ESTUDIOS ECONÓMICOS ESTADÍSTICOS

Deepening GDP revision analysis: GDP bias breakdown and compositional change

Ignacio Martínez

N.°136 Abril 2021

banco central Chile

A contar del número 50, la Serie de Estudios Económicos del Banco Central de Chile cambió su nombre al de Estudios Económicos Estadísticos.

Los Estudios Económicos Estadísticos divulgan trabajos de investigación en el ámbito económico esta- dístico realizados por profesionales del Banco Central de Chile, o encargados por éste a especialistas o consultores externos. Su contenido se publica bajo exclusiva responsabilidad de sus autores y no com- promete la opinión del Instituto Emisor. Estos trabajos tienen normalmente un carácter definitivo, en el sentido que, por lo general, no se vuelven a publicar con posterioridad en otro medio final, como una revista o un libro.

As from issue number 50, the *Series of Economic Studies of the Central Bank* of Chile will be called *Studies in Economic Statistics.*

Studies in Economic Statistics disseminates works of investigation in economic statistics carried out by professionals of the Central Bank of Chile or by specialists or external consultants. Its content is publis- hed under exclusive responsibility of its authors and it does not reflect the opinion of the Central Bank. These documents normally are definitives and are not made available in any other media such as books or magazines.

Estudios Económicos Estadísticos del Banco Central de Chile
Studies in Economic Statistics of the Central Bank of Chile
ISSN 0716 - 2502

Estudios Económicos Estadísticos
N° 136

Studies in Economic Statistics
N° 136

Deepening GDP revision analysis: GDP bias breakdown and compositional change*

Ignacio Martínez
División de Estadísticas
Banco Central de Chile

Resumen
Este trabajo contribuye a la literatura de revisiones del PIB, desarrollando una nueva metodología que profundiza el análisis estadístico de las series del PIB. Específicamente se desarrollan dos análisis: (i) Identificación de los componentes del PIB que mayormente contribuyen a la presencia (o ausencia) de sesgo en la revisión de las tasas de crecimiento de este, y (ii) Test estadístico para detectar la presencia de un cambio significativo en la composición del PIB entre sus distintas versiones. Aplicamos esta metodología a los datos Chile para el periodo 2006-2019. Nuestros resultados muestran que la ausencia de sesgo en la revisión del crecimiento del PIB se debe a efectos compensatorios entre sus principales componentes. Finalmente, no encontramos evidencia de un cambio significativo en la composición del crecimiento del PIB entre las distintas versiones.

Abstract
This paper contributes to the GDP revision literature by developing a novel methodology to further analyse the statistical properties of GDP series. We undertake two specific analyses: (i) To identify which of the main GDP components contributes the most to the presence (or absence) of a GDP growth revision bias, and (ii) To test the presence of a significant compositional change between data vintages. We apply these methodologies to the Chilean data for the period 2006-2019. Our main results show that the absence of a GDP growth revision bias is due to compensating effects between its main components. Finally, we don't find significant evidence for a potential compositional change among different data vintages.

* Email: imartinez@bcentral.cl. I deeply thank Felipe Aviles-Lucero, Felipe Labrin and Simón Guerrero for their comments and insights. I also thank the feedback of Jorge Bravo and of an anonymously commentator of the Central Bank of Chile. The views expressed in this paper are solely those of the author and not necessarily those of the Central Bank of Chile.

1 Introduction

One consequence of estimating quarterly national accounts (QNA) on a continuing basis is that data sources change and improve over time. For this reason, a good practice for statistical offices is to perform a revision analysis and to formulate revision policies that effectively support users needs (UN, 2008) (IMF, 2018). Undertaking a revision analysis provides both users and producers of statistics with the opportunity to study the accuracy of preliminary data. This is an important element in understanding the quality of the published statistics and, for interpreting the figures when analyzing the current state of the economy.

Previous studies have analyzed the magnitude and direction of revisions of GDP data. For US data, Mankiw & Shapiro (1986) find that revisions to the first GDP estimation are high but without bias. In a later study Faust et al. (2005) observe little predictability in GDP revisions[1]. On the other hand, Arouba (2008) analyzed revisions for major macroeconomic variables, concluding that these revisions do not have a zero mean, which indicates that the initial announcements by statistical agencies are biased. Sinclair & Stekler (2013) examine the quality of the initial estimates of headline GDP and 10 major components for the US, concluding that, despite the presence of some bias, analysts could use the early data to obtain a realistic picture of what had happened in the economy in the previous quarter.

Regarding OECD countries, Zwijnenburg (2015) performed a revision analysis for QNA for a sample of 18 countries. The author encountered that while in most countries revisions after five months are upwards on average, only a few of these are statistically significant. When performing an analysis from the Expenditure approach of GDP, the author infers that Imports and Gross Fixed Capital Formation are the components with the largest revisions.

In the case of Chile, Pedersen (2010) analyzed GDP growth revisions between first and final versions during the period 1987-2009, and finds that QNA revisions show a systematic behavior. In a later study, Scherman (2020) developed a statistical analysis for QNA revisions during the period between 2006-2019. It was found that quarterly GDP growth rates do not present a revision bias, however, some of their components do have bias in their different vintages. In particular, the GDP excluding mining activities exhibited a revision bias mainly because of the overlap of Benchmark Compilations.[2] Additionally, Exports[3] presented a revision bias not attributable to methodological changes.

Most of the previous studies have focused their analyses on the statistical significance of the mean growth revision for the GDP and/or its components by computing only t-statistics, overlooking the opportunity to further their analyses in other interesting directions. According to Romer (2020), focusing solely on point estimates and statistical significance obscures the implications that can be found by analyzing other values. In addition, McCloskey & Ziliak (1996) report that more than half of publications consider nothing but the size of the t-statistic and F-statistic, stating that serious attention to the scientific question should replace the attention to statistical significance. Following these recommendations, this paper contributes to the revision literature by further ana-

[1] In contrast, the authors find that for several G7 countries the GDP revisions are highly predictable.
[2] For more information, see BCCh (2017).
[3] From here on, Exports (Imports) are defined as Exports (Imports) of goods and services.

lyzing the sources of GDP growth revision bias and compositional change in the economy through the analysis of growth contributions. In particular, using growth contributions of main GDP components, we undertake two specific analyses: (i) We identify which of the main components contribute the most to the presence (absence) of a GDP revision bias using a t-statistic breakdown, and (ii) We test the presence of a significant compositional change between data vintages using a vector distance measure. We apply this methodology to the case of Chile, where recently, the Central Bank published a comprehensive new data base of revisions for GDP and its major components[4].

Regarding the first point, we breakdown the t-statistic of GDP growth rate revision into a weighted sum of t-statistics of growth contributions revisions between its main components. Given this breakdown, we can identify if there are opposite or same sign effects in the potential presence of a GDP growth revision bias. These results could help data providers to focus their efforts on specific components that can cause larger effects in an overall bias result.

Concerning the second point, we notice that each data vintage is composed of a vector where its entries are the growth contributions of every component of the GDP. Since growth contributions reflect the relative importance of each component in total GDP growth, this vector can give a proper representation of how the overall economy is changing in a particular period. Therefore, the vector of growth contributions reflects the evolution of the economy for a given quarter and each data vintage could give a different evolution. The change in the entries for this vector can be interpreted as a compositional change in the GDP growth. In order to measure the difference between data vintages, we use the Mahalanobis distance.

Our main results indicate that the absence of bias in GDP growth rates revisions in Chile are due to the presence of compensating effects. This result holds for all the vintages studied. With the Production approach, the components of Mining and Non-mining activities present opposite effects, where in terms of absolute value they have similar magnitudes. In the Expenditure approach, we use two disaggregations: (i) in the first disaggregation we separate into Domestic Demand, Exports and Imports (ii) in the second disaggregation we expand Domestic Demand into its sub components of Gross Fixed Capital Formation (GFCF), Change in Inventories (CI), Household Consumption (HC) and Government Consumption (GC). In the first disaggregation, we see Imports compensating the contributions of Domestic Demand and Exports, where in terms of absolute value, the effects of Imports is around twice the effect of both Domestic Demand and Exports. In the second disaggregation, we see that the effect of Domestic Demand is mainly determined by the effect of GFCF. These results can help data providers to focus their efforts on specific components that can cause larger effects in a overall bias result.

Finally, we don't find evidence of a significant compositional change when we take the different vintages of the GDP's publications. In this sense, a data user can work with earlier vintages of the data in order to get a realistic picture of the development of the Chilean economy.

[4]For more information, see BCCh (2020).

2 Chile's data and revisions policy

According to OCDE and IMF guidelines, QNA should be periodically updated due to the incorporation of unavailable information in previous vintages. In line with these recommendations, the BCCh posseses a well defined revisions policy for its national accounts statistics, allowing researchers to compute the differences between vintages. Following Scherman (2020), for the Chilean QNA data we can distinguish the following vintage series:

- Quarterly version ($T^y_{q,r}$): Refers to the versions of data published within the same year of the reference quarter.
- Preliminary version (L^y_q): Refers to the first annual estimation of the QNA series, and is published in march of the subsequent reference year.
- Provisional version (P^y_q): Refers to the second annual estimation of the QNA series, and is published one year after the preliminary vintage.
- Revised version (R^y_q): Refers to the third annual estimation of the QNA series, and is published two years after the preliminary vintage.
- First version (F^y_q): Refers to the first version of data published.

Where q is the quarter, y is the year and, r is the vintage for quarterly versions. For example, $T^{2018}_{1,3}$ consists of the data from the first quarter of 2018 released in the publication period for the third quarter of the same year. According to the BCCh revisions policy, the publication period for the first, second, third and fourth quarter are May 18th, August 18th, November 18th and March 18th of the following year respectively.

According to the above definitions, for the first three quarters the first version coincides with the first quarterly version, i.e. $F^y_1 = T^y_{1,1}$; $F^y_2 = T^y_{2,2}$; $F^y_3 = T^y_{3,3}$. For the fourth quarter we have the first version coinciding with the preliminary version, i.e. $F^y_4 = L^y_4$.

The consecutive versions of the data mentioned above correspond to the systematic incorporation of new facts and more robust sources of information, defined in the revisions policy of the National Accounts of Chile [5]. Thus, the estimations will gain robustness and accuracy as the new versions replace the former ones.

In this paper, we include revisions for the years 2006 to 2019 and we work with the provisional and revised vintages only, since these are the only ones that allow us to compute revisions using all the quarters.[6] Thus, we define the following revisions to the first version as:

Provisional revision (RP):

$$RP^y_q = P^y_q - F^y_q \qquad \text{for } q \in (1,2,3,4) \text{ and } y \in (2007,\ldots,2018). \tag{1}$$

[5] For more information, see BCCh (2017)

[6] As Scherman (2020) points out, the quarterly and preliminary vintages can only be used to compute revisions using 2 and 3 quarters, respectively.

Revised revision (RV):

$$RV_q^y = R_q^y - F_q^y \qquad \text{for } q \in (1,2,3,4) \text{ and } y \in (2007,\ldots,2017). \tag{2}$$

For example, RP_1^{2018} and RV_1^{2018} are the provisional and revised revisions of the data from the first quarter of 2018.

3 Methodology

3.1 GDP growth bias breakdown

The statistical properties of the revision (RP_q^y or RV_q^y) tell us about the accuracy of the first GDP growth estimation. For instance, if the first vintage (F_q^y) is consistently over or under estimating GDP growth regarding its final version (R_q^y), we will have that RV_q^y has a mean statistically different from 0. In order to check for potential biases we compute the t-statistic for α in the following regression:

$$X_q^y = \alpha + \epsilon_q^y, \tag{3}$$

where $X_q^y \in \{RP_q^y, RV_q^y\}$ and $\epsilon_q^y \sim (0, \sigma^2)$. Therefore, if the estimated coefficient of α is statistically different from zero, it is possible to assume that the first version of GDP's growth is biased.

In order to calculate the t-statistic a variance estimator for $\hat{\alpha}$ is needed. The literature recommends that the estimation of this variance should be performed with the Newey-West method, which controls for error auto-correlation. However, this method suffers a considerable problem for the revision's series used in this paper. As Scherman (2020) points out, the series RP_q^y and RV_q^y are known simultaneously for all quarters within a year, which invalidates the information assumption in auto-regressive models with lags less than four quarters. Hence, the variance of α was calculated using the traditional formula of ordinary least squares.

In addition, data users express interest in how the different components of the GDP contribute to the overall growth.[7] This information is represented by the growth contributions of each GDP component[8]. In practice, calculating growth contributions is carried out by weighting the growth rates for all industries. This analysis helps to identify the most relevant economic activities in a particular time period.

In order to illustrate the breakdown of the t-statistic of GDP growth revisions between its components using growth contributions, we can use the first disaggregation for the Expenditure approach mentioned previously. For each data vintage we can express the GDP growth revision as:

$$X_q^y = XD_q^y + XX_q^y + XM_q^y, \tag{4}$$

[7] See (Tuke, 2002).

[8] Another reason to focus on contributions to growth is to deal with the problem of non additivity of series by using chain-linked volume measures (Cobb, 2013).

where again $X_q^y \in \{RP_q^y, RV_q^y\}$, and XD_q^y, XX_q^y and XM_q^y are the revisions to growth contributions of Domestic Demand, Exports and Imports, respectively.[9]

Hence the t-statistic for $\hat{\alpha}$ can be written as:[10]

$$t_X \equiv \theta_{XD} t_{XD} + \theta_{XX} t_{XX} + \theta_{XM} t_{XM}. \tag{5}$$

Where:

- t_i: t-statistic of the growth contribution revision for component i.
- θ_i: ratio of the standard error of component i over GDP's growth revision standard error. Hence,

$$\theta_i = \frac{\hat{\sigma}_i}{\hat{\sigma}_{GDP}}. \tag{6}$$

Equation (5) shows that the revision of GDP growth t-statistic is a weighted sum of the t-statistics for each growth contribution revision.

It is important to notice that the weights doesn't necessary have to add up to one, because of the correlations that might exist between GDP components. It is also relevant to mention that if a component has a larger standard error, it will have a greater weight in equation (5).

Regarding the signs of the components t-statistics there can be same sign or compensating effects. For instance, if Exports present an upward bias in the first vintage (negative t-statistic) and Imports present a downward bias (positive t-statistic), both effects will compensate each other in the weighted sum, implying a GDP revision that doesn't present bias. It is important to notice that these findings cannot be observed using just the growth rates for each component.

3.2 Compositional change bias

For each data vintage, there is a vector with the growth contributions of every component of the GDP. This vector represents the evolution of the economy for a given quarter, where in each data vintage, a different evolution of the economy is revealed. The change in the entries of this vector between vintages can be viewed as a compositional change in the economy. For data users, it is important to know if these changes are significant, because if this is the case, it would mean that the first picture of the evolution of the economy is not a reliable estimate of its true development.

In order to test if the later revealed evolution of the economy is statistically different from the first one published, we use the Mahalanobis distance. This methodology is related to Sinclair & Stekler (2013), although they work with the vector of growth rates instead of growth contributions. Our methodology is a more accurate way to measure a compositional change of the economy mainly because growth contributions are directly related to GDP growth and they control for small and

[9]For more information about growth contribution in chain linked volume measures see Cobb (2013) and IMF (2017).

[10]More details of the mathematical expression can be found in the Appendix 1.

volatile components, with a smaller participation in the economy.

For instance, the Mahalanobis distance between the first and provisional vintages is:

$$D^2 = (\overline{\mathbf{P}} - \overline{\mathbf{F}})'\widehat{\mathbf{W}}^{-1}(\overline{\mathbf{P}} - \overline{\mathbf{F}}), \tag{7}$$

where $\widehat{\mathbf{W}}$ is the pooled sample var-covar matrix and $\overline{\mathbf{P}}$ and $\overline{\mathbf{F}}$ are the mean for the provisional and first vintage growth contributions vectors, respectively. Let $c = \frac{N_F N_P (N-p+1)}{(N_P+N_F)pN}$, where p is the number of GDP components, N_F is the number of observations for the first vintage, N_P is the number of observations for the preliminary vintage and $N = N_F + N_P - 2$. Under the assumption of normality, cD^2 is distributed as a noncentral F-distribution with p and $N - p + 1$ degrees of freedom. The null hypothesis tests if both revealed evolutions of the economy are the same.[11]

Another option to measure the distance between two vectors corresponds to the Euclidean distance. However, this formula is only applicable to vectors that are independent and does not control for correlation between them. Therefore we did not use it.

4 Results

4.1 GDP growth bias breakdown

Tables 1 and 2 present the GDP bias breakdown from the Production approach, regarding provisional and revised revisions. Even though we have a relative small span of time, we cannot reject that GDP growth revisions for both vintages are normally distributed.[12] In both cases, we can observe compensating effects that result in a t-statistic of GDP of 0.74 and 1.01 for the provisional and revised versions respectively.

In the provisional vintage, the overall GDP mean growth revision of 0.06 percentage points (pp) can be decomposed between the contributions of Non-mining (0.09pp) and Mining (-0.02pp) activities. Similarly, the GDP t-statistic of 0.74, which implies the absence of bias, can also be decomposed between the positive effect of Non-mining (1.03) and the negative effect of Mining activities (-0.29) resulting in compensating effects.

When considering the revised vintage, the overall GDP growth revision is higher than the provisional case, reaching an average of 0.09pp, composed of 0.14pp from Non-mining and -0.05pp from Mining activities. For this vintage, the growth contribution revision in the Non-mining activity is biased (t-statistic of 1.88), with an overall effect in GDP growth revision of 1.55. This effect by itself does not imply bias for the GDP growth revision and is compensated with the effect of Mining (-0.55).

Tables 3 and 4 present the results regarding the Expenditure approach of GDP on its first disaggregation. As in the Production approach, for both vintages there are compensating effects between the main components, nonetheless, we can notice more pronounced effects in comparison

[11] For more information, see McLachlan (1999).
[12] See Appendix 2.

Table 1: Production approach - Provisional revision

N = 49	**Coef.**	**SD**	t**-statistic**	θ	**Effect** (†)
Non-mining	0.09 (1)	0.07	1.26	0.82	1.03 (3)
Mining	-0.02 (2)	0.04	-0.61	0.48	-0.29 (4)
GDP	(1)+(2)=0.06	0.08	(3)+(4)=0.74	-	-

Source: Author's elaboration.
(†): Following equation (5), the effect is given by $\theta_i \cdot t_i$.

Table 2: Production approach - Revised revision

N = 45	**Coef.**	**SD**	t**-statistic**	θ	**Effect** (†)
Non-mining	0.14 (1)	0.08	1.88	0.83	1.55 (3)
Mining	-0.05 (2)	0.05	-0.97	0.56	-0.55 (4)
GDP	(1)+(2)=0.09	0.09	(3)+(4)=1.01	-	-

Source: Author's elaboration.
(†): Following equation (5), the effect is given by $\theta_i \cdot t_i$.

with the Production approach. For the provisional vintage, the overall GDP growth revision of 0.06pp is composed of -0.26pp of Domestic Demand, -0.24pp of Exports and 0.57pp of Imports. The negative effects of Domestic Demand and Exports plus the positive effect of Imports have as a result the absence of GDP growth revision bias, where in terms of absolute value, the effect of Imports is approximately twice the effect of both Domestic Demand and Exports. We can see in table 3 that Exports and Imports have bias in their growth contribution revisions (t-statistics of -2.97 and 2.77 respectively), where those effects by themselves do not imply bias for the GDP growth revision and is compensated by the effect of Domestic Demand (-3.21).

In the revised vintage, the average GDP growth revision of 0.09pp is composed of -0.19pp of Domestic Demand, -0.22pp of Exports and 0.50pp of Imports. Again, the absence of bias can be explained by the opposite effects of Domestic Demand and Exports versus the one from Imports. Lastly, the compensating effects on the revised vintage are lower in comparison with the provisional vintage. As well as the provisional vintage, Exports and Imports have bias in their growth contribution revisions (t-statistics of -1.87 and 1.98 respectively), where those effects by themselves do not imply bias for the GDP growth revision and are compensated by the effect of Domestic Demand (-2.01).

Table 3: Bias breakdown Expenditure approach I - Provisional revision

N = 49	**Avg.**	**SD**	t**-statistic**	θ	**Effect** (†)
Domestic Demand	-0.26 (1)	0.19	-1.41	2.3	-3.21 (4)
Exports	-0.24 (2)	0.08	-2.97	1.0	-2.91 (5)
Imports	0.57 (3)	0.20	2.77	2.5	6.86 (6)
GDP	(1)+(2)+(3)=0.06	0.08	(4)+(5)+(6)=0.74	-	-

Source: Author's elaboration.
(†): Following equation (5), the effect is given by $\theta_i \cdot t_i$.

Table 4: Bias breakdown Expenditure approach I - Revised revision

N = 49	**Avg.**	**SD**	**t-statistic**	θ	**Effect** (†)
Domestic Demand	-0.19 (1)	0.26	-0.71	2.8	-2.01 (4)
Exports	-0.22 (2)	0.12	-1.87	1.3	-2.33 (5)
Imports	0.50 (3)	0.25	1.98	2.7	5.35 (6)
GDP	(1)+(2)+(3)=0.09	0.09	(4)+(5)+(6)=1.01	-	-

Source: Author's elaboration.

(†): Following equation (5), the effect is given by $\theta_i \cdot t_i$.

Tables 5 and 6 present the results regarding the Expenditure approach of GDP on its second disaggregation where we decompose Domestic Demand into its sub components. Again we can see compensating effects for both vintages. For the provisional vintage, the effect of Domestic Demand of -3.21 is composed of -4.17 of GFCF, 1.91 of CI, -1.58 of HC and 0.64 of GC. The overall negative effect of Domestic Demand is mainly composed by the effect of GFCF, which is compensated by the effect of Imports, resulting in an absence of bias in the GDP growth revision. In this case, we see that GFCF has a bias in its growth contribution revision (t-statistic of -3.17), where this effect by itself is not causing a bias for the GDP growth revision due the compensating effects mentioned above.

In the revised vintage we get similar effects. The effect of Domestic Demand of -2.01 is composed of -3.13 of GFCF, 2.08 of CI, -1,47 of HC and 0.52 of GC. Again, the overall negative effect of Domestic Demand for this vintage is due mainly to the effect of GFCF, where, when we obtain the overall GDP mean growth revision, it is compensated by the effect of Imports resulting in an absence of bias. Once more, we can see that the compensating effects on the revised vintages are lower than the effects in the provisional vintage.

It is important to notice that some GDP components present growth contribution bias in their results. Because growth contributions represent a combination of two effects consisting of the speed with which a component changes and the relative weight of the component to total GDP, it is difficult to interpret the bias directly. For this, the recommendation would be to inspect both effects separately to determine the issues regarding the presence of bias.

On the other hand, adjustments in imports can be reflected in other components of GDP. For example, most of the durable goods in HC in the Chilean economy come from imports, implying that revisions in the imports of these kind of goods can cause changes in HC. Therefore it is expected that compensating effects can be found in the Expenditure approach. Nonetheless, the magnitude of the effects found depend on the variables expressed in equation (6), where in the case of Chile the overall effect produces an absence of bias in the GDP growth rates.

Finally, figure 1 summarizes the aggregation of the different effects of GDP components and shows how they compensate resulting in an overall absence of GDP growth revision bias. As mentioned above, the compensation effect is more pronounced in the Expenditure approach, with Imports having a larger effect.

Table 5: Bias breakdown Expenditure approach II - Provisional revision

N = 49	**Avg.**	**SD**	***t*-statistic**	θ	**Effect** (†)
Gross Fixed Capital Formation	-0.34 (1)	0.11	-3.17	1.3	-4.17 (7)
Change in Inventories	0.16 (2)	0.10	1.52	1.3	1.91 (8)
Household Consumption	-0.13 (3)	0.08	-1.67	0.9	-1.58 (9)
Government Consumption	0.05 (4)	0.04	1.29	0.5	0.64 (10)
Exports	-0.24 (5)	0.08	-2.97	1.0	-2.91 (11)
Imports	0.57 (6)	0.20	2.77	2.5	6.86 (12)
GDP	(1)+...+(6)=0.06	0.08	(7)+...+(12)=0.74	-	-

Source: Author's elaboration.
(†): Following equation (5), the effect is given by $\theta_i \cdot t_i$.

Table 6: Bias breakdown Expenditure approach II - Revised revision

N = 49	**Avg.**	**SD**	***t*-statistic**	θ	**Effect** (†)
Gross Fixed Capital Formation	-0.29 (1)	0.16	-1.87	1.7	-3.13 (7)
Change in Inventories	0.19 (2)	0.14	1.34	1.6	2.08 (8)
Household Consumption	-0.14 (3)	0.11	-1.28	1.2	-1.47 (9)
Government Consumption	0.05 (4)	0.04	1.20	0.4	0.52 (10)
Exports	-0.22 (5)	0.12	-1.87	1.3	-2.33 (11)
Imports	0.50 (6)	0.25	1.98	2.7	5.35 (12)
GDP	(1)+...+(6)=0.06	0.08	(7)+...+(12)=0.74	-	-

Source: Author's elaboration.
(†): Following equation (5), the effect is given by $\theta_i \cdot t_i$.

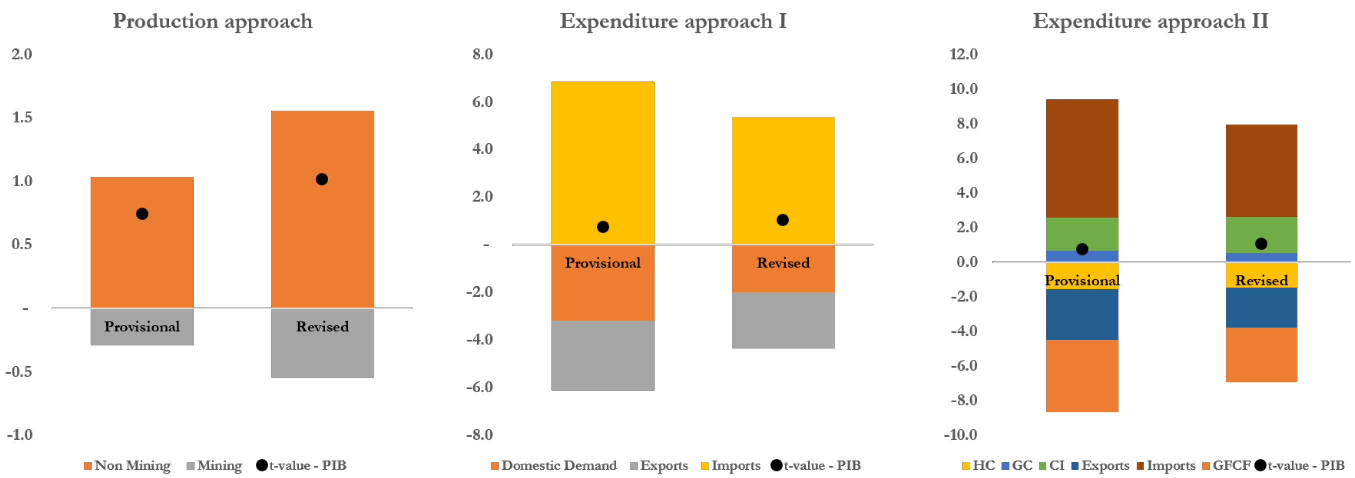

Figure 1: Supply and Expenditure approach breakdown.

4.2 Compositional change bias

We now present the results for the potential presence of a compositional change between vintages. Table 7 shows the results for the Production approach, and tables 8-9 show the results for the Expenditure approach in its two disaggregations. In all cases, the tests reject the presence of a significant compositional change between vintages and this result holds for the provisional and revised vintages.

In the second Expenditure approach disaggregation, more components are included, thus we can get a more exhaustive picture of the evolution in the economy. Regardless of this expansion, we obtain the same outcomes as above, rejecting the presence of a significant compositional change between vintages.

According to this, data users can use the first picture of the GDP and its major components as a good estimator of the development of the economy.

Finally, these results turn interesting when compared with the findings of Scherman (2020). Despite the presence of bias in Exports growth rates, this will not cause a bias in the overall GDP growth rates because of the presence of the compensating effects of Imports. Additionally, this also doesn't cause a significant compositional change between vintages.

Table 7: Compositional change - Production approach

	Mean first vintage	**Mean provisional vintage**	**Mean revised vintage**
Non-mining PIB	3.12	3.20	3.23
Mining	0.10	0.08	0.02
Mahalanobis distance		0.06	0.17
F-statistic		0.04	0.62
p-value		0.96	0.54

Source: Author's elaboration.

Table 8: Compositional change - Expenditure approach I

	Mean first vintage	**Mean provisional vintage**	**Mean revised vintage**
Domestic Demand	4.74	4.48	4.56
Exports	0.81	0.57	0.54
Imports	2.32	1.76	1.85
Mahalanobis distance		0.27	0.27
F-statistic		0.57	1.03
p-value		0.64	0.38

Source: Author's elaboration.

5 Conclusions

This paper contributes to the national accounts revisions literature by developing a novel methodology that analyzes the sources of GDP revisions. In particular, we undertook two spe-

Table 9: Compositional change - Expenditure approach II

	Mean first vintage	**Mean provisional vintage**	**Mean revised vintage**
Gross Fixed Capital Formation	1.28	0.93	0.99
Change in inventories	-0.16	-0.00	-0.04
Household Consumption	3.10	2.97	3.02
Government Consumption	0.52	0.58	0.59
Exports	0.81	0.57	0.54
Imports	2.32	1.76	1.85
Mahalanobis distance		0.56	0.49
F-statistic		1.03	0.74
p-value		0.42	0.64

Source: Author's elaboration.

cific analyses: (i) We identified the contribution of each GDP component to the overall t-statistic, and (ii) We tested the presence of a significant compositional change between data vintages.

Using Chilean data from 2006 to 2019, our main results indicate that the absence of bias in the GDP growth revisions is due to the presence of compensating effects between its components. This result holds for vintages published one and two years after the first version. On the Production approach, the components of Mining and Non-mining activities present opposite effects, where in terms of absolute value, they have similar magnitudes. In the Expenditure approach, we see Imports compensating for the contributions of Domestic Demand and Exports.

Finally, we don't find evidence of a significant compositional change when we take the different vintages of the GDP's publications. In other words, the changes in the growth contributions of GDP and its major components are not significant when a new evolution of the economy is revealed. In this sense, a data user can work with earlier vintages of the data in order to get a realistic picture of the development of the Chilean economy.

References

[1] Arouba, S. *Data Revisions Are Not Well Behaved*. Journal of Money, Credit and Banking, 40(2), pp. 319-340. 2008.

[2] BCCh *Cuentas Nacionales de Chile: Compilacion de Referencia 2013*. s.l.:Banco Central de Chile. 2017.

[3] BCCh *Cuentas Nacionales de Chile: Evolución de la actividad económica en el año 2019*. s.l.:Banco Central de Chile. 2020.

[4] BCCh *Cuentas Nacionales de Chile: Métodos y Fuentes de Información*. s.l.:Banco Central de Chile. 2017.

[5] Cobb, M. *Contribución Sectorial al Crecimiento Trimestral del PIB*. Estudios Económicos Estadísticos, Banco Central de Chile. Vol. 100. 2013.

[6] Faust, J., Rogers, J.H. and Wright, J. *Announcements, News and Noise in G-7 GDP*. Journal of Money, Credit and Banking, 37(3), pp. 403-419. 2005.

[7] IMF *Quarterly national accounts manual*. Washington, D. C.: International Monetary Fund. 2018.

[8] McCloskey, D. and Ziliak, T. *The standard error of regressions*. Journal of Economic Literature. Vol. 34 pp. 97-114. 1996.

[9] McLachlan, G.J. *Mahalanobis Distance*. Resonance, 6, 20-26. 1999.

[10] Pedersen, M. *Extracting GDP Signals from the Monthly Indicator of Economic Activity: Evidence from Chilean Real-Time Data*. Documentos de Trabajo, Banco Central de Chile. No. 595. 2010.

[11] Romer, D. *In praise of confidence intervals*. NBER Working papers 26672. 2020.

[12] Sinclair, T. and Stekler, H.O. *Examining the quality of early GDP component estimates*. International Journal of Forecasting. 29 pp. 736-750. 2013

[13] Scherman, D. *Revisiones en cuentas nacionales trimestrales 2006-2018*. Estudios Económicos Estadísticos. 2020.

[14] Tuke, A. *Analysing the effects of annual chain-linking on the output measure of GDP*. Economic Trends No. 581. 2002.

[15] Zwijnenburg, J. *Revisions of quarterly GDP in selected OECD countries*. The Statistics Brief - OECD. 2015.

Appendix (1)

t-statistic decomposition

Let the GDP growth revision for quarter q and year y be written as X_q^y. We assume that X_q^y is a random variable distributed $N(\mu_X, \sigma_X)$. As we mention in the main text, the GDP growth revision can be expressed as the sum of the revisions of all growth contributions. Following the example in equation (4), for the expenditure approach this equation is given by:

$$X_q^y = XD_q^y + XX_q^y + XM_q^y.$$

Adding observations for all periods and dividing the number of observations we have:

$$\overline{X} = \overline{XD} + \overline{XX} + \overline{XM}, \tag{8}$$

where the over line represents the average of the variable. Let $\widehat{\sigma}_X$ be GDP growth revision's sample standard error and $\widehat{\sigma}_{XD}$, $\widehat{\sigma}_{XX}$ and $\widehat{\sigma}_{XM}$ be the sample standard error for growth contribution revisions for domestic demand, exports and imports, respectively.

If we want to test that the mean for growth revisions is zero:

$$\begin{aligned} H_0: \quad \mu_X &= 0, \\ H_1: \quad \mu_X &\neq 0, \end{aligned}$$

we have to compute the t-statistic which is given by $t_X = \overline{X}/\widehat{\sigma}_X$. From equation (8), we can decompose the t-statistic as:

$$t_X = \theta_{XD} t_{XD} + \theta_{XD} t_{XX} + \theta_{XD} t_{XM}. \tag{9}$$

In the equation above, θ_Y is the ratio of sample standard errors between Y and GDP growth revisions for $Y \in \{XD, XX, XM\}$, i.e., $\theta_Y = \widehat{\sigma}_Y / \widehat{\sigma}_X$. Clearly $\theta_Y > 0$ for all Y and the sign of the t-statistic for GDP growth contribution's revisions will depend if they are revised upward (positive) or downward (negative).

Appendix (2)

Normality tests GDP growth revisions

In this section we compute normality tests for the GDP growth revisions. As table 10 shows, we cannot reject the null hypothesis of normal distribution for the for the provisional and revised vintages.

Table 10: Normal distribution tests for GDP growth revisions

Data vintage	**Obs**	**Pr(Skewness)**	**Pr(Kurtosis)**	**Prob** $> \chi^2$
Revised version	49	0.6139	0.0772	0.1667
Revised version	45	0.6019	0.6290	0.7715

Source: Author's elaboration.

Estudios Económicos Estadísticos
Banco Central de Chile

Studies in Economic Statistics
Central Bank of Chile

NÚMEROS ANTERIORES

PAST ISSUES

Los Estudios Económicos Estadísticos en versión PDF pueden consultarse en la página en Internet del Banco Central www.bcentral.cl . El precio de la copia impresa es de $500 dentro de Chile y US$12 al extranjero. Las solicitudes se pueden hacer por fax al: +56 2 26702231 o por correo electrónico a: bcch@bcentral.cl.

Studies in Economic Statistics in PDF format can be downloaded free of charge from the website www.bcentral.cl . Separate printed versions can be ordered at a price of Ch$500, or US$12 from overseas. Orders can be placed by fax: +56 2 26702231 or email: bcch@bcentral.cl.

EEE – 135 **Abril** 2021
Huella de Carbono para la Economía Chilena 2017
Felipe Avilés-Lucero, Gabriel Peraita, Camilo Valladares

EEE – 134 **Julio** 2020
External Debt Characterization of Non-Banking Companies in Chile
Jorge Fernández B., Fernando Pino M., Francisco Vásquez L.

EEE – 133 **Junio** 2020
Mercado de derivados sobre tasas de interés en Chile: Comparación internacional y mercado de Swap Promedio Cámara
Nicole Delpiano, José Miguel Villena

EEE – 132 **Mayo** 2020
Mercado Cambiario Chileno, una comparación internacional: 1998 a 2019
José Miguel Villena y Alexander Hynes

EEE – 131 **Abril** 2020
Revisiones en cuentas nacionales trimestrales Chile 2006-2019
Danae Scherman

EEE – 130 Octubre 2019
Un Nuevo Indicador de Endeudamiento de Empresas Chilenas Utilizando Registros Administrativos de Deuda y Actividad
Jorge Fernández y Francisco Vásquez

EEE – 129 Julio 2019
Índice de Avisos Laborales de Internet
Erika Arraño y Katherine Jara

EEE – 128 Febrero 2019
Medidas de Incumplimiento de Empresas Chilenas Basadas en Datos Administrativos
Jorge Fernández y Francisco Vasquez

EEE – 127 Febrero 2019
Assessing Firm Hetrogeneity within Industries for the Chilean Economy
Diego Vivanco

EEE – 126 Septiembre 2018
Evolución de los Medios de Pago en Chile y su Incidencia en el Comportamiento de los Componentes de M1
Erika Arraño y Juan Pablo Cova

EEE – 125 Junio 2018
Evolución de los Medios de Pago en Chile y su Incidencia en el Comportamiento de los Componentes de M1
Erika Arraño y Juan Pablo Cova

EEE – 124 Junio 2018
Balance del Banco Central de Chile, 1926 a 2015
Pablo Filippi, José Román y José Miguel Villena

EEE – 123 Junio 2017
Series Históricas del PIB y Componentes del Gasto, 1986-2013
Felipe Labrin

EEE – 122 Marzo 2017
Caracterización de las Tasas de Interés de Créditos para la Vivienda
Patricio Hevia y César Vásquez

EEE – 121 Febrero 2017
Caracterización de la Deuda de Empresas No Bancarias en Chile
Jorge Fernández, Pedro Roje y Francisco Vásquez

EEE – 120 Febrero 2017
Medición de los Servicios de Capital para la Economía Chilena
Ivette Fernández y Pablo Pinto

EEE – 119 Febrero 2017
Evolución de la Normativa de Riesgo de Mercado de la Banca Chilena
José Miguel Matus

EEE – 118 Agosto 2016
Derivados de Tipo de Cambio por Sector Financiero: El Caso de Chile
Paulina Rodríguez y José Miguel Villena

EEE – 117 Abril 2016
La Economía Chilena en el Período 2003-2014: Un Análisis desde la Perspectiva de las Cuentas Nacionales por Sector Institucional
Claudia Henríquez y Josué Pérez

EEE – 116 Marzo 2016
Acciones Financieras Prudenciales y Ciclo Crediticio
Erika Arraño, Juan Pablo Cova, Pablo Filippi y Enrique Marshall

EEE – 115 Enero 2016
Valor Agregado Doméstico y Contenido Importado de las Exportaciones: Evidencia de las Matrices Insumo-Producto de Chile 2008-2012
Sebastián Rébora y Diego Vivanco

EEE – 113 Julio 2015
Estadísticas de Tasas de Interés del Sistema Bancario
Erika Arraño, Pablo Filippi y César Vasquez

EEE – 112 Mayo 2015
Tipo de Cambio Real: Revisión Internacional
Erika Arraño y Faruk Miguel

EEE – 111 Enero 2015
Empalme IPC sin Alimentos ni Energía
Hernán Rubio y Andrés Sansone

EEE – 110 Enero 2015
Provisiones por Riesgo de Crédito de la Banca Nacional: Análisis de los Cambios Normativos, Periodo 1975-2014
José Miguel Matus

EEE – 109 Noviembre 2014
Inversión Extranjera Directa en Chile: Mecanismos de Ingreso y Compilación para la Balanza de Pagos
Juan Eduardo Chackiel y Valeria Orellana

EEE – 108 Septiembre 2014
Demografía de Empresas en Chile
Gonzalo Suazo y Josué Pérez

EEE – 107 Junio 2014
Índice de Precios de Viviendas en Chile: Metodología y Resultados
División de Estadísticas y División de Política Financiera

banco central Chile