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EXTRACTING GDP SIGNALS FROM THE MONTHLY INDICATOR OF ECONOMIC ACTIVITY: EVIDENCE FROM CHILEAN REAL-TIME DATA

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Resumen

Utilizando datos en tiempo real se analiza cuanta información contiene el indicador mensual de actividad económica chilena (IMACEC) del PIB final, definido como la tasa de crecimiento que ha estado sujeta, al menos, a dos revisiones anuales. Se presentan los datos y se analizan brevemente las revisiones. Se encuentra que cuando se dispone de tres meses de datos del IMACEC, es posible extraer señales del PIB final que son tan creíbles como los de la primera publicación de la tasa de crecimiento. Este resultado se obtiene con la evaluación tanto dentro como fuera de muestra.

Luego, se investiga cuánta información extra aportan los datos del IMACEC al PIB final, comparado con la que ya contienen los datos históricos. El análisis dentro de muestra indica mejoras estadísticamente significativas cuando hay más datos del IMACEC del trimestre disponibles. Medido por la raíz del error cuadrático medio (RECM), el desempeño fuera de muestra también mejora cuando hay disponibles más datos mensuales; sin embargo, cuando solamente está disponible el primer dato del IMACEC, se encuentra que la ganancia no es estadísticamente significativa.

Abstract

With real-time data it is analyzed what information Chile's monthly indicator of economic activity (*IMACEC*) contains about the final GDP, defined as the growth rate that has been subject to at least two annual revisions. Data are presented and revisions briefly analyzed. It is argued that when three months of *IMACEC* data are available, it is possible to extract signals about the final GDP, which are as reliable as those contained in the first release of the growth rate. This result is obtained with the evaluation in-sample as well as out-of-sample.

It is then investigated how much extra information *IMACEC* data provide of the final GDP compared to what is already present in historical data. The in-sample analysis indicates statistically significant improvements when more *IMACEC* data of the quarter are available. Measured by the root mean square nowcast error (RMSNE) the out-of-sample performance also improves as more monthly data are published, although when only the first *IMACEC* data of the quarter are available, this is not statistically significant.

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1. Introduction

For the conduct of monetary policy, timely and reliable information is of great importance and since several macroeconomic data are subject to revisions, an analysis of the contents of first released observations is particularly relevant. In the case of Chile, the Board of the Central Bank meets every month, usually after the publication of the monthly indicator of economic activity (*IMACEC*[1]). Utilizing data available in real-time, this paper is the first to investigate what signals this indicator contains about the final gross domestic product (GDP), defined as the observation which has been subject to at least two annual revisions.

The results show that with respect to the final growth rates, signals which are as reliable as those of the first GDP release[2] can be extracted from the *IMACEC*. Furthermore, comparing to in-sample nowcasting the final GDP with historical data, each month of available *IMACEC* data improves the performances significantly, while the evidence from the out-of-sample exercise is less clear. Although the root mean square nowcast error (*RMSNE*) does decrease when the first *IMACEC* data is available, two data are needed before any clear improvement is visible. A further statistically significant improvement is obtained when three months of data have been published.

Usually, with exceptions such as Canada and Peru, GDP is published quarterly and this fact has created a need for the construction of monthly indicators with the purpose of obtaining more timely information. In particular, several Latin American countries publish monthly indicators of economic activity, often referred to as *IMAE*.[3] While the purpose of these indicators is for the short-term analysis of the economy's development, it has, to the knowledge of the author, not yet been investigated how much information these indicators

[1] For it's Spanish acronym: *Indicador mensual de actividad económica*.

[2] Before March 2009, GDP was published about three weeks after the publication of the third *IMACEC* of the quarter. This delay has been reduced to about two weeks. The publication of the fourth-quarter GDP, however, coincides with the publication of the annual accounts about one month and two weeks after the publication of the *IMACEC* of December.

[3] For its Spanish abbreviation: Índice mensual de actividad económica.

contain of the quarterly GDP, published with a further delay. Thus, the present paper is the first to provide such an analysis utilizing Chilean data.

Since historical data of *IMACEC* are revised in order to fit the published GDP, the analysis has to be made with real-time data. Research on such data has been going on for a while and by now several real-time databases have been constructed; among these some are available for external users.[4] Along with the creation of these databases, the related literature has been growing rapidly and a recent review can be found in Croushore (2008). According to Croushore the existing research on real-time data can be divided into five areas: analysis of data revisions; implications for forecasting; analysis of monetary policy; macroeconomic research; and analysis of business and financial conditions. The analysis in this paper falls within the first two categories, although strictly speaking the issue investigated is nowcasting rather than forecasting.

The analysis in the present paper focuses on final released GDP data and, as argued by Croushore and Stark (2003), data revisions can have a significant impact on empirical results of macroeconomic models. Because of this fact, there is an emergent body of literature applying real-time data in modeling and forecasting.[5] In the case of Chile, Chumacero and Gallego (2002) have shown in a study using real-time *IMACEC* data that "revisions are extremely important and can lead to inconsistent estimates of the trend component". Faust et al. (2005) argue that for several G-7 countries revisions are predictable and this could be used to improve preliminary data. The objective of this paper is related to the study of Faust et al. as the aim is to nowcast the final released GDP with data available in real time.

[4] These include a US real-time database (Croushore and Stark, (2001, 2003)); one from the UK (Castle and Ellis, 2002); one from New Zealand (Sleeman, 2006) and, recently, a German real-time database has been released (Deutsche Bundesbank, 2009).

[5] Examples, not mentioned elsewhere in this document, include Diebold and Rudebusch (1991), Evans (1998), Robertson and Tallman (1998), Orphanides (2001, 2003), Christoffersen et al. (2002), Bernanke and Boivin (2003), Faust et al. (2003) and Schumacher and Breitung (2008).

The rest of the paper is organized as follows. The next section describes the real-time data used in the analysis. Section 3 analyzes the revisions made in *IMACEC* and GDP data, while section 4 investigates what signals *IMACEC* data contain about the final GDP growth rate. The last section concludes and offers a few guidelines for future research using real-time data for Chile's economic activity.

2. Description of data

The *IMACEC* has been published since 1987; the first release included six years of observations.[6] Since then, two major revisions have taken place, both coinciding with changes of the base year.[7] As the name indicates, *IMACEC* is an indicator of activity; in fact, it is classified as a synthetic indicator with an accounting approach.[8] It has proven to be an important tool for the measurement of the evolution of the Chilean economy in the short run.

Even though it is an indicator, its resemblance with the GDP is unquestionable. For example, GDP publications and revisions are accompanied with revisions in the monthly indicator, though these revisions cannot be related to specific sectors as the *IMACEC* is only published in aggregate form.[9]

In the following analysis, data from 1987 to 2009 are applied, i.e. data up till the first publication of the GDP of the fourth quarter 2008. During this period the Chilean growth rates have fluctuated between -6.0% and 14.6% with an average of 4.6% (see figure 1).

[Figure 1]

[6] See Venegas (1987). The updated methodology is described in Venegas and Zambrano (2000).

[7] Changes of the GDP base year are documented in Correa et al. (2002) and Stanger (2007).

[8] See Escandón et al. (2005).

[9] From 2009 components of the *IMACEC* have been published together with the annual accounts. See Pozo and Stanger (2009).

2.1 The real-time data

The data used in the present analysis consist of observations of *IMACEC* and GDP published since 1987. The source is several issues of the “Boletín Mensual” and “Avance Estadístico del Boletín Mensual”, which are monthly publications by the Central Bank of Chile. The *IMACEC* is published with a lag of approximately five weeks, while the delay of the GDP is about seven weeks. Hence, *IMACEC* data for a given quarter usually are available two weeks before the first publication of the GDP.[10, 11]

The database prepared for the present analysis contains all observations published in a given issue, such that it is possible to track all historical revisions. Examples are shown in tables 1 and 2. *IMACEC* data are revised every quarter in order to match the published GDP data,[12] while GDP data of the current year are revised when the data of the following quarter are published.[13] These “preliminary” data are revised with the publication of the annual accounts in March each year to obtain the “provisory” observations, which are revised again a year later. These last data are referred to as “revised”. Every five years a major revision takes place. In March 2007 the GDP base year was changed from 1986 to 2003 and at the same time the *IMACEC* was re-based to an index with year 2003 = 100. In the next section revisions of the two series are analyzed in greater detail.

[Table 1]

[Table 2]

[10] As mentioned in footnote 2, GDP of the fourth quarter of the year is published with an additional month’s delay.

[11] The monetary policy meetings in the Central Bank of Chile are usually held in the first half of each month; hence, in four of the meetings each year, data of three *IMACEC*s of the quarter are available, while the first GDP release has yet not been published.

[12] The revision policy is described in Escandón et al. (2005).

[13] See, for example, page 47 in Central Bank of Chile (2009).

3. Revisions of *IMACEC* and GDP

Two aspects of the revisions are analyzed in this section: revisions of *IMACEC* made after the GDP is published, and revisions of the GDP between the first and the final release. Even though national accounts data in principle are always subject to revisions, in the present study observations which have undergone at least two annual revisions are considered as final, thus, observation up till 2007 are applied.

Growth rates are calculated with levels published at the same point in time, i.e. data included in the same vintage. Hence, the growth rate at time t for quarterly GDP, x_t, is calculated as:

$$\Delta^4 x_{t,\tau} = 100 * \left(\frac{x_{t,\tau}}{x_{t-4,\tau}} - 1 \right), \tag{1}$$

where $x_{t,\tau}$ is the level of the series at time t published at time τ. Final growth rates are calculated with the latest vintage possible. The source of the final rates up till 2002 is Stanger (2007)[14] and thereafter the most recent issues of "Boletín Mensual", which include the observations necessary for the calculations: the April 2005 issue for the rates of 2003 and the March 2010 issue for the rest of the sample.

With respect to *IMACEC*, y_t, the annual growth rate for quarter t is calculated as:

$$\Delta^4 y_{t,\tau} = 100 * \left(\frac{\frac{1}{3}\sum_{i=1}^{3} y_{t_i,\tau}}{\frac{1}{3}\sum_{i=1}^{3} y_{t_i-12,\tau}} - 1 \right), \tag{2}$$

[14] The paper presents a splicing of the GDP series from 1986 to 2002. The method used splices the annual series and uses the method suggested by Denton (1971) to obtain quarterly numbers.

where t_i (i = 1, 2, 3) indicates the i^{th} month of the t^{th} quarter. Figure 2 shows the revisions to the growth rates made between the publication of the last *IMACEC* of the quarter and the first publication of GDP in the same quarter. Note that the last two years of observations have not yet been subject to two annual revisions and, hence, are not considered as final in the present context.

[Figure 2]

Due to methodology improvements, the revisions in the latter part of the period are generally smaller than the early ones. Of the 84 revisions shown in figure 2, 64% were positive. The revisions do not seem to be systematic since about 50% have the same sign as the one of the period before, i.e. in half of the cases a positive (negative) revision is followed by another positive (negative) one. In fact, in an estimated AR(1) model the coefficient of the lagged revision is not statically significantly different from zero when standard confidence levels are applied.

With respect to GDP, figure 3 shows revisions made between the first and the final release. As in the case of the *IMACEC*, revisions are generally smaller in the latter part of the period. GDP revisions seem to be systematic; approximately 70% of the revisions have been positive and 70% have the same sign as the previous one. Furthermore, estimation of an AR(1) model shows that the coefficient of the lagged revision is statistically significantly positive, supporting the presence of systematic behavior.

[Figure 3]

In the next section it is investigated what GDP signals can be extracted from monthly *IMACEC* data.

4. GDP nowcasting using monthly *IMACEC* data

Since *IMACEC* data for a given quarter is available before the corresponding GDP data, a natural question is whether this first GDP release contains extra information about the final value, i.e. the number that has been subject to at least two annual revisions. In the next subsection this issue is analyzed and subsection 4.2 is dedicated to the analysis of how much extra information *IMACEC* data can provide about the final GDP compared to the information already contained in historical data. To focus the analysis on final data, only annual growth rates for the period 1987 – 2007 are utilized in this section.

Two exercises are conducted; an in-sample nowcast evaluation and another nowcasting out-of-sample. The first exercise is theoretical in the sense that it could only be made ex-post, while the results of the second exercise could have been obtained in real-time. The out-of-sample exercise is made in two steps, which are repeated: (1) The model is estimated with data up till the fourth quarter of year *T*. (2) Nowcasts are made for the four quarters of the year *T*+3. This design ensures an evaluation of the "real" real-time performance. Evaluations are based on (in-sample) root mean square error (*RMSE*)[15] and (out-of-sample) root mean square nowcast error (*RMSNE*). The models evaluated include the less parsimonious and restricted versions of this one.

4.1 Comparing signals extracted from the IMACEC and the first release of the GDP

For comparing final GDP signals extracted from *IMACEC* with those contained in first released data, two models are estimated: one includes first release growth rates to explain variations in final GDP, while the other replaces this rate by that of the quarterly *IMACEC*. To control for possible persistence, up to four lags of the first released GDP rate are

[15] For comparability of different models, the *RMSEs* are calculated with errors starting from the first quarter of 1988.

permitted in the models as well as moving average (MA) specifications of the residuals, also with a maximum of four lags.

The general model including the first released GDP growth rate has the following specification:

$$\Delta^4 x_t^f = c + \beta_0 \Delta^4 x_t^1 + \sum_{k=1}^{4} \beta_k \Delta^4 x_{t-k}^1 + \varepsilon_t, \quad \varepsilon_t = \sum_{j=0}^{4} \rho_j \mu_{t-j}, \tag{3}$$

where $\rho_0 = 1$, $\Delta^4 x^f$ is the annual growth rate of the final GDP and $\Delta^4 x^1$ is the annual growth rate of the first publication, both calculated according to (1). The term c is a constant and ε_t is an error term, which is described by a MA model where μ_t indicates *iid* errors.

Replacing the first released GDP growth rate in (3) with the *IMACEC* growth rate, the general model specification becomes:

$$\Delta^4 x_t^f = c + \alpha \Delta^4 y_t^3 + \sum_{k=1}^{4} \beta_k \Delta^4 x_{t-k}^1 + \varepsilon_t, \quad \varepsilon_t = \sum_{j=0}^{4} \rho_j \mu_{t-j}, \tag{4}$$

where $\Delta^4 y^3$ is the annual growth rate calculated with (2).

Observe that the models (3) and (4) only contain lags of first release data, while GDP for a given quarter is revised with every data published in the same year. For the purposes of the present analysis, the impact of these short-term revisions is considered to be of minor importance since, apart from the first GDP release and the *IMACEC* growth rates, the models are identical and estimated with the same observations.

Table 3 presents estimates of the less parsimonious model specified in (3), i.e. the model that includes the first GDP release, and some more parsimonious ones. Though reduction to a model including only the first released GDP and a MA term of order 1 (model 3.F) cannot be accepted by a Wald test, the fit is practically unchanged according the adjusted R^2

statistic, while the *RMSE* do increase with more than 10%. In quantitative terms, the in-sample nowcast of this reduced model is closer to the final value only in 43% of the observations. The in-sample evaluation indicates that it is possible to estimate a model that predicts the final GDP better than the first release, which suggests that Chilean GDP revisions may be predictable.

[Table 3]

With respect to the out-of-sample nowcasting, in terms of *RMSNE*, the best model includes the first release data, the third lag of this and an MA(1) component (model 3.E). According to the Diebold and Mariano (1995)[16] test (henceforth D-M), models with more MA terms (3.C and 3.E) have the same predictive power as the minimum *RMSNE* model and the model 3.B point nowcasts better than 3.E in 53% of the observations. On the other hand, the G-N test supports the alternative that 3.E nowcasts better than 3.B. In more than half of the observations, the first released data (model 3.H) nowcasts better than model 3.E and the D-M test indicates that the two models have equal performance in out-of-sample nowcasting the final GDP. In other words, the evidence from the out-of-sample exercise suggests that in practice it is not possible to improve significantly the first release estimate of the final GDP through the use of historical observations.[17]

Table 4 reports the results of the estimations of model (4). Wald tests suggest that the biggest model can be reduced to include only the *IMACEC* growth rate, the fourth lag of the first released GDP and MA components of orders one to three (model 4.C). The *RMSE* of these two models are almost equal, while it increases when more variables are excluded. In fact, the in-sample performances of the first three models reported in table 4 are equal, both in terms of the *RMSE* and in the sense that, compared to 4.A, the models 4.B and 4.C make better nowcasts half of the times. According to the *RMSNE*, model 4.E out-of-sample

[16] Unless reported otherwise, the results of the Diebold and Mariano (1995) tests were validated applying the Granger and Newbold (1973) test (henceforth G-N).

[17] Note, however, that the *p*-value of the G-N test for the hypothesis of equal performance of models 3.E and 3.H, against the alternative that 3.H is better, is only 0.11.

nowcasts the final GDP better than the other models in the table, and the D-M test suggests that the performance is statistically significantly better than several of the other models. It is noteworthy, however, that the *IMACEC* growth rate itself (model 4.G) makes better nowcasts in 50% of the cases and the *RMSNE* of this model is statistically equal to that of model 4.E. This indicates that it is hard to beat the quarterly *IMACEC* growth rate in nowcasting the final GDP.

[Table 4]

To compare the signals extracted from the *IMACEC* with those of the first GDP release, the D-M test reveals that there is no statistical difference between the nowcasting performance of the best models reported in tables 3 and 4. With respect to in-sample nowcasting, the hypothesis that the models 3.A and 4.A are equal, against the alternative that 3.A is better, is accepted with a *p*-value of 0.70. In fact, in almost half of the cases each model makes the better point nowcasts. The out-of-sample test shows a similar picture; the hypothesis that the models 3.E and 4.E are equal is accepted with a *p*-value of 0.70 but, surprisingly, the *IMACEC* model makes better point nowcasts in 56% of the periods. The simple models, i.e. the models consisting only of the growth rates (3.H and 4.G) show similar results, although in this case the first released growth rate is superior in the majority of the cases with respect to the point nowcasts and in the in-sample period the G-N test suggests that 3.H is the better model.[18]

The evidence from the analysis in this subsection suggests that the information contained in the *IMACEC* is as useful, with respect to nowcasting the final GDP growth rate, as the information contained in the first GDP release. The next subsection includes an analysis of the signals about the final GDP which can be extracted from the monthly released *IMACEC* data.

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[18] When there are no model estimations, as in the case of model 3.H and 4.G, the difference between in-sample and out-of-sample performances is due only to different sample lengths. For the long sample (1988Q1 – 2007Q4), the G-N test rejects the hypothesis of equal models against the alternative that the 3.H is better, while this is not the case for the shorter sample (1999Q1 – 2007Q4).

4.2 Extracting GDP signals from the IMACEC

The monthly publications of the *IMACEC* most likely contain useful information about the final quarterly GDP figure to be released later and in this subsection it is investigated how much extra information, compared to historical GDP data, there is in respectively one, two and three months of *IMACEC* data of the quarter in question.

Given i ($i = 1, 2, 3$) months of *IMACEC* data, the annual growth rate is calculated as:

$$\Delta^4 y_{t,\tau}^i = 100 * \left(\frac{\frac{1}{i}\sum_{h=1}^{i} y_{t_h,\tau}}{\frac{1}{i}\sum_{h=1}^{i} y_{t_h-12,\tau}} - 1 \right), \tag{5}$$

where the notation used is similar to the one in (2).

The benchmark model used for comparison includes historical data available when the *IMACEC* is published, i.e. lagged observations of first release GDP rates:

$$\Delta^4 x_t^f = c + \sum_{k=1}^{4} \beta_k \Delta^4 x_{t-k}^1 + \varepsilon_t, \quad \varepsilon_t = \sum_{j=0}^{4} \rho_j \mu_{t-j}, \tag{6}$$

where the notation is as indicated earlier. As mentioned in the previous sub-section, often GDP data, which have been subject to a first revision, are available for some of the lags in (6), but the impact of these revisions is of little relevance for the present analysis. Furthermore, when the *IMACEC* of January is available, the fourth quarter GDP rate for the previous year has not yet been published. This means that the information available for this specific quarter consists of *IMACEC*s for the three previous months. In any case, as demonstrated in the preceding sub-section, signals from three months of *IMACEC* data are as reliable as those of the first GDP release and, thus, the results presented in this sub-section should not be substantially affected by this fact.

When data of *IMACEC* are available, the model to be estimated is:[19]

$$\Delta^4 x_t^f = c + \alpha_i \Delta^4 y_t^i + \sum_{k=1}^{4} \beta_k \Delta^4 x_{t-k}^1 + \varepsilon_t, \quad \varepsilon_t = \sum_{j=0}^{4} \rho_j \mu_{t-j}, \quad i = 1,2,3, \tag{7}$$

where $\Delta^4 y^i$ (i = 1, 2, 3) is the annual *IMACEC* growth rate calculated with (5). For i = 3 equation (7) coincides with (4).

Table 5 reports the results of the estimations of the benchmark models (6). The least parsimonious model can, according to the Wald test, be reduced to a model including a constant term, the fourth lag of the first GDP release, and MA terms of orders one to three (model 5.B). Eliminating the lagged variable does not reduce the adjusted R^2 and the D-M test suggests equal nowcasting capacity. In fact, the model 5.C makes better point nowcasts than the *RMSE*-minimizing model in 54% of the cases. The *RMSNE* suggests that the last known first released GDP data (model 5.G) nowcasts better out-of-sample than the other models estimated, though it should be noted that 5.C point nowcasts better 58% of the periods.

[Table 5]

When one month of *IMACEC* data is available for the quarter (time t_1), the *RMSE*-minimizing model can, according to the Wald tests reported in table 6, be reduced by all the lags of the first released GDP rates and the MA component of order four. This model has statically equal nowcast performance, but makes better point nowcasts less than half of the observations. With respect to out-of-sample nowcasts, a further reduction of the *RMSNE*-minimizing model (6.C) results in loss of predictive power according to the D-M test. This, however, is not validated by the G-N test, which indicates equal performance with the model including only a constant and the *IMACEC* growth rate (model 6.F). Finally, according to the D-M test, the pure *IMACEC* data for the first month of the quarter (model

[19] Equation (7) is a type of bridge-model (see Parigi and Schlitzer (1995) and Baffigi et al. (2004)) using monthly observations to explain the variation in quarterly data.

6.H) is as good the *RMSNE*-minimizing model even though it makes worse point nowcasts more often than not.

[Table 6]

The models estimated when two months of *IMACEC* data are available for the quarter (time t_2), i.e. equation (7) with $i = 2$, are shown in table 7. The D-M test suggests that the in-sample performance of the model, which includes only the *IMACEC* rate and MA terms of order one and three (model 7.C), is as good as that of the less parsimonious model (7.A), while the G-N test suggests that the MA(3) component could also be disregarded (*p*-value of 0.10). With respect to the out-of-sample performance, the *RMSNE*-minimizing model includes only the contemporaneous *IMACEC* and an MA(1) term (model 7.E), but making out-of-sample nowcasts with the pure *IMACEC* (model 7.G) yields similar results and this latter model point nowcasts better 56% of the times.

[Table 7]

Comparing the models reported in tables 3-7 makes it possible to evaluate what signals the *IMACEC* contains about the current quarter final GDP growth rate. The results of the preceding analysis have shown that, with respect to out-of-sample nowcasting, there are no statistical gains in using historical data to estimate models, which also include the latest released data. Hence, prior to comparing the best models, it may be useful to analyze what signals the pure data contain. The results are reported in table 8.[20] Compared to the last known GDP data (t_0), the first *IMACEC* data of the quarter does not significantly improve the nowcast performance, while the second data does contribute some increase in the predictive capacity. This is supported by the G-N test, which strongly rejects the hypothesis of equal models against the alternative that the t_2 model is better. The last *IMACEC* data enhance the predictive power further, while, as reported earlier, there is no clear evidence

[20] As mentioned earlier, since there are no estimations involved, the difference between the in-sample and out-of-sample results is due to different samples.

that the first released GDP is a better predictor of the final GDP than the quarterly *IMACEC*.

[Table 8]

With respect to the estimated models, in terms of the coefficient of determination (R^2), compared to the model which includes only historical GDP data (reported in table 5), adding the *IMACEC* of the first month of the quarter (table 6) increases this by 15% and adding the second month does so by another 9%. The last *IMACEC* of the quarter (table 4) adds an additional 4% to this coefficient, while there is no improvement in replacing this with the first release of the GDP (table 3).

These observations are supported by the *RMSE* calculated in-sample; adding the first *IMACEC* minimizes this with 22% and with another 21% when the second month is available. Both of these improvements are statistically significant in agreement with the D-M tests reported in the left-hand side of table 9. The improvement from adding the last *IMACEC* of the quarter is also statistically significant, while replacing this with the first GDP release does not add to the nowcast performance.

[Table 9]

The right-hand side of table 9 compares the number of times different models make better point nowcasts. The model including one month of *IMACEC* data makes better nowcasts than the benchmark models in 58% of the cases and when including an additional *IMACEC*, this model nowcasts better than the t_1 model 65% of the times. When including the last *IMACEC* of the quarter, the resulting model nowcasts better than the t_2 model 54% of the periods.

The comparisons reported above are in-sample and, hence, could not have been made in real-time. The out-of-sample comparison reveals somewhat different results. The *p*-values of the D-M tests are reported in the left-hand side of table 10 and the percentage of times a given model makes better point nowcasts than another are shown at the right-hand side. According to the D-M test, the benchmark model makes out-of-sample nowcasts as well as the models including one and two months of *IMACEC* data, respectively, even though the t_2 model does make better point nowcasts 58% of the cases. These results, however, are not supported by the G-N test, which suggests that the models t_0 and t_1 may be equal (*p*-value of 0.07), but rejects the same hypothesis in favor of the alternative that the t_2 model is better than t_0 (*p*-value of 0.00). Furthermore, both tests indicate that the t_2 model nowcasts significantly better than the t_1 pointing towards the fact that the nowcast of the final GDP is indeed improved when two months of *IMACEC* data are available. The models with three months of *IMACEC* data and the one including the first GDP release are both significantly better than the models with less information.

[Table 10]

To answer the question: "how much extra information about the final GDP growth rate does *IMACEC* data supply?", the evidence from the analysis above suggests that the in-sample nowcast performance improves significantly when the *IMACEC* from each month of the quarter is added and the improvements are statistically significant. With respect to the out-of-sample performance, however, the evidence suggests no significant improvement when only one piece of data is published in the sense that the *RMSNE* decreases 8%, but tests indicate the this improvement is not statistically significant. On the other hand, adding an additional month of *IMACEC* does improve the nowcast and, compared to the model with only the first data of the quarter, it makes better point nowcasts in 67% of the periods considered. Finally, when having information of the last *IMACEC* of the quarter, the performance is improved significantly.

5. Conclusion

In this paper it was analyzed what signals of the final GDP could be extracted from the monthly indicator of Chile's economic activity (*IMACEC*). For this purpose real-time data were applied and the revisions of *IMACEC* and GDP were analyzed with respect to the properties of nowcasting final growth rates (which have been subject to at least two annual revisions). It was shown how a simple model with *IMACEC* data from three months of the quarter could nowcast final growth rates as properly as models including the first publication of the GDP, which is released later than the activity indicator. This result holds when nowcasting in-sample as well as out-of-sample.

With a benchmark model consisting of historical GDP observations, it was investigated how much extra information monthly *IMACEC* data could offer with respect to the final GDP. The in-sample analysis revealed that there is indeed useful information in the monthly released *IMACEC* rates as the nowcast performance improved significantly with each extra month of data available. In practical terms, however, the out-of-sample analysis indicated that the benchmark model nowcasted as properly as the model including one month of *IMACEC* data, while the model with two months of data showed signs of better performance and made better point nowcasts in almost 60% of the periods analyzed. With three months of *IMACEC* data there was a significant improvement of the performance.

Since research with Chilean real-time data is still at its beginning, there are several subjects which would be interesting to investigate. Among others, the following questions are appealing: Can specific components on the demand and/or the supply side explain GDP revisions? Is it possible to predict short-term data revisions? Do revisions affect short-term and medium-term forecasts? If so, does this have implications for the conduct of monetary policy? These and other questions will be left for future research.

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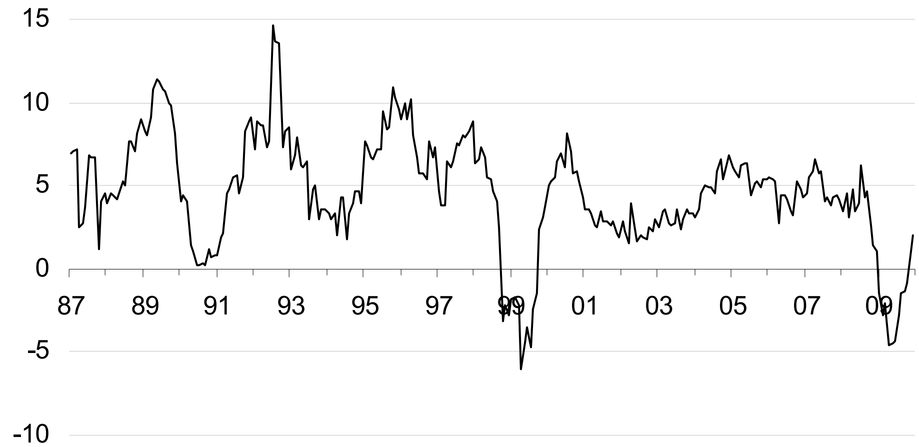
Figures

Figure 1. Annual growth rates, first publications of *IMACEC*

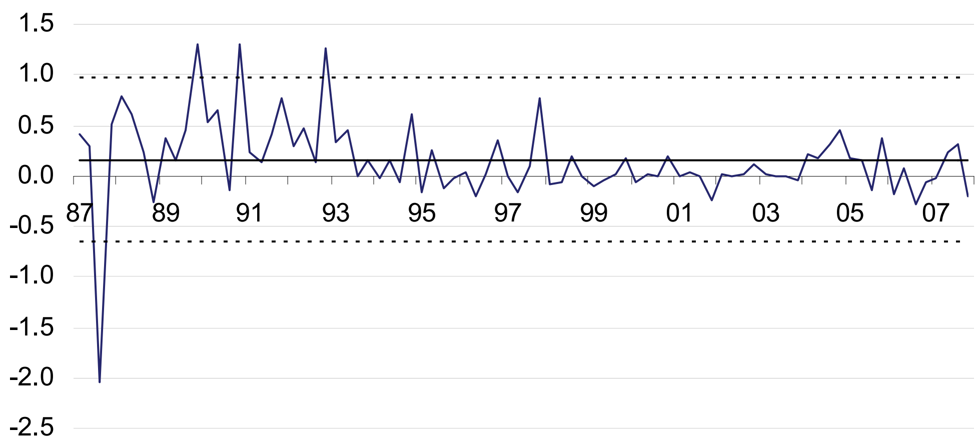
(percentage)



Source: Central Bank of Chile.

Figure 2. Revisions made between the first publications of *IMACEC* and GDP

(percentage points)

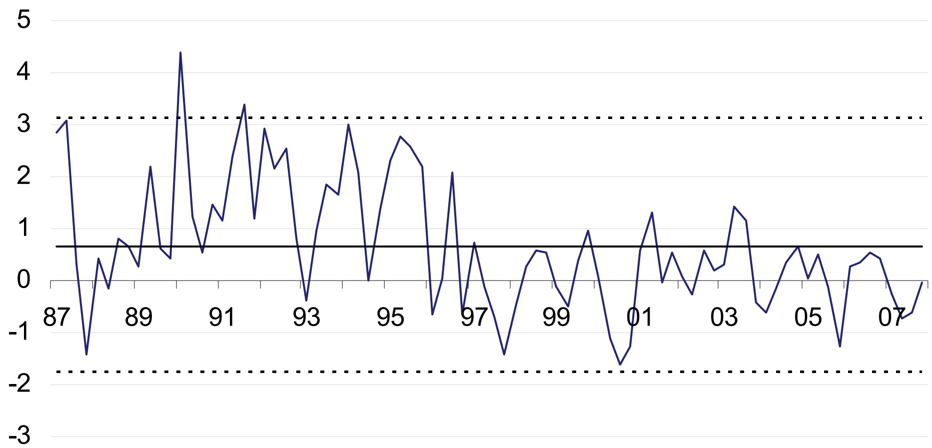


Source: Author's elaboration.

Note: Solid straight line indicates the average and the dotted lines are the averages plus / minus two times the standard deviation.

Figure 3. GDP revisions: last minus first publication

(percentage points)



Source: Author's elaboration.

Note: Solid straight line indicates the average and the dotted lines are the averages plus / minus two times the standard deviation.

Tables

Table 1. A section of the real-time GDP database

(constant prices, million pesos)

	2006			2007				2008
	May	**Aug.**	**Nov.**	**Mar.**	**May**	**Aug.**	**Nov.**	**Mar.**
I/06	11.464.700	11.488.754	11.478.428	14.767.446	14.767.446	14.767.446	14.767.446	14.668.483
II/06		11.668.947	11.657.484	15.128.813	15.128.813	15.128.813	15.128.813	15.189.667
III/06			11.092.285	14.462.037	14.462.037	14.462.037	14.462.037	14.537.983
IV/06				15.230.521	15.230.521	15.230.521	15.230.521	15.352.820
I/07					15.629.265	15.617.348	15.634.239	15.580.886
II/07						16.045.098	16.071.464	16.130.990
III/07							15.057.612	15.110.208
IV/07								15.971.384

Source: Central Bank of Chile.

Note: The rows contain the published data of the quarter indicated in the first column. The data were published in the issue of the "Boletín Mensual" indicated in the first row. Marked numbers indicate that the data has been revised. The data published in 2006 are in constant 1986-prices; while those published since March 2007 are in 2003-prices.

Table 2. A section of the real-time *IMACEC* database

(constant prices, index)

	2006										2007												2008	
	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
1/06	146.2	147.7	147.7	147.2	147.2	147.2	147.1	147.1	147.1	147.0	147.0	147.0	147,0	114.5	114.5	114.5	114.5	114.5	114.5	114.5	114.5	114.5	114.5	114.5
2/06		136.9	136.9	136.8	136.8	136.8	137.3	137.3	137.3	137.1	137.1	137.1	137,1	107.0	107.0	107.0	107.0	107.0	107.0	107.0	107.0	107.0	107.0	107.0
3/06			156.6	156.5	156.5	156.5	157.0	157.0	157.0	156.9	156.9	156.9	156,9	124.9	124.9	124.9	124.9	124.9	124.9	124.9	124.9	124.9	124.9	124.9
4/06				147.9	147.9	147.9	147.8	147.8	147.8	147.8	147.8	147.8	147,8	118.0	118.0	118.0	118.0	118.0	118.0	118.0	118.0	118.0	118.0	118.0
5/06					153.0	153.0	153.2	153.2	153.2	153.1	153.1	153.1	153,1	121.7	121.7	121.7	121.7	121.7	121.7	121.7	121.7	121.7	121.7	121.7
6/06						147.1	147.3	147.3	147.3	146.9	146.9	146.9	146,9	115.2	115.2	115.2	115.2	115.2	115.2	115.2	115.2	115.2	115.2	115.2
7/06							142.4	142.4	142.4	141.6	141.6	141.6	141,6	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
8/06								142.6	142.6	142.3	142.3	142.3	142,3	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
9/06									142.3	142.2	142.2	142.2	142,2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2
10/06										150.2	150.2	150.2	150,2	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3
11/06											148.3	148.3	148,3	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0
12/06												155.4	155,4	122.0	122.0	122.0	122.0	122.0	122.0	122.0	122.0	122.0	122.0	122.0
1/07													153,7	120.6	120.6	120.7	120.7	120.7	120.7	120.7	120.7	120.8	120.8	120.8
2/07														113.1	113.1	112.7	112.7	112.7	112.6	112.6	112.6	112.8	112.8	112.8
3/07															133.0	133.2	133.2	133.2	133.1	133.1	133.1	133.1	133.1	133.1
4/07																125.8	125.8	125.8	126.2	126.2	126.2	126.3	126.3	126.3
5/07																	127.6	127.6	127.9	127.9	127.9	128.1	128.1	128.1
6/07																		122.2	122.3	122.3	122.3	122.6	122.6	122.6
7/07																			118.1	118.1	118.1	118.9	118.9	118.9
8/07																				118.6	118.6	118.7	118.7	118.7
9/07																					115.4	115.6	115.6	115.6
10/07																						123.4	123.4	123.4
11/07																							122.4	122.4
12/07																								126.6

Source: Central Bank of Chile.

Note: The rows contain the published data of the month indicated in the first column. The data were published in the issue of the “Avance Estadístico del Boletín Mensual” indicated in the first row. Marked numbers indicate that the data has been revised. Until February 2007 the base year is 1996 and from March 2007 it is 2003.

Table 3. Estimations of models. Dependent variable: Final GDP

	3.A	3.B	3.C	3.D	3.E	3.F	3.G	3.H
Constant	0.49							
	(0.46)							
$\Delta^4 x^1$	0.97	0.99	0.99	1.01	1.01	1.10	1.11	1
	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)	(0.03)	(0.03)	
$\Delta^4 x^1(-1)$	-0.003							
	(0.07)							
$\Delta^4 x^1(-2)$	0.003							
	(0.05)							
$\Delta^4 x^1(-3)$	0.21	0.13	0.13	0.11	0.11			
	(0.07)	(0.05)	(0.05)	(0.04)	(0.04)			
$\Delta^4 x^1(-4)$	-0.16							
	(0.09)							
MA(1)	0.59	0.57	0.61	0.50	0.58	0.52		
	(0.11)	(0.12)	(0.12)	(0.11)	(0.08)	(0.09)		
MA(2)	0.61	0.32	0.28					
	(0.13)	(0.16)	(0.15)					
MA(3)	0.33	0.27	0.29	0.14				
	(0.11)	(0.13)	(0.11)	(0.13)				
MA(4)	-0.40	-0.12						
	(0.11)	(0.11)						
Adj. R^2	0.92	0.92	0.92	0.92	0.92	0.91	0.89	0.85
Wald		0.41	0.00	0.00	0.00	0.00	0.00	0.00
			[0.26]	[0.05]	[0.29]	[0.00]	[0.00]	[0.00]
				In-sample nowcasting				
RMSE	**0.92**	0.96	0.96	0.98	1.00	1.04	1.18	1.34
D-M		0.30	0.28	0.20	0.17	0.12	0.01	0.01
Best		46%	51%	44%	43%	43%	44%	44%
				Out-of-sample nowcasting				
RMSNE	2.48	0.83	0.71	0.71	**0.69**	0.91	0.95	0.70
D-M	0.08	0.13	0.25	0.21		0.02	0.03	0.41
Best	36%	53%	50%	50%		39%	44%	53%

Source: Author's elaboration.

Note: Numbers in parentheses are Newey and West (1987) HAC consistent standard errors. The evaluation of the in-sample performance is made with data from 1988 to 2007, while the out-of-sample nowcasts are made from 1999. *RMSE*: Root mean square error calculated in-sample. *RMSNE*: Root mean square nowcast error calculated out-of-sample. Wald: *p*-value of the Wald test for reduction of model compared to the less parsimonious model. Numbers in hard brackets are *p*-values for the comparison with the model reported in the column to the left. D-M: *p*-value for the Diebold and Mariano (1995) test of equality with the model with lowest *RMSE* /*RMSNE* (in bold). Best: Percentage of times where the model makes better projections than the model with minimum *RMSE* / *RMSNE*.

Table 4. Estimations of models. Dependent variable: Final GDP

	4.A	4.B	4.C	4.D	4.E	4.F	4.G
Constant	0.29						
	(0.53)						
$\Delta^4 y^3$	1.08	1.13	1.09	1.07	1.12	1.14	1
	(0.08)	(0.07)	(0.05)	(0.05)	(0.04)	(0.04)	
$\Delta^4 x^1(-1)$	0.07						
	(0.07)						
$\Delta^4 x^1(-2)$	-0.16	-0.09					
	(0.08)	(0.07)					
$\Delta^4 x^1(-3)$	0.06						
	(0.06)						
$\Delta^4 x^1(-4)$	0.14	0.17	0.16	0.07			
	(0.05)	(0.04)	(0.02)	(0.03)			
MA(1)	0.80	0.75	0.82	0.61	0.65		
	(0.15)	(0.09)	(0.17)	(0.08)	(0.09)		
MA(2)	0.06						
	(0.19)						
MA(3)	0.44	0.43	0.50				
	(0.13)	(0.12)	(0.14)				
MA(4)	-0.08						
	(0.15)						
Adj. R^2	0.93	0.93	0.93	0.91	0.91	0.87	0.82
Wald		0.65	0.48	0.00	0.00	0.00	0.00
			[0.21]	[0.00]	[0.04]	[0.00]	[0.00]
In-sample nowcasting							
RMSE	**0.88**	0.91	0.89	1.04	1.06	1.26	1.50
D-M		0.19	0.36	0.02	0.01	0.00	0.00
Best		55%	50%	48%	44%	31%	41%
Out-of-sample nowcasting							
RMSNE	2.74	1.10	1.83	0.71	**0.66**	0.98	0.69
D-M	0.06	0.01	0.02	0.16		0.01	0.34
Best	31%	25%	22%	36%		28%	50%

Source: Author's elaboration.

Note: See Table 3.

Table 5. Estimations of models. Dependent variable: Final GDP

	5.A	5.B	5.C	5.D	5.E	5.F	5.G
Constant	4.75	5.66	5.81	5.81	5.81	1.39	
	(2.15)	(1.05)	(0.76)	(0.73)	(0.70)	(0.55)	
$\Delta^4 x^1(-1)$	-0.08					0.85	1
	(0.20)					(0.09)	
$\Delta^4 x^1(-2)$	-0.15						
	(0.11)						
$\Delta^4 x^1(-3)$	0.25						
	(0.18)						
$\Delta^4 x^1(-4)$	0.16	0.03					
	(0.11)	(0.15)					
MA(1)	1.06	0.96	0.95	0.94	0.86		
	(0.22)	(0.07)	(0.07)	(0.14)	(0.07)		
MA(2)	1.09	0.78	0.76	0.24			
	(0.20)	(0.07)	(0.08)	(0.13)			
MA(3)	0.99	0.79	0.78				
	(0.19)	(0.07)	(0.07)				
MA(4)	0.11						
	(0.19)						
Adj. R^2	0.71	0.71	0.71	0.57	0.54	0.58	0.53
Wald		0.07	0.00	0.00	0.00	0.00	0.00
			[0.83]	[0.00]	[0.07]		[0.04]
In-sample nowcasting							
RMSE	**1.78**	1.85	1.85	2.27	2.36	2.27	2.40
D-M		0.15	0.16	0.03	0.01	0.01	0.01
Best		51%	54%	48%	41%	40%	38%
Out-of-sample nowcasting							
RMSNE	42.86	2.19	2.09	2.21	2.37	1.98	**1.65**
D-M	0.13	0.03	0.10	0.08	0.06	0.11	
Best	36%	50%	58%	42%	36%	36%	

Source: Author's elaboration.

Note: See table 3.

Table 6. Estimations of models. Dependent variable: Final GDP

	6.A	6.B	6.C	6.D	6.E	6.F	6.G	6.H
Constant	1.80	1.82	2.51	2.07	2.02	1.42		
	(0.75)	(0.62)	(0.52)	(0.43)	(0.42)	(0.37)		
$\Delta^4 y^1$	0.66	0.64	0.67	0.77	0.78	0.90	1.10	1
	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)	(0.07)	(0.05)	
$\Delta^4 x^1(-1)$	0.21	0.16						
	(0.10)	(0.09)						
$\Delta^4 x^1(-2)$	-0.12							
	(0.09)							
$\Delta^4 x^1(-3)$	0.08							
	(0.11)							
$\Delta^4 x^1(-4)$	-0.02							
	(0.12)							
MA(1)	0.57	0.62	0.66	0.58	0.57			
	(0.14)	(0.14)	(0.12)	(0.16)	(0.09)			
MA(2)	0.40	0.38	0.45	0.07				
	(0.15)	(0.12)	(0.10)	(0.15)				
MA(3)	0.41	0.45	0.48					
	(0.11)	(0.10)	(0.10)					
MA(4)	-0.16							
	(0.13)							
Adj. R^2	0.82	0.83	0.82	0.79	0.79	0.73	0.68	0.65
Wald		0.19	0.18	0.00	0.00	0.00	0.00	0.00
			[0.07]	[0.00]	[0.62]	[0.00]	[0.00]	[0.05]
In-sample nowcasting								
RMSE	**1.39**	1.41	1.43	1.57	1.57	1.80	1.97	2.06
D-M		0.30	0.17	0.02	0.01	0.00	0.00	0.00
Best		46%	48%	35%	39%	34%	34%	33%
Out-of-sample nowcasting								
RMSNE	3.36	1.52	**1.52**	1.83	1.81	2.16	1.90	1.59
D-M	0.09	0.49		0.02	0.02	0.01	0.07	0.32
Best	39%	53%		47%	47%	33%	50%	44%

Source: Author's elaboration.

Note: See table 3.

Table 7. Estimations of models. Dependent variable: Final GDP

	7.A	7.B	7.C	7.D	7.E	7.F	7.G
Constant	0.99	1.12	0.96	0.99			
	(0.66)	(0.40)	(0.34)	(0.32)			
$\Delta^4 y^2$	0.94	0.93	0.97	0.96	1.10	1.13	1
	(0.07)	(0.07)	(0.06)	(0.05)	(0.04)	(0.04)	
$\Delta^4 x^1(-1)$	-0.005						
	(0.07)						
$\Delta^4 x^1(-2)$	-0.02						
	(0.07)						
$\Delta^4 x^1(-3)$	0.09						
	(0.08)						
$\Delta^4 x^1(-4)$	-0.05						
	(0.09)						
MA(1)	0.72	0.74	0.62	0.71	0.67		
	(0.14)	(0.14)	(0.11)	(0.07)	(0.08)		
MA(2)	0.36	0.30					
	(0.22)	(0.19)					
MA(3)	0.35	0.37	0.22				
	(0.14)	(0.08)	(0.11)				
MA(4)	-0.14						
	(0.11)						
Adj. R^2	0.89	0.89	0.89	0.88	0.88	0.83	0.78
Wald		0.52	0.15	0.00	0.00	0.00	0.00
			[0.12]	[0.06]	[0.00]	[0.00]	[0.00]
In-sample nowcasting							
RMSE	**1.10**	1.11	1.13	1.17	1.22	1.45	1.64
D-M		0.24	0.23	0.01	0.01	0.01	0.01
Best		51%	49%	45%	44%	40%	40%
Out-of-sample nowcasting							
RMSNE	1.71	2.05	2.01	1.25	**1.08**	1.39	1.08
D-M	0.01	0.09	0.10	0.05		0.09	0.39
Best	36%	42%	39%	33%		39%	56%

Source: Author's elaboration.

Note: See table 3.

Table 8. Comparisons of simple models

In-sample					Out-of-sample				
***p*-values of D-M tests**									
	t_0	t_1	t_2	t_3		t_0	t_1	t_2	t_3
t_1	0.42				t_1	0.36			
t_2	0.08	0.00			t_2	0.07	0.00		
t_3	0.03	0.00	0.00		t_3	0.02	0.00	0.00	
t_3+	0.03	0.00	0.01	0.63	t_3+	0.03	0.00	0.01	0.70
Best point nowcasts									
	t_0	t_1	t_2	t_3		t_0	t_1	t_2	t_3
t_1	51%,				t_1	47%			
t_2	65%	69%			t_2	64%	72%		
t_3	71%	73%	56%		t_3	75%	89%	69%	
t_3+	75%	70%	65%	63%	t_3+	75%	78%	67%	58%

Source: Author's elaboration.

Note: *p*-values for the hypotheses of equal models against the alternative that the row model is better. Percentage of times the row model makes better point nowcasts that the column model. t_i (i = 0,1,2,3): *i* months of *IMACEC* data available for the quarter. t_3+: First released GDP data available. The models used are 3.H, 4.G, 5.G, 6.H and 7.G.

Table 9. In-sample comparisons of the best models

***p*-values of D-M test**					**Best point nowcasts**				
	t_0	t_1	t_2	t_3		t_0	t_1	t_2	t_3
t_1	0.01				t_1	58%			
t_2	0.00	0.00			t_2	70%	65%		
t_3	0.00	0.00	0.01		t_3	73%	60%	54%	
t_3+	0.00	0.02	0.07	0.70	t_3+	63%	64%	56%	49%

Source: Author's elaboration.

Note: See table 8. The models used are 3.A, 4.A, 5.A, 6.A and 7.A.

Table 10. Out-of-sample comparisons of best models

***p*-values of D-M test**					**Best point nowcasts**				
	t_0	t_1	t_2	t_3		t_0	t_1	t_2	t_3
t_1	0.36				t_1	50%			
t_2	0.08	0.00			t_2	58%	67%		
t_3	0.02	0.00	0.00		t_3	72%	78%	69%	
t_3+	0.03	0.00	0.01	0.70	t_3+	67%	75%	75%	44%

Source: Author's elaboration.

Note: See table 8. The models used are 3.E, 4.E, 5.G, 6.C and 7.E.

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