	0.15	0.89
M2_F	0.01	0.05	0.19	0.07	0.22	-0.19	0.18	0.03
M3_F	0.01	0.06	0.20	0.08	0.23	-0.30	0.18	0.44
M4_F	0.01	0.06	0.21	0.08	0.25	-0.32	0.21	0.58
M5_F	0.01	0.06	0.23	0.09	0.27	-0.30	0.23	0.43
Y1_F	0.01	0.09	0.32	0.11	0.34	-0.32	0.28	0.39
Y2_F	0.02	0.12	0.41	0.15	0.44	-0.43	0.35	0.20
Y3_F	0.03	0.13	0.46	0.17	0.48	-0.45	0.35	0.31

GDP-by-industry revisions are unbiased. Growth was revised down only 0.001 percentage point, on average, with the next month’s publication. As the revision interval is extended, the MR increases, reaching 0.03 percentage points after three years. The difference from zero for mean revisions for various intervals, however, is not statistically significant, with one exception: the marginal revision M2_M1 is strongly significant (shown in **Table A1**).

Revisions are also small, especially in the shorter term. The MAR increases in size with each subsequent revision, but by smaller increments, moving from 0.04 percentage points after the first revision to 0.13 percentage points after three years. This dynamic is consistent with the fact that as time passes, Statistics Canada staff receive more industry surveys, GST data and other source information, which they then incorporate into their estimate of GDP by industry through revisions. As each release embodies more information, less new information remains to be incorporated with future revisions, and the marginal revision declines over time. Putting the MAR into the context of the initial growth rate, the RMAR increases to just 0.23 percentage points over the first five revisions, which signals that the first publication contains much more signal than noise compared with the sixth release. The RMAR continues to increase with the revision interval, however, and at 0.41 percentage points and 0.46 percentage points the RMAR pushes the boundary of what might be considered a small revision at the two- and three-year intervals, respectively. Still, with all RMARs less than 0.5 percentage points, the first published growth rates give more signal than noise and can be considered relatively small.

Revisions have a low variance, especially in the shorter term. The standard deviation of the first revision is 0.05 percentage points and only increases to 0.17 percentage points at revision interval Y3_F. The volatility ratio shows that the variance of revisions does not reach half the variance of the original series at any interval, which suggests that variance is low relative to the original series.

Lastly, revisions are not predictable. The Mincer-Zarnowitz indicator is well above 0.1 percentage point for most intervals, which suggests that we cannot predict the revisions based on the first release. M2_F is an exception, with a p-value of 0.03, but predictability is not found when extending the revision interval; therefore, M2_F's predictability is of little practical use. Taken together, these indicators establish that GDP-by-industry revisions are well behaved.

That GDP-by-industry revisions are well behaved serves to reinforce confidence in the use of nowcasting models, which rely heavily on this series. Data revisions cause large changes in informational content (Lamprou 2016); therefore, it is preferable that they be small and well behaved.

Headline revisions at key turning points

While the results from the full sample are reassuring, it is also informative to examine how revisions behaved in specific subsamples over the business cycle. Analysis of other countries' data suggests revisions for recessionary periods may be dissimilar to those of other periods. For instance, Walton (2016) looks at growth in the United Kingdom and

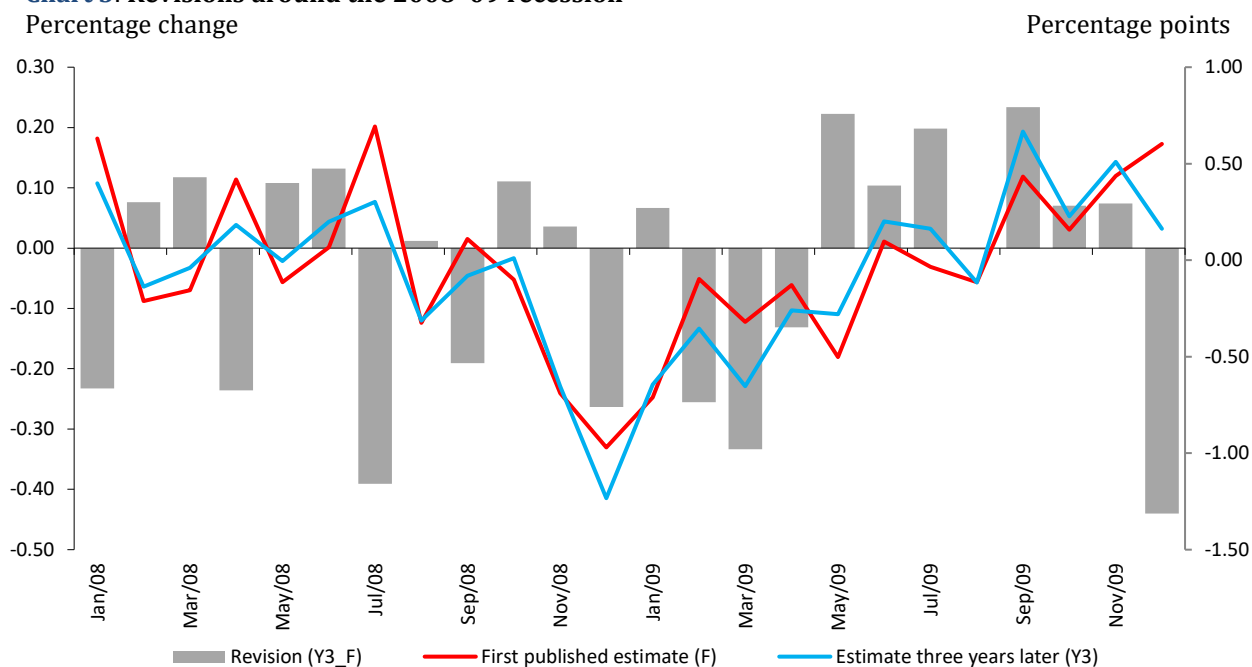
finds that revisions are larger around turning points. Therefore, we first consider the period around the Great Recession.

Revisions to the months from January 2008 to December 2009 do indeed prove to have been larger than the full sample (**Table 2**). The MAR for 2008–09 averaged 0.02 percentage points higher for the revision intervals considered than in the full sample. Further, although the absolute mean of the first published growth rate over this period was also higher, the 2008–09 RMAR was larger for most intervals considered, with the exception of M1_F and Y2_F. Lastly, the minimum and maximum revisions reported in **Table 2** are close to or the same as those reported in **Table 1**, signifying that many of the largest revisions over the last decade occurred in this period.

	MR	MAR	RMAR	Std Dev	Volatility ratio	Min	Max	Mincer-Zarnowitz
M1_F	-0.02	0.04	0.11	0.05	0.12	-0.15	0.10	0.29
M2_F	0.00	0.08	0.23	0.10	0.22	-0.19	0.18	0.55
M3_F	-0.01	0.08	0.25	0.11	0.26	-0.30	0.16	0.87
M4_F	-0.01	0.09	0.28	0.13	0.28	-0.32	0.21	0.93
M5_F	-0.01	0.09	0.28	0.12	0.27	-0.30	0.20	0.94
Y1_F	-0.02	0.12	0.35	0.15	0.32	-0.32	0.28	0.91
Y2_F	-0.02	0.13	0.38	0.16	0.36	-0.41	0.23	0.75
Y3_F	-0.04	0.17	0.50	0.20	0.47	-0.44	0.23	0.41

It is worth noting that as growth decelerated and moved into a contractionary phase, downward revisions were more important, which suggests a bit of an upward bias to the first published growth rates. As economic growth moved toward a return to expansion, growth tended to be underestimated, necessitating mostly upward revisions (**Chart 3**). This could reflect the fact that the initial release is estimated using partial information, and some data gaps are filled using recent trends. The trade-off between accuracy and the speed with which GDP-by-industry data are released is inevitable, but as a result it may be that the signals from initial estimates are weaker when they are arguably most important, around key inflection points.

Chart 3: Revisions around the 2008–09 recession



End of quarter

As previously discussed, revisions tend to decrease in size as more time passes, reflecting the larger pool of information with which Statistics Canada can work. However, the revisions that occur at the end of a quarter, that is, the revisions that accompany the first release of March, June, September and December data, are of particular importance because those releases are the first to incorporate surveys that are collected only on a quarterly basis. Furthermore, at the end of the quarter, GDP data measured using the expenditure and income approaches are also released. The three approaches are reconciled to the greatest extent possible, adding an unavoidable source of revisions.

We can illustrate the importance of end-of-quarter revisions by isolating the first month of each quarter (i.e., every January, April, July and October) and analyzing their marginal revisions. We would expect these months to deviate from the general pattern of decreasing marginal revision size with each subsequent release when the revision occurs at the end of a quarter. With these isolated first months, the end-of-quarter marginal revision is the revision that occurs two months after the first publication, M2_M1. Indeed, the MAR for M2_M1 is almost twice as large for the subsample of first months as it is for the rest of the sample (**Chart 4** and **Table 3**).

Chart 4: First months of each quarter have larger second revisions than first
Mean average revision for first months of all quarters (January, April, July and October) compared with the rest of the sample

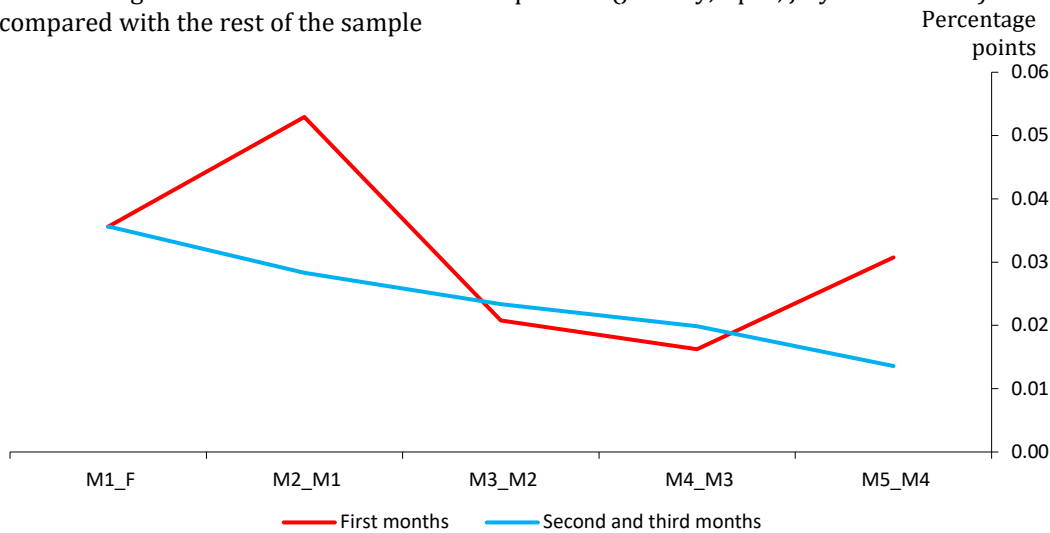


Table 3: Summary statistics for marginal revisions of headline GDP-by-industry growth (first month of each quarter)

	MR	MAR	RMAR	Std Dev	Volatility ratio	Min	Max	Mincer-Zarnowitz
M1_F	-0.006	0.036	0.13	0.05	0.17	-0.09	0.15	0.65
M2_M1	0.017*	0.053	0.20	0.06	0.23	-0.11	0.13	0.00
M3_M2	0.001	0.021	0.08	0.04	0.13	-0.19	0.06	0.27
M4_M3	-0.003	0.016	0.06	0.02	0.08	-0.05	0.08	0.75
M5_M4	0.001	0.031	0.11	0.04	0.15	-0.10	0.08	0.58
Y1_M5	-0.007	0.059	0.20	0.07	0.27	-0.17	0.17	0.26
Y2_Y1	0.002	0.056	0.20	0.08	0.26	-0.16	0.22	0.70
Y3_Y2	-0.013	0.052	0.19	0.08	0.27	-0.18	0.11	0.33

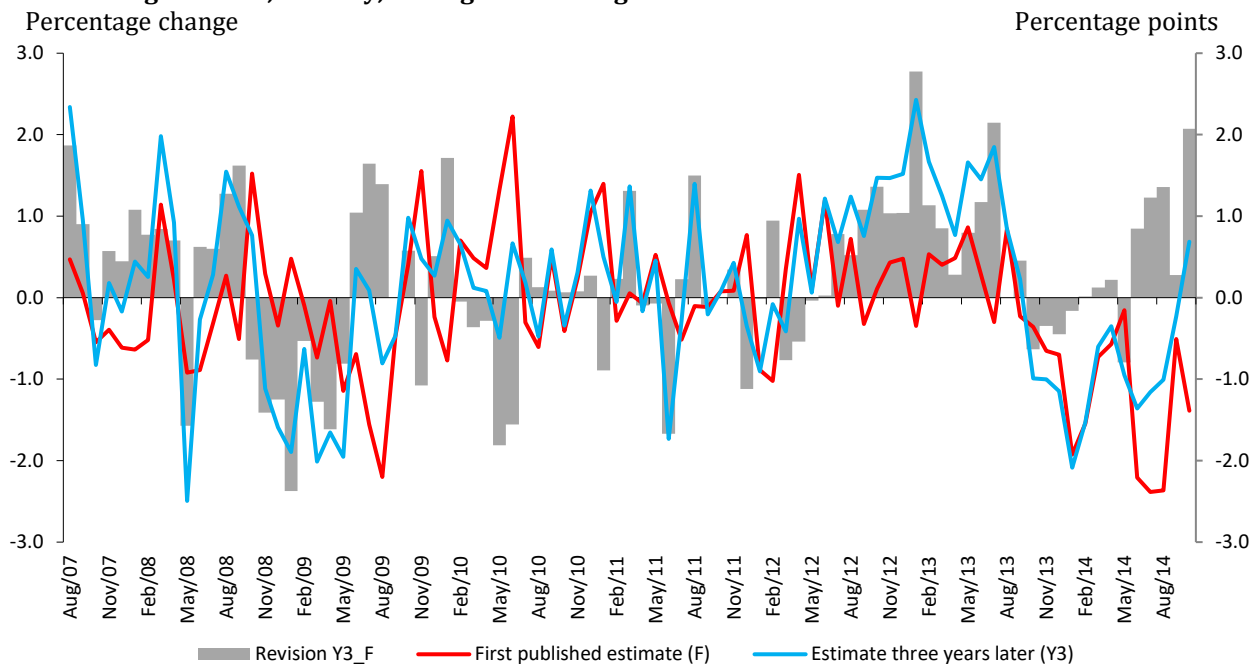
Note: * signifies statistical significance at 10 per cent.

Revisions to sectors

It is evident from the monthly GDP-by-industry data that certain sectors are more heavily revised than others, and these revisions can be large and important. The agriculture, forestry, fishing and hunting sector offers one of the more obvious examples of how the growth path for a sector can change through revisions. **Chart 5** presents the sector's first published growth rate against the rate published three years later. Note how dissimilar the growth dynamic is for certain periods, including a period beginning in mid-2012 that saw 14 consecutive positive revisions. Bank of Canada staff monitor GDP by industry using a

bottom-up approach by building on expectations for growth at the sectoral level to reach a headline growth expectation. With this in mind, to understand the implication for the outlook, Bank staff would benefit from knowing what sectors, if any, have revisions that are not well behaved. **Tables A2 to A4** in the Appendix present the summary statistics for the revision intervals M1_F, M5_F and Y3_F, respectively.⁴

Chart 5: Agriculture, forestry, fishing and hunting sector revisions



The first published growth rate is biased for about a third of the sectors after one revision (M1_F), but only three sectors have a statistically significant bias three years after publication (Y3_F). Residential building construction has the most biased first published growth rate, by far. The MR for the sector is 0.22 percentage points after only one revision, and it more than doubles to 0.46 percentage points after five months. The first publication of growth for the health care and social assistance sector and the public administration sector also remained biased after three years, though the MR for both is a much more moderate 0.05 percentage points.

Revisions are much larger at the sectoral level than they are for headline growth. One indication of this is the comparatively large MAR for most sectors. Relative to the sectors' growth rates, the revisions are still much larger than for the economy as a whole. At 0.90 percentage points, the average RMAR of all sectors is almost twice that of headline

⁴ Most series analyzed represent two-digit NAICS code aggregations with some goods sectors further disaggregated to the three-digit level (construction, mining, quarrying and oil and gas extraction, and manufacturing).

GDP by industry (0.46 percentage points) over the three-year interval. The elevated RMARs indicate that there is much noise and little signal in the initial release for most sectors and highlight the importance of using caution when interpreting the initial growth of the sectors, rather than the relatively reliable initial headline growth release.

The variance of revisions at the sectoral level is high compared with the variance of growth in each sector. At the three-year mark two sectors have a volatility ratio of 0.49, the ratio seen in the headline GDP-by-industry number, and what was considered at the upper bound of what might be characterized as low variance. All other sectors have even larger volatility ratios, including seven ratios above 1.0, signifying the revisions have more variability than the original series.

Finally, revisions in most sectors are predictable. Looking at the Mincer-Zarnowitz indicator, we see that more than two-thirds of the sectors analyzed are predictable for both M5_F and Y3_F. Based on these indicators, we can say that revisions to the sectoral series of GDP by industry are not well behaved and that the first published growth rate should be interpreted with a good deal of caution.

4. Conclusion

Revisions to headline GDP-by-industry growth are well behaved. They have a mean of zero and low variance, and growth does not get revised substantially or predictably. Therefore, the signal for growth from the first release of headline GDP-by-industry data can be received with a good deal of confidence, which supports the use of nowcasting models that rely heavily on these data. This analysis suggests, however, that while this result is true on average, there are times when revisions can be more important. Two examples discussed are when the economy begins to contract or expand and when end-of-quarter revisions are made. In contrast, revisions to the sectoral series are not as well behaved. Some of their means are not zero, they are generally much larger and more volatile than those for headline GDP-by-industry growth, and revisions to most sectors exhibit predictability. As a result, the monthly signal from the sector data should be considered more cautiously than should the headline growth series.

5. Appendix

Table A1 : Summary statistics for marginal revisions of headline GDP-by-industry growth (all months)

	MR	MAR	RMAR	Std Dev	Volatility ratio	Min	Max	Mincer-Zarnowitz
M1_F	-0.001	0.04	0.13	0.05	0.15	-0.15	0.15	0.89
M2_M1	0.012*	0.04	0.13	0.05	0.15	-0.11	0.14	0.00
M3_M2	-0.004	0.02	0.08	0.04	0.11	-0.19	0.11	0.15
M4_M3	0.000	0.02	0.06	0.03	0.08	-0.06	0.14	0.98
M5_M4	0.001	0.02	0.06	0.03	0.09	-0.10	0.08	0.59
Y1_M5	0.008	0.06	0.19	0.07	0.21	-0.17	0.20	0.46
Y2_Y1	0.006	0.06	0.21	0.08	0.25	-0.27	0.24	0.46
Y3_Y2	0.005	0.06	0.20	0.08	0.24	-0.23	0.18	0.68

Note: * signifies statistical significance at 10 per cent.

Table A2: Summary statistics for sector growth revisions M1_F

	MR	MAR	RMAR	St. Dev.	Volatility ratio	Min	Max	Mincer-Zarnowitz
All industries	0.00	0.04	0.13	0.05	0.15	-0.15	0.15	0.89
Agriculture, forestry, fishing and hunting	0.03	0.26	0.39	0.37	0.41	-1.74	1.50	0.49
Oil and gas extraction	0.01	0.47	0.29	0.69	0.31	-2.88	2.47	0.00
Mining and quarrying	-0.03	0.60	0.29	0.92	0.32	-5.27	2.89	0.92
Support activities for mining, oil and gas	0.10	1.53	0.31	2.18	0.30	-8.78	8.06	0.79
Utilities	0.00	0.20	0.19	0.30	0.23	-1.49	1.24	0.97
Residential building construction	0.22*	0.44	0.46	0.78	0.57	-1.89	5.58	0.00
Non-residential building construction	0.04*	0.16	0.27	0.27	0.20	-1.15	1.38	0.02
Repair and engineering construction	0.03	0.20	0.38	0.29	0.39	-0.89	1.50	0.26
Non-durable manufacturing	-0.06*	0.25	0.32	0.32	0.32	-0.90	0.97	0.04
Durable manufacturing	-0.11*	0.35	0.29	0.45	0.29	-1.14	1.39	0.00
Wholesale trade	-0.05	0.24	0.24	0.32	0.27	-1.36	0.73	0.01
Retail trade	0.03	0.15	0.24	0.22	0.26	-0.54	1.21	0.39
Transportation and warehousing	0.03	0.16	0.33	0.21	0.33	-0.66	0.60	0.41
Information and cultural industries	-0.01	0.09	0.58	0.13	0.59	-0.38	0.52	0.03
Finance and insurance	-0.01	0.12	0.32	0.16	0.35	-0.56	0.38	0.63
Real estate and rental and leasing	0.00	0.03	0.12	0.04	0.21	-0.13	0.11	0.68
Professional, scientific and technical services	0.01	0.10	0.52	0.14	0.63	-0.50	0.50	0.00
Administrative and support, waste management and remediation services	0.02	0.12	0.59	0.15	0.52	-0.34	0.45	0.17
Educational services	0.00	0.10	0.45	0.21	0.53	-1.83	0.46	0.81
Health care and social assistance	0.03*	0.06	0.42	0.08	0.75	-0.23	0.44	0.00
Arts, entertainment and recreation	-0.01	0.32	0.28	0.43	0.25	-1.25	1.33	0.14
Accommodation and food services	0.07*	0.20	0.37	0.25	0.40	-0.56	0.72	0.00
Other services	0.04*	0.10	0.54	0.14	0.64	-0.22	0.80	0.00
Public administration	0.02*	0.06	0.46	0.08	0.46	-0.25	0.30	0.00

Note: * signifies statistical significance at 10 per cent.

Table A3: Summary statistics for sector growth revisions M5_F

	MR	MAR	RMAR	St. Dev.	Volatility ratio	Min	Max	Mincer-Zarnowitz
All industries	0.01	0.06	0.23	0.09	0.27	-0.30	0.23	0.43
Agriculture, forestry, fishing and hunting	0.06	0.48	0.74	0.67	0.79	-2.41	2.14	0.00
Oil and gas extraction	0.00	0.63	0.38	0.94	0.40	-3.39	2.55	0.18
Mining and quarrying	-0.07	1.04	0.51	1.36	0.48	-4.99	3.08	0.22
Support activities for mining, oil and gas	0.25	2.13	0.44	2.90	0.42	-11.83	8.63	0.02
Utilities	-0.02	0.37	0.35	0.54	0.40	-2.97	1.45	0.29
Residential building construction	0.46*	0.73	0.76	0.96	0.81	-1.82	5.02	0.00
Non-residential building construction	0.06	0.35	0.58	0.47	0.34	-1.41	1.76	0.44
Repair and engineering construction	0.11	0.47	0.87	0.62	0.76	-1.43	2.14	0.06
Non-durable manufacturing	-0.08*	0.43	0.54	0.52	0.55	-1.28	1.11	0.00
Durable manufacturing	-0.05	0.58	0.47	0.77	0.51	-2.88	1.79	0.00
Wholesale trade	-0.05	0.39	0.39	0.50	0.41	-1.49	1.34	0.02
Retail trade	0.03	0.21	0.33	0.28	0.32	-0.67	1.01	0.35
Transportation and warehousing	0.01	0.22	0.47	0.29	0.46	-0.83	0.77	0.38
Information and cultural industries	0.00	0.15	0.96	0.19	0.83	-0.42	0.62	0.00
Finance and insurance	0.05*	0.18	0.50	0.24	0.50	-0.83	0.61	0.09
Real estate and rental and leasing	0.00	0.05	0.20	0.07	0.33	-0.15	0.26	0.31
Professional, scientific and technical services	0.02	0.13	0.69	0.17	0.74	-0.51	0.42	0.00
Administrative and support, waste management and remediation services	0.02	0.16	0.80	0.19	0.69	-0.43	0.46	0.07
Educational services	0.00	0.18	0.81	0.28	0.70	-1.91	0.79	0.16
Health care and social assistance	0.04*	0.09	0.62	0.12	0.93	-0.22	0.52	0.00
Arts, entertainment and recreation	0.03	0.45	0.40	0.64	0.36	-2.10	2.53	0.30
Accommodation and food services	-0.03	0.31	0.59	0.43	0.63	-2.10	1.46	0.08
Other services	0.03	0.15	0.83	0.20	0.91	-0.47	0.65	0.00
Public administration	0.03*	0.11	0.77	0.13	0.67	-0.30	0.45	0.02

Note: * signifies statistical significance at 10 per cent.

Table A4: Summary statistics for sector growth revisions Y3_F

	MR	MAR	RMAR	St. Dev.	Volatility ratio	Min	Max	Mincer-Zarnowitz
All industries	0.03	0.13	0.46	0.17	0.49	-0.45	0.35	0.31
Agriculture, forestry, fishing and hunting	0.24	0.81	1.24	1.00	1.17	-2.37	2.77	0.00
Oil and gas extraction	0.11	1.04	0.63	1.35	0.58	-3.91	3.80	0.17
Mining and quarrying	-0.04	1.84	0.90	2.58	0.91	-8.13	11.76	0.31
Support activities for mining, oil and gas	0.10	3.33	0.68	4.37	0.63	-12.01	10.79	0.07
Utilities	0.02	0.73	0.70	0.94	0.71	-2.59	2.56	0.00
Residential building construction	0.48*	0.86	0.89	1.13	0.96	-3.09	5.12	0.00
Non-residential building construction	0.09	0.53	0.88	0.66	0.49	-1.90	1.72	0.42
Repair and engineering construction	0.17	0.74	1.38	0.97	1.19	-2.35	2.77	0.56
Non-durable manufacturing	-0.05	0.69	0.87	0.85	0.89	-1.95	1.74	0.20
Durable manufacturing	-0.07	0.83	0.68	1.02	0.67	-2.02	2.01	0.01
Wholesale trade	-0.06	0.72	0.72	0.89	0.73	-1.76	2.75	0.00
Retail trade	0.04	0.46	0.73	0.61	0.70	-1.42	1.89	0.12
Transportation and warehousing	0.02	0.41	0.86	0.52	0.82	-1.14	1.45	0.89
Information and cultural industries	0.02	0.19	1.18	0.23	1.01	-0.47	0.58	0.00
Finance and insurance	0.07	0.35	0.95	0.43	0.88	-1.23	1.38	0.30
Real estate and rental and leasing	-0.02	0.10	0.35	0.13	0.62	-0.41	0.31	0.49
Professional, scientific and technical services	0.05	0.24	1.21	0.29	1.28	-0.73	0.66	0.00
Administrative and support, waste management and remediation services	0.03	0.19	0.97	0.24	0.86	-0.54	0.57	0.00
Educational services	0.00	0.21	0.97	0.31	0.78	-1.61	0.61	0.05
Health care and social assistance	0.05*	0.12	0.81	0.15	1.19	-0.44	0.57	0.00
Arts, entertainment and recreation	-0.07	0.80	0.71	1.05	0.59	-3.35	2.50	0.00
Accommodation and food services	-0.05	0.57	1.07	0.72	1.06	-1.69	1.95	0.00
Other services	0.02	0.26	1.40	0.33	1.52	-0.91	0.95	0.00
Public administration	0.05*	0.13	0.92	0.15	0.79	-0.24	0.46	0.02

Note: * signifies statistical significance at 10 per cent.

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