An Uncertain Past: Data Revisions and Monetary Policy in Canada

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- *Policy-makers rely on macroeconomic data released by Statistics Canada, such as consumption and GDP growth, to gauge the current state of the economy. Such variables are necessarily released with a lag, however, and past observations are subject to revision. Such uncertainty complicates the task of forecasters and policy-makers.*
- *In recent years, economists have tried to document the uncertainty inherent in initial data releases by analyzing the nature of the revisions. Analysis of data revisions for Canada is now possible, using newly constructed databases that track the data as they were released.*
- *Revisions to Canadian GDP growth tend to be smaller, on average, than those of some major OECD countries and are also somewhat less volatile.*
- *The growth rates of GDP components tend to be revised more substantially than the growth rate of GDP itself, rendering the analysis and forecasting of components more difficult. The growth of exports and imports tends to be subject to the largest revisions.*
- *Data revisions can affect policy decisions in different ways. We discuss issues that analysts, researchers, and policy-makers may need to confront.*

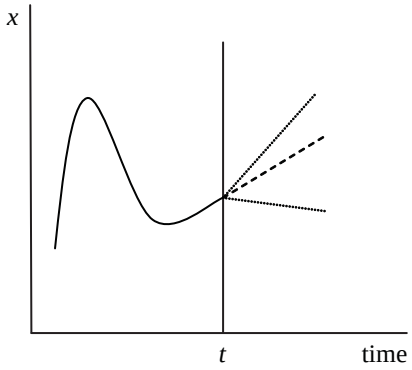
* Thanks to Bob Fay, Sharon Kozicki, Robert Lafrance, John Murray, and Simon van Norden for several valuable comments. All views are those of the author and do not necessarily reflect those of the Bank of Canada.

Economic forecasters must deal with two issues that do not necessarily confront forecasters in other fields: (i) delays in the release of current-period data and (ii) revisions to past data. National Accounts data are released about two months after the end of each quarter. This implies that forecasters trying to predict the *future* path of National Accounts variables are often unsure as to where those variables actually lie *today*. This has led to the development of a specialized area of forecasting, dubbed *nowcasting*, which is described in more detail below. With respect to the second issue, economists are also confronted with possibly non-trivial revisions to past observations of key economic variables. This has implications for the estimation of economic models and for the forecasts produced using them. For example, if the growth of the gross domestic product (GDP) from the previous quarter is revised down by one percentage point, then followers of this variable will likely have to revise their forecasts.

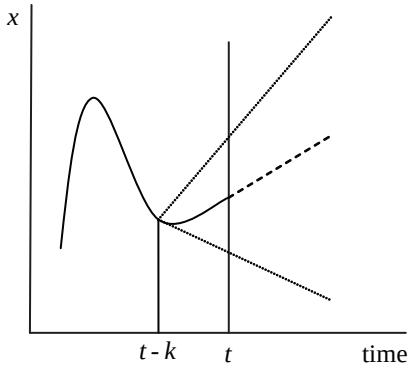
Economic forecasters must therefore confront three forms of uncertainty related to time: uncertainty about the future, the present, and the past. **Chart 1** presents the consequence of these additional layers of uncertainty, using the path of some arbitrary variable x as an example. It is assumed that forecasters are required, at some point in time, t, to produce a forecast about the future path of x. In panel (a), the forecaster is assumed to know the current value of the variable with certainty (this would be the case, for example, of a financial-asset price or a commodity price). A forecast is produced for this variable, depicted by the dashed line. The uncertainty associated with this forecast is arbitrarily depicted by the dotted lines, which provide a confidence interval for the forecast. Typically, but not always, the farther into the future one wishes to forecast, the wider is the confidence interval.

Chart 1: Different forms of uncertainty as a function of time

a. Future uncertainty



b. Past, present, and future uncertainty



In panel (b), the forecaster is required to forecast a variable that cannot be directly observed at the time the forecast is to be made. This is depicted by the existence of a confidence interval at time t. There is also a possibility that the values for this variable that were observed in the recent past may be revised. Variables such as the National Accounts (GDP, consumption, business investment, etc.) and money and credit aggregates are all subject to revision. The period t-k depicts the time at which variables may no longer be subject to revision, so that observations prior to t-k can be assumed to be measured with certainty.[1] Thus, forecasters of these variables are subject to additional layers of uncertainty that forecasters of precisely measured variables do not confront, which, all other factors being the same, would result in wider confidence intervals around future forecasts.

This article expands on uncertainty about the future and the present, and more thoroughly analyzes uncertainty about the past and how economists have tried to confront it. The challenges posed by data revisions have long been acknowledged by economists but have not been closely scrutinized until recently, owing to lack of databases that incorporate current and past releases of economic variables. The article concludes with a discussion of how policymakers can account for uncertainty about the past in the conduct of monetary policy.

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Uncertainty as a Function of Time

Uncertainty about the future

Most developments in the field of economic forecasting have tried to address the issue of uncertainty about the future. Recognizing that point forecasts by themselves are of limited value without any associated knowledge about the uncertainty surrounding them, economic forecasters have been trying to better quantify estimates of that uncertainty. In the past several years, methods have been developed to produce and evaluate density forecasts: that is, forecasts of the entire probability distribution of a variable of interest. Density forecasts allow forecast users to easily compute the probability that the variable of interest will lie within a certain range.

As an illustration, Li and Tkacz (2006) demonstrate how density forecasts can be produced for the Canadian inflation rate in the next period. Given that the Bank of Canada wishes to maintain inflation in the centre of a 1 to 3 per cent target band, computing the

1 However, Campbell and Murphy (2006) note that National Accounts can be revised several years after they were first released, with such long-term revisions largely reflecting changes to the methodology used to measure these variables. Revisions to the National Accounts in the near past typically reflect new information received by Statistics Canada, thereby yielding improved estimates of economic activity. See the **Appendix** for details regarding the revision schedule.

probability that inflation would deviate from the target band would be of value. **Table 1** presents the computed probabilities that the next period's inflation rate will lie within various ranges.

Density forecasts reveal that the inflation rate would be within the target band with 97 per cent confidence for the period under study, with the probability of being above the target band being slightly higher than the probability of being below it.

Table 1: Inflation probabilities forecast for different ranges

Inflation range	< 1%	1% to 2%	2% to 3%	> 3%	1% to 3%
Probability	0.007	0.487	0.485	0.021	0.971

Source: Li and Tkacz (2006), Table 4

Uncertainty about the present

Quantities such as GDP, and many other economic variables, are not directly observable and must therefore be estimated by Statistics Canada. The estimates are produced using various surveys and variables covering all sectors of the economy. Because of the time required to compile all this information, data for a given quarter will not be released until about two months after the end of the quarter. For example, data for the first quarter, ending on 31 March, will not be available until about 31 May, which is well into the second quarter. To produce GDP forecasts at any point during the second quarter, forecasters will, at best, have data only up to the previous quarter. This problem of "forecasting" the current value of an economic variable is commonly called "nowcasting." For the purpose of nowcasting, analysts rely on coincident indicators, that is, variables that are correlated with fluctuations in GDP growth but are available on a more timely basis (i.e., with a shorter reporting lag). Nunes (2005) is a recent example of a nowcasting study of GDP growth, but work on identifying coincident indicators of economic activity goes back to Burns and Mitchell (1946) who classified hundreds of economic variables as leading or coincident indicators.

Generally, analysts can monitor developments in variables where the publication lags are shorter, such as employment, housing starts, and manufacturing indexes, in order to gauge economic activity prior to the official release of data on GDP growth. Such monitoring can be used to provide advice to decision-makers prior to the release of National Accounts data.

Uncertainty about the past

This type of uncertainty relates to revisions that occur to variables following their first release. Economists have long recognized that variables get revised (e.g., Stekler 1967), but only in recent years have they made systematic efforts to better understand the revision process. This was mainly because historical data were not maintained. For example, when Statistics Canada releases the latest GDP number, it releases revisions to past GDP figures at the same time. In the process, the new GDP series replaces the old one in the database; so unless researchers systematically saved the old series, they could not analyze the revision process.

At some point, researchers decided to construct their own databases by physically scanning the old series as they originally appeared in the hard copies of statistical agency publications. In the United States, such efforts were spearheaded by the Federal Reserve Bank of Philadelphia[2] and the Federal Reserve Bank of St. Louis, which maintains an extensive real-time database for the United States (dubbed ALFRED, for ArchivaL Federal Reserve Economic Data). Other countries followed with similar databases, which are referred to as "real-time" databases, since they include the data as they were originally reported at each point in time.

Construction of a real-time database for Canada was recently initiated by Campbell and Murphy (2006), and the Organisation for Economic Co-operation and Development (OECD) maintains real-time data for member countries going back a few years. In addition, Keshishbanoosy et al. (2008) document the contents of a real-time database for Canadian money and credit aggregates.

With access to National Accounts data as they were initially published through time, economists can now begin quantifying the uncertainty surrounding the initial estimates of variables of interest, thereby producing confidence intervals around past data as depicted in Chart 1, panel (b). Some effort is also being made to understand whether the revision process can be predicted. If that is the case, it would reduce the uncertainty associated with data revisions.[3] For example, Galbraith and Tkacz (2007) find that debit

2 See the database developed by Croushore and Stark (2001).
3 Of course, some revisions, such as those related to conceptual changes, are necessarily unpredictable. Studies that deal with predicting revisions focus on near-term revisions related to the incorporation of additional information that improves estimates of key National Accounts variables. Proxy variables can potentially be useful for predicting this regular revision process.

card transactions can be useful for predicting revisions to GDP growth up to four quarters in the past.

Revisions to National Accounts

This section presents some updated descriptive statistics of the revision process for data in the Canadian National Accounts, thereby providing some estimates about uncertainty related to the past. The focus is specifically on the annualized quarterly growth rate of GDP or one of its components (consumption expenditures, business investment, government spending, exports, and imports).

The first release of the level of real GDP, or any of its components, is denoted by $x_{1,t}$ for time t, and $x_{2,t}$ denotes the second release of the level of real GDP (or any of its components) for time t.

The initial, or first-release, annualized quarterly growth rate is then calculated as

$$\dot{x}_{1,t} = \ln \frac{x_{1,t}}{x_{2,t-1}} \times 400, \qquad (1)$$

where ln denotes the natural logarithm. Note that the initial annualized quarterly growth rate of GDP for a given period is computed using the first release of the level of GDP for the current period and the second release of the level for the previous period. For example, the annualized growth rate of 0.3 per cent for the third quarter of 2009 is a function of the first estimate for the level of GDP in the third quarter (time t) and the second estimate of the level of GDP for the second quarter of 2009 (time t-1).

Following this logic, the second estimate of the annualized quarterly growth rate for period t is computed as

$$\dot{x}_{2,t} = \ln \frac{x_{2,t}}{x_{3,t-1}} \times 400, \qquad (2)$$

and so forth. If past data were not revised, then the initial and subsequent growth rates would not change; i.e., $\dot{x}_{2,t} - \dot{x}_{1,t} = 0$, and there would consequently be no uncertainty about the past. As new information becomes available, however, the statistical agency will revise its past estimates of GDP and its components, thereby affecting the estimated growth rates. This could be particularly important in instances when economic growth is stagnating and a recession is a possibility.

Revisions to GDP growth: An international comparison

To put revisions to Canadian data into context, revisions to Canadian GDP growth are compared with those reported by a small number of other OECD countries. To ensure that the data are as comparable across countries as possible, all our data are obtained from the OECD. The data were initially published in the OECD's *Main Economic Indicators*, and every issue from 2001 onwards was used to create a real-time database for OECD-member countries and for a select group of other countries.[4] Levels of real GDP are obtained for each country from the first quarter of 2001 to the third quarter of 2009.[5] Once the growth rates are computed as described by equations (1) and (2), the first and last observations are dropped, so that $\dot{x}_{2,t} - \dot{x}_{1,t}$ can be studied.

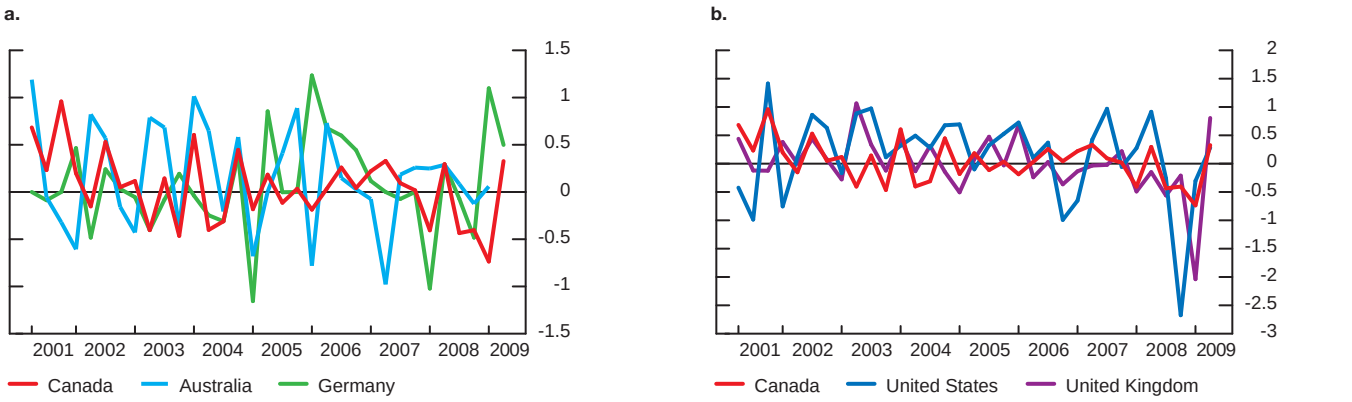
Release dates for National Accounts differ across countries, and this may influence the size of the reported revisions.

Although the data studied were compiled by a single organization, international comparisons are still complicated by the fact that release dates for National Accounts differ across countries, and this may influence the size of the reported revisions. For example, the first release for GDP growth in the third quarter of 2007 for Canada, Germany, and the United Kingdom appeared in the December 2007 issue of the *Main Economic Indicators*; however, it appeared in the November 2007 issue for the United States, and in the January 2008 issue for Australia. In other words, first-release estimates for GDP growth were available earlier for the United States and later for Australia. If statistical agencies are allowed more time to release their first estimates of National Accounts, they may be able to incorporate additional information and therefore require smaller revisions in the future.

4 The database, located at http://stats.oecd.org/mei, currently contains National Accounts data for 35 countries and the euro area.

5 Note that in 2001, Statistics Canada switched from a Laspeyeres to a Chain Fisher index in computing GDP in order to make Canadian figures more accurate and more directly comparable with those of the United States; see Statistics Canada (2002) for technical details. Conceptual changes may also have been implemented for some countries over the sample in our study, so our cross-country results should be viewed as suggestive rather than conclusive.

Chart 2: Revisions to GDP growth for selected OECD countries
Quarter-over-quarter growth at annualized rates



Source: Author's calculations using data from OECD *Main Economic Indicators*

The second release is defined as the revision that accompanies the release of the subsequent quarter's National Accounts data: i.e., the estimate published by the OECD three months later. Thus, the second release of GDP growth for the third quarter of 2007 for Canada, Germany, and the United Kingdom appeared in the March 2008 issue of the *Main Economic Indicators*; in the February 2008 issue, for the United States; and in the April 2008 issue, for Australia.

We now examine the difference between the second and first releases to GDP growth ($\dot{x}_{2,t} - \dot{x}_{1,t}$). The larger this number is in absolute terms, the greater the revisions, and therefore the greater the uncertainty surrounding the initial estimate.

Charts 2a and **2b** present revisions to the growth rate of GDP for Canada, Australia, Germany, the United Kingdom, and the United States.[6] Several features emerge:

- The revisions are not necessarily correlated across countries over time. GDP is computed by each country's statistical agency, and although the definition of GDP and data-collection techniques are very similar across these countries, there are only a few instances where revisions are of the same magnitude or, indeed, in the same direction across a group of countries. This could reflect differences in the business cycle, the differing time constraints imposed on the statistical agency to produce a first estimate of GDP for a given quarter, the resources of the statistical agency, etc.
- Revisions to Canadian GDP are somewhat smaller and less volatile than those of other countries. Although Canadian GDP growth is sometimes revised by more than 0.5 percentage points, this is not unusual for the countries in our sample.

To more accurately depict the revision process in these countries, **Table 2** presents some simple descriptive statistics. The second column is an estimate of the mean revision to GDP growth over the sample period, which provides a measure of bias in the revision process. A mean close to 0.0 indicates that upward and downward revisions tend to offset each other, so the initial growth rate release is said to be *unbiased*. If the mean is above zero, this indicates that GDP growth tends to be, on average, revised upwards in the following quarter; below zero, it would indicate that the growth rate tends to be revised downwards.

Table 2: Revisions to GDP growth for selected OECD countries
Sample: 2001Q2 to 2009Q2

Country	Mean revision	Mean absolute revision	Confidence interval	Largest absolute revision
Canada	0.05	0.30	(-0.70, 0.80)	0.96
Australia	0.15	0.45	(-0.94, 1.24)	1.19
Germany	0.08	0.35	(-0.94, 1.10)	1.23
United Kingdom	0.00	0.35	(-1.05, 1.06)	2.04
United States	0.15	0.60	(-1.39, 1.70)	2.67

Note: Revisions are defined as the differences between the second and first release of the annualized quarterly GDP growth rate for each country. The confidence interval is a simple estimate within which we expect the GDP growth-rate revision to lie 19 quarters out of 20. Data obtained from the OECD *Main Economic Indicators Original Release and Revisions* database.

6 McKenzie (2007) analyzes revisions across a broader set of OECD countries, using different metrics, and over the 1995 to 2007 period.

The mean revision to Canadian GDP growth is 0.05 percentage points, which is trivial. Such a revision is consistent with the revisions of other countries and statistically is not significantly different from 0.0. The largest average revision is for Australia and the United States at 0.15 percentage points. Because our sample is relatively short, however, the associated estimated standard errors are sufficiently large that the average revision for each country is not statistically different from 0.0.

The third column presents the mean absolute revision, which is the average of the absolute value of the revisions. This statistic allows us to gauge the average magnitude of the revisions, regardless of whether the revision is positive or negative. A higher value here indicates that revisions to the GDP growth rate tend to be more substantial; a value of zero would indicate that the initial growth rate is not revised.

We find that the mean absolute revision for Canada is 0.3 percentage points, which is smaller, but not significantly different, than the numbers for other countries in the sample. The United States tends to have the largest revisions, but as mentioned above, this may reflect the fact that its data are released one month sooner than those of the other countries in our sample.

Large revisions to the GDP growth of foreign countries are not simply an issue for policy-makers abroad, but can have implications for policy decisions in Canada. Given that trade is an important component of the Canadian economy, Canadian policy-makers are interested in monitoring economic conditions abroad in order to gauge the potential demand for Canadian goods. If figures for foreign GDP growth are substantially revised, this can potentially complicate policy decisions in Canada. Being aware of revisions to foreign data is therefore important from a Canadian perspective.

Apart from the average size of revisions, analysts and policy-makers are also interested in the volatility of revisions, since less-pronounced revisions lead to less uncertainty about the initial estimate of GDP growth. Using estimates of the standard deviations of the revisions, the fourth column of Table 2 presents confidence intervals for revisions, which correspond to an estimate of the uncertainty around the past growth rate for k=1 in Chart 1, panel (b). For Canada, we estimate that the revision to GDP growth will lie in a range of -0.7 to 0.8 percentage points, 19 quarters out of 20. This is narrower than the ranges computed for the other countries. Although not necessarily statistically lower than other countries, it does suggest that Canadian decision-makers may have somewhat more confidence in initial releases of GDP growth than their counterparts in other countries.

Finally, the last column lists the largest (in terms of absolute values) revision for each country. The largest revision for Canada, of almost one percentage point, was recorded for the fourth quarter of 2001, which can be observed in Chart 2a. The United States also had a large positive revision in this quarter (+1.41 percentage points). Since growth for the fourth quarter of 2001 is computed as the percentage change in real GDP from the third quarter to the fourth quarter, we can surmise that the events of 11 September 2001 (which occurred in the third quarter) likely made the task of estimating economic activity especially difficult in both countries.

Revisions to growth rates of Canadian GDP components

Although headline GDP numbers are very important to monetary policy, policy-makers are also interested in the underlying factors that contribute to GDP growth, since some of these components are necessarily more sensitive to interest rate movements and therefore react more strongly to monetary policy actions.

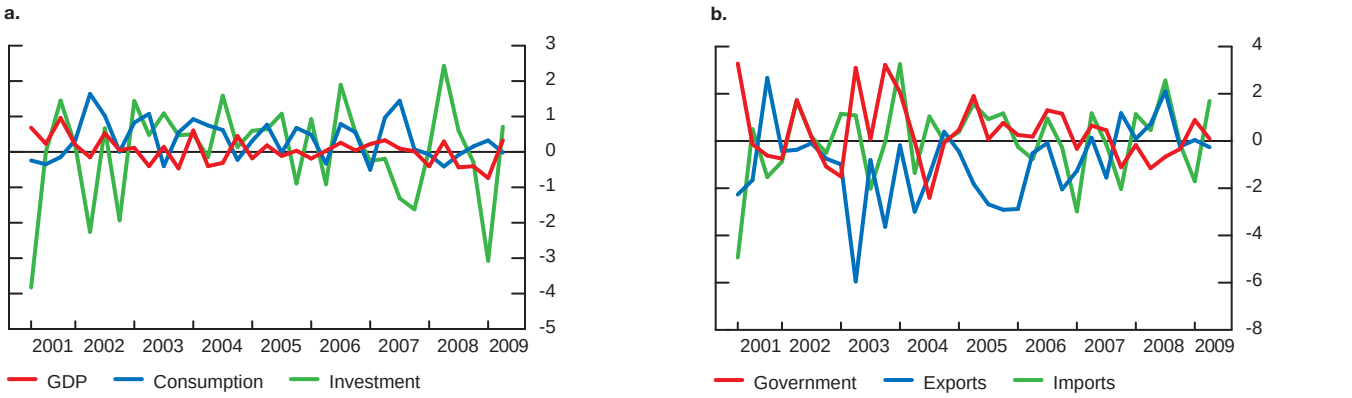
The major components of expenditure-based GDP are

- total household expenditures on goods and services (C);
- business fixed investment (I);
- expenditures by all levels of government (G);
- total exports (X); and
- total imports (IM).

In practice, Statistics Canada obtains growth estimates for each component (which can be further disaggregated) and then aggregates them to obtain an estimate of GDP growth. **Chart 3** presents the same revision series for Canadian GDP growth shown in Chart 2, together with the revisions to the growth rates of each major GDP component. Some observations:

- Revisions to the growth rates of GDP components are more pronounced than the revisions to GDP growth itself. Note that the vertical scale of Chart 3 is wider than that of Chart 2, so revisions to total GDP growth seem almost benign in Chart 3 relative to Chart 2. In contrast, the growth rates of some of the components in Chart 3 are often revised by more than 2 percentage points.

Chart 3: Revisions to estimates of Canadian GDP growth and its components
Quarter-over-quarter growth at annualized rates



Source: Author's calculations using data from OECD *Main Economic Indicators*

- Revisions to export and import growth are the most pronounced. In particular, export growth was subject to several downward revisions between 2003 and 2006. Revisions to consumption growth appear to be the smallest.
- In the fourth quarter of 2001, export growth was revised upwards by more than 2 per cent, while import growth was revised down by almost 2 per cent. Taken together, net exports $(X - IM)$ were raised substantially in this quarter, and combined with an upward revision to business investment this can explain the relatively large upward revision to GDP growth observed for the quarter.

Table 3 presents descriptive statistics for the revisions to GDP growth and its components. The mean revisions deviate more substantially from zero for some components. For example, growth of consumption and government expenditure tend to be revised upwards by more than 0.35 percentage points, while export growth is revised downwards by 0.9 percentage points, on average. In terms of mean absolute revisions, consumption growth is revised by over 0.5 percentage points, on average, growth of investment and government expenditures by about 1 percentage point, and export growth by almost 1.4 percentage points. As a result, analysts who are required to monitor and forecast the growth of Canadian trade face a more daunting task than those who focus on other GDP components.

Table 3: Revisions to Canadian GDP growth and its components
Sample: 2001Q2 to 2009Q2

Series	Mean revision	Mean absolute revision	Confidence interval	Largest absolute revision
GDP	0.05	0.30	(-0.70, 0.80)	0.96
Consumption	0.35	0.51	(-0.78, 1.48)	1.64
Investment	0.02	1.04	(-2.75, 2.80)	-3.83
Government expenditures	0.35	0.98	(-2.30, 3.00)	3.28
Exports	-0.94	1.38	(-4.31, 2.43)	-5.95
Imports	0.04	1.23	(-3.23, 3.31)	-4.93

Note: Revisions are defined as the differences between the second and first release of the annualized quarterly growth rate of GDP and its components. The confidence interval is a simple estimate within which we expect the growth-rate revision for each series to lie 19 quarters out of 20. Data obtained from the OECD's *Main Economic Indicators Original Release and Revisions* database.

The associated confidence intervals for revisions to the growth rates of the components of GDP are wider, sometimes substantially so, than for GDP growth itself. Among the components, consumption growth is revised between -0.8 and +1.5 percentage points 19 quarters out of 20; growth in investment and government expenditure have roughly similar ranges (-2.7 to 2.8 and -2.3 to 3.0 percentage points, respectively); while export and import growth have the most uncertainty associated with their initial estimates (ranges of -4.3 to 2.4, and -3.2 to 3.3 percentage points, respectively).

Based on the data from 2001 to 2009, we can conclude that greater uncertainty is associated with the first-release growth rates of the components of GDP than with the growth rate of GDP itself. This result can arise because revisions to the components offset each other (for example, higher consumption growth can offset lower business investment), thereby muting the impact of the revisions to the estimate for total GDP, and also because the GDP components are necessarily lower in level than total GDP, so revisions

to the levels of the components will result in correspondingly larger changes to the growth rates of the components.

Data Revisions and Monetary Policy: Some Issues and Future Directions

The literature on the consequences of data revisions for economic analysis and forecasting has been growing in the past few years, driven by the availability of real-time databases. With the availability of the OECD's real-time database and the Bank of Canada's real-time money and credit database, researchers and analysts now have access to vintage data that allow them to study some important issues for Canadian policy-makers. Below are some areas for which researchers have recently used real-time data to further our understanding.

The output gap

One of the initial motivations for exploring the impact of data revisions was the analysis of past policy decisions; for example, Runkle (1998) and Croushore and Stark (2003). To conduct a fair assessment, however, one would have to use data that were available to policy-makers at the time decisions were being made. As demonstrated above, GDP growth rates are revised by an average of more than one-half a per cent in some countries, and this after only one quarter. To analyze the policy actions of, say, five years ago, one would have to study the data that policy-makers had at that time.

One of the initial motivations for exploring the impact of data revisions was the analysis of past policy decisions.

A key variable monitored by policy-makers when making policy decisions is the output gap: the difference between the current level of real GDP and the level that would exist if all resources in the economy were fully employed and the inflation rate had no tendency to deviate from the target. The press releases that accompany interest rate announcements by the Bank of Canada on fixed announcement dates often allude to the output gap in statements such as, "Overall, the Canadian economy remained above its production capacity at year-end,"[7] which signals a positive output gap.

Given its importance for policy decisions, researchers have documented the impact of data revisions on the measurement of the output gap. Orphanides (2001) found that, once data revisions are taken into account, estimates of the output gap in the United States may differ by more than two percentage points, a magnitude that is non-trivial from a policy perspective. Kozicki (2004) provides measures of the policy implications of such revisions.

Proper measurement of the output gap requires not only the current level of real GDP, but also an estimate of potential GDP. There are several techniques for estimating the latter,[8] but they tend to provide relatively poor estimates of the output gap in real time.[9]

The output gap also figures prominently in the literature on policy rules, where the policy rate is specified as a simple linear function of the output gap and the deviation of the inflation rate from some target. Taylor (1993) found that policy rates in the United States could be well explained by such a rule in the 1980s; however, if data revisions were taken into account, and policy rules were estimated with the data available to policy-makers at the time decisions were being made, such conclusions might not hold. Côté et al. (2004) is the most comprehensive assessment of policy rules for Canada, and it remains to be determined how their most robust rules would change, given the issue of data revisions.

Finally, the output gap is often used to predict inflation. If it is subject to measurement error, it would be useful to determine how this affects inflation forecasts. Orphanides and van Norden (2005) find that output gaps predict inflation relatively well in the United States, but that the forecast performance diminishes substantially if real-time estimates of the output gap are used instead. An extension of this study using recent Canadian data would be very useful.

The role of money

The various measures of growth in the money supply are not given as much importance in making policy decisions today as was the case 20 years ago. This is because the empirical link between growth in the money supply and future inflation appears to have

7 "Bank of Canada lowers overnight target by 1/2 percentage point to 3 1/2 per cent," Bank of Canada Press Release, 4 March 2008.
8 See St-Amant and van Norden (1997) for a survey.
9 See Orphanides and van Norden (2002) for U.S. evidence and Cayen and van Norden (2005) for Canada.

weakened, partly as a result of innovations in banking products. However, as Keshishbanoosy et al. (2008) show, the money supply itself is subject to revision. It may therefore be worthwhile to further explore the links between money growth, macroeconomic variables, and policy decisions in a real-time context. Garratt et al. (2007) find some evidence that the predictive power of broad money in the United Kingdom did not decrease as much in the 1980s as is popularly perceived when real-time data is used.

Monitoring

From equation (1) we observe that the current growth rate of GDP is a product of this period's GDP level and the revised level of last period's GDP. In other words, success in monitoring this period's growth rate hinges partly on the magnitude of the revision to last period's GDP. Analysts should therefore expend some effort in trying to understand the nature of revisions and, indeed, try to predict them, if possible.

The literature remains divided as to whether past revisions are, in fact, predictable, but preliminary evidence presented by Galbraith and Tkacz (2007) for Canadian data suggests that revisions can be partially anticipated. In future work, analysts can explore other explanatory variables, as well as understanding whether revisions are likely to be more pronounced in some periods than in others. For example, revisions may be larger around the turning points of business cycles, so in such periods of uncertainty analysts may wish to anticipate large revisions and therefore build larger confidence intervals around their estimates of current GDP growth.

Given the large revisions to the components of GDP growth, the payoff for predicting the revisions could be potentially smaller confidence intervals around the monitoring of these variables.

Statistical methodology

Some statistical methods used by economists may not be valid in the presence of data that are subject to revision, and so some empirical findings may have to be reconsidered. New techniques are currently being developed to deal with such issues, but it may be some time before analysts can fully exploit them. For example, Clark and McCracken (2009) propose a new forecast-encompassing test (a test used to select among competing forecasting models) that can be used in the presence of revised data. Up to this point, many tests applied in the field have ignored data revisions, so it is possible that some incorrect inferences may have been made in past studies that have assessed the relative performance of competing forecasting models. In a different context, Jacobs and van Norden (2006) develop a method for constructing optimal forecasts and confidence intervals that are valid in the presence of data revision and use multiple vintages of data.

Development of such new techniques and their application to Canadian data are also important areas for future research.

Conclusion

Data revisions have been recognized as an issue by economists for some time, but research on the impact of data revisions has grown markedly in recent years with the advent of real-time databases. Canadian real-time databases are now available, and Canadian practitioners are expected to use these resources to improve the reliability of their models.

Data revisions can be viewed as uncertainty about the past, which feeds into uncertainty about the future. Revisions to Canadian GDP growth are found to be somewhat lower than those in some other OECD countries. However, revisions to the growth rates of the components of Canadian GDP are appreciably larger, which can lead to greater uncertainty for analysts who must monitor and forecast those components.

Data revisions can affect policy decisions in several ways, notably by yielding more uncertainty around the true values of the variables of interest to policy-makers. Furthermore, they can affect the existence of fundamental relationships between variables and cloud the judgment of analysts. Many outstanding research questions remain to be resolved for policy-makers, but the existence of real-time databases for Canada should help to answer some of these questions in coming years.

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Appendix: Revision Policy for the Canadian National Accounts

Revisions to the National Accounts can be of three different types: (i) regular revisions that take into account new information and/or reconcile data from the myriad surveys and sources that are used as inputs to the construction of the National Accounts; (ii) conceptual revisions arising from changes in definitions within the National Accounts; and (iii) historical revisions that are (infrequently) performed for various reasons.

Regular revisions

In the absence of conceptual changes or major historical revisions, the National Accounts are regularly revised to take into account new information and/or to reconcile data from the sources used to construct them. The revision schedule is as follows:

- Data for preceding quarters of the year are revised when the data for the current quarter are published.
- Revisions extending back four years are made with the publication of first-quarter data for a new year.

These are the revisions that should be of most interest to analysts and policy-makers since they can influence one's perception about the relative strength or weakness of the economy and can therefore influence current decisions.

Source: Statistics Canada <http://www.statcan.ca/english/freepub/13-010-XIE/2003001/revision2003001.htm>

Conceptual revisions

These revisions can arise because of changing perceptions about how certain segments of the economy should be classified or because of fundamental changes in quantifying economic activity. For example, major conceptual changes occurred with the release of the May 2001 National Accounts in which the method for measuring the capitalization of software was changed and the move from a Laspeyres Index to a Chain Fisher Volume Index took place, which made the Canadian and U.S. National Accounts more comparable. This second factor, in particular, renders the comparison of revisions before and after 2001 more challenging. See Statistics Canada (2002) for technical details.

Historical revisions

About once every ten years, Statistics Canada will revise data farther back than the typical four years. Such historical revisions are conducted to "improve estimation methods, eliminate statistical breaks resulting from more limited revisions and introduce conceptual changes into the system." Such revisions would have the greatest impact on users of macroeconomic models, who might find that parameter estimates were affected by such revisions. The latest historical revision occurred in December 1997, and the next is scheduled for 2012/2013. For further details see <http://www.statcan.ca/english/concepts/nateco/ann.htm>.