

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

- **Impact of climate change on Chile's economic activity: past and future**
- **Shocks to commodity prices, factor utilization, and productivity dynamics**
- **Using the press as a real-time economic confidence indicator**

Impact of climate change on Chile's economic activity: past and future

The analysis and measurement of the evolution and effects of the climate change process has taken center stage in the public policy debate, due to its importance for the future prospects of humankind and the planet. Beyond its ecological impacts, this process, expressed in aspects such as significant variations in average temperatures or the amount of rainfall, anticipates, by its very nature, severe consequences in multiple economic and social dimensions.

Along these lines, a long series of studies have predicted in recent years that climate change will be associated with adverse effects on economic growth in most countries, reducing global GDP. Furthermore, this effect will be heterogeneous, hitting hardest those countries that are closest to the equatorial zones. Thus, given their geographic location and productive structure, the economic costs of climate variations may be particularly severe in Latin America and the Caribbean, with harsh effects in terms of poverty and inequality. All of this poses great policy challenges, regarding both the correct measurement and prediction of the potential effects and the adoption of possible mitigation strategies.

Contributing to this debate, the working paper [*"The impact of climate change on economic output in Chile: past and future."*](#) by Karla Hernández (U. of Wisconsin-Madison) and Central Bank of Chile (CBC) economist [Carlos Madeira](#) examines the economic impact of climate change in Chile over the past 35 years, and project its possible effects into the future. They also review other studies that have estimated potential future consequences. In their analysis, the authors use data from the University of Delaware, which allows them to characterize changes in rainfall and temperatures

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by region in Chile over the last three decades. By weighting regions by their GDP, the authors find that this period has been associated with a significant increase in average temperature, close to 0.4°C (0.72°F), and a marked drop in average precipitation. The climate information is combined with GDP data by region/industry from 1985 to 2017 to study the effects on activity of variations in precipitation and temperature.

A first message of the paper is that, in general, the effects on activity of the climate changes experienced in recent decades have been moderate. Statistically, variations in precipitation levels have not had an impact on GDP, but there is a negative effect of higher summer temperatures on the Agriculture-Forestry and Fishing industries. In particular, a rise in temperature of one degree Celsius in the month of January reduces the Agriculture/forestry and Fisheries' GDP by 3% and 12%, respectively, and also has an adverse impact on the Construction and Electricity, gas and water industries (table 1). However, many industries have not been affected, or have even been marginally benefited. In any case, the absence of regional GDP series by sector on a monthly or quarterly basis makes it difficult to make a more accurate estimate.

A second message refers to future projections. Quantitative exercises for 2050 and 2100 based on estimated coefficients and different scenarios for the evolution of global temperature show, in the central scenario, a relatively limited impact of

climate change on Chile's GDP at those horizons, partly because of its relatively low weight in the output of the most affected sectors. However, different stress scenarios show that the adverse effects of climate change are potentially very important, with a drop in GDP as big as 15% by 2050 and up to 40% by 2100.

These results are in line with earlier literature reviewed by the authors. While some studies expect the effects of the future climate trajectory on variables such as GDP growth, productivity and mortality to be moderate, more recent work describes scenarios in which higher temperatures may be associated with significant costs in terms of activity, and that the economy's adaptation to a warmer climate will not be straightforward. In addition, the paper discusses how the costs associated with climate change will be expressed not only in terms of reduced activity, but in multiple dimensions such as air pollution, water access issues, migration flows, and changes in ecosystem classification. Summing up, the paper shows that, although in recent decades climate change has had limited effects on activity in Chile, going forward there are risk scenarios of potentially very significant negative impacts. This reinforces the importance of improving analytical and measurement tools for climate change and its repercussions on different regions and sectors, as well as for designing and preparing contingency plans and mitigation actions.

Table 1: Total impact on the industry GDP growth rate (in %) of the estimated models for a one degree Celsius temperature increase throughout the year

Sum of the coefficients' impact	Agriculture	Fishing	Mining	Manufacture	EGA	Construction	Commerce	Transport	Finan. serv.	Home property	Pers. serv.	Public adm.
Quarterly weather fluctuations model												
All quarters	0,9	-7	-1,5	2,6	-0,1	0,7	1	0,3	0,7	-0,6	0,3	-0,4
Stat. significant	0,9	-10,8	-0,1	0	1,8	0	1	0	0,6	0	0	0
Significant & negative	0	-10,8	-0,1	0	0	0	0	0	0	0	0	0
Monthly weather fluctuations model												
All months	1,3	-8,8	-1,9	2,5	1,9	1,2	0,4	0,2	1,1	-0,7	0,1	-0,2
Stat. significant	-3	-12,1	0,5	-2,2	-3,9	-0,3	-0,7	0	1,7	0	0,2	0
Significant & negative	-3	-12,1	0	-2,2	-3,9	-0,3	-0,7	0	0	0	0	0

Shocks to commodity prices, factor utilization, and productivity dynamics

Chile is a small and open economy and, as such, is exposed to various shocks originating in international markets. Among the most important in terms of their incidence on local activity are variations in the copper price. Together with affecting gross domestic product, employment and investment, changes in the price of the red metal are positively associated with contemporaneous variations in the Chilean economy's aggregate productivity (the correlation coefficient is 0.69 for the 1997-2009 period). This phenomenon is replicated elsewhere in the world and has attracted the attention of several researchers (Kehoe and Ruhl (2008), for example) because, in principle, price movements would not necessarily be so closely associated with oscillations in the level of technology. This paper proposes that the observed association can be explained by adjustments in the utilization of primary factors of production (i.e., capital and labor), which are not adequately captured or measured by the statistics.

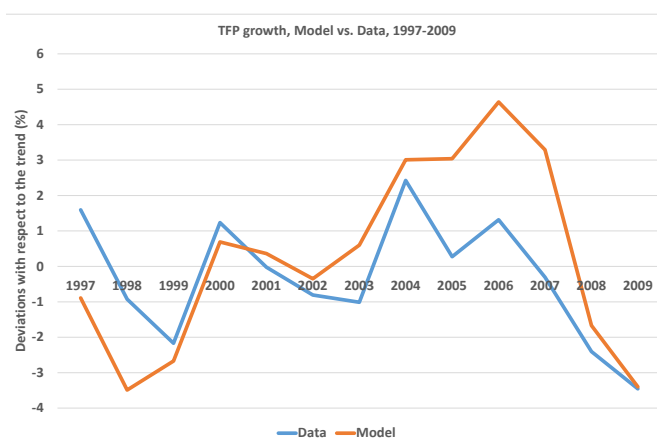
A firm can adjust the total amount of services from primary factors in two ways: by hiring more machines and workers (the so-called extensive margin of utilization) or by varying the intensity of use of these inputs in the production process (the intensive margin of utilization). Suppose a situation in which a plant unexpectedly needs to increase its production and where, in addition, there are frictions for an immediate adjustment in the extensive

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margin. In this case, the firm may respond to this scenario by, say, increasing the power at which machines operate or inducing workers to work harder per hour. Since these adjustments are not reported in the statistics on input hiring, but are reflected in the final product, they are measured as changes in the total productivity of the factors used by the firm.

In his paper "*Commodity price shocks, factor utilization, and productivity dynamics*" CBCh economist [Gustavo González](#) makes use of the Annual National Industrial Survey (ENIA) for the years 1995-2007, and provides plant-level empirical evidence that indirectly supports the hypothesis discussed in the previous paragraph. Relying on the 1996 input-output matrix and the methodology outlined in Acemoglu et al. (2015), the author creates measures of total exposure of industrial establishments to the copper sector, both on the cost side and on the final demand side. These exposure measures are then interacted with the variations observed in the international copper price, as traded on the London Metal Exchange. Thus, the aim is to evaluate how changes in the price of the metal affect productivity indicators, total factor productivity measures and the hiring of capital, labor and materials at the plant level. The paper finds that establishments that were more exposed in terms of costs to the copper industry suffered greater productivity losses when the copper price rose, while those that served mainly the local market saw

Figure 1: Total Factor Productivity



gains. In both cases, changes in capital and labor contracting were substantially smaller than changes in productivity or output.

Based on these results, the author estimates the relevance of variations in the intensive margin of factor use on the economy's total factor productivity. To this end, he proposes a real cycles model that incorporates a complete production network across sectors, frictions in primary factor contracting

and the possibility of variation in capital and labor utilization. The key parameters of the model are assigned values using the empirical results on productivity responses obtained with the microeconomic data. After simulating what would happen in the model when submitting it to the copper price trajectory observed in real life, the author finds that, consistently with the data, it is possible to generate a strong positive association between changes in the copper price and changes

in aggregate productivity. This can be seen more clearly in figure 1. Likewise, variations in the intensive margin that are induced by changes in the copper price explain more than 100% of the observed changes in aggregate productivity during the 1997-2009 period, which suggests that productivity adjusted for this copper-price-induced variation in factor utilization is in fact negatively correlated with the copper price shocks.

Using the press as a real-time economic confidence indicator

The economic outlook of businesses and consumers directly influences decision making and, hence, the future performance of the economy. For this reason, central banks and other organizations that need accurate economic projections increasingly include information on expectations and confidence of economic agents in the forecasting models they use.

This information has been mostly collected in surveys of consumers and firms, and has contributed to improve the prediction of the economic cycle and inflation, among other variables. However, recent computational advances have made it possible to go beyond surveys, which take time to complete, and use the subjective information contained in the news to measure the mood of economic agents. These advances make it possible to gather information almost instantaneously, a feature that is especially valued in times of economic stress, precisely when the situation calls for fast economic policy decisions.

CBCh researchers María del Pilar Cruz¹, Hugo Peralta, and Juan Pablo Cova, in their paper [“Using the Press as a Real-Time Economic Confidence Indicator,”](#) construct a daily frequency indicator of economic sentiment based on the computational reading of about 935 thousand news items contained in the six main print media with nationwide coverage in Chile for the period 2015-2020. This indicator captures the emotional tone of economic news and opinion in real time and the authors find a high correlation with confidence indicators based on surveys but which are measured with at least a one-month lag. To capture the emotional tone of the texts, a Spanish-to-Spanish dictionary is constructed with an extensive number of words labeled according to the sentiment they carry, comparable to its English counterparts and which can be used in the future.

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The methodology used—known as sentiment analysis—captures the optimistic or pessimistic sentiment underlying the texts.

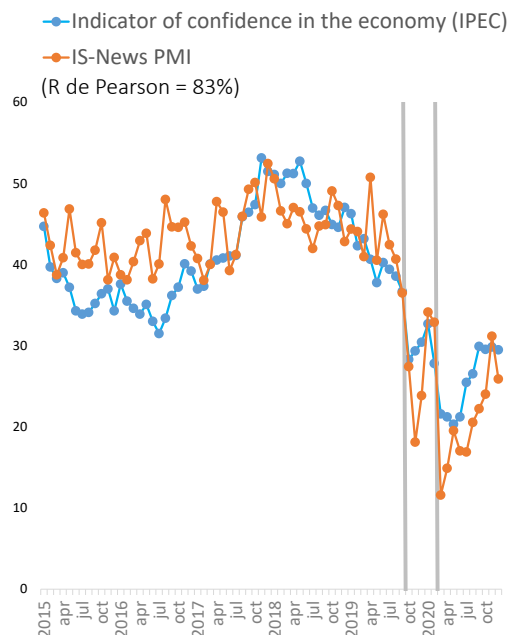
With this in mind, they produce a dictionary of selected terms, which are manually labeled according to the tone they carry, considering those that reflect a clear feeling orientation, and which are classified with valences. Words with positive valences are used to pick up desired states and those with negative

valences, undesired states. The dictionary generated by the authors contains about 5400 lemmas and their derivations, which are labeled according to international recommendations.

Once the dictionary has been constructed, the words that appear in each day's news are detected. These include, with different scores according to their effect, sentiment words, modifying words that intensify or attenuate the tone, and negation words, which invert the polarity of adjacent words. An index is calculated for each sentence and then their average is used as the index of the news item. A second index is also constructed, based on the Pointwise Mutual Information (PMI) methodology, which modifies the value previously assigned to each word in the dictionary according to the use made of it in the analyzed news items. If a positive word is used repeatedly in negative news then its value will be diminished, and vice versa. Finally, sentiment indexes are constructed for each day, which represent the linear average of the polarity of the news items reviewed, calculated either on the basis of the dictionary alone or also using the PMI methodology.

To evaluate the usefulness of the high frequency indicator, the authors explore its correlation with various confidence indices such as the Economic Perception Index (IPEC), the Monthly Business Confidence Indicator (IMCE) and the Business Confidence Index (ICE), in

Figure 2: IS-News vs Indicators of Confidence in the Economy (IPEC): 2015-2020



¹Currently with the Finance Ministry.

addition to the Imacec. In all cases the correlations are significantly higher when the PMI methodology is used to adjust the value of the words previously defined in the dictionary. The same is true when confidence and activity indicators lag by about four weeks, evidencing the faster speed with which the constructed indicators capture the sentiments of economic agents.

The highest correlations are observed with the IPEC, suggesting that the news is a good predictor of the degree of confidence that citizens have in the economy. As can be seen in figure 2, where the series are lagged by one month, the relationship holds during the two major shocks that hit the Chilean economy in the past few years: the 2019 social crisis and the Covid-19 pandemic, which arrived in Chile

in March 2020 (both dates marked with a vertical line in figure 2).

In this way, this work contributes with a valuable tool to improve the Central Bank of Chile's projections, especially in critical moments when the speed with which information is obtained becomes paramount.

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Alfaro, R. and A. Sagner “S&P 500 under a Structural Macro-Financial Model” *Economic Analysis Review*, 36(2), 3-20.

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Morales-Resendiz, R., J. Ponce, P. Picardo, A. Velasco, B. Chen, L. Sanz, G. Guiborg, B. Segendorff, J. L. Vasquez, J. Arroyo, I. Aguirre, N. Haynes, N. Panton, M. Griffiths, C. Pieterz, and A. Hodge “Implementing a retail CBDC: Lessons learned and key insights” *Latin America Journal of Central Banking*

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