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## Research Paper

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# Revisions and the Income and Expenditure Accounts

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Statistics Canada  
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Canada

# Revisions and the Income and Expenditure Accounts

This paper provides some background information on revisions within the Income and Expenditure Accounts as well as a detailed revisions analysis of the quarterly real growth rate of Gross domestic product. The analysis of revisions strives to ascertain if preliminary estimates have been significantly different from the final estimate, thereby indicating reliability needs to be improved. The revisions analysis presented here looks at the behaviour of the revisions to quarterly real gross domestic product growth rate for the period 1981 to 2007 with the objective of determining if a significant bias exists.

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## Introduction and summary

The Canadian System of National Accounts (CSNA) provides a comprehensive overview of developments in the economy for a wide range of users. To remain relevant, the main economic indicators must be accurate and reliable, in addition to being timely.” Statistics Canada defines the quality of information in terms of its fitness for use. This is a multidimensional concept embracing both the relevance of information to users’ needs, and characteristics of the information such as accuracy, timeliness, accessibility, interpretability and coherence that affect how it can be used.”<sup>1</sup>

The first quarterly estimate of income-based and expenditure-based gross domestic product (GDP), released approximately sixty days after the reference period, provides a timely estimate of broad economic activity. Although this schedule results in timely and relevant information, this timeliness has a trade-off with accuracy. The initial estimates are based on data available at the time of the release; however, this information is incomplete. As a result of the eventual availability of more complete data, the data undergo a series of revisions that give rise to different vintages of the datasets. Revisions can also occur as a result of new compilation methods or data sources, conceptual or methodological improvements, and, less frequently, the adoption of new international standards. *Statistics Canada’s Quality Assurance Framework 2002* notes that the tracking of the size and direction of revisions can serve to assess the reliability of early estimates. Revisions analysis also provides a basis for recognizing any biases in preliminary data that could be removed through estimation.

Revisions of the Income and Expenditure Accounts normally occur over a four-year period, in accordance with the current revisions policy.<sup>2</sup> Partial revisions are sometimes carried out with respect to periods further back than four years, and historical revisions are conducted periodically, once every 10 to 15 years. Historical revisions are large-scale revisions that include a comprehensive update of concepts, methods, classifications, and statistical innovation, and as such are not a reflection of the underlying quality of the data used in the GDP estimates.

This paper provides background information on revisions within the Income and Expenditure Accounts as well as a detailed revisions analysis of the quarterly growth rate of real GDP. The analysis of revisions seeks to ascertain whether preliminary estimates have been significantly different from final estimates. Analysis of revisions has been carried out on an occasional basis over the last 40 years within the CSNA. Corrective action was taken to improve compilation methods, making estimates more reliable, when earlier revisions analyzes have shown small biases. Earlier studies include the following: *An Analysis of the Revisions of the Canadian National Accounts*, which examined the impact on revisions of the timeliness initiative (under this initiative, the release was moved up from 90 days to 60 days after the reference period); *National Income and Expenditure Accounts: Revised Estimates for the period from 1989 to 1992*, which included an historical perspective for 1971 to 1992 and concluded that the downward bias that existed in the 1970s and early 1980s was eliminated and that the absolute size of revisions was reduced by half; and *National Income and Expenditure Accounts: revised estimates for the period from 1990 to 1993*, which included an analysis of selected GDP aggregates for 1980 to 1993.

The revisions analysis presented here looks at the behaviour of the revisions to quarterly real GDP growth rates for the period 1981 to 2007 with the objective of determining whether a bias exists in the initial estimate of GDP growth. Revisions are examined in regard to measures of bias and dispersion, different vintages, statistical inference, and the economic cycle. The analysis finds that:

- revisions to the real GDP growth rate have become smaller over time;
- the largest revision occurs with the second annual revision;
- there is no statistically significant bias in the estimates;
- there is a tendency to revise GDP up when GDP growth is increasing and to revise GDP down when GDP growth is slowing; and
- there may be a slight time lag around economic turning points.

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1. *Statistics Canada’s Quality Assurance Framework 2002*. 2002. Statistics Canada catalogue no. 12-586-XIE.

2. More information on the Income and Expenditure Accounts revision policy can be found in Appendix A.

There is significant interrelatedness between the components of income-based and expenditure-based GDP. A future revisions article will examine revisions to these components.

## Reasons for revisions

The GDP estimates are revised for any of a number of reasons. Revisions to income-based and expenditure-based GDP can be classified into four groups: 1) vintage of source data, which are routine revisions that occur as more complete and more comprehensive information becomes available including updates to seasonal factors; 2) changes to the statistical system, such as survey redesigns; 3) conceptual, classification, and definitional changes; and 4) methodological changes, such as improvements to estimation methods.

Revisions due to vintage of source data occur over the four-year revision period as more complete source data are incorporated. The estimates for GDP and its components are compiled on the basis of a vast array of data sources, including survey results and administrative data, often with various lags in the availability of these data sources. Table 1 provides an example of the major data sources used in compiling the series wages, salaries, and supplementary labour income, computing the annual growth rate at each vintage, and determining the timeline in which the source data are incorporated.<sup>3</sup>

**Table 1 Revisions due to different vintages of source data, example using labour income, reference year 2003**

	Release date				
	Fourth quarter 2003 (initial estimate)	First quarter 2004 (first annual revision)	First quarter 2005 (second annual revision)	First quarter 2006 (third annual revision)	First quarter 2007 (fourth annual revision)
Wages, salaries and supplementary labour income, annual growth rate (%)	3.4	3.5	4.2	4.7	4.7
Source data	SEPH, LFS, PSS, HRSDC bulletins	Updated SEPH, LFS, PSS, HRSDC bulletins	T4 benchmark, EI data, CQPP data, PPIC, updated PSS	Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail

Note: See Appendix D for acronyms and initialisms.

The remaining three types of revisions (changes to the statistical system; conceptual, classification, and definitional changes; and methodological changes) can be considered exceptional revisions. Table 2 classifies some past revisions on the basis of these three categories. Changes to the statistical system occurred with the Business Survey Redesign Project in the late 1980s and the Project to Improve Provincial Economic Statistics (PIPES) in the late 1990s. PIPES brought about major changes to data sources used in the compilation of GDP, and these changes were progressively incorporated over a number of years. Conceptual, classification, and definitional changes include the implementation of some System of National Accounts 1993 (SNA 1993) recommendations, including the capitalization of software, and the adoption of North American Industry Classification System (NAICS) 2002. A major methodological change occurred in 2001 with the adoption of the chain Fisher formula as the official measure of real GDP in terms of expenditures.

3. For details on other income-based and expenditure-based GDP components, please see Appendix B.

**Table 2 Classification of past exceptional revisions**

Release date	Changes to the statistical system	Conceptual, classification, and definitional	Methodological changes
1988		1986 historical revision	
1989	Business survey redesign		
1997		SNA 93 historical revision	
1998 to 2000	Project to Improve Provincial Economic Statistics		
2001		Capitalization of software	Chain Fisher
2002		Licenses and registrations and land transfer taxes	
2003			Exchange rate adjustment
2007		NAICS 2002	

Note: See Appendix D for acronyms and initialisms.

## Reliability versus accuracy?

Data revisions are a normal part of the statistical compilation process, and ongoing revisions analysis is a component of good monitoring of data quality. The analysis of revisions facilitates transparency and provides users and producers with important information. Users will have the information necessary to assess the reliability of the first published estimates, to determine the 'fitness for use' of the dataset, and to gain a better understanding of the statistical compilation process. Producers (National Accounts statisticians or compilers) will be able to detect measurement issues and to identify areas for improvement.

It is important to note that revisions analysis provides an assessment of data reliability of the initial estimates, not an assessment of accuracy. According to the International Monetary Fund's Data Quality Assessment Framework,<sup>4</sup> accuracy refers to the closeness of the estimated value to the (unknown) true value that the statistic is intended to measure. In practical terms, there is no single overall measure of accuracy; accuracy is evaluated in terms of the potential sources of error. One measure of accuracy may be the statistical discrepancy of the GDP income-based and expenditure-based calculations. The size, sign, and variability of the discrepancy may shed some light on the level of accuracy of the estimate. Comparisons with like estimates or with partner-country data may also provide some information on the accuracy of the estimate.

Reliability of the estimate refers to the closeness of the initial estimated value to the subsequent estimated values. Assessing reliability involves comparing estimates over time, in other words, performing revisions analysis. The analysis of revisions can reveal biases in the early estimates. It should be kept in mind that the reliability and the accuracy of the data may not be dependent on the extent of revisions of the data. Data that are not revised are not necessarily accurate and reliable; the converse is also true. Multiple revisions do not guarantee accuracy and reliability.

## Why study revisions?

Economic indicators that are released on a timely basis are often used in forecasts and analytical databases. Policy decisions are based on the most recent data; consequently, revisions can have implications for policy makers. Revisions analysis will assist users in making informed judgements about the reliability of the initial estimate and about the likelihood and magnitude of further revisions.<sup>5</sup> Ongoing analysis will enable data producers to monitor the reliability of the estimation process. Any bias that is found might indicate that the process needs to be improved. Analysis will also help determine whether revisions are larger at certain points in the economic cycle, indicating that there may be a cyclical bias to the estimates.

## Statistics for revisions analysis

Performing regular revisions analysis with a standard set of summary statistics allows users to quickly see the impact of revisions.

4. Carson, C., and L. Laliberté. 2002. *Assessing Accuracy and Reliability: A Note Based on Approaches Used in National Accounts and Balance of Payments Statistics*. IMF Working Paper 02/24.

5. Revisions analysis does not predict future revisions, but can provide users with an idea of 'normal' and 'acceptable' revisions.

**Table 3 Suggested revision summary statistics for revisions analysis**

Statistic	Measure of...	Notes
range of revisions	volatility of first estimate	Difference between highest and lowest revision, includes outliers
range that 90% of revisions lie within	usual size	Normal range expected for the revision without being affected by outliers
mean revision	bias	Positive sign - on average, earlier estimates are underestimated (vice versa for negative)
mean absolute revision	dispersion	Avoids offsetting revisions, more stable than the mean revision
median revision	bias	Value in the centre of the distribution, not affected by extreme observations
median absolute revision	dispersion	Measure of central tendency, not affected by extreme observations as is the mean
relative mean absolute revision	robustness of first estimate	The expected proportion of the first estimate that is likely to be revised over the revision interval being considered
t-test	statistical significance of mean	Is mean revision statistically different from zero, therefore bias exists in the earlier estimates
standard deviation of revision	revision spread	Indication of the volatility of revisions
skewness	symmetry of distribution	Distribution is negative when the median is greater than the mean, with the distribution presenting a longer tail towards the left (vice versa for positive)
% sign (later) = sign (earlier)	direction of growth	Percentage of times both the sign of early estimate and the final estimate are the same
acceleration / deceleration	direction of growth	Percentage of times both early and final estimates show increase (or decrease)

The revision interval and analysis period should be clearly stated at the outset of analysis so that users are aware of the scope. Basic summary statistics should include measures of bias and dispersion, as well as the expected revision range. The mean and median revisions provide information on the possible bias of first estimates, whereas the mean absolute revision and the median absolute revision provide information on the dispersion of the estimates. More advanced summary statistics could include significance tests such as the t-test. Table 3 outlines some of the recommended statistics from the Organization for Economic Cooperation and Development (OECD).<sup>6</sup>

The following sections will present the results of a revisions analysis of quarterly real GDP growth rates for the period 1981 to 2007. This is an update of the Statistics Canada System of National Accounts revisions project by Doris de Silva (April 2004) with expanded content and analysis. The summary statistics mentioned above will be used for the analysis. As of the date of this paper, the GDP growth rate estimate for 2007 was final in that it was no longer part of the regular revision cycle.

## Revisions analysis, 1981 to 2007

The following analysis will focus on the seasonally adjusted, quarter-to-quarter real GDP growth rate for Canada.<sup>7</sup> Using the real GDP growth rate in revisions analysis is advantageous compared to using the level or nominal growth rate, because: 1) it eliminates the trend problem whereby revisions to GDP tend to grow over time as economic growth and inflation raise the GDP level at current prices; and 2) it reduces the need to account for the impact on revisions of the significant changes in concepts, sources, and methods, including scale changes due to rebasing.

6. McKenzie, R., and M. Gamba. 2008. *Interpreting the Results of Revision Analyses: Recommended Summary Statistics*. Contribution to the OECD/Eurostat Task Force on "Performing Revisions Analysis for Sub-Annual Economic Statistics." OECD.

7. Quarter-to-quarter growth rate of GDP is used in the analysis rather than the annualized rate, which is calculated by means of a compound growth formula. Annualized rate is useful with comparisons to the U.S.

GDP and its components are revised up to seven times over a four-year revision period as per the revisions policy outlined in Appendix A. GDP can be revised again at the time of a historical revision. Chart 1 illustrates five different vintages of real GDP growth rate for the period from the first quarter of 1981 to the first quarter of 2010.<sup>8</sup>

**Chart 1 Real gross domestic product, five different vintages**

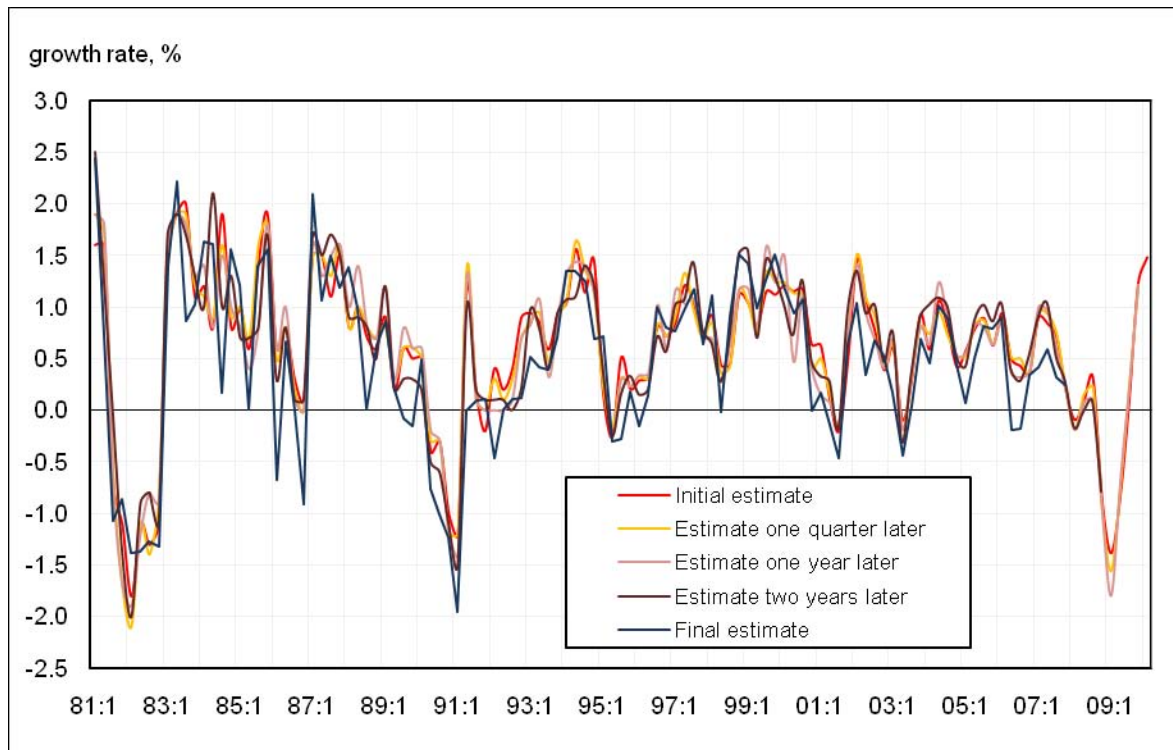


Table 4 presents summary statistics for the quarterly real GDP growth rate over the time period from the first quarter of 1981 to the fourth quarter of 2007. Revisions have had an impact on GDP growth rates as the average growth rate increased with each vintage and the spread of those growth rates became larger (the mean and standard deviation). The volatility of revisions can be seen in the variability of the range of growth rates for the different vintages. The average GDP growth rate of the initial estimate was 0.64%; with subsequent revisions, the average growth rate of the final estimate was 0.69%. The preliminary growth rates ranged from -1.8% to 2.0%, increasing to a range of -1.5% to 2.5% for the final estimate.

8. Final estimate available for the fourth quarter of 2007. Data for the following years are data available as of the date of this analysis. The chart contains data that were readily available for five vintages of real GDP back to 1981.



**Table 4 Summary statistics, real gross domestic product growth rate, first quarter of 1981 to fourth quarter of 2007**

	Initial estimate	Estimate one quarter later	Estimate one year later	Estimate two years later	Final estimate
	percentage points				
Mean growth rate	0.64	0.64	0.64	0.64	0.69
Mean absolute growth rate	0.84	0.85	0.84	0.84	0.87
Standard deviation	0.71	0.74	0.75	0.75	0.75
Range of growth rates					
Minimum value	-1.80	-2.10	-1.90	-2.00	-1.51
Maximum value	2.00	1.90	1.90	2.50	2.50
Range that 90% of values lie within					
Minimum value	-0.20	-0.16	-0.18	-0.17	-0.34
Maximum value	1.46	1.50	1.49	1.50	1.55

During this time period, the statistical system changed significantly. Selected annual services surveys were added in the early 1980s, and the redesign of business surveys occurred in 1989. The historical revision that took place in 1997 introduced new international standards from the SNA 1993. PIPES introduced higher-quality business survey frames; this allowed for comprehensive coverage of industries, particularly services. These improvements, which increased the level of GDP, were phased in over a number of years, from 1998 to 2000. The capitalization of software in 2001, which was an international recommendation from the SNA 1993, raised the level of GDP back to 1981 and affected growth rates in the late 1990s due to the high-tech boom.

### Revision summary statistics

The following table (Table 5) provides summary statistics often used in revisions analysis.<sup>9</sup> Measures of reliability include those for bias, such as the mean revision, and those for dispersion, such as the mean absolute revision and the relative dispersion. The chart that follows illustrates the initial and final GDP growth rates and the amount of the total revision.

There were 108 quarters over the time period from the first quarter of 1981 to the fourth quarter of 2007. The revisions ranged from -1.47 percentage points in the third quarter of 1984 to 0.93 percentage points in the second quarter of 1984. The low value of -1.47 is the only extreme outlier in the series. If this value were ignored, the lowest value would be -0.94, from the first quarter of 1986. With the exception of this extreme outlier, all revisions were within 1 percentage point. The range in the first ten years is larger than the range in the following fifteen years. The range that 90% of revisions lie within provides an indication of the normal range of revisions not influenced by unusually large revisions or outliers. This range is larger in the earlier periods, excluding the first ten years (1981 to 1990); the range of 90% of revisions for 1991 to 2007 is -0.52 to 0.53.

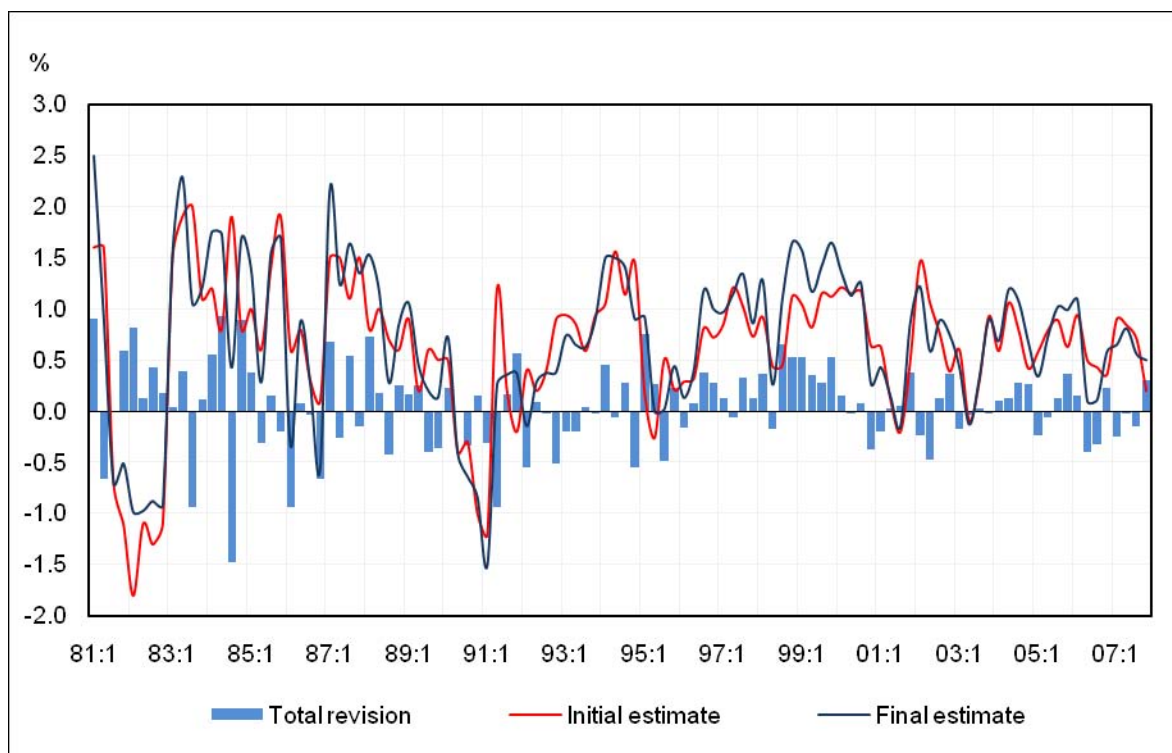
The mean revision of 0.05 percentage points is quite small. The small positive average indicates that the earlier releases have been slightly under-estimated. This can be seen in Chart 2, where most revisions have been positive. As revisions of opposite signs will have a tendency to cancel out, it is beneficial to examine the mean absolute revision (MAR). The MAR is a measure of dispersion between the initial estimates and the corresponding final estimates; it also provides an indication of the magnitude of revisions. The MAR over the entire period of 0.32 percentage points reflects the higher MAR of 0.42 percentage points for the 1980s. The MAR was only 0.31 percentage points for the 1990s and has been 0.20 percentage points for the last seven years.

The standard deviations, which are a measure of the volatility of revisions, are smaller in the more recent periods. The lower standard deviations, combined with the lower MARs, suggest that revisions have gotten smaller over time, a trend that can also be observed in Chart 2.

9. Formulas for these summary statistics are included in Appendix C.

**Table 5 Revision summary statistics, quarterly real gross domestic product growth rate**

	1981 to 1990	1991 to 2000	2001 to 2007	1981 to 2007
Number of quarters	40	40	28	108
	percentage points			
Range of revisions				
Minimum value	-1.47	-0.93	-0.47	-1.47
Maximum value	0.93	0.75	0.37	0.93
Range that 90% of revisions lie within				
Minimum value	-0.94	-0.55	-0.40	-0.42
Maximum value	0.89	0.57	0.36	0.54
Median revision (median bias)	0.14	0.10	0.03	0.09
Mean revision (mean bias)	0.06	0.07	0.01	0.05
Variance	0.29	0.14	0.06	0.17
Standard deviation of revisions	0.54	0.37	0.24	0.41
Mean absolute revision (mean dispersion)	0.42	0.31	0.20	0.32
	percentage			
Share of negative revisions	40.0	40.0	46.4	41.7
Relative bias (mean revision divided by mean absolute growth rate)	6.0	8.4	1.7	6.1
Relative dispersion (mean absolute revision divided by mean absolute growth rate)	40.5	35.5	30.7	36.8

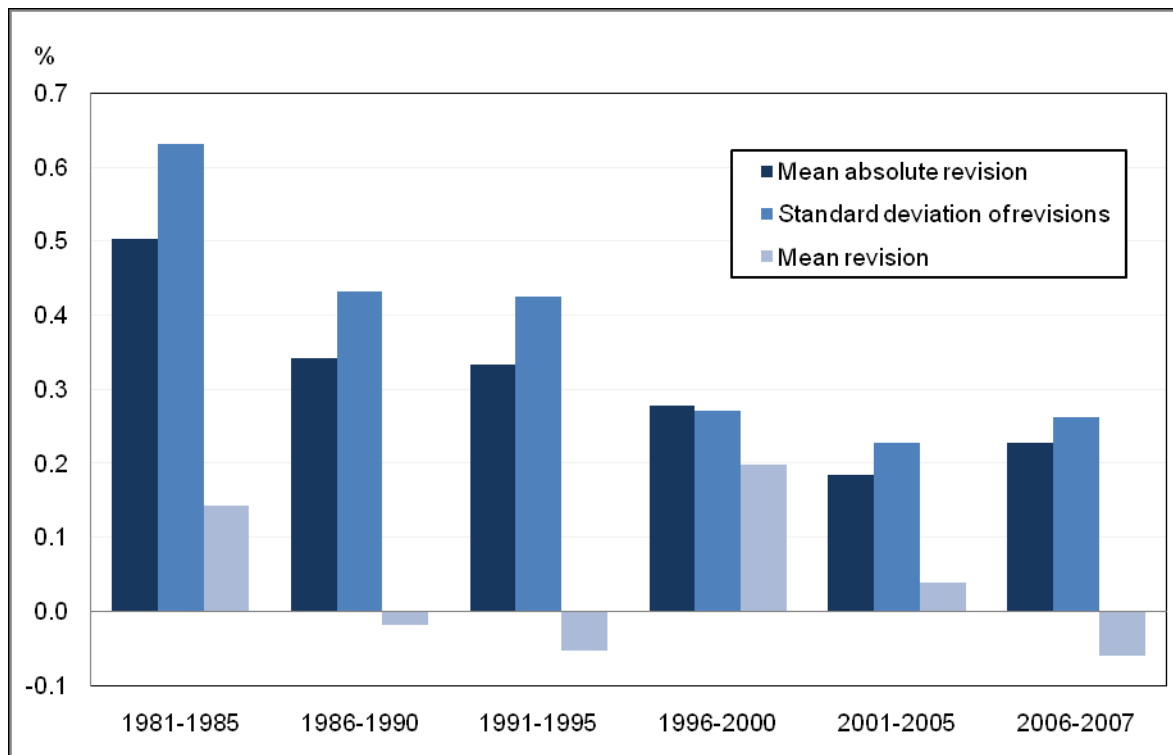
**Chart 2 Real gross domestic product growth rates and total revision**

To examine the behaviour of revisions over time, the analysis period was further decomposed into five-year periods of 20 quarters. Table 6 and Chart 3 illustrate the summary revision statistics for the interval periods. The standard deviation, or spread of revisions, is large in the first interval, at 0.63, and is much smaller in the final interval, at 0.26. The MAR is half a percentage point in the first five years, but decreases in the following years.<sup>10</sup> When one excludes the extreme outlier in the third quarter of 1984, the first five-year interval still has the largest MAR (0.45 percentage points) and the largest standard deviation (0.52 percentage points).

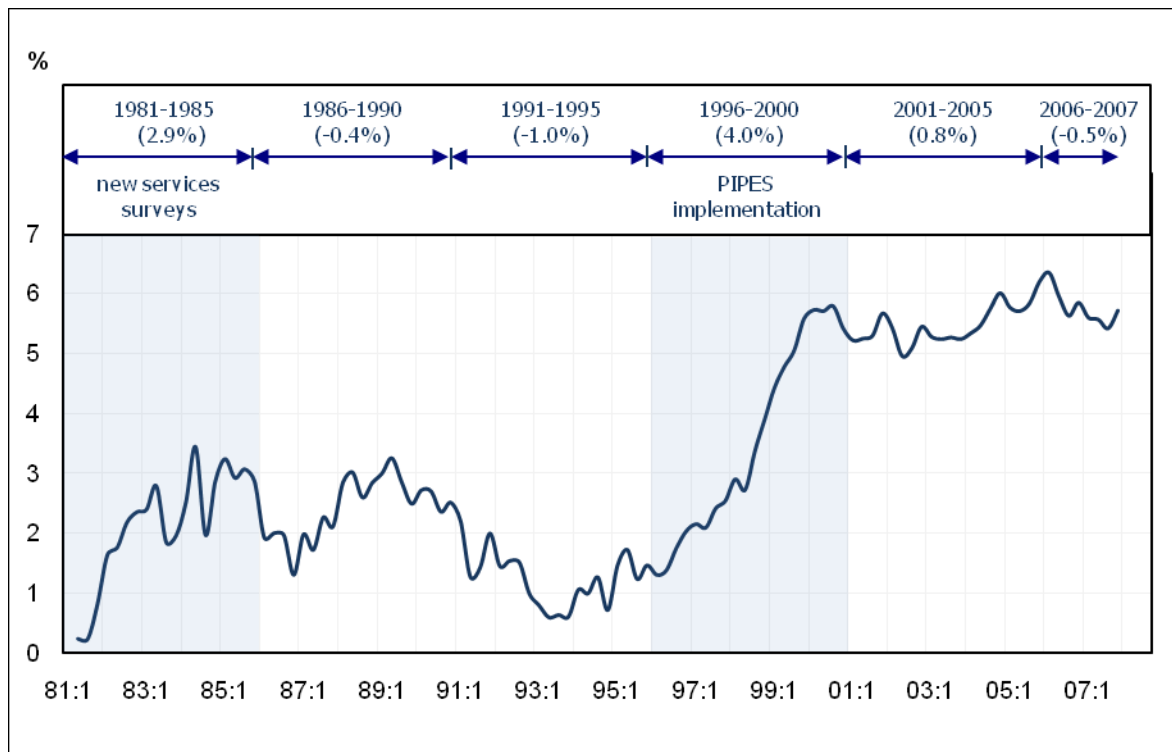
10. Earlier periods have undergone more revision intervals in comparison to later periods.

**Table 6 Selected revision summary statistics for five-year intervals**

	1981 to 1985	1986 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2007
Number of quarters	20	20	20	20	20	8
	percentage points					
Mean absolute revision	0.50	0.34	0.33	0.28	0.18	0.23
Standard deviation of revisions	0.63	0.43	0.42	0.27	0.23	0.26
Range of revisions						
Minimum value	-1.47	-0.94	-0.93	-0.37	-0.47	-0.40
Maximum value	0.93	0.73	0.75	0.65	0.37	0.30
Range that 90% of revisions lie within						
Minimum value	-0.94	-0.66	-0.55	-0.18	-0.24	-0.32
Maximum value	0.90	0.67	0.57	0.53	0.36	0.30

**Chart 3 Measures of bias and dispersion for five-year intervals**

The mean revisions for the 1981-to-1985 and 1996-to-2000 time periods are larger than those occurring in the mid-1980s to the mid-1990s and in the 2000s. This may be partly the result of statistical system improvements that took place during those two time periods. As mentioned previously, the early 1980s saw the introduction of new services surveys; as well, there was a historical revision and the implementation of PIPES in the late 1990s. The PIPES implementation resulted in more widespread coverage of a given industry and in the number of industries covered. These statistical system improvements can also be seen in the following chart, which is the cumulative sum of revisions. The cumulative sum is larger in those two time periods as well: 2.9 percentage points for the 1981-to-1985 time period and 4.0 percentage points for the 1996-to-2000 time period.

**Chart 4 Cumulative sum of revisions to real gross domestic product growth rate**

### Revision vintages

Revisions to the estimates occur with each new vintage in the normal four-year revision cycle. Previous revisions analysis (de Silva 2004) noted that the revision is larger when the Input-Output benchmarking takes place. To understand this revision pattern a little further, a subset of years was examined, namely the quarters for years 1993 to 2007, for which all vintages are readily available.<sup>11</sup> For this period, seven vintages were included in a decomposition analysis. Table 7 presents the summary statistics for quarterly real GDP for each vintage of data within this time frame.

**Table 7 Summary statistics, real gross domestic product growth rate, first quarter of 1993 to fourth quarter of 2007**

	Initial estimate	Estimate one quarter later	Estimate one year later	Estimate two years later	Estimate three years later	Estimate four years later	Final estimate
	percentage points						
Mean growth rate	0.72	0.73	0.72	0.75	0.77	0.79	0.80
Mean absolute growth rate	0.74	0.75	0.74	0.77	0.80	0.80	0.81
Standard deviation	0.40	0.40	0.43	0.44	0.45	0.45	0.47
Range of growth rates							
Minimum value	-0.26	-0.19	-0.25	-0.31	-0.34	-0.15	-0.15
Maximum value	1.56	1.64	1.59	1.55	1.57	1.65	1.65
Range that 90% of values lie within							
Minimum value	0.11	0.15	0.07	0.15	0.11	0.10	0.02
Maximum value	1.21	1.34	1.41	1.43	1.44	1.42	1.50

11. Data vintages readily available from the Statistics Canada Real-time Data Analysis Tool (RTDAT).

The mean absolute growth rate for the initial estimate of quarterly real GDP was 0.74 percentage points; with subsequent revisions, the mean absolute growth rate for the final estimate was 0.81 percentage points. Examining the mean absolute growth rate provides a more precise indication of direction because this avoids the offsetting that can occur with positive and negative growth rates. The largest increase in the mean absolute growth rate appears to be between the estimate one year later and the estimate two years later.

Chart 5 illustrates the revisions from each vintage, with the total revision as the bar and the various revisions by vintage as the line for first quarter of 1993 to the fourth quarter of 2007. The first graph shows the revision between the initial estimate and the estimate one quarter later. For the most part, this new estimate reflects late survey returns and more up-to-date seasonal factors. The second graph shows the revision between the estimate one quarter later and the estimate one year later. This estimate is from the first annual revision and reflects benchmarking to the Input-Output Tables for two years previous. Input-Output benchmarking may revise the GDP level for the Input-Output year; this may impact the current-year growth rate.

The third graph is the revision between the estimate one year later and the estimate two years later, and reflects the second annual revision. This estimate includes results from the Capital Expenditure Survey and T4 data for wages and salaries, which led to a large revision to the series. This revision also reflects benchmarking to the Input-Output Tables for one year previous.

The fourth graph shows the revision as a result of the third annual revision. This is also a large revision and is due to the Input-Output benchmarking. Annual surveys that cover the entire economy are incorporated at this time. The fifth graph illustrates the revision between the estimate three years later and the estimate four years later (at the fourth annual revision). This estimate is considered the final estimate within the regular revisions cycle and contains updated health and education sector data. The fifth graph contains the revisions resulting from the historical revisions in which new concepts and methods were carried back to 1981.

**Chart 5 Revisions to real gross domestic product at different vintages**

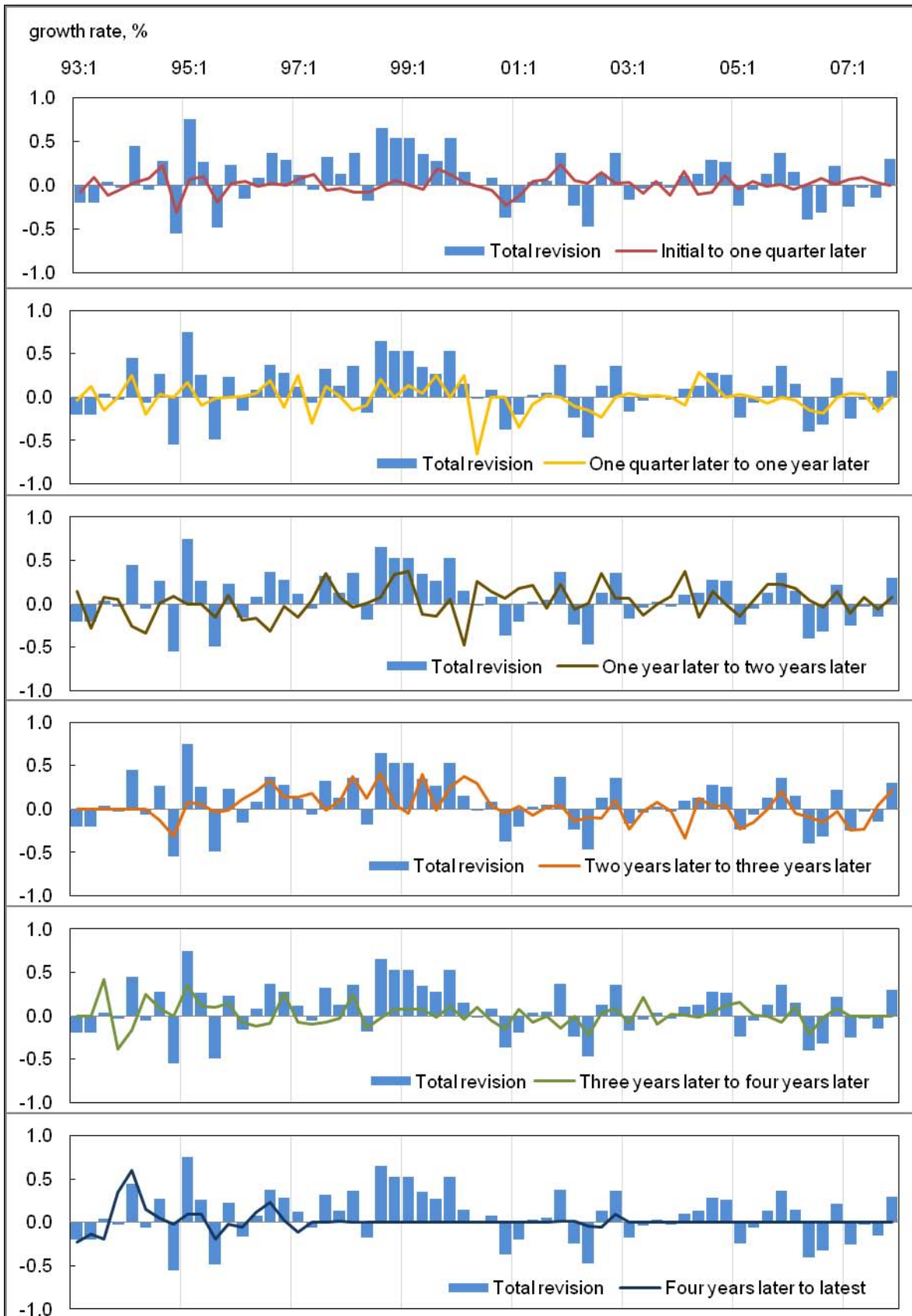


Table 8 provides a more detailed breakdown of the revision vintages. From this table, it is easier to identify that the largest revision occurs between the estimate one year later and the estimate two years later. This revision accounts for approximately 25% of the total revision over the 1993-to-2007 period. This vintage represents, among other things, the incorporation of the Capital Expenditure Survey and T4 data for wages and salaries.

**Table 8 Selected revision summary statistics for different vintages, first quarter of 1993 to fourth quarter of 2007**

	Initial to one quarter later	One quarter later to one year later	One year later to two years later	Two years later to three years later	Three years later to four years later	Four years later to final	Total revision
	percentage points						
Mean absolute revision	0.08	0.10	0.14	0.12	0.10	0.05	0.59
Standard deviation	0.10	0.16	0.18	0.17	0.14	0.11	0.29
Range of revisions							
Minimum value	-0.31	-0.66	-0.47	-0.34	-0.38	-0.23	-0.55
Maximum value	0.24	0.29	0.37	0.41	0.42	0.60	0.75
Range that 90% of revisions lie within							
Minimum value	-0.13	-0.23	-0.28	-0.23	-0.17	-0.14	-0.40
Maximum value	0.15	0.25	0.35	0.38	0.25	0.15	0.53
	percentage						
Percent of total revision	14.5	15.3	24.6	21.9	17.1	6.5	100.0

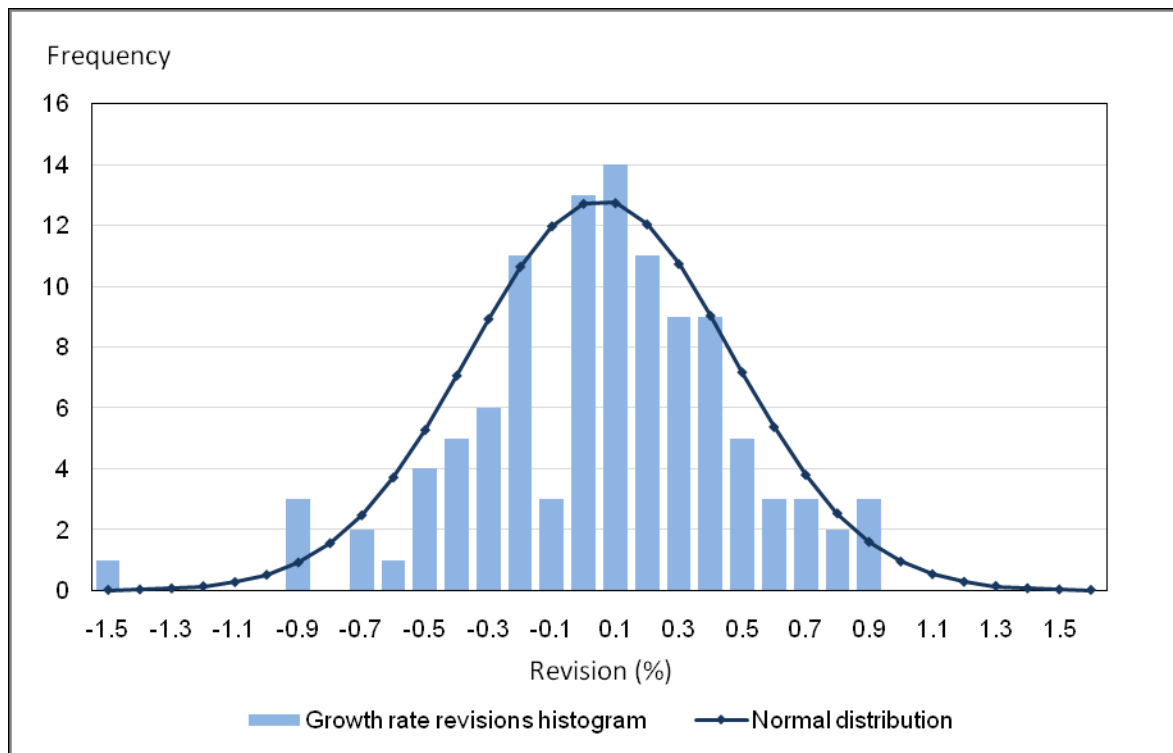
## Distribution and statistical inference

The following chart (Chart 6) shows the frequency histogram of revisions to quarterly real GDP growth and the normal distribution curve fitted to that histogram. The histogram graphically summarizes the distribution of the data set; users can see the spread of the data, how the data may be skewed, and the presence of any outliers. This revisions data set has a slight negative skew, since the median (0.09) is larger than the mean (0.05). This can be seen with the longer tail on the left of the histogram. When the extreme outlier is excluded, a negative skew still remains. The lack of symmetry means that this distribution is not exactly the same as a normal distribution but is nevertheless very close.

As noted by de Zilva<sup>12</sup>, a t-test can be used to conduct statistical inference. The t-test will determine whether the mean revision is significantly different from zero. If initial estimates were consistently, or in the majority, underestimating the final estimates, the revisions would tend to be positive, and vice-versa. For the t-test to be valid, no significant serial correlation between the quarters should be present. The coefficient of determination is 0.026; this means that 2.6% of the variation in the revisions for a certain quarter is due to its linear relationship with revisions in the previous quarter. The correlation coefficient of -0.161 indicates that the relationship is a low, negative one. Where the null hypothesis is 'the mean revision is zero,' this would be rejected if the mean of the revisions were too high or too low. The alternative hypothesis is 'the mean is not zero'. The rejection region is  $t < -1.984$  or  $t > 1.984$ , with 0.05 level of significance and a sample size of 108. The test statistic is computed as 1.321; this result does not fall in the rejection region. The test failed to reject the null hypothesis that the set of revisions is representative of a population with mean zero. This indicates that there is no significant bias; in other words, the initial estimates are a reliable estimate of the final estimates.

12. de Zilva, D. 2004. Toolkit for Revision Studies. 2003-04 Revision Project, System of National Accounts. Paper presented to the OECD-ONS *Workshop on Assessing and Improving Statistical Quality – Revisions Analysis for the National Accounts*, held on October 7 and 8. Ottawa: Statistics Canada.

**Chart 6 Histogram of revisions and normal distribution curve, real gross domestic product growth rate, 1981 to 2007**



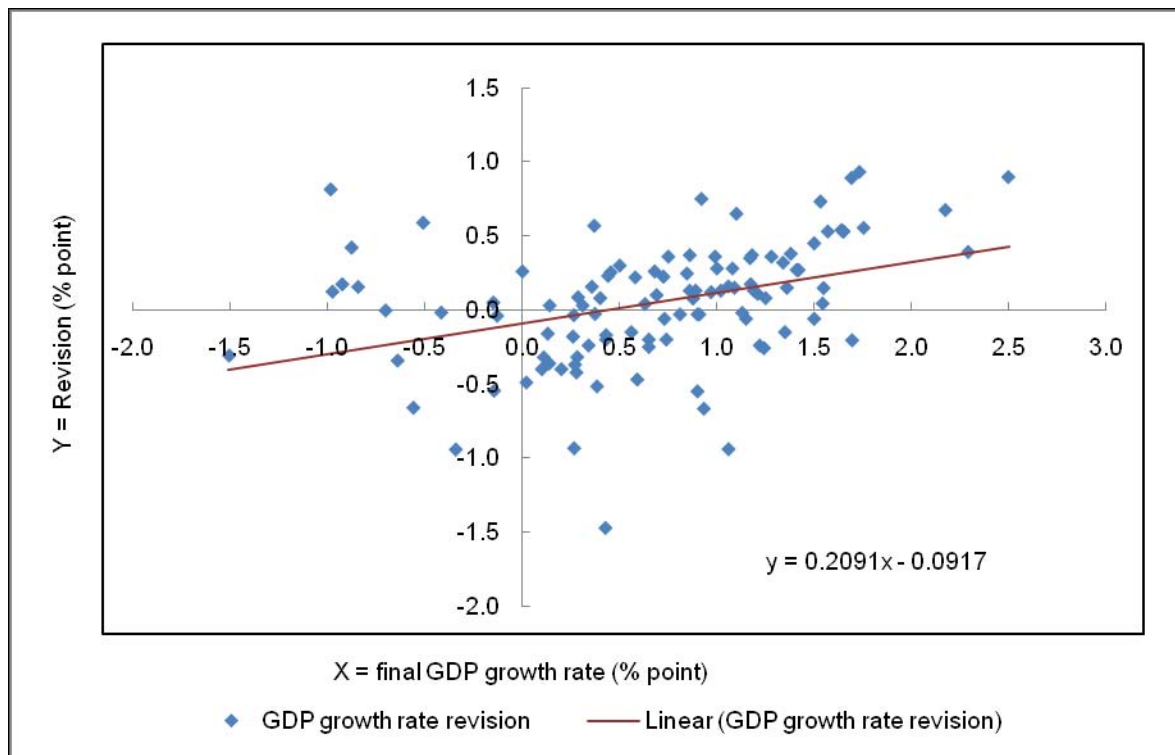
## Revisions and the economic cycle

During times of accelerated or decelerated growth and around cyclical turning points (peaks and troughs), the reliability of GDP is especially important. This reliability can be investigated by examining the behaviour of revisions with respect to the direction of this growth and in relation to the economic cycle.

A regression analysis can help determine whether there is a correlation between revisions and the economic cycle (GDP growth rate). The coefficient of determination is 0.141; this means that 14.1% of the variation in the revisions is due to its linear relationship with the economic cycle. The correlation coefficient of 0.379 indicates that the relationship is a low, positive one. This relationship is illustrated in the scatter plot (Chart 7), which shows the correlation between GDP growth rate revisions and the economic cycle. 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.



**Chart 7 Real gross domestic product growth rate revisions and the economic cycle, first quarter of 1981 to fourth quarter of 2007**

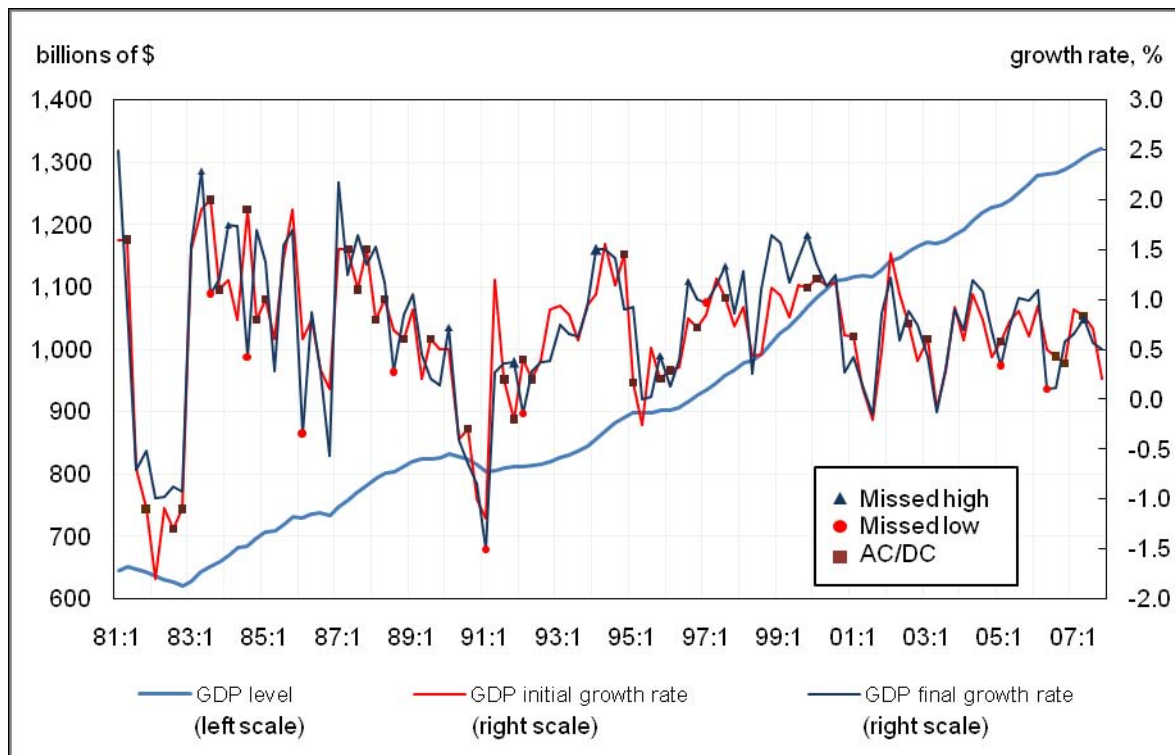


It is of interest to know how often the final growth rate is in the opposite direction to the initial growth rate. A weakness of this measure is that it does not record the total magnitude of the revision. For example, a change from a small negative to a small positive, or vice versa, may not be that substantial. Over the analysis period, estimates switched direction in only five quarters, or 4.6% of the time. The average revision for these five quarters was small, at -0.26 percentage points. The revision to two of these five quarters was a result of the mini-historical revision that took place in the first quarter of 2001. There were no cases throughout the time period when the sign of the growth rate switched away from, and then back to, the original sign of growth.

### Changes in trend

The initial GDP estimate ideally needs to correctly indicate the direction of economic growth and to capture shifts in economic activity. A question to ask in determining reliability is: How often do initial estimates capture changing economic trends?

From 1981 to 2007, a peak or trough was missed 17.6% of the time (19 out of 108 quarters). Of those 19 quarters, 8 quarters experienced the turning point within one quarter of the reference quarter. The average revision for a missed peak was 0.36 percentage points, and the average revision for a missed trough was -0.51 percentage points. For the purposes of this analysis, a peak at quarter  $t$  occurs when the growth rate of real GDP at that quarter is larger than the growth rate in the previous two quarters and in the following two quarters. A trough occurs when the growth rate is smaller than that in the previous two quarters and in the following two quarters. The missed changes in economic trends are highlighted in Chart 8.

**Chart 8 Missed changes in trend from the initial estimate to the final estimate, real gross domestic product level and growth rate**

### Acceleration and deceleration

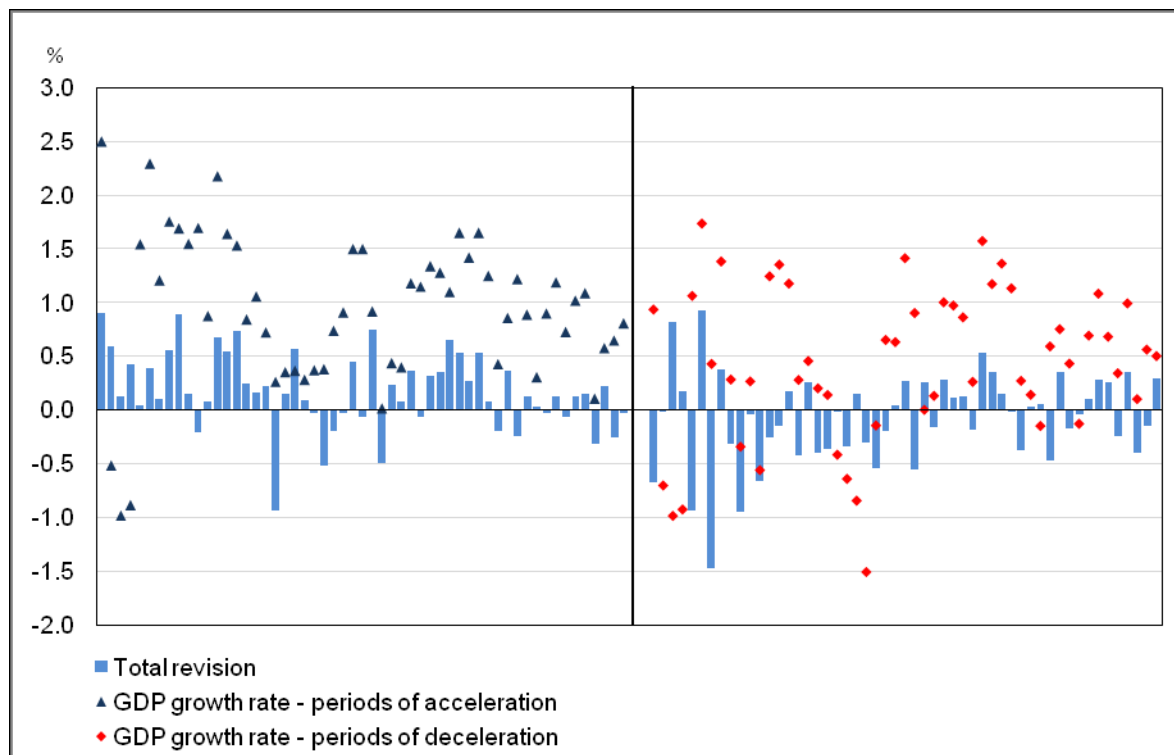
Preliminary statistical estimates based on surveys and methods used to project the components of GDP are sometimes based on assumptions of little change in the structure of components of GDP. This may lead to an overestimate of growth when there is a slowdown or to an underestimate when there is acceleration. An examination of acceleration and deceleration (AC/DC) in the initial versus final estimates can shed light on whether the initial estimate correctly estimated growth of economic activity. An acceleration of growth is what takes place when the change in growth rate from the previous quarter is positive, and a deceleration is what results when that change is negative.

AC/DC represents the number of times that the initial estimate of GDP growth indicated acceleration of economic activity from the previous period while the final estimate indicated deceleration, or vice versa. Over the analysis period, the AC/DC was incorrectly captured 36 out of 108 times. The relative AC/DC, which is the AC/DC as a percent of the total number of quarters, is 33.3%. Chart 8 identifies the quarters in which AC/DC existed. The average revision for a missed deceleration was -0.29 percentage points, whereas the average revision for a missed acceleration was 0.31 percentage points.

Chart 9 illustrates the growth rate of real GDP during periods of acceleration and deceleration and the corresponding revision for that quarter. An upward revision during accelerated growth is an indication that the initial estimate is underestimating growth. Conversely, downward revisions may mean that the initial estimate is overstating growth. During the analysis period, 55 quarters were found to have experienced acceleration, and 53 quarters were found to have experienced deceleration. The average revision for accelerating periods was 0.18 percentage points whereas the average for decelerating periods was -0.08 percentage points. In both cases, the initial estimate tended to flatten out the rate of change in GDP. As can be seen in Chart 9, most revisions during

periods of acceleration are upwards, with only 29% of quarters experiencing a downward revision. For decelerating growth, 53% of revisions are upwards, but 44% are downwards. This may indicate that, during periods of slowing growth, there is a tendency to underestimate the slowdown in GDP.

**Chart 9 Revisions to real gross domestic product growth rate during periods of acceleration and deceleration, first quarter of 1981 to the fourth quarter of 2007**



### Periods with negative growth rates

Table 9 shows the revisions and standard deviations for different categories of growth rates, periods of acceleration, periods of deceleration, and periods of negative growth. Although the MARs are similar, they are slightly larger for periods of slowing growth and negative growth; the standard deviations for those periods are larger as well.

**Table 9 Real gross domestic product growth rate, average estimate and revision, first quarter of 1981 to the fourth quarter of 2007**

	Real GDP growth rate		Revision	
	Mean initial estimate	Mean final estimate	Mean absolute revision	Standard deviation
	percentage points			
Periods of acceleration	0.77	0.95	0.31	0.36
Periods of deceleration	0.50	0.43	0.33	0.43
Periods of decline	-0.61	-0.65	0.35	0.47
All periods	0.64	0.69	0.32	0.41

Fifteen quarters over the analysis time frame had negative final growth rates. When one ignores these negative growth rates and looks at the same chart showing only positive growth rates (Chart 10), it is quite evident that, during periods of acceleration, revisions are mostly upwards. A downward revision was made in only 16 of the 52 quarters (31%). During slowing GDP growth, there are more negative revisions, in 21 out of 41 quarters (this translates as 51% being downward revisions).

**Chart 10 Change in real GDP growth rate during periods of acceleration and deceleration with positive growth rates and the revision, first quarter of 1981 to the fourth quarter of 2007**

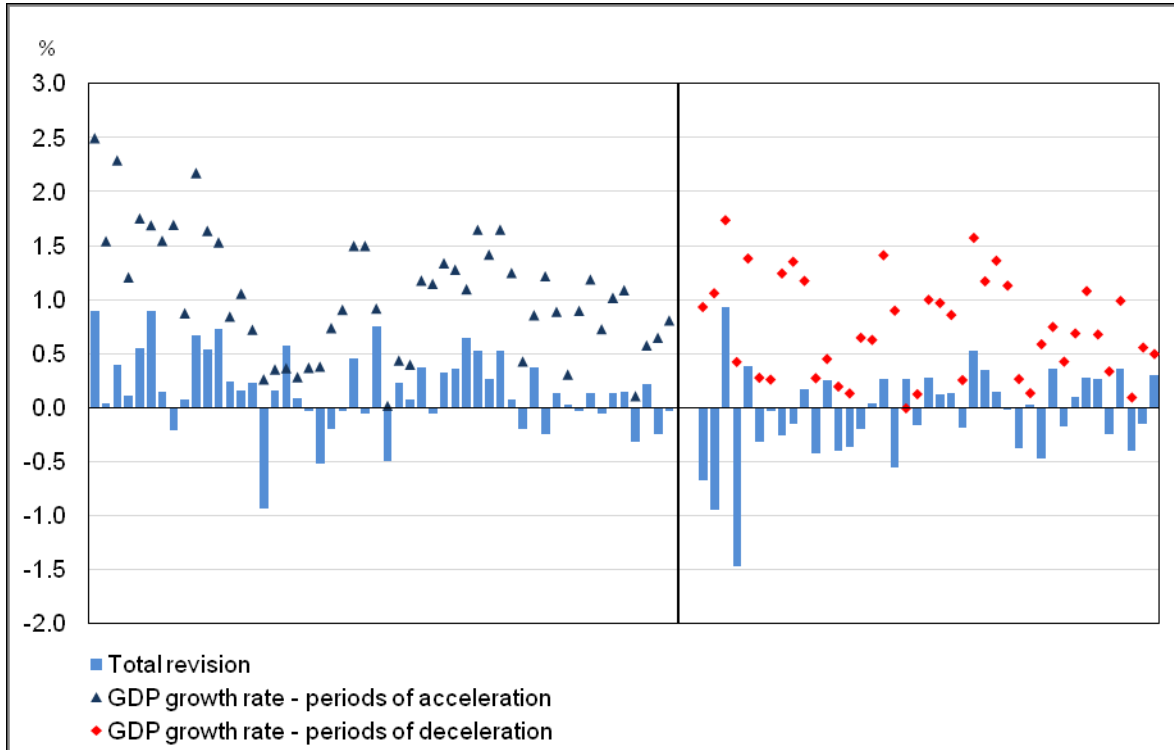


Table 10 contains summary statistics of the real GDP growth rate for quarters with negative growth. The mean growth rate is similar throughout the different vintages, but the standard deviation, or spread, is much smaller for the final estimate. By the final estimate, the range is much tighter than for the initial estimate, and this is the first time that the growth rates for all quarters are negative. Prior to the final estimate, the preceding vintages had positive values for the upper range.

**Table 10 Summary statistics, real gross domestic product growth rate, quarters with negative growth, first quarter of 1981 to fourth quarter of 2007**

	Initial estimate	Estimate one quarter later	Estimate one year later	Estimate two years later	Final estimate
	percentage points				
Mean growth rate	-0.61	-0.69	-0.67	-0.67	-0.65
Mean absolute growth rate	0.76	0.80	0.75	0.73	0.65
Standard deviation	0.69	0.76	0.71	0.67	0.39
Range of growth rates					
Minimum value	-1.80	-2.10	-1.90	-2.00	-1.51
Maximum value	0.60	0.50	0.60	0.30	-0.13
Range that 90% of values lie within					
Minimum value	-1.30	-1.70	-1.70	-1.50	-0.99
Maximum value	0.40	0.30	0.00	0.10	-0.15

The mean revision for quarters with negative growth was -0.04 percentage points, which is quite small. The MAR was 0.35 percentage points; this is higher than the MAR for all quarters (0.32 percentage points). The larger MAR for negative growth quarters suggests that there is greater volatility in revisions to estimates with negative growth.

### Significant economic events

Significant economic events can have a considerable impact on GDP and its components. It is worthwhile to investigate the behaviour of revisions during these times of uncertainty to see whether a larger revision occurs during these periods. Table 11 lists some recent major economic events in Canada.

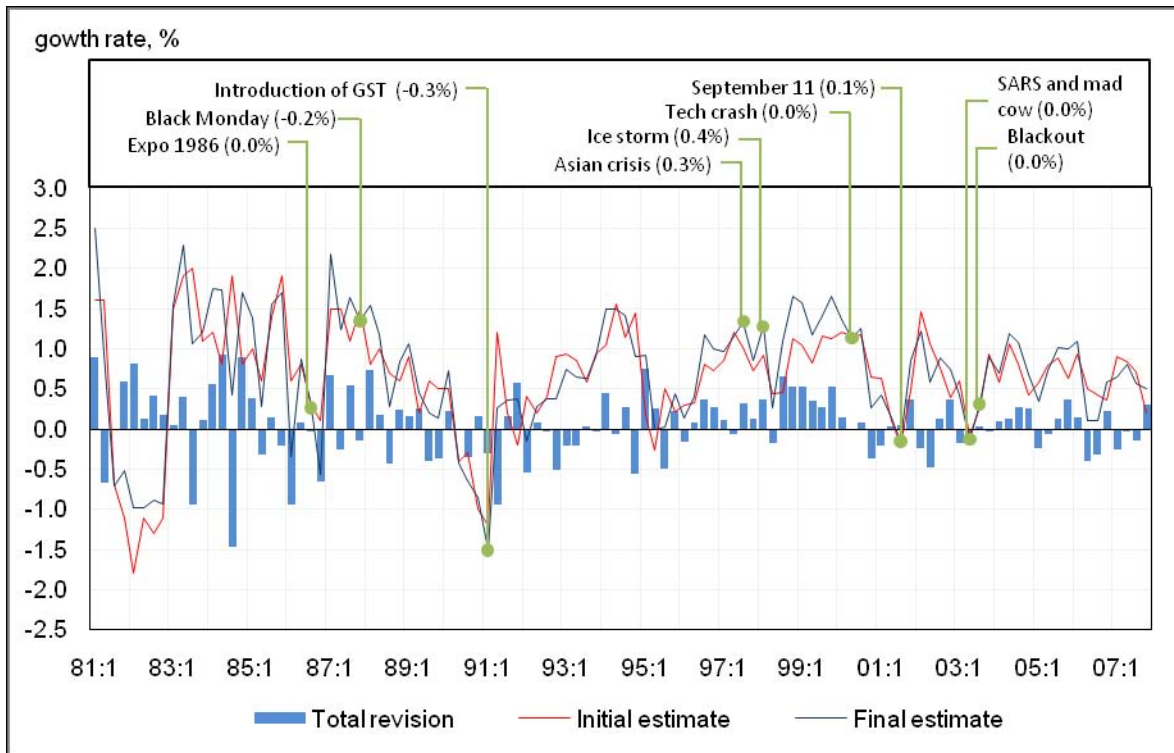
**Table 11 Recent significant economic events**

Event	Date	Notes
Ice storm	First quarter 1998	Freezing rain fell on parts of Eastern Canada. Hundreds of thousands of people lose electricity, some lasting longer than one month.
High-tech crash	Second quarter 2000	After a strong build-up, the information technology sector crashes leading to massive lay-offs and declining stock prices.
September 11 terrorist attacks	Third quarter 2001	September 11, 2001 terrorist attacks on New York City and Washington, D.C. lead to cancelled travel plans and absences from work.
SARS	Second quarter 2003	SARS infection rates peak. China is the epicentre of the disease which is easily transmitted. The World Health Organization issues a travel warning to Toronto.
Mad cow disease scare	Second quarter 2003	Cases of bovine spongiform encephalopathy (BSE) identified in cattle in Alberta lead to massive cull of cattle. Prices plummet.
Blackout	Third quarter 2003	In August 2003, a U.S. electricity transmission line goes down leaving 50 million people without power, some for weeks. Activities in some Ontario industries are suspended.

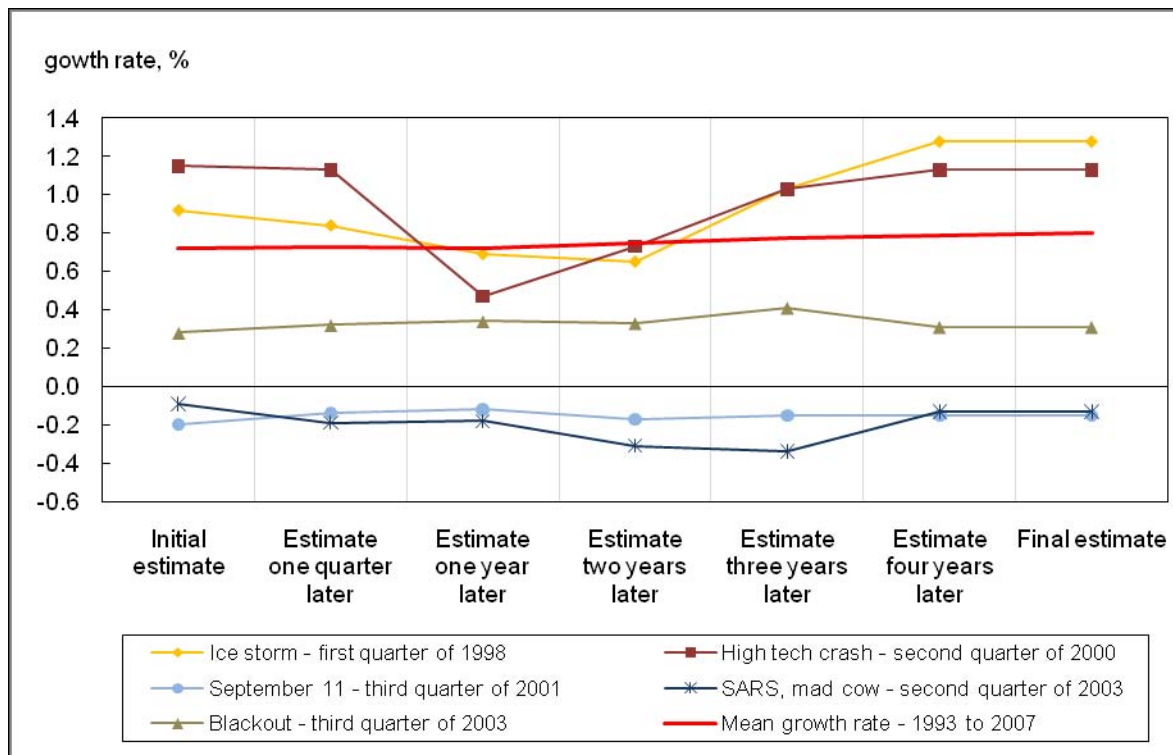
Note: See Appendix D for acronyms and initialisms.

The recent major economic events set out in Table 11, along with other past economic events and the total revision for the quarter in which they occurred are highlighted in Chart 11 (Chart 2 reproduced with economic events indicated). For the most part, the total revisions for the quarter in which each of these events occurred were quite small. The only time when the total revision was higher than the average total revision for all quarters was for the first quarter of 1998, when the 1998 ice storm occurred; the total revision for this quarter was 0.4%. These results would suggest that the statistical system is as good at times of significant economic events as at other times.

**Chart 11 Real gross domestic product growth rates and total revision**



Although the total revisions during the above economic events were relatively low, it is of interest to see how those revisions progressed over different vintages. Chart 12 illustrates the growth rates for different vintages during the quarters that experienced these economic events. The revisions to the quarters affected by the ice storm of 1998, the high-tech crash of 2000, and the SARS and mad cow epidemics of 2003 fluctuated more between revision vintages.

**Chart 12 Real gross domestic product during recent major economic events for different vintages**

## Conclusions

The analysis of revisions to the quarterly real GDP growth rate provides information on the reliability of the initial GDP growth rate estimate. The preceding revisions analysis allows certain conclusions to be made:

- Historically, revisions to quarterly real GDP growth rate have declined over time; therefore, the initial estimate has become more reliable.
- Throughout the four-year revision cycle, the largest revision occurs with the second annual revision, which reflects, among other things, the incorporation of the Capital Expenditure Survey and T4 data for wages and salaries.
- The sign of the initial estimate versus the final estimate was different only in a small number of quarters.
- Statistical inference has shown that the initial estimates are a reliable indicator of the final estimate. There is no significant bias.
- There is a tendency to revise the real GDP growth rate upward when GDP growth is increasing and to revise it downward when GDP growth is slowing.
- The total revisions for specific significant economic events are close to the mean total revision for all periods but fluctuate within the different vintages.
- This analysis demonstrates that the initial estimates of GDP are reliable estimates. To monitor this reliability, regular revisions analyses will be conducted. Revisions to the components of GDP will also be analyzed in a future revisions study.

## **Appendix A Income and Expenditure Accounts revision policy**

In principle, the revision schedule for the Income and Expenditure Accounts is as follows: the first estimate for a given quarter is released approximately 60 days after the end of the reference quarter; this estimate is revised when estimates for subsequent quarters of the same calendar year are released. Thereafter, the estimates are open for revision only once a year for the next four years, at the time of the release of the first-quarter estimates. For example, the preliminary estimates for the first quarter of 2004 were released in May 2004. The first revision to these estimates took place when the second-quarter estimates were released, in August 2004; further revisions occurred when the estimates for the third and fourth quarters of 2004 were released. These estimates were revised again once a year in each of the next four years, with the last of these revisions taking place with the estimates for the first quarter of 2008.

For the annual revision process, the integration of GDP estimates by component occurs through compiling Input-Output Tables in current prices for the first two years of the four-year revision period. These data are released in the fall of each year, when the full provincial Input-Output Tables are completed. Revisions to the last two years of the four-year revision cycle arise as a result of updated sub-annual and annual sources of information.

Limited revisions are sometimes carried out for periods further back than four years, and historical revisions are conducted periodically, roughly once every ten years. Historical revisions provide an opportunity to improve estimation methods, to eliminate statistical breaks resulting from more limited revisions, and to introduce conceptual and methodological changes into the system. The most recent historical revision was completed in December 1997.

Following the May 2010 release, the Income and Expenditure Accounts moved towards a three-year revision cycle. Over the last number of years, Statistics Canada has been able to increase the overall timeliness of its annual business and institutional surveys and of its administrative-data processing. Consequently, the majority of 'final' data are now incorporated into the first release of the national Input-Output Tables, which serve as the benchmark for the Income and Expenditure Accounts. Given that little new information is available with the second release of the Input-Output Tables, Statistics Canada will produce only one vintage of the national, provincial, and territorial Input-Output Tables.



Table 1A Revisions schedule

		Reference period																				
		2004				2005				2006				2007				2008				
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
<b>Release date</b>	<b>2004</b>																					
	Q1	P																				
	Q2	R1	P																			
	Q3	R2	R1	P																		
	Q4	R3	R2	R1	P																	
	<b>2005</b>																					
	Q1	R4	R3	R2	R1	P																
	Q2					R1	P															
	Q3					R2	R1	P														
	Q4					R3	R2	R1	P													
	<b>2006</b>																					
	Q1	R5	R4	R3	R2	R4	R3	R2	R1	P												
	Q2									R1	P											
	Q3									R2	R1	P										
	Q4									R3	R2	R1	P									
	<b>2007</b>																					
	Q1	R6	R5	R4	R3	R5	R4	R3	R2	R4	R3	R2	R1	P								
	Q2													R1	P							
	Q3													R2	R1	P						
	Q4													R3	R2	R1	P					
<b>2008</b>																						
Q1	F	F	F	F	R6	R5	R4	R3	R5	R4	R3	R2	R4	R3	R2	R1	P					
Q2																	R1	P				
Q3																	R2	R1	P			
Q4																	R3	R2	R1	P		

## Notes:

P: Preliminary estimate  
R1: First revision  
R2: Second revision  
R3: Third revision  
R4: Fourth revision  
R5: Fifth revision  
R6: Sixth revision  
F: Final revision

Q1: First quarter  
Q2: Second quarter  
Q3: Third quarter  
Q4: Fourth quarter

## Appendix B Revisions due to different vintages of source data

**Table B1 Revisions due to different vintages of source data**

	Initial estimate	First annual revision	Second annual revision	Third annual revision	Fourth annual revision
<b>Revisions to income aggregates</b>					
Wages, salaries and supplementary labour income	SEPH, LFS, PSS, HRSDC bulletins	Updated SEPH, LFS, PSS, and HRSDC bulletins	T4 benchmarks, EI and CQPP data, Pension Plans in Canada survey, updated PSS	Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail
Corporation profits before taxes	QFS	QFS	AFTS, CIT records	Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail
Government business enterprise profits before taxes				Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail
Interest and miscellaneous investment income				Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail
Accrued net income of farm operators from farm production	CWB and Agriculture and Agri-Food Canada data	Agriculture surveys		Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail
Net income of non-farm unincorporated business, including rent	SEPH		T1 files, various surveys including retail stores, LFS and SHS	Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail
Inventory valuation adjustment				Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail
Taxes less subsidies			Public Accounts, CRA data	Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail
Capital consumption allowances			CIT records	Input-Output preliminary industry detail, revised pension detail, updated PSS	Input-Output final industry detail

**Table B1 Revisions due to different vintages of source data, cont'd**

	Initial estimate	First annual revision	Second annual revision	Third annual revision	Fourth annual revision
<b>Revisions to expenditure aggregates</b>					
Personal expenditure on consumer goods and services		NMVSS, QRCS	SHS, travel surveys	Input-Output preliminary	Input-Output final
Government current expenditure on goods and services			Public Accounts	Culture, tourism and education surveys	Culture, tourism and education surveys
Government gross fixed capital formation		CAPEX preliminary	CAPEX actual, Public Accounts		Culture, tourism and education surveys
Government investment in inventories				Culture, tourism and education surveys	Culture, tourism and education surveys
Business investment in residential structures	CMHC and building permits surveys		REAB, SHS		Culture, tourism and education surveys
Business investment in non-residential structures		CAPEX preliminary	CAPEX actual		Culture, tourism and education surveys
Business investment in machinery and equipment		CAPEX preliminary	CAPEX actual		Culture, tourism and education surveys
Business investment in inventories		CAPEX preliminary	CAPEX actual		Culture, tourism and education surveys
Trade in goods and services	CBSA	CBSA		Culture, tourism and education surveys	Input-Output final

## Appendix C Formulas for calculating revision summary statistics

The formulas for the summary statistics are calculated using the following terminology:

**$j=1...n$ :** number of reference time points in the analysis period

**$F$ :** final estimate for reference period  $t$

**$P$ :** initial (earlier) estimate for reference period  $t$

**$R$ :**  $F - P$ , value of revision (over a specified interval being analyzed)

**Mean revision**  $= \Sigma R_j / N$

**Mean absolute revision**  $= \Sigma ABS(R_j) / N$

**Median revision**  $= Me(R_j)$

**Median absolute revision**  $= Me(ABS(R_j))$

**Relative mean absolute revision**  $= \{ \Sigma ABS(R_j) / \Sigma ABS(F_j) \} * 100$   
(also called *relative dispersion*)

**Variance**  $= (1/N) \{ \Sigma [R_j - (\Sigma R_j / N)]^2 \}$

**Standard deviation**  $= [ (1/N) \{ \Sigma [R_j - (\Sigma R_j / N)]^2 \} ]^{1/2}$

**Skewness**  $= 3(\mu - Me) / SDR$

## Appendix D Acronyms and initialisms

AC/DC	Acceleration and deceleration
AFTS	Annual Financial and Taxation Statistics
CAPEX	Capital and Repair Expenditures Survey
CBSA	Canada Border Services Agency
CIT	Corporate income taxes
CMHC	Canada Mortgage and Housing Corporation
CQPP	Canada and Quebec pension plans data
CRA	Canada Revenue Agency
CWB	Canadian Wheat Board
EI	Employment Insurance data
GDP	Gross domestic product
GNP	Gross national product
GST	Goods and Services tax
HRSDC	Human Resources and Skills Development Canada
IMF	International Monetary Fund
IO	Input-Output
LFS	Labour Force Survey
MAR	Mean absolute revision
MSM	Monthly Survey of Manufacturing
NAICS	North American Industrial Classification System
NMVSS	New Motor Vehicle Sales Survey
OECD	Organisation for Economic Co-operation and Development
PIPES	Project to Improve Provincial Economic Statistics
PPIC	Pension Plans in Canada Survey
PSS	Public Sector Statistics
QFS	Quarterly Financial Statistics for Enterprises
QRCS	Quarterly Retail Commodity Survey
REAB	Annual Survey of Service Industries: Real Estate Agents, Brokers, Appraisers and Other Real Estate Activities
RTDAT	Real-time data analysis tool
RTS	Retail Trade Survey
SARS	Severe Acute Respiratory Syndrome
SEPH	Survey of Employment, Payroll and Hours
SHS	Survey of Household Spending
SNA 93	System of National Accounts 1993
StdDev	Standard deviation
T1	Canada Revenue Agency's T1 Income Tax and Benefit Return
T4	Canada Revenue Agency's T4 Statement of Remuneration Paid
WTS	Wholesale Trade Survey

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1. "Laspeyres, Paasche and Chain Price Indexes in the Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, fourth quarter 1988.
2. "Technical Paper on the Treatment of Grain Production in the Quarterly Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, first quarter 1989.
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