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Revisions to Economic Statistics and Their Impact on Policymaking

To paraphrase Kierkegaard's observation about life, economic policymaking must be lived forward, but the economy can only be understood backwards, and that backward understanding itself can change due to revisions in data.

Philip Cross

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About The Author

Philip Cross
is a Research Fellow, C.D. Howe Institute and former Chief, Economic Analyst at Statistics Canada.

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Daniel Schwanen
Vice President, Research

The Study In Brief

Revisions to economic data, with a few exceptions, are part of the normal process of compiling and improving statistics. However, this does not mean they should be ignored.

Policymakers have expressed their frustration with data revisions, saying that inappropriate policies sometimes were adopted because misleading data were incorporated into the policymaking process. In the United States, the Fed has been particularly vocal in its criticisms; in Canada, the Bank of Canada has been publicly more discrete. GDP is a frequent target of such criticisms, although not even the Labour Force Survey has been immune. As a Bank of Canada analyst has noted, policymakers have to deal with uncertainty about the future, the present, and the past when formulating policy. Revisions mean that the inevitable uncertainty about making projections also needs to take account of the lower, but non-trivial, uncertainty about what happened in the past.

Policymakers need not be the passive victims of revisions to the data they are scrutinizing. They can proactively take measures to anticipate revisions. The Bank of Canada, for example, found it could predict some revisions to consumer spending and GDP through its monitoring of the use of debit cards. As well, knowing that the GDP estimates might be revised more around turning points means that, during these periods, analysts should build larger confidence intervals around their GDP estimates. Finally, analysts can put more emphasis on data that are less liable to revision, such as employment or retail sales, while downplaying statistics such as exports that are known to be more variable.

Inevitably, however, analysts must accept that their knowledge of the world will always be uncertain, regardless of the quality of the data. Trying to understand the economy based on data alone risks being so backward-looking that mistakes inevitably will be made, irrespective of revisions.

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For most analysts, revisions of economic statistics are the mundane process by which statistical agencies amend and update their data.

Yet revisions of data have a much more fundamental importance: they manifest the uncertainty that permeates our understanding of what the economy has done in the past and will do in the future and the reasons for its behaviour. That understanding is inextricably linked to the concepts and methods analysts use to track the development of the economy. As our understanding of the economy changes, so does our measurement of key concepts such as gross domestic product (GDP) and employment. What is included in GDP today and how it is measured are radically different from nearly a century ago. Revisions partly reflect the continuing difficulty and inevitable lag of adapting statistics to the reality of today's economy.

Why do revisions to economic statistics matter? Revisions occur because the preliminary estimates were inaccurate or because the concepts and methods underpinning data computations needed to be updated or improved. Although revisions improve the quality or relevance of data, they also imply that a range of uncertainty surrounds data points, complicating their analysis. Many of the key issues facing Canadian society today have major implications for statistics. Technological change is altering both the market basket of goods and services and their quality, making it harder to measure GDP and prices. Is the nature of employment changing as the Internet allows producers and consumers to connect directly? What does retirement mean when so many people drawing a pension are self-employed or working part time? Indeed, the uncertainty that has always surrounded statistical measures of the economy, partly because of revisions, might well be increasing rapidly.

Another major determinant of revisions reflects the inevitable trade-off between the timeliness of statistics and their accuracy. Simply put, the faster statistics are compiled and published, the greater the risk of inaccurate results that should lead to further revisions. The United States regularly publishes its major business statistics, other than the consumer price index (CPI) and unemployment, about one month faster than does Statistics Canada. This reflects the fact that users of US data place so much importance on a quick reading of what is happening to the world's largest economy that they tolerate less accurate preliminary data. Because Canada's economy has less global importance and is dependent on trends in the US economy, users of Canadian data are more willing to tradeless timeliness for more accurate data.

Revisions that cause a break or discontinuity in the time series of data are especially problematic for users. For Canadian macroeconomic statistics such as GDP and employment, a consistent record is available only from 1961 and 1976, respectively. In the United States, in contrast, data on GDP and employment are available for much longer periods without breaks in the series, extending to 1939 for

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employment and to 1947 for GDP. The shorter period of available data in Canada thus severely restricts the amount available for economic research and downplays lessons to be learned from earlier business cycles. For Canadian users, conceptual and methodological revisions to already short time series might be an even bigger problem than is the magnitude of revisions of the published data.

More broadly, statistical revisions reflect the uncertainty that surrounds our knowledge and understanding of the economy. It is therefore important for policymakers to understand the quantitative and qualitative features of revisions and their effect on decisionmaking. At the same time, statistical agencies could be more proactive in documenting the importance of revisions and warning users of their inevitability.

Why Are Data Revised?

Statistical agencies routinely revise data as they are collected, compiled, and disseminated. Preliminary estimates of monthly or quarterly series such as retail sales, trade flows or corporate profits are based on surveys designed to produce a quick estimate of overall trends, with response rates well below 100 percent. As more responses come in over the following few months, estimates are revised. Eventually, high-frequency survey data are supplemented by more comprehensive annual surveys and ultimately are benchmarked to more complete data, usually based on tax records – compensation of employees, for example, is benchmarked to income tax data, which become available with a three-year lag. These more comprehensive data are also authoritative at the industry and provincial levels, where detailed estimates from the preliminary survey are problematic.

There are many reasons for revisions beyond the availability of more complete data, and statistical agencies are not the only ones affected. All surveys take the responses from their sample and make adjustments based on various assumptions. For example, the US National Association of Realtors found it overestimated existing home sales by 15 percent during the 2008–09 recession because it counted sales made through its real estate agents and then added an estimate of sales made directly by owners (Rich 2012). During the recession, however, fewer owners than expected made sales without using an agent. As well, the Association assumed that all new home sales were made exclusively by the builder without help from real estate agents. But the severity of the downturn in housing sales during this period led builders to enlist the help of real estate agents, leading to a double-counting of some sales.

There are other reasons to revise data. For example, factors used to adjust data seasonally need regular updating because seasonality is constantly shifting. As well, the inevitable errors that occur when quickly compiling preliminary estimates need to be corrected. A vivid example was the misallocation of 61,000 Quebecers as "English-speaking" people in the 2016 census, which was corrected but not before fueling the always volatile linguistic political debate in the province.[1] Periodically, the concepts and methodology underlying major economic statistics are updated when classification boundaries are updated. Past examples include the 1976 overhaul of Statistics Canada's Labour Force Survey, the 1986 conversion from gross national product to GDP, and the 1999 capitalization of software expenditure in business investment.

1 Statistics Canada "The Daily." 2016 Census Topic: Language. August 17, 2017. www12.statcan.gc.ca/census-recensement/2016/rt-td/lang-eng.cfm.

Revisions usually improve the data, but they are not the only guide to the reliability of data. A refusal to make revisions is not a guarantee of accuracy; in the words of two analysts ant the International Monetary Fund (IMF), the "absence of revision is not necessarily an indication of good quality. In fact, in certain cases where data are not revised to take into account better data or changing economic situations, the absence of revisions indicate poor data quality" (Shrestha and Marini, 4). It is better to incorporate improved sources and revise the data than to ignore the opportunity to improve data. Not making revisions also can simply reflect an organization's policy, as we will see with Canada's CPI. As well, more frequent revisions might reflect an organization's decision to publish more timely estimates, thus trading off accuracy for timeliness. This is clearly the case for the US Bureau of Economic Analysis, which produces its first estimate of GDP one month ahead of Canada but warns users that the estimate could be revised substantially.

One of the most insidious effects of revisions is a conceptual change that leads to a break or disruption in the time series of a variable. For example, as noted, GDP in Canada currently is available on a consistent basis only from 1961. This means that models cannot incorporate all the information about business cycles and long-term growth from earlier decades. The loss of historical data can be crucially important – for example, a widespread problem with the modelling of risk in the US banking system leading up to the 2008–09 financial crisis was the use of only postwar data on housing prices, which discounted the possibility that house prices could have fallen nationwide, as occurred in the 1930s.

An important determinant of the magnitude of revisions reflects the trade-off between timeliness and accuracy. Although most users seem content with the current timeliness with which data are published in Canada and the United States, a vocal minority, especially people working in financial markets and in the media, want data faster, even at the risk of less reliability. Increasingly, this group can obtain more timely (and riskier) data from private sources outside of official statistics agencies. Examples of this include the publication of the ADP employment report in the United States, the compilation of a consumer price index by academics using price quotes from the Internet, and purchasing managers' indices compiled by trade associations for manufacturing and services. The very fact that much of these newer, more timely data are never revised should be a warning about their quality, implying that there are few checks on the accuracy of the data from sources other than statistics agencies. Indeed, as technology evolves and data continue to proliferate, pressure on statistics agencies to produce more timely data and instead focus on reducing revisions might be reduced.

Revisions to GDP

In Canada, quarterly revisions of the National Accounts are made during the same calendar year; once the calendar year is past, however, the estimates are revised only once a year for the next three years, after which they are considered final (Barber-Dueck 1995). The last of these revisions potentially is the most significant, because that is when the income and expenditure estimates are benchmarked to the input/output (or supply-use) measure of GDP, which determines the final growth and distribution of GDP and its components.[2] Subsequent revisions are made on

2 See Cross (2016) for a detailed review of different GDP measures. Also at this time, the monthly estimates of industry GDP are converted from a Laspeyres basis that values output at its price several years ago to a chain that values output at the previous period's price. Until that is done, the monthly GDP and quarterly expenditure GDP estimates are not directly comparable.

an occasional basis to include conceptual changes to the National Accounts, not because new source information becomes available. Some analysis tries to separate revisions made due to changes in the source data from revisions made due to conceptual changes, but this seems an unnecessary distinction. Although the former reflects the reliability of the gathering of statistics, the latter reflects the reliability and relevance of the concepts of GDP, but a statistics agency's shortfall in either function is problematic for users.

The magnitude of revisions has changed over time (see Table 1). Revisions to GDP were exceptionally large in the 1970s due to "rapid price change, wide price dispersion and upheaval in the data sources" (Clift and Wells 1990, 3.9). The average revision to the quarterly growth of real GDP fell from 0.4 percent in the 1970s to 0.1 percent in the 1980s as surveys were improved and as lower inflation facilitated the accurate measurement of GDP (Clift and Wells 1990, 3.10). Revisions remained low in the first half of the 1990s, but then increased to an average of 0.19 percent as the National Accounts underestimated the acceleration of growth in the second half of that decade powered by the information and communications technology (ICT) sector. Average revisions to quarterly real GDP growth returned to near zero in the early 2000s.

Revisions to GDP attract the most attention from users around turning points, when the economy shifts from growth to recession, at which moments such revisions tend to increase (see Box 1). As an IMF study concludes, "early data are less reliable in tougher economic times" (Shrestha and Marini 2013, 5). A Statistics Canada study found that revisions tend to be procyclical: "When GDP is expanding, the initial estimate tends to underestimate the growth. When GDP is contracting, the initial estimate is more likely to overestimate the growth" (Statistics Canada 2011, 14). Turning points cause difficulty for the statistical system because the increased turnover of firms during these periods means that the representativeness of survey samples changes unexpectedly, while response rates decline. High-frequency surveys mostly collect data from large and medium-sized enterprises to avoid burdening small businesses, whose behaviour is usually imputed by extrapolating past trends. This methodology, however, is clearly problematic, as it is mostly small firms that come into existence or die just when the economy is moving to a new, less predictable path, meaning that just when policymakers most need the assurance of reliable data, uncertainty surrounding the estimates might increase.

Table 1: Revisions to Real GDP Quarterly Growth, by Decade, 1971–2009

	1971–80	1981–90	1991–2000	2001–09
	(*percentage points*)			
Mean revision	0.4	0.14	0.10	0.05
Mean absolute revision	0.6	0.42	0.31	0.31
Source	Clift and Wells 1990	Statistics Canada 2011	Statistics Canada 2011	Tkacz 2010

Note: Mean revision is the average difference between preliminary and final data over a set of observations; mean absolute revision removes the directional bias, as it cancels the offset of two revisions with opposite signs.

The Distribution of Revisions to GDP

Further complicating the analysis of revisions to GDP, including by the C.D. Howe Institute Business Cycle Council (see Box 2), is their quarterly distribution. Revisions to data for the first and second quarters of the year are, on average, larger than those for the third and fourth quarters because changes to earlier quarters have more weight than later in the year – indeed, the first quarter has four times the weight of the fourth quarter. The greater weight of earlier quarters in determining annual GDP means that revisions

Box 1: Historical Examples of GDP Revisions to Recessions

The difficulty in estimating GDP at turning points is reflected in how entire recessions in Canada have disappeared in subsequent revisions or in how revisions have created a recession where none existed in the first estimates. The 1970s provide an example of each. In 1970, there were no quarterly declines in the preliminary estimates of the expenditure-based estimates of GDP. Two years later, the estimates showed that the first quarter of 1970 was negative, joined by the fourth quarter; more revisions were made in 1974; in the 1986 historical revision, the second quarter was revised to negative growth. So a positive growth story throughout 1970 in the preliminary estimates ultimately ended up becoming negative growth in three of the four quarters. A recession now occurred where none existed in the preliminary estimates.

Conversely, for the 1974–75 recession, the preliminary estimates showed zero growth in the second and third quarters of 1974 and sharp declines in the next two quarters. Over time, the severity of the declines moderated, until, by the 1986 historical revision, only a 0.1 percent decline in the first quarter of 1975 was all that remained in the income and expenditure measure of real GDP, implying that the recession had vanished. Even more confusing, the recession remained in the data published for the industry-based measure of GDP. Then, in 2017, another round of revisions reintroduced a marked recession in expenditure-based GDP, with three consecutive quarterly declines of 0.1 percent, 0.5 percent and 0.7 percent, indicating not only a recession, but one of the more severe ones in post-war history. For over three decades, however, the historical record was ambiguous about whether there even was a recession in 1974–75.

to first-quarter data are passed through to all subsequent quarters in the same calendar year, while revisions to fourth-quarter data affect only that quarter (Cross and Wyman 2011) Therefore, when adjusting quarterly data to align with revisions coming from annual benchmarks, revising data from quarters early in the year minimizes the average revision to quarterly growth rates, which is universally used as a key indicator of the reliability of the statistics. Between 1981 and 2011, for example, the magnitude of real GDP revisions for the first quarter was greater than for the fourth quarter in 19 of the 31 years, in eight years the revisions were the same, and in only five were the fourth-quarter revisions greater than those for the first quarter.[3] The quarterly distribution of revisions has important implications for the assessment of the 2015 GDP data. All of the drop in quarterly GDP in that year occurred in the first half of the year, yet Statistics Canada has not yet revised the data for these two quarters; in fact, there is no precedent for the agency's not revising two consecutive quarters of GDP growth at all in the following two years.

3 Statistics Canada, Cansim database, table 380-0064. The data in this table cover revisions made between 2012 and 2017. The revisions include only those made due to changes in the annual level of GDP, which are the only type susceptible to a quarterly pattern. The average revision to data from the first and second quarters was 0.8 percent of GDP, versus 0.7 percent for data from the third and fourth quarters.

Revisions to the Labour Force Survey

Two sources of revisions to the monthly Labour Force Survey yield estimates for employment and unemployment.[4] First, once a year, seasonal factors are updated, with changes to seasonality becoming more pronounced over time,[5] reflecting changing weather conditions and, more important, changes to social norms (such as gift cards shifting Christmas spending into the new year) and new technology (such as better techniques to work outdoors in winter). Second, every five years, the employment estimates are benchmarked to data provided by the census,[6] although revisions based on this source historically have been minor. For 2014, for example, the Labour Force Survey's estimates of employment diverged from the census data by 102,100 people, which might seem large, but it represented only 0.6 percent of total employment, and redistributing the difference over five years renders the revision essentially inconsequential. The Labour Force Survey is highly accurate because its sample is very large: at 55,000, the size is comparable to the US household survey of unemployment for a population ten times as large as Canada. Moreover, its methodology is state of the art, with the possible exception of its seasonal adjustment.

Major revisions to the Labour Force Survey data are much less frequent than those to the GDP data, partly because it is conceptually easier to define employment and hours worked than the volume and prices of all goods and services. A major overhaul of the Labour Force Survey's concepts and methods occurred in 1976, partly to "fit better within the production boundary, as defined by the System of National Accounts" (Usalcas and Kinack 2017, 7), which, however, created a discontinuity with the data published before 1976. Changes to the Labour Force Survey since then, notably a major change in 1997, have not created any breaks in the existing data.

Despite its infrequent revisions of the numbers, the Labour Force Survey has drawn criticism from policymakers for other reasons. In 1973 then Bank of Canada governor Gerald Bouey said "It is far from easy to reconcile virtually all the other evidence bearing on the state of the Canadian economy with the report from the labour force survey that as recently as August of this year, the number of Canadians unemployed was still a full 5 1/2 per cent of the labour force" (quoted in Crow 2002, 144). Some of the curious behaviour of unemployment during this slowdown of growth came from reforms making it easier to get unemployment insurance benefits, which "also changed the economic meaning of the unemployment statistics." (Crow, 2002, 144.) One result was an overhaul of the survey, including a change in the criteria about the job search needed to quality as being unemployed in the labour force, implemented in 1976.

Revisions to the Merchandise Trade Data

The monthly estimates of exports are the largest source of revision to the components of GDP (Tkacz 2010, 47), due to a change in the 1980s in the methodology of collecting export data. At that time, Statistics Canada used data on imports from Canada collected by the US Department of

4 An exception occurred in July 2014 when job growth was quickly revised from 200 to 42,000 when an error in computer programming was discovered.

5 Philip Cross. "Are monthly changes in the economy becoming more volatile?" *Canadian Economic Observer*. Statistics Canada Catalogue no 11-010-X. January 2009.A Statistics Canada study of recent revisions to the Labour Force Survey focuses exclusively on unadjusted data, ignoring the increased volatility of seasonality.

6 The voluntary 2011 National Household Survey therefore did not affect the data on population and employment.

Box 2: The C.D. Howe Institute Business Cycle Council and Revisions to GDP Data

The C.D. Howe Institute Business Cycle Council has had to wrestle with potential revisions to GDP data when drawing up a chronology of business cycles in Canada. Revisions have affected the Council's understanding of when recessions happened in the past, including whether the preliminary estimates of a small decline in GDP in the first two quarters of 2015 would survive the inevitable revisions. Employment, however, showed steady growth, and this is unlikely to be changed significantly based on past revisions to this survey. Clearly, the Council would not want to state publicly that a recession had occurred and then later have to issue a retraction reaching the opposite conclusion because the underlying GDP data had been revised.

One way to minimize the possible impact of revisions is always to examine the full array of available indicators. For example, in making its assessment, the Council considers two separate measures of GDP as well as employment and a diffusion index. This type of enhanced analysis is one example of how analysts and policymakers can insulate themselves from the impact of revisions to the data.

Commerce, under the reasonable assumption that nations monitored goods entering the country more closely than goods leaving the country. As part of an arrangement to integrate US and Canadian trade data, however, Canada had to accept the more timely publishing schedule of the United States, which releases its trade data about 35 days after the end of the reference month. The new system proved to be a good source of trade data – at the same time, the US Commerce Department switched to Canadian data on imports from the United States to estimate its exports to Canada – but with one important exception: crude oil and natural gas. Because these products are shipped by pipeline, there are no precise data for prices and volumes of oil and gas exports.[7] Canada's National Energy Board does collect data on such exports, but these take a couple of extra months to compile.

Initially, in the 1980s, the importance of energy exports was small and their weakness in the preliminary trade data was not a major source of revisions to data on total exports. In the 1990s, however, energy exports began to rise in importance. After the implementation of the Free Trade Agreement with the United States, producers rapidly began to develop natural gas in Canada for export to what were secure and stable US markets. Then, in the late 1990s, output from Canada's oil sands began to expand rapidly. Finally, higher prices after 2002 for the rising volume of both oil and gas quickly vaulted energy products to become Canada's leading exports. What was once just an annoying irritant for energy export statistics had now become an Achilles heel of vulnerability in the data for both exports and GDP. As a Bank of Canada article concludes, "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" (Tkacz 2010, 47).

7 Since Canada imports relatively little oil and gas by pipeline from the United States, the vulnerability of estimates of Canada's imports is much less significant.

Without firm data from either the US Department of Commerce or Canada's NEB, Statistics Canada has to use less reliable sources for its preliminary estimates of oil and gas exports, such as estimates from surveys of pipeline companies and of energy shipments from the provinces (Statistics Canada 2015). The result is that monthly estimates of Canada's energy exports can undergo revisions of $1 billion or more – a significant portion of total monthly exports of about $45 billion. Statistics Canada is aware of the vulnerability of trade data to revisions: its release of these data is the only major one that provides a monthly summary of revisions made to data from previous months. Such transparency should extend to other major releases. Even better, all major releases of economic data should include statistical measures of their track record of revisions, to allow users to make their own assessment of the quality of the data.

Revisions to Consumer Price Data

Not all data are subject to revision, even when they are found to be incorrect. A case in point is the CPI, which Statistics Canada never revises – indeed, the CPI is probably the only major economic statistic that is not subject to revision.[8] This policy is so absolute that Statistics Canada will not revise the CPI even to correct for errors it admits have occurred. In 2006, the Bank of Montreal's Douglas Porter brought to light an error in the data on hotel rates between 2001 and 2006, which reported a drop of 16 percent when rates should have risen by 32 percent (Grant 2006).[9] Statistics Canada acknowledged that a mistake had been made and that its reported inflation rate should have been revised upward by 0.1 percent, but the agency nevertheless refused to break with its policy of never revising the CPI.[10] The reason for this stance is that because so many wage and price formulas are indexed to the CPI, revising the index potentially could have made Statistics Canada liable for the cost of changes to all the contracts that are indexed to inflation, as well as retroactively changing the annual indexation factor used to adjust most government taxes and transfers for inflation.

The lack of revisions to the CPI has several ramifications. For users, it means there is an unbroken time series stretching back to 1914, the longest among Statistics Canada's macroeconomic data. Although this facilitates historical analysis, the long time frame means there are other problems related to quality and technological changes that make long-term comparisons of prices problematic. Also, because the CPI is never revised, the price index for GDP is rarely revised significantly except for those components whose prices are based on wages and salaries (notably in the government sector). As a result, revisions to current dollar estimates tend to be passed through to correspondingly similar revisions to constant dollar estimates. When revisions to the price index for GDP do occur, however, they can be significant. Barry Eichengreen speculates that, in the United States, "[d]istorted data may have…contributed to the [US Federal Reserve's] exaggerated concern with deflation" in the recovery from the 2001 recession (2015, 84). Initially, the price deflator for personal expenditure was estimated to have increased by less than 1 percent in 2003, close enough to deflation that the Fed might have been encouraged to hold interest rates too low, helping to fuel the bubble in housing prices. Later, this

8 The seasonally adjusted estimates of the CPI are updated for changes in seasonality, but these are minor and do not affect the annual estimates of inflation.

9 Internal analysis at Statistics Canada, however, had already flagged concerns about the hotel data.

10 See "Statistics Canada finds room for error," *Edmonton Journal*, August 16, 2006.

measure of inflation was revised to a 1.5 percent increase.

The Importance of Revisions to Policymakers

Policymakers have expressed their frustration with data revisions, saying that inappropriate policies were adopted because misleading data were incorporated into the policymaking process. In the United States, the Fed has been particularly vocal in its criticisms; in Canada, the Bank of Canada has been publicly more discrete (Kozicki 2004; Runkle 1998). GDP is a frequent target of such criticisms, although not even the Labour Force Survey has been immune. As a Bank of Canada analyst has noted, policymakers have to deal with uncertainty about the future, the present, and the past when formulating policy (Tkacz 2010). Revisions mean that the inevitable uncertainty about making projections also needs to take account of the lower, but non-trivial, uncertainty about what happened in the past. To paraphrase Kierkegaard's observation about life, economic policymaking must be lived forward, but the economy can be understood only backwards, and that backward understanding itself can change due to revisions or for other reasons, such as a better understanding of economic processes. Complicating matters is that revisions often are larger around turning points in the economy, when uncertainty already is high for policymakers and analysts are trying to determine the best route for policy or whether a recession had occurred and when.

One way to avoid vulnerability to data revisions is always to keep in mind the context of all the available economic statistics. A good example is the record increase in employment in the Labour Force Survey estimate for October 2008. The counterintuitive estimate of rapid job growth at a time of global recession reflected several factors unique to Canada that month, including the boost to jobs from temporary hiring for a federal election, a record grain crop and unusually mild autumn weather. Analysts – including traders of the Canadian dollar – were quick to discount the increase in jobs, correctly concluding that Canada inevitably would be sucked into the vortex of plunging global trade.

Policymakers need to accept that data are inherently uncertain; indeed, much of managing the product of a statistics agency involves managing uncertainty. This is why data are properly presented with confidence intervals: monthly employment numbers are centred in a confidence interval of plus or minus 29,500 (or 0.2 percent) around the estimated monthly change. Opinion polls do a good job of reminding people that the results are "accurate 19 times out of 20, with a probability of 95 percent." Any informed policymaker knows that some data are more reliable than others, based on their publicly available track record.

Policymakers need not be the passive victims of revisions to the data they are scrutinizing. They can proactively take measures to anticipate revisions. The Bank of Canada, for example, found it could predict some revisions to consumer spending and GDP through its monitoring of the use of debit cards (Galbraith and Tkacz 2007, 11). As well, knowing that the GDP estimates might be revised more around turning points means that, during these periods, analysts "therefore build larger confidence intervals around their estimate of current GDP growth" (Tkacz 2010, 49). Finally, analysts can put more emphasis on data that are less liable to revision, such as employment or retail sales, while downplaying statistics such as exports that are known to be more variable.

Inevitably, however, analysts must accept that their knowledge of the world will always be uncertain, regardless of the quality of the data. Trying to understand the economy based on data alone risks being so backward-looking that mistakes inevitably will be made, irrespective of revisions. It is unsettling to hear the Fed say that its policies are "data dependent." Monetary policy has to be forward-looking, given the inevitable lags (estimated at up to two years) between when

policy changes and the full impact on the economy is felt. Waiting for the data to tell central banks when, for example, policy needs to be tightened to head off inflation entails the risk that inflationary pressures will have several quarters or years to build before policy reacts. Forward-looking policy needs to anticipate what will happen, based on a realistic theory of how the economy works. If the theory is wrong, as has often proved to be the case over the past decade, then policy will be mistaken no matter how accurate are the underlying data. While they demand better data from the statistical system, policymakers should also devote energy to developing better and more realistic ways of imagining how the economy works. A notable feature of the shortcomings of models before the 2007 financial crisis began was the failure of central banks to integrate the financial system into their models, thereby excluding even the possibility of a financial shock.

Given our imperfect understanding of the economy, it is more important that policy be prepared to adapt quickly to changing circumstances than to engage in futile attempts to forecast the future precisely. Unexpected – and therefore hard to diagnose – shifts in the economy, either positive (such as the ICT boom of the late 1990s) or negative (as in the "stagflation" in the 1970s) are likely to cause problems for both statistics agencies and policymakers. The late 1990s boom in productivity led agencies to underestimate growth and policymakers to miss an increase in potential non-inflationary growth. The 1970s was a difficult time for both macroeconomic theory and economic statistics. In retrospect, what was lacking in the mid-1970s was not only accurate data showing that growth was weak and inflation high – the "stagflation" that macroeconomic theory at the time held to be impossible – but also the proper model to identify the source of inflation and the political will to adopt the macroeconomic policies needed to curb inflation. When the economy suddenly behaves in an unexpected manner, analysts often are reflexively suspicious of the accuracy of the statistics instead of questioning the relevance of theories about how the economy works. In the 1970s, Germany's Bundesbank showed that disciplined monetary policies could limit inflation, but North American central banks did not undertake these policies until 1979 – which was also the year the Anti-Inflation Board was dissolved, signalling the end of Ottawa's experiment with wage and price controls to deal with inflation.

Conclusion

Revisions to economic data, with a few exceptions, are part of the normal process of compiling and improving statistics. The inevitability of revisions means that the uncertainty policymakers and analysts face about the future also extends to the present and into the past. A far greater source of uncertainty is understanding what is currently unfolding, what is significant and how to shape events in the future that lead to better outcomes. This lack of knowledge is shared by both statistics agencies and policymakers.

There is some trade-off between the timeliness of data and its accuracy, although the superior track record of Statistics Canada's Labour Force Survey in measuring employment implies that this trade-off is not inevitable. The increasing popularity of unofficial data that are released quickly means analysts increasingly may choose their own trade-off between timeliness and accuracy, instead of statistics agencies making that choice for them.

Users of economic data can take practical steps to minimize the impact of revisions. It is public knowledge that some data are revised more than others; thus, relying heavily on data that are subject to major revisions, such as energy exports, leaves users vulnerable to forming misleading initial assessments. A more comprehensive approach would look at a wide range of data from many sources, thus minimizing the impact of revisions to any one data source. However, there is almost no way to anticipate revisions that come from conceptual changes in the way we think about and

measure economic growth: neither economists nor statisticians expected the boost to productivity from the ICT boom in the late 1990s. Users, however, have no alternative when revisions cause a break in the time series of data that shorten the period of the economy they can study.

Perfect data would not guarantee perfect policy, something that all users seem to understand: even the best data need to be analyzed and interpreted properly. Data have to be added to theoretical models that accurately and fully represent our society and economy. Of all the types of uncertainty policymakers and analysts face, data revisions would seem to rank among the least important; more accurate data are always better, but they would not significantly reduce such uncertainty.

There are reasons to suspect that society is undergoing fundamental technology-driven transformation that could alter what we produce, the prices we pay, the contractual relationships under which we supply our labour and the trajectory of our career paths – such as regular return to learning institutions, longer leaves for child-rearing and a continuing presence in the labour force even after starting to draw a pension. If borne out, these trends imply greater uncertainty surrounding all our major statistics about GDP, employment and inflation.

As it now stands, statistics agencies might not be doing enough to communicate clearly to users and the public the uncertainty surrounding most data. Other than merchandise trade data, it is rare that Statistics Canada conveys that its estimates are surrounded by a confidence interval of possible results and are subject to revision. This partly reflects the media's unrealistic demands for precision, although polling firms have been able to communicate the concept of uncertainty to the same journalists. Unable to communicate even the basic uncertainty surrounding its current statistics, Statistics Canada is not well-positioned to communicate that a wider range of uncertainty might soon surround its estimates of GDP, employment and prices. Again, the work of pollsters suggests that educating the public about the uncertainty of statistics is difficult, but not impossible.

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