Analysis of revisions to quarterly GDP – a real-time database

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Gross Domestic Product (GDP) is one of the key data series used by the Reserve Bank to inform monetary policy decisions. The measures of GDP, published by Statistics New Zealand (SNZ), are estimates rather than exact figures and may be revised in subsequent releases. Analysis of the most recent measures of GDP should incorporate the extent of uncertainty that surrounds these estimates. To enable a more detailed examination of revision patterns, the Reserve Bank has constructed a real-time database containing each quarterly release of Expenditure GDP (GDP(E)) and its components. The database is available to users on the Reserve Bank's website and will be regularly updated. This article provides an introduction to the database and, by way of example, presents a basic analysis of the revisions made to GDP(E) and its components.

1 Introduction

Gross Domestic Product (GDP) is a measure of the value of economic activity within a country over a given period. SNZ publishes measures of GDP for New Zealand on both a quarterly and annual basis. As it is neither possible to observe all forms of economic activity nor calculate their values precisely, the published measures of GDP are estimates rather than exact figures.

The Reserve Bank uses the measures of quarterly GDP both to gauge the current pace of economic growth and as a basis on which to forecast future growth. These measures may be substantially revised by SNZ in later quarters to incorporate additional and improved data. It is helpful to have some idea of the extent to which the latest GDP measures are reliable indicators of the revised and more accurate measures that will come to be associated with the quarters in later years.

The Reserve Bank has formed a 'real-time' database that contains each quarterly release of Expenditure GDP (GDP(E)) and its components published by SNZ.[2,3] The first constant price measures of GDP(E) were released in June 1990 and the first current price measures were released in July 1994. For a selected series, the database provides the complete set of estimates that have been associated with each quarter. The database can be used to analyse the size and dispersion of the revisions made to each series, the results of which may assist in analysing the latest unrevised data.[4]

It is important to recognise that the revisions analysis undertaken in this article provides an assessment of the data's reliability, but not of its accuracy. The IMF's Data Quality Assessment Framework (DQAF) distinguishes the two concepts as follows (Carson and Laliberte, 2002, p.4):

- 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.
- Reliability refers to the closeness of the initial estimated value to the subsequent estimated values. Assessing reliability involves comparing estimates over time. Data that are revised more frequently are not necessarily less accurate.

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2 'Real-time data' refers to the set of measures for a series that were the latest available at a particular point in time.

3 SNZ considers Expenditure GDP to be more volatile and consequently less reliable than Production GDP. The Reserve Bank uses both measures to inform monetary policy decisions.

4 For example, if the revisions to a series were found to be consistently positive, this would suggest that the latest measures may be underestimates.

2 Measures of Gross Domestic Product

GDP can be measured in three ways, by estimating the value of the production, expenditure or income of an economy. SNZ publishes annual estimates of each measure and quarterly estimates of the production and expenditure measures.[5] The three measures are defined by SNZ as follows:[6]

Production GDP

This approach measures the value added by producers and is calculated by deducting the value of goods and services used up in production from the total value of goods and services produced. Production GDP is SNZ's headline measure of GDP and is released with a breakdown of value added by industry.

Expenditure GDP (GDP(E))

This technique directly calculates the value of goods and services produced for final use by measuring consumer purchases. Expenditure GDP can be broken down into the purchases by households, firms, the government and overseas residents, less any imports.

Income GDP

This approach measures the value added by producers and entails summing the incomes accruing to the factors of production ie, labour payments and profits.

Although all three measures of GDP are conceptually equivalent and should in theory equal each other, the combination of survey errors, timing differences, and other measurement errors in the various components typically give rise to statistical discrepancies between their values (SNZ, 1996, p.14).

At present, the real-time database contains the quarterly releases of Expenditure GDP and its components. Over the coming year, we hope to expand the database to include the quarterly releases of Production GDP and value added by industry.

[5] For recent releases of GDP visit http://www.stats.govt.nz/datasets/economic-indicators/national-accounts-and-gdp.htm.

[6] Further information about GDP can be found at http://www.stats.govt.nz/products-and-services/Articles/national-accounts-guide-Feb04.htm.

3 Causes of revisions to Gross Domestic Product

All three measures of GDP and their respective components are subject to revision. Each quarterly and annual release of these series by SNZ contains not only estimates of the series for the latest period but also revised estimates for previous periods. While the majority of revisions are made to the four most recent quarters of a series, there is no restriction on when an estimate of a series for a given period will no longer be revised. The five main causes of revisions are discussed in turn.

Incorporation of additional and improved data

Most revisions reflect the incorporation of a wider range of data. In particular, survey data that were not available at the release date are incorporated through revisions into subsequent releases. For example, the measures of quarterly Production GDP may be revised as a result of new data from the Retail Trade Survey. Similarly, data from the tri-annual Household Economic Survey may lead SNZ to revise past estimates of Expenditure GDP. Changes in the source data used to compile the measures may also lead to revisions.

Reconciliation of quarterly and annual measures

The process of reconciling the quarterly measures of Production and Expenditure GDP, and their respective components, to the annual measures can lead to further revisions. The quarterly measures of these series are based on a smaller range of data than the annual measures and are regarded by SNZ as less accurate. When a provisional annual measure is compiled, the four quarterly measures may be revised to ensure that the nominal quarterly estimates sum to the annual estimate. Provisional annual estimates are then subject to revision when balanced within the supply and use framework. This may result in further revisions to quarterly series.

Introduction of methodological changes

Infrequent revisions arising from methodological changes can have a substantial impact on the measures of GDP and their components. When the approach used to measure a series is changed, SNZ will attempt to use the new methodology to revise all the past values of the series. Large methodological changes are generally the result of new international standards or recommendations. The adoption of new methodologies allows New Zealand's statistics to remain internationally comparable. For example, in November 2005, SNZ changed the method used to estimate software investment from a demand-based approach to a supply-based approach as the latter was considered to provide more accurate measures. This change caused substantial revisions to past measures of GDP, and increased annual nominal Production GDP in 2004 by 1.4 billion.[7]

Re-basing and re-weighting of the constant price series

GDP measures expressed in constant prices enable users to compare the levels of GDP in different years without the distorting effects of inflation. Both the re-basing and re-weighting of these series can lead to further revisions.

Constant price measures of the quarterly GDP series are generated using the technique of chain-linking (see Box 1). The volumes of the components are weighted by the average prices of the previous year. Initially however, the volumes of the current year will be weighted using an earlier year and later re-weighted when the annual measures for the previous year have been reconciled within the supply-use framework.

At the time chain-linking was introduced, the base year (whose prices were used to benchmark volumes of the constant price series) was changed from 1991–92 to 1995–96. While re-basing will cause changes in the levels of the series, the growth rates will not be affected. In the past, however, changes in base years have coincided with the introduction of new methodologies.

Box 1

The adoption of chain-linking

In 2000, SNZ adopted the technique of chain-linking to generate volume measures of Expenditure and Production GDP, and their respective components.[8] Chain-linking involves weighting the volumes of a series using the average prices of the previous year. Prior to chain-linking, constant price series were generated using a 'fixed-weight' approach, in which the year whose prices were used to weight the volumes was only changed every five to ten years. As relative prices change, fixed weights become increasingly unrepresentative and may cause constant price series to become misleading. The changes in relative prices between consecutive pairs of years tend to be much smaller than the cumulative changes over a number of years. Countries such as the United States and Australia found that chain-linking can provide more accurate measures of growth (SNZ, 1998). Annual updating of weights, or chain-linking, was also recommended in the 1993 *System of National Accounts*.[9] Although annual re-weighting creates the need for addition revisions, these must be considered against the infrequent but large revisions required under the fixed-weight approach.

Re-estimation of the seasonal factors for seasonally-adjusted series

Seasonal variation is the regular pattern of behaviour displayed by a data series over the course of a year. For example, Christmas creates seasonal variation in retail trade, which in turn affects GDP in the fourth quarter of each year. Removing the seasonal variation from a series allows the more meaningful variation in the series to be observed.

7 For further information about the measurement of software investment in the New Zealand national accounts visit http://www2.stats.govt.nz/domino/external/pasfull/pasfull.nsf/7cf46ae26dcb6800cc256a62000a2248/4c2567ef00247c6acc2570ba0010fbc5?OpenDocument.

8 The first constant price Production GDP measures expressed in chain-linking terms were released in December 2000. Chain-linked Expenditure GDP measures were first released in June 2001.

9 The 1993 System of National Accounts is a framework that set international statistical standards for the measurement of various economic series. The framework was published jointly by the United Nations, the Commission of the European Communities, the International Monetary Fund (IMF), the OECD, and the World Bank. For further information about the SNA93 visit http://unstats.un.org/unsd/sna1993/introduction.

Seasonally-adjusted series (ie, those without seasonal variation) are formed by estimating and then removing the seasonal factors for each period. The seasonal factors at the end of the data sample are particularly difficult to estimate. When a new estimate is added to the end of the series, SNZ will re-estimate the seasonal factors for all the quarters. This can lead to revisions in the seasonally-adjusted estimates ,particularly for the most recent quarters.

4 A real-time database for Gross Domestic Product

A real-time database is a collection of vintages, where a vintage is defined as the set of measurements for a series, each relating to a different period, that were published in the same release. The OECD has encouraged countries to take up 'the systematic archiving of all vintages of data' and further has described revision analysis as 'an integral part of the statistical production process' (di Fonzo, 2005, p.5). Many central banks have already constructed real-time databases for GDP and other series that are subject to revision. For example, both the Bank of England[10] and the Federal Reserve Bank of Philadelphia[11] have made their databases available to the public.

Following the recommendations of the OECD, the Reserve Bank has constructed a real-time database for New Zealand's quarterly measures of Expenditure GDP and its components.[12] Each series in the database may be viewed both in seasonally and non seasonally-adjusted terms, and in both current and constant prices.[13]

Table 1 shows a section of the real-time database for Expenditure GDP (GDP(E)) expressed in constant prices and seasonally adjusted. Each column of data represents a vintage, and corresponds to the set of GDP(E) figures released on the date shown at the top of the column. For example, the first estimates of quarterly GDP(E) expressed in constant prices were released on 06/06/1990, and contained estimates of GDP(E) for the quarters June 1982 to December 1989. In subsequent releases, the estimates of GDP(E) for these quarters were revised and estimates for later quarters released.[14] The lowest element of each column in the table shows the first estimate of GDP(E) for a given quarter. At the time of writing, the latest series of estimates for GDP(E) were those released on 29/09/2005. This release contained the first estimate of GDP(E) for the June 2005 quarter. The rows of the Table show the set of GDP(E) estimates that have been associated with each quarter. The two rows immediately above the date of release provide the INFOS number applied by SNZ (to classify the series) and the base year used to express the constant prices series.

5 The real-time problem

The most recent vintage of GDP, used to inform monetary policy decisions, may contain estimates that are later revised. These later estimates will be based on more accurate information. It is uncertain whether the initial estimates for recent quarters are sufficiently reliable indicators of the more accurate 'final' estimates. This uncertainty faced by policy-makers is known as the 'real-time problem'.

To illustrate the extent of the real-time problem, figures 1 and 2 show how the rates of quarterly growth in GDP(E) for the quarters December 1989 and June 1998 changed over time as a result of revisions made to the data. The first measure of GDP(E) for the quarter December 1989 was estimated to be NZD8.91 billion in 1982–83 prices and published in June 1990 (see table 1). As shown in figure 1, this level of GDP(E) was 6.3 per cent higher than September quarter's level. In subsequent releases, revisions to the September and December levels of GDP(E) caused the growth rate for the

10 Bank of England's real-time database: http://www.bankofengland.co.uk/statistics/gdpdatabase/index.htm. A description of the database is provided in Castle and Ellis (2002).

11 Federal Reserve Bank of Philadelphia's real-time database: http://www.phil.frb.org/econ/forecast/reaindex.html. This database is described in Croushore and Stark (2003).

12 A database containing the consecutive quarterly releases of Production GDP and its components (at the industry level) is scheduled for release later this year.

13 The OECD has recently constructed a real-time database for each OECD member country including New Zealand (di Fonzo, 2005). The database only contains the historical releases of Production GDP and does not include vintages before December 1994. The data were taken from MEI (Main Economic Indicator) publications released by the OECD.

14 The number of quarters in each vintage varies. Blank spaces were filled in only when the estimates in the adjacent vintages were identical.

Table 1

A section of the real-time database

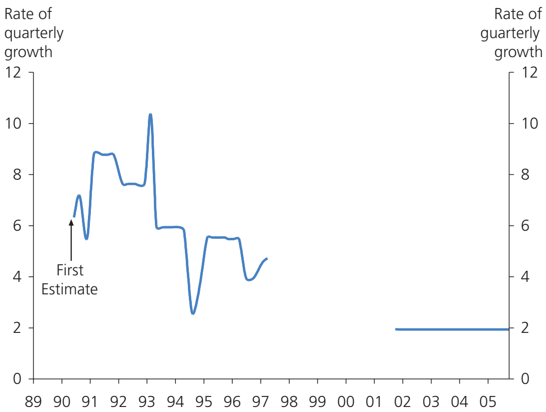
Expenditure GDP *($millions)* — Constant Prices, Seasonally Adjusted

Vintage

	SNBQ SWSN 1982-1983 Prices					SNBQ SWSN 1982-1983 Prices	SNCQ S1RB15S 1995-1996 Prices
Quarter	06/06/1990	16/08/1990	20/11/1990	19/02/1991	04/06/1991	20/08/1991	29/09/2005
Jun 1982	7,752	..	..	..	..	..	..
Sep 1982	8,060	..	..	..	..	..	..
Dec 1982	7,922	..	..	..	..	..	..
Mar 1983	7,770	..	..	..	..	..	..
Jun 1983	8,102	..	..	..	..	..	..
Sep 1983	8,274	..	..	..	..	..	..
Dec 1983	8,154	..	..	..	..	..	..
Mar 1984	8,503	..	..	..	..	..	..
Jun 1984	8,327	..	..	..	..	..	..
Sep 1984	8,283	8,283	..	..	..	..	..
Dec 1984	8,675	8,675	8,674	..	..	..	..
Mar 1985	8,894	8,894	8,894	8,994	..	..	..
Jun 1985	8,588	8,588	8,588	8,647	8,627	..	..
Sep 1985	8,436	8,436	8,436	8,520	8,499	8,499	..
Dec 1985	8,650	8,650	8,651	8,702	8,716	8,717	..
Mar 1986	8,242	8,242	8,242	8,325	8,334	8,334	..
Jun 1986	8,662	8,662	8,662	8,699	8,668	8,668	..
Sep 1986	9,230	9,230	9,230	9,364	9,289	9,289	..
Dec 1986	8,723	8,723	8,724	8,745	8,671	8,671	..
Mar 1987	8,501	8,501	8,501	8,543	8,486	8,486	..
Jun 1987	8,570	8,570	8,570	8,568	8,569	8,569	19,424
Sep 1987	8,640	8,640	8,640	8,759	8,791	8,791	19,471
Dec 1987	8,438	8,438	8,438	8,588	8,621	8,622	19,738
Mar 1988	8,900	8,900	8,899	8,848	8,838	8,839	19,820
Jun 1988	8,425	8,378	8,363	8,326	8,329	8,329	19,795
Sep 1988	9,001	9,108	9,063	9,256	9,254	9,254	19,925
Dec 1988	8,743	8,743	8,711	8,905	8,895	8,895	20,045
Mar 1989	8,865	8,804	8,755	8,946	8,843	8,843	20,133
Jun 1989	9,063	9,044	8,977	9,175	9,124	9,124	20,303
Sep 1989	8,359	8,327	8,350	8,177	8,190	8,190	19,617
Dec 1989	8,905	8,946	8,821	8,931	8,941	8,941	20,001
Mar 1990		8,681	8,781	9,022	8,992	8,992	20,130
Jun 1990			8,785	8,946	8,857	8,912	20,013
Sep 1990				8,898	8,881	8,793	20,035
Dec 1990					9,229	9,122	20,305
Mar 1991						8,742	19,750
…							…
Jun 2005							31,666

December quarter to climb as high as 10.4 per cent. Figure 1 contains a gap because the quarterly releases from June 1997 to September 2001 did not contain estimates of GDP(E) for quarters as early as in 1989. The more recent releases, which extend back further, estimate the rate of growth for the December quarter to be just under 2 per cent.

Figure 1
Revisions to the quarterly growth rate in GDP(E) for December 1989

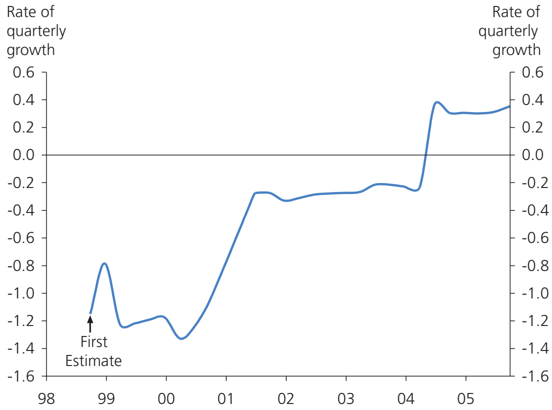


As a second example of the real-time problem, figure 2 shows the revisions made to GDP(E) in the June 1998 quarter. The first estimate for this quarter was -1.15 per cent lower than the level of GDP(E) for the previous quarter. This initial growth rate, however, was revised up substantially, both in the following quarter and then again in June 2001 when chain-linking was first applied to GDP(E). In mid 2004, the levels of GDP(E) for the March and June quarters of 1998 were revised up further, to the extent that the rate of growth for the June quarter became positive. Through the process of revisions, what was initially considered to be a quarter of contraction became a quarter of expansion.

For the two quarters illustrated in figures 1 and 2, the first estimates of quarterly growth were not reliable indicators of the estimates that came to be associated with the quarters in later years. Although the size of the revisions to the quarters are not atypical for the period in which they were made, later analysis will show that the revisions to GDP(E) have become smaller in recent years.

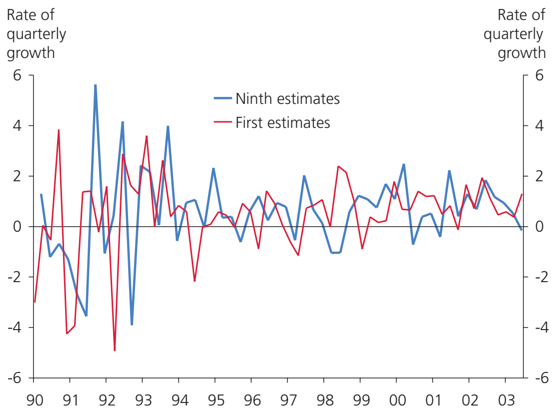
Revisions to quarterly estimates of GDP, such as those illustrated in figures 1 and 2, influence the Reserve Bank's view of the business cycle. Figure 3 contrasts the first

Figure 2
Revisions to the quarterly growth rate in GDP(E) for June 1998



estimates of GDP(E) growth in each quarter against the estimates of growth made nine quarters after each first estimate. Revisions over just a two year period can have a substantial effect on the timings and magnitudes of the peaks and troughs in the economic cycle. The large revisions made to the December 1994 and March 1995 quarters illustrate this effect.

Figure 3
A comparison of the first and ninth estimates of quarterly growth in GDP(E)



6 Analysis of the revisions to GDP(E) and its components

This section uses the real-time database to analyse the revisions made to GDP(E) and its components. The types of analysis used are similar to those recommended by the OECD (di Fonzo, 2005) and employed by other central banks (for example, see Castle and Ellis, 2002). All data are expressed in constant prices and are seasonally adjusted.

Over the vintages, three different base years have been used to express the volumes of the constant price series.[15] As it is not possible to compare the levels of constant price vintages that were formed using different base years, the following analysis examines how revisions influenced the quarterly growth rates of these series. The quarterly growth rate is defined as the percentage change from the previous quarter in the same vintage, and is calculated using logarithms.

6.1 Size and dispersion of total revisions

This sub-section examines the size and dispersion of the total revisions made to GDP(E) and its components. We define the total revision for a quarter as the difference between the 'final' estimate of the growth rate for the quarter and the first estimate of the growth rate for the quarter. A total revision that is positive indicates that the growth rate was initially underestimated.

The first estimates of each series are obtained from the lowest diagonal elements of the columns in the database. As SNZ may revise any previous quarter's estimate of GDP, there is no defined length of time after which the estimate for a quarter becomes 'final'. While there are several possible ways in which to define a set of 'final' estimates, we have used the set of estimates in the last available vintage, which at the time of writing was published on 29/09/2005 and contained the first estimate for the June 2005 quarter.[16] As the observations for the most recent quarters in this vintage are still likely to be revised, the last quarter included in the sample was June 2003.[17] Thus for each series, the following analysis is conducted for the first and final estimates of the quarters December 1989 to June 2003.

15 For the constant price series, the first estimates of the quarters December 1989 to December 1995 were expressed in 1982–1983 prices, while the quarters March 1996 to June 2000 were first expressed in 1991–1992 prices. For both of these periods, the prices of the base years also served as the 'fixed-weights' that were used to compile the volumes of constant price series. From the vintage that contained the first estimates for the September 2000 quarter, the series have been compiled using the 'chain-linking' technique and the volumes have been expressed in 1995–1996 prices.

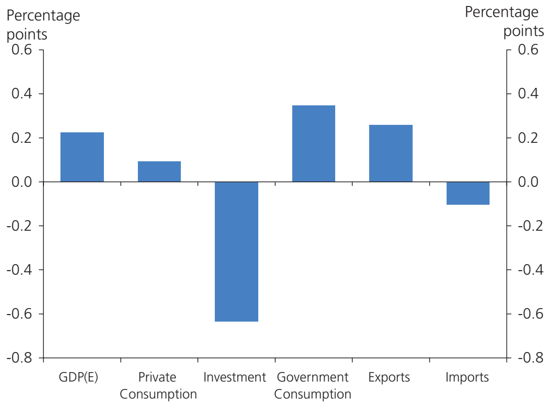
16 Subsequent vintages have since been released.

17 Alternatively, the final measures could have been defined as those estimates made a selected number of quarters after the first (ie, the set of ninth estimates, etc). However, in analysing past economic activity, it is the estimates contained in the latest vintage that are regarded as providing the 'true' figures.

Mean total revisions

Figure 4 shows the mean of the total revisions, expressed in percentage points, made to the quarterly growth rates of GDP(E) and its components over the quarters December 1989 to June 2003.[18] The mean revision to the quarterly growth rates of GDP(E) was 0.22 percentage points which, given an average first estimate for quarterly growth of 0.51 per cent, amounts to an increase of 44 per cent. The mean revisions made to the components of GDP(E) varied substantially. The first estimates of Investment growth were revised down on average by 0.64 percentage points, while the first estimates of growth in Government Consumption were revised up on average by 0.35 percentage points.

Figure 4
Mean total revisions to GDP(E) and its components



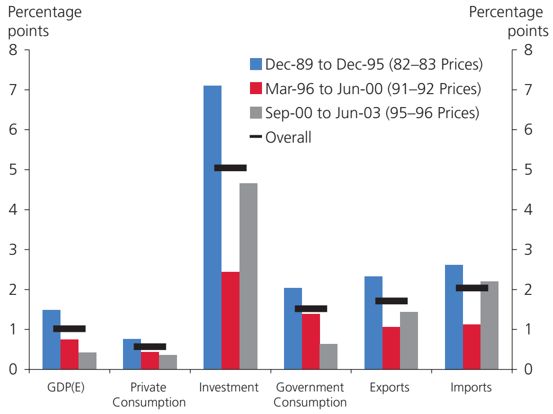
Mean absolute total revisions

Changes in the size of the revisions over time can be compared using the mean of the absolute total revisions. Using absolute values prevents positive and negative revisions cancelling each other out. Figure 5 compares the mean absolute total revisions for GDP(E) and its components, both for the entire sample period (shown by the horizontal line) and for three sub-samples. The sub-samples represent the quarters over which different base years were used to express the volumes of the constant price series. Although changes in base years should not affect the growth rates, each re-basing coincided with the introduction of methodological improvements.

18 The Investment series was created by summing several series published by SNZ.

For all the series, the mean of the absolute total revisions fell substantially between the first and second sub-samples, suggesting an improvement in the reliability of the first estimates. However, the same conclusion cannot be drawn when comparing the second and third sub-samples. While the mean of the absolute total revisions made to GDP(E) and both Private and Government Consumption were smaller in the chain-linking period (the third sub-sample), the average revisions made to the Investment, Exports and Imports series all increased. This result may in part be due to the annual updating of the chain-linking weights, which has created the need for additional revisions.

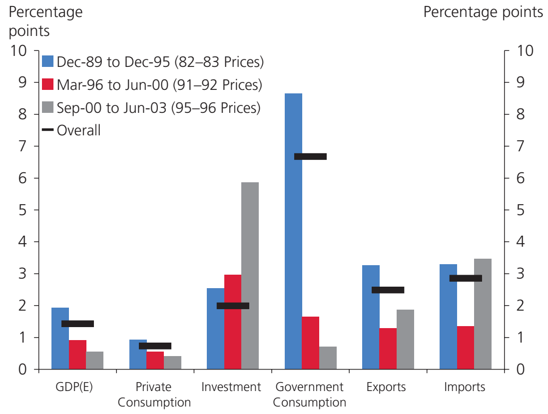
Figure 5
Mean absolute total revisions to GDP(E) and its components by sub-periods



Root mean square error of total revisions

The root mean square error is a measure of dispersion, where a higher value indicates greater volatility. As Figure 6 shows, the revisions made to GDP(E) and both Private and Government Consumption have become less volatile over time. However, the revisions made to both the Investment and Import series are more widely dispersed in the chain-linking period than in either of the fixed-weight periods.

Figure 6
Root mean square error of total revisions to GDP(E) and its components by sub-periods



6.2 Measuring the reliability of the total revisions

When analysing the latest quarterly measure of GDP(E) we assess whether this first estimate is an unbiased measure of the more accurate final estimate. Using the techniques employed by Mankiw, Runkle and Shapiro (1984) and more recently by Garratt and Vahey (2006) we test for bias in the revisions by estimating for each series the values of α and β in the following relationship:

$$\text{Total Revision}_t = \alpha + \beta \ \text{First}_t + \varepsilon_t \qquad \text{(Eq.1)}$$

where Total Revision$_t$ (= Final$_t$ - First$_t$) refers to the percentage point difference between the final and first estimates of the quarterly growth rate in quarter t, First$_t$ denotes the first estimate of the quarterly growth rate and ε_t is a residual term. For the total revisions to be unbiased, the values of the two parameters, α and β, must be jointly insignificant from zero.

The results of the estimations are shown in table A1 of the Appendix. For each series, with the exception of Private Consumption, the values of α and β estimated using data from the first sub-sample (Dec-89 to Dec-95) were significantly different from the values estimated over the combined second and third sub-samples (Mar-96 to Jun-

Box 2

An international comparison of revisions to GDP(E)

To appreciate the relative size and dispersion of the revisions made to New Zealand's GDP(E), it is helpful to compare our revisions with those made by other countries' statistical agencies. Table 3 shows the key results from two major studies, by Faust, Rogers and Wright (2005) and by Ahmad, Bournot and Koechlin (2004), that analysed the revisions made to estimates of quarterly GDP(E) growth in each of the G7 countries. In the final column of table 3, we have computed the equivalent results for New Zealand, using where possible the same revision periods and definitions for the final estimates.

In comparison to the G7 countries, the revisions made to New Zealand's first estimates of GDP(E) growth were among the largest and most widely spread. Over both periods, New Zealand exhibited the largest mean total revision. In absolute terms, New Zealand's mean total revisions were first and second largest. For the period examined by Faust et al. (2005), revisions to New Zealand's GDP(E) had the largest root mean square error.

It is important to recognise that the statistical agencies of the G7 countries have been publishing quarterly estimates of GDP(E) for a much longer period than SNZ. As observed in figures 5 and 6, there have been substantial improvements in the size and dispersion of the revisions to New Zealand's quarterly GDP(E). For example, since the advent of chain-linking in New Zealand, the absolute mean total revision has been just 0.43 percentage points, which compares more favourably with the G7 countries. Both studies conducted their analysis using data from the Main Economic Indicators (MEI) published by the OECD. The first estimate released in the MEI is not necessarily the same as the first estimate released by the country's statistical agency.

More generally, it is important to remember that the size of the revisions will be dependent on the revisions policy of each country's statistical agency, and these sizes should not therefore be used as an indicator of data accuracy. Also, as countries release their first estimates of GDP(E) with different lags after the end of a period, any cross-country assessment of data quality should include measures of timeliness.

Interestingly, over both periods studied the mean of the total revisions were positive for all but two of the G7 countries. The tendency to underestimate initial growth rates, that was identified in New Zealand's GDP(E) estimates (see figure 4), appears widespread.

Table 3
Revision statistics for the GDP (E) measures of the G7 countries and New Zealand

	Canada	France	Germany	Italy	Japan	UK	US	NZ
Faust et al. (2005)	**Revision period:** 1988Q1 - 1997Q4*							
	Final Estimates: April 2003 CD of MEI**							
Mean total revision	0.02	-0.02	0.22	0.03	0.05	0.25	0.11	0.28
Mean abs. total Revision	0.27	0.26	0.72	0.42	0.67	0.44	0.31	1.29
Root mean square	0.34	0.32	1.05	0.57	0.84	0.75	0.37	1.73
Ahmad et al. (2004)	**Revision period:** 1996Q1 - 2000Q4							
	Final estimates: June 2004***							
Final mean growth	1.05	0.74	0.44	0.50	0.51	0.75	0.98	0.74
Mean total revision	0.20	0.10	-0.08	0.13	0.22	0.16	0.06	0.26
Mean abs. total revision	0.28	0.27	0.40	0.39	1.02	0.34	0.38	0.75

* For New Zealand, the revision period used was 1989Q4 - 1997Q4.

** The authors used the October 2000 CD of MEI for Canada, West Germany and Japan. For New Zealand, the final estimates used were those released on 28/03/2003.

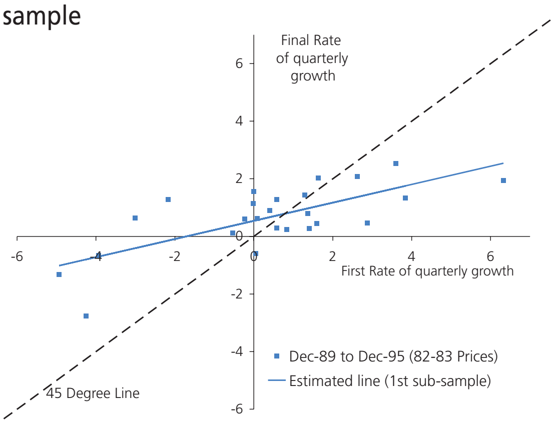
*** For New Zealand, the final estimates used were those released on 25/06/2004.

03).[19] Accordingly, we report two sets of results for these series.

From December 1989 to December 1995, the first sub-sample, the revisions made to all series were significantly biased.[20] In each series, it was found that the smaller the first estimate the greater the upward revision, and conversely the larger the first estimate the smaller the upward revision or the greater the downward revision. In this respect, the revisions compressed the amplitude of the business cycle.

Figure 7 illustrates the bias in the revisions made to GDP(E) present in the first sub-sample. The scatter points denote the actual values of the first and final rates of growth for each quarter, while the solid line shows the estimated relationship between the first and final rates. If the first estimates were unbiased, the estimated line would lie on, or close to, the 45 degree line shown in the figure. Instead, the slope of the line is substantially flatter than 45 degrees. First estimates of GDP(E) that were less than 0.79 per cent tended to be revised up, while those larger than this bound tended to be revised down. The mean first estimate of quarterly growth in GDP(E) over this period was 0.40 per cent and accordingly was revised up (by 0.27 percentage points) to 0.67 per cent.

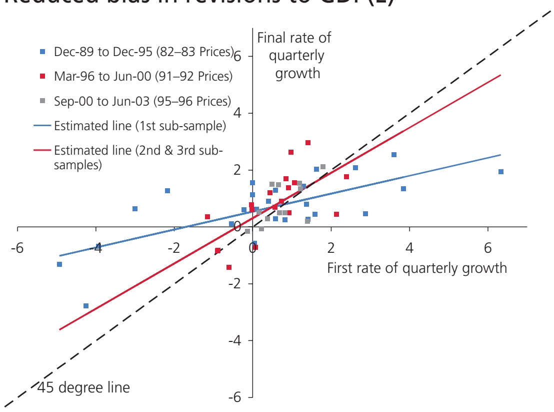
Figure 7
Bias in revisions to GDP(E) over the first sub-sample



Over the period March 1996 to June 2003, the second and third sub-samples, only the revisions made to Private Consumption, Government Consumption and Exports were significantly biased. In both series, there remained the tendency to compress the amplitude of the quarterly growth rates, by revising down the absolute size of expansions and contractions. However, for both the Government Consumption and Export series, the absolute revisions from this tendency were smaller than those estimated over the first sub-sample.

Figure 8 compares the relationship between the first and final estimates of growth in GDP(E) for quarters in the first sub-sample against quarters in the combined second and third sub-samples. The estimated line based on observations

Figure 8
Reduced bias in revisions to GDP(E)



from the last two sub-samples is clearly closer to the 45 degree line, implying a reduction in bias. Over these two sub-samples, the mean first estimate of quarterly growth in GDP(E) was 0.59 per cent and was revised up by only 0.19 percentage points to 0.78 per cent. As indicated by the results of table A1 and figure 8, there appears to have been a marked increase in the degree to which the first estimates of GDP(E) and the majority of its components provide reliable measures of the series final estimates.

19 For each series (with the exception of Private Consumption), the structural break was found to be statistically significant at the 5 per cent level using a Wald test for structural change that allowed for unequal variances between the sub-samples. There was no significant difference in the estimated values of α and β between the second and third sub-samples for any of the series.

20 That is, the probability that the values of α and β were jointly zero was less than 0.05.

6.3 Improvements in reliability provided by subsequent estimates of GDP(E)

Analysis of economic activity is most frequently conducted using the latest released vintage of GDP. Each quarter's estimate has had the opportunity to be revised one more time than the following quarter's estimate. Thus, it is important to focus not just on the extent to which first estimates of GDP are reliable indicators of the final estimates, but also on the marginal improvements offered by each subsequent estimate.

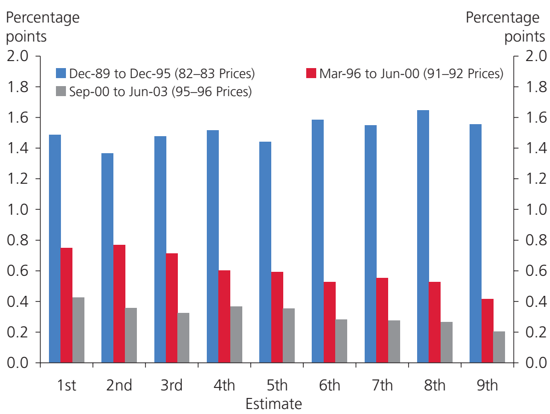
Figure 9 shows, for each of the three sub-samples, the mean revision (in absolute terms) between each of the first nine estimates of a quarter's GDP(E) growth and the quarter's final estimate. For example, the columns in the '9th Estimate' group provide the absolute mean revisions needed to reach each final estimate two years after the first estimates were released. Ideally, the size of the revision still to be made would decay quickly and smoothly with each subsequent quarter. This would imply that the early estimates are reasonably good approximations of their final figures.

For the first sub-sample however, the average value of the ninth estimate was no closer to the final estimate, in absolute terms, than the average value of the first estimate. The revisions made over the first two year period did not tend to move an estimate of growth closer to its final figure. In contrast, over the second and third sub-samples, the first nine estimates of GDP(E) growth show evidence of converging to their final estimate. Indeed, over the chain-linking period (the third sub-sample), more than half of the total revision had been made within the first two years. For these two sub-samples, subsequent estimates provided increasingly better indicators of the final estimate.

The results illustrated in figure 9 are supported by tests for bias shown in table A2 of the Appendix. For each estimate, the relationship between the revision still to be made and the measurement itself was estimated using Equation 1 and estimated values of the parameters α and β were obtained.[21,22] Over the first sub-sample, the bias detected in the total revisions made to GDP(E) was also found to persist in each of the eight subsequent estimates, and showed no sign of decay over time. Thus, the large upward revisions made to the first estimates of GDP(E) typically occurred after the two year period. Over the second and third sub-samples, all but one of the first nine estimates was unbiased. Furthermore, the estimated values of α and β generally became less significant in each subsequent quarter.

The general tendency to converge towards the final estimate, identified over the last two sub-samples shows a clear trade-off between the timeliness of an estimate and its reliability. The greater the length of time that an estimate has had to be revised, the closer the estimate is to its final value. The methodological changes made at the time chain-linking was introduced appear to have reduced the severity of this trade-off. Of course, in formulating monetary policy, the Reserve Bank faces time constraints. Analysis proceeds while bearing in mind the level of reliability associated with each figure.

Figure 9
Mean absolute revisions to the estimates of GDP(E)



21 The values of α and β were found to be significantly different between the first and second sub-samples for each of the nine estimates.

22 While Table A1 provides the relationships between the final and first estimates of different series, Table A2 shows the relationships between the final and each of the first nine estimates of GDP(E). The estimated values of α and β for GDP(E) shown in Table A1 are the same as the values for the 1st estimate shown in Table A2.

7. Conclusions

This article has introduced the real-time database constructed by the Reserve Bank. The database was created to provide greater insight into the latest measures of GDP(E) that are used to inform monetary policy decisions. As shown, the first estimate of GDP(E) for a quarter can be a noisy indicator of the eventual revised estimate at times.

Analysis was conducted of the revisions made to the constant price and seasonally-adjusted measures of GDP(E) and its components. Prior to chain-linking, revisions to New Zealand's GDP(E) measures were greater than those of some G7 countries. After the adoption of chain-linking in June 2001 the reliability of the first measures of GDP(E) and its components improved markedly.

We hope that the release of the New Zealand real-time database will prove to be useful to researchers interested in forecasting and policy issues.[23] Orphanides (2001) demonstrated the importance of using real-time data for policy evaluation. Recommendations for US monetary policy based on data available at the time the decision was made were found to differ considerably from those based on revised data. Garratt, Koop and Vahey (2006) used UK real-time data to forecast the probability of 'substantial' revisions (to which monetary policy may be sensitive). Researchers should find our real-time database helpful for similar New Zealand policy and forecast evaluations.

Appendix

Tables A1 and A2, opposite, report the estimation results discussed in sub-sections 6.2 and 6.3 respectively. The equations were estimated using Ordinary Least Squares. The estimated values of α and β are shown in the third and fourth columns of each table. The figures in brackets below each estimated parameter provides the probability that the coefficient is insignificantly different from zero.[24] The last columns of each table show the probability that the regression coefficients are jointly insignificantly different from zero. Small numbers (such as 0.05) in this column imply biased revisions.

When analysing the estimation results, several aspects of their computation should not be overlooked. First, the number of quarters in each of the two periods was small and this increases the likelihood of incorrectly inferring unbiased revisions. For example, Mankiw and Shapiro (1986) found no bias in US GDP when they used the sample 1975–1982. When Runkle (1998) used a larger sample, 1961–1996, he found that there was in fact a bias in US GDP. Second, the first estimates of quarters in the second and third sub-samples have had fewer opportunities to be revised, those estimates made in the first sub-sample. This may overstate the improvement in reliability.

[23] For a bibliography of papers that use real-time data, compiled by Dean Croushore, visit http://oncampus.richmond.edu/~dcrousho/docs/spf_bibliography.pdf

[24] These probabilities were calculated using Newey-West adjusted standard errors to correct for any heteroskedasticity and autocorrelation (Newey and West, 1987).

Table A1

Tests for bias in the revisions to GDP(E) and its components

Variable	Sample of quarters	α	β	Pr(α = β = 0)
GDP(E)	Dec-89 – Dec-95	0.54 (0.0135)	-0.68 (0.0000)	0.0000
	Mar-96 – Jun-03	0.31 (0.0394)	-0.20 (0.2779)	0.0718
Private Consumption	Dec-89 – Jun-03	0.31 (0.0096)	-0.36 (0.0040)	0.0061
Investment	Dec-89 – Dec-95	0.04 (0.9697)	-0.54 (0.0000)	0.0000
	Mar-96 – Jun-03	-0.47 (0.3332)	-0.07 (0.5840)	0.3505
Government Consumption	Dec-89 – Dec-95	0.42 (0.1293)	-0.74 (0.0014)	0.0007
	Mar-96 – Jun-03	0.24 (0.1671)	-0.15 (0.0000)	0.0000
Exports	Dec-89 – Dec-95	1.20 (0.0032)	-0.70 (0.0003)	0.0000
	Mar-96 – Jun-03	0.40 (0.0105)	-0.20 (0.0141)	0.0022
Imports	Dec-89 – Dec-95	0.62 (0.1210)	-0.47 (0.0000)	0.0000
	Mar-96 – Jun-03	-0.08 (0.7855)	-0.05 (0.6485)	0.6958

Table A2

Tests for bias in the revisions to GDP(E) over subsequent estimates

Estimate	Sample of quarters	α	β	Pr(α = β = 0)
1st Estimate	Dec-89 – Dec-95	0.54 (0.0135)	-0.68 (0.0000)	0.0000
	Mar-96 – Jun-03	0.31 (0.0394)	-0.20 (0.2779)	0.0718
2nd Estimate	Dec-89 – Dec-95	0.43 (0.0476)	-0.66 (0.0000)	0.0000
	Mar-96 – Jun-03	0.29 (0.1258)	-0.20 (0.3927)	0.2005
3rd Estimate	Dec-89 – Dec-95	0.47 (0.0475)	-0.69 (0.0000)	0.0000
	Mar-96 – Jun-03	0.27 (0.0747)	-0.19 (0.3125)	0.1582
4th Estimate	Dec-89 – Dec-95	0.48 (0.0704)	-0.77 (0.0000)	0.0000
	Mar-96 – Jun-03	0.21 (0.1452)	-0.05 (0.7074)	0.0716
5th Estimate	Dec-89 – Dec-95	0.46 (0.0450)	-0.71 (0.0000)	0.0000
	Mar-96 – Jun-03	0.19 (0.2107)	0.05 (0.7507)	0.0049
6th Estimate	Dec-89 – Dec-95	0.49 (0.0334)	-0.75 (0.0000)	0.0000
	Mar-96 – Jun-03	0.13 (0.3833)	-0.00 (0.9842)	0.1847
7th Estimate	Dec-89 – Dec-95	0.48 (0.0357)	-0.72 (0.0000)	0.0000
	Mar-96 – Jun-03	0.12 (0.5016)	-0.01 (0.9497)	0.2529
8th Estimate	Dec-89 – Dec-95	0.44 (0.0889)	-0.74 (0.0000)	0.0000
	Mar-96 – Jun-03	0.14 (0.3625)	0.02 (0.9032)	0.0741
9th Estimate	Dec-89 – Dec-95	0.48 (0.0440)	-0.74 (0.0000)	0.0000
	Mar-96 – Jun-03	0.07 (0.5510)	0.01 (0.9212)	0.4349

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