RESEARCH HIGHLIHTS

Review of the current research conducted at the Central Banck of Chile

April 2020

This issue of Research Highlights reviews the following subjects that have been recently analyzed at the Central Bank of Chile (CBC):

- Implications of using output gap measures in real time
- Constructing a sentiment indicator based on the business perceptions reports
- International Shocks and their Effect on Domestic Prices: How the Source and the Sector Matter

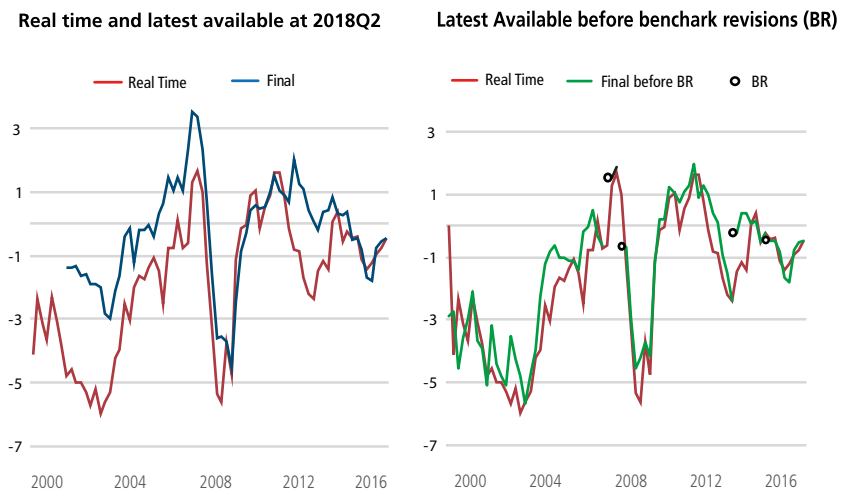
Implications of using output gap measures in real time

In an inflation-targeting regime, monetary policy decisions are guided by the expected differences between headline and target inflation in the policy horizon. Forecasting inflation over such horizon is thus a key element, and for this purpose the Central Bank has a rich toolkit of forecasting models to carry out this task. However, beyond the capacity of these models, there is a statistical constraint that comes from the fact that future inflation depends on the current activity gap, which has to be measured with only incomplete information. Firstly, because activity indicators are published with a lag and are subsequently revised over up to three years. Secondly, the estimation of the gap requires estimating potential GDP, which is influenced with greater weight by the most recent data, so with the passing of time the new information improves the estimates.

What is the magnitude of the output gap measurement errors due to this restriction? Is it possible to establish some pattern that would allow minimizing them? How relevant is this restriction for the correct forecasting of inflation and, therefore, for monetary policy decisions? These questions motivate the working paper "Hindsight vs. Real Time Measurement of the Output Gap: Implications for the Phillips Curve in the Chilean Case" (Working Paper N°854, November 2019) by authors Camila Figueroa, Jorge Fornero and Pablo García. The paper estimates and explores in detail the errors in estimating the real-time output gap for Chile from 1999 to date, and how they influence the projection of the inflation rate using Phillips curves.

> The successive changes in the methodology adopted by the Central Bank of Chile to estimate the output gap have reduced the volatility of its measurement errors and have contributed to more efficient inflation forecasting.

Real Time and Final Output Gap Time Series.



The methodology consists of comparing the output gap reported at each moment with the output gap that would be estimated today, with the complete and revised series of activity, and also with the latest method with which Central Bank of Chile staff estimates potential output. Then, the estimated error is divided according to three causes: (1) changes in the method used to estimate the potential product, (2) the passing of time, and with it the accumulation of more information that allows generating a better measurement of potential GDP, and (3) the revised activity data.

A statistical analysis of these errors seeks to check whether they behave correctly, i.e. whether they have a zero mean, a relatively small variance and it is not possible to predict them with the information available at each date. The results show that the mean of the errors is significantly different from zero, which is explained by changes in the methods used for estimating the gap and, to a lesser extent, by the revision of the data. While increasing their mean, changes in methods reduce the variance, which yields a lower signal-to-noise ratio than purely statistical methodologies do. In addition, it is found that it is not possible to predict revisions, concluding that the early estimates are efficient, and that the new information reduces the uncertainty in the estimation of the gap, as should be expected.

Finally, the authors estimate Phillips curves to explore how the statistical constraints in real-time estimations of the output gap influence the forecasting of core inflation measures. The results show that the CBC staff's revisions to the methods for estimating the output gap improve inflation projections with respect to other estimates that use the same statistical method to estimate it, especially for horizons of more than one quarter. Also, using only the information available at the time of the projection generates a worse performance than when using final information, although the differences tend to be small in relation to the gains obtained from the methods used to estimate the output gap.

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Constructing a sentiment indicator based on the business perceptions reports

Using the texts of the Business Perceptions Reports (IPN) a publication of the Central Bank of Chile (CBC) dating back to 2013, the working paper "Análisis de Sentimiento Basado en el Informe de Percepciones de Negocios del Banco Central de Chile"[2] (Working paper No. 862, January 2020), presents the construction of a numerical series that describes the emotional tone of the reports' content. The authors, María del Pilar Cruz, Hugo Peralta and Bruno Ávila, use a "text mining" methodology called Sentiment Analysis (SA) to extract the positive or negative polarity of the language used. They build a quantitative indicator and analyze its characteristics in relation to other quantitative indicators of business confidence and activity in the Chilean economy.

The application of the SA tool requires classifying the words in the text as having a "positive", "negative" or "neutral" orientation. By means of this classification, the method scans the text to calibrate its core feeling. The authors apply this methodology to the twenty-five IPNs issued quarterly by the CBC from May 2013 to August 2019, to then produce a numerical series for the entire period.

The methodology begins by preparing the texts to make them reader-friendly and then generates a dictionary of key words. The creation of the dictionary aims to define the words that best describe the sentiment of the text. For the dictionary to be usable, each word in it is assigned a score, which can be "-1" if the word has a negative tone, "0" if neutral, and "+1" if positive. The IPN sentiment index (IS-IPN) is calculated as the difference between positive and negative words divided by the sum total of positive and negative words. The index is normalized with a pivot of 50 assigned to the May 2013 IPN. The authors then compute the index both on aggregate and by region.

> By making use of algorithms, the text mining methodology can extract messages that go unnoticed to the human eye and are therefore a source of new knowledge.

To evaluate the characteristics of the aggregate IS-IPN, the document presents a comparison with business confidence indicators such as the IMCE (Monthly Business Confidence Indicator of Universidad Adolfo Ibáñez) and the ICE (Business Confidence Index of Universidad del Desarrollo), expressed in their aggregate form, by sector and by component. It is also compared with other indicators of activity in the Chilean economy, such as the Imacec and Gross Capital Formation and Consumption (see figure). Overall, the correlations are higher with the sub-indicators of expectations of the IMCE, with coefficients close to 90% and somewhat lower with the ICE. With the economic activity indicators, the correlation coefficients are lower, ranging from 40% to 59%. As for the regional indicators, correlations with the total IMCE are between 57% and 70%.

The paper also presents the application of the Latent Dirichet Allocation (LDA) model, a method that groups words by topic. The authors explore what the main topics addressed by the IPN are and how they have evolved over time. They identify five topics, namely "General expectations," "Investment and real estate," "Employment," "Costs," and "Financial conditions," finding that "General expectations" has the highest weight in the reports, although its importance has tended to decline in recent quarters. In any case, its weight continues to predominate, as in the last report analyzed it was nearly 50%.

Transforming the information contained in economic texts into quantitative indexes can be presented as a useful tool for the analysis of the economic scenario. The methods exhibited in the document are possible to replicate for

[2]/ Title translation: "Sentiment Analysis Based on the Central Bank of Chile's Business Perceptions Report."

other reports, such as the Monetary Policy Report, the Financial Stability Report and the minutes of the Monetary Policy Meetings. In this context, the dictionary associated with the study can serve as a basis for future research.

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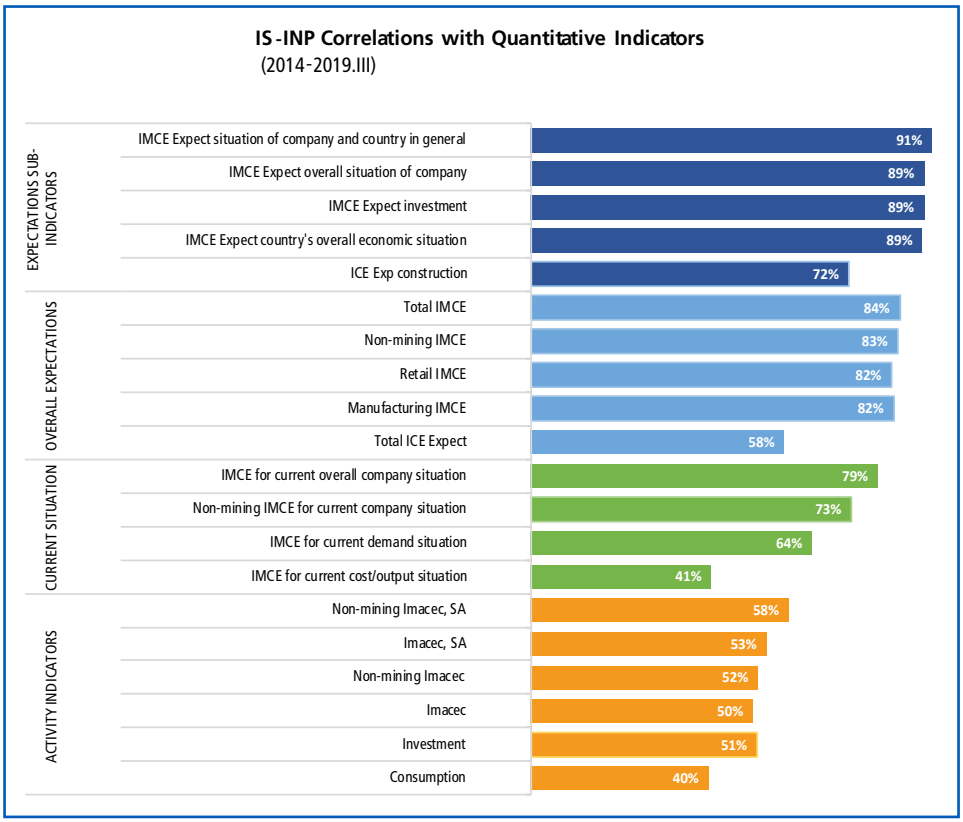


International shocks and their effect on domestic prices: how the source and the sector matter

One of the main challenges facing emerging economies is to understand how international shocks propagate domestically and what policymakers can do about it, if anything. An economy equipped with automatic stabilizers, like a flexible exchange rate, can adjust more easily to international shocks, but that might have differential effects in the domestic economy, giving rise to winners and losers from those stabilizers. This, in turn, implies policy challenges if the authority is interested in stabilizing output and reducing the uncertainty that comes with external shocks.

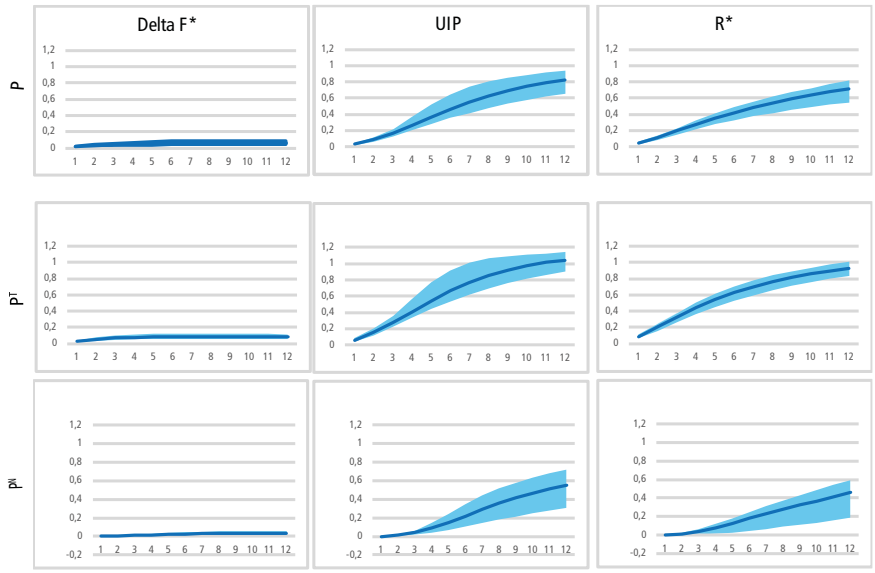
In the paper "A TNT DSGE Model for Chile: Explaining the ERPT" (Working Paper N°868, February 2020) CBC economist Mariana García-Schmidt and Central Bank of Argentina economist Javier García-Cicco study how shocks that affect the nominal exchange rate (NER) are transmitted to Chile's local economy, and how this transmission is heterogeneous across different industries, in particular tradable versus non-tradable sectors. In Chile, there is a high correlation between the NER and inflation (see figure, panel 1). But at the same time, changes in the NER can affect tradable goods, say manufacturing, more than non-tradable services, say restaurants, because the former are exposed to international competition, making the impact of international changes bigger on the prices of those tradable goods. And if prices can adapt more easily in the tradable sector, the real effect on output might be smaller. But for this analysis, the authors stress, the source of international shocks matters for how they are transmitted domestically.

> Shocks to international prices are passed-through to domestic prices via changes in the NER, but this pass-through is lower and short-lived (both for tradable and non-tradable goods), whereas shocks to the risk premium have a much higher effect on domestic prices and are longer-lived.

The authors implement an empirical analysis of how international shocks affect the domestic economy through changes in the NER and study its implication in a dynamic and stochastic

general equilibrium (DSGE) model. First, they find that shocks to international prices and to the risk-premium of the domestic economy (beyond the country risk-premium), weigh the most in driving the NER. In fact, the former represents around 70 percent of the variation of the NER over time, compared with 18 percent for the latter. Second, these shocks have very different inflationary consequences. Shocks to international prices are passed-through to domestic prices via changes in the NER, but this pass-through is lower and short-lived (both for tradable and non-tradable goods), whereas shocks to the risk premium have a much higher effect on domestic prices and are longer-lived. These results have important consequences. Figure XX displays the conditional exchange rate pass-through of international price shocks (column 1), risk-premium shocks (column 2) and international interest rate shocks (column 3) on prices of all goods (row 1), prices of tradable goods (row 2) and prices of non-tradable goods (row 3). Shock, but it may be so, to the one that has a more important impact and lives longer. This stresses the importance in recognizing the source of shocks to the NER over time.

Conditional Exchange-Rate Pass-Through (ERPT)



Note: Each graph displays the ERPT of the shock in each column on the price index in each row. The first column has the effects of the international price shocks (F*), the second column has the effects of the risk-premium shock (UIP) and the third column has the effects of the international interest rate shock (R*). The first row has the effect on the price index for all goods (P), the second row has the effect on the price index of tradable goods (PT), the third row has the effect on the price index of non-tradable goods (PN). The shaded area of each graph shows the 2.5th and 97.5th percentiles of the distribution of each ERPT.

Finally, the authors document that the effect of these shocks is bigger and shorter-lived on tradable than non-tradable prices, consistently with standard economic intuition.

All these ideas are applied to a particular event: the sharp depreciation of the NER during 2013-2015 that occurred after the tapering of the US Federal Reserve. After that, there was an important rise in inflation. The authors find that not every change in the NER had the same inflationary consequence during that event. While the main driver of the movements in the NER was the shock to external prices, the one that caused the biggest rise in inflation was the risk-premium shock. This shock was more active at the beginning of the sample. This implies that at least half of the inflation of 2015 could have been anticipated by the end of 2013 if the analysis of this paper had been used. In order to anticipate the inflation path, it is crucial to identify the shocks in time in order to use the conditional exchange rate pass-through and not the one that is regularly used, i.e. the empirical or unconditional version. Finally, the authors suggest that when evaluating these effects in real-time (and not ex-post as it was done in their paper), it is important to keep track of ongoing revisions to the data because updated information can alter the initial analysis.

Recent Articles Published in Academic Journals by Central Bank Researchers, January-March 2020

Bauducco, S., and R. Caputo, "Wicksellian Rules and the Taylor Principle: Some Practical Implications," *The Scandinavian Journal of Economics*, 122 (1): 340-368.

Carvalho, C., N. Pasca, L. Souza and E. Zilberman, "Macroeconomic Effects of Credit Deepening in Latin America," forthcoming, *Journal of Money, Credit and Banking*.

Fornero, J., Fuentes, M., and Gatty, A., "How do manufacturing exports react to RER and foreign demand? The Chilean case," *The World Economy* 43(1), 274-300.

Gonzalez, M., and Tadle, R., "Signaling and Financial Market Impact of Chile's Central Bank Communication: A Content Analysis Approach," forthcoming, *Economía*.

Pasten, E., Schoenle, R., and Weber M., "The Propagation of Monetary Policy Shocks in a Heterogeneous Production Economy," forthcoming, *Journal of Monetary Economics.*

Pasten, E.,"Prudential Policies and Bailouts - A Delicate Interaction," Forthcoming, *Review of Economic Dynamics.*

Pedersen, M., and Caputo, R. "The Changing Nature of the Real Exchange Rate: The Role of Central Bank Preferences," in press, *Economic Modelling*.

Recent working papers of the Central Bank of Chile

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