RESEARCH HIGHLIGHTS

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

April 2023

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

- **Where is the Inflation? The Diverging Patterns of Prices of Goods and Services.**
- **Business Cycle Asymmetry and Input-Output Structure: The Role of Firm-to-Firm Networks.**
- **From Dominant to Producer Currency Pricing: Dynamics of Chilean Exports.**

Where is the Inflation? The Diverging Patterns of Prices of Goods and Services

In recent years, and in view of the behavior of prices on a global scale, concern about inflation has once again taken center stage in the international public discussion. In this regard, there has been growing interest in a more careful and detailed analysis of price dynamics, of the differences in behavior between different types of goods and services, and of the way local prices are affected by global trends.

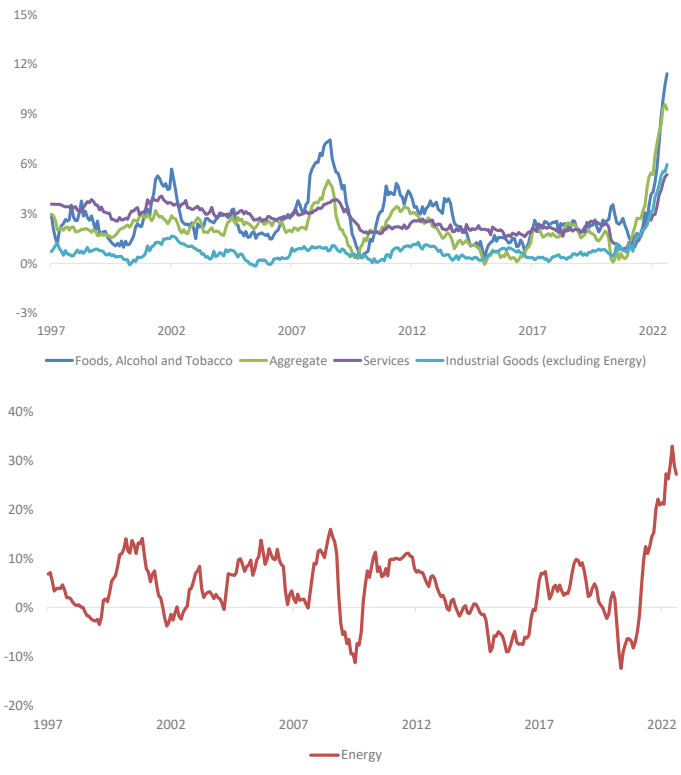
Contributing to this debate, in the working paper *"Where is the Inflation? The Diverging Patterns of Prices of Goods and Services"*, Central Bank economists Gent Baraj, Guillermo Carlomagno and Juan Marcos Wlasiuk present, for a broad sample of countries, a series of stylized facts on relative prices across countries and sectors, and assess the relevance of local, global and sectoral factors in explaining aggregate CPI and its main components.

For their analysis, the authors construct a new database of disaggregated monthly CPI data for 44 countries between 1996 and 2022. The sample includes most of the developed economies, as well as some emerging economies. The authors not only aggregate and consolidate the publicly available information, but also adjust it in order to make it comparable and with homogeneous criteria, taking into account the methodological differences and expenditure patterns between countries. Thus, the CPIs are broken down into 93 components with a common methodology and a precise definition. These components are then aggregated into 10 intermediate indexes for each country, which in turn can be divided into four main categories: Energy; Industrial goods (excluding Energy); Foods, alcohol and tobacco; and Services. The database allows for international comparisons of inflation dynamics free of methodological, structural, and weighting differences. This extends the evidence available in previous literature, as it allows for a more granular analysis and for a larger sample of countries.

"Over the twenty-five years under analysis, systematic differences are found around the world in the behavior of inflation for the four main CPI components."

A first message of the paper is that there is a clear co-movement in inflation among the 44 countries analyzed, in terms of both the aggregate CPI and its components. Thus, in most countries inflation trended downward since the mid-1990s, and especially after the Global Financial Crisis (GFC) of 2009. This global pattern was recently reversed during the Covid-19 pandemic, with inflation rising sharply in the last two years. Thus, average annual inflation for the median base country fell from 2.3% between 1997-2009 to 1.7% in 2010-2019, before rising to 3.5% in 2020-22. In disaggregated terms, the fall in inflation in the decade following the GFC was mainly due to the performance of services inflation, while the rise associated with the pandemic is mainly explained by energy prices.

Figure 1: Median inflation of main CPI components, 1997-2022



A second message is that over the two and a half decades analyzed there are systematic differences in the behavior of inflation for the four main components of aggregate CPI (figure 1). These differences are observed in average levels, as well as in volatility and cyclical dynamics. Thus, while average annual Energy inflation of 1997-2022 was almost 4% and highly volatile, the average

annual inflation of Industrial goods barely reached 0.8%, and was much more stable. The average inflation of Industrial goods was also much lower than that of Foods (2.8%) and Services (2.7%). These differences are associated with relative price trends, reflecting different forces such as the dynamics of technological change and the evolution of households' spending patterns.

A third message, obtained from a dynamic factor model, is that in statistical terms, international factors play a predominant role in the behavior of the main inflation categories, especially Energy and overall inflation. This is consistent with the cross-country co-movement in inflation described above. Interestingly, local factors tend to have more weight in non-energy industrial goods inflation, while the influence of the global factor is greater in services inflation.

To summarize, the study shows that inflation patterns show important similarities across a broad sample of countries, both in the moderation of inflation over most of the last three decades and in the recent acceleration associated with the pandemic. In addition, a disaggregated look at the behavior of inflation shows systematic differences among its various components, again reflecting global patterns that are associated with changes in relative prices. These stylized facts, as well as the new database to describe them, provide a valuable starting point to improve our understanding of inflation dynamics and the local and global forces behind them, and thus improve the ability of central banks to conduct monetary policy.

Business Cycle Asymmetry and Input-Output Structure: The Role of Firm-to-Firm Networks

It is a generally accepted fact that recessions are shorter and more severe than expansions, i.e., they are "sharper". This asymmetry leads to a negatively-skewed distribution of real GDP growth as documented in, for example, Ordonez (2013). The primary explanation for this in the literature is the existence of financial constraints (Ordonez, 2013; Jensen et al., 2020). In the paper *"Business Cycle Asymmetry and Input-Output Structure: The Role of Firm-to-Firm Networks"* economists Jorge Miranda (Central Bank of Chile), Alvaro Silva (University of Maryland), Eric Young (University of Virginia and FRB of Cleveland), offer a different explanation for this asymmetry, based on the empirical importance of sectoral shocks and the structure of input-output connections.

"They show that more connections amplify the adverse effects of negative productivity shocks, creating a more negative skewness of output, if inputs are gross complements; the opposite holds if firms are more flexible in substituting their inputs."

The authors use two different types of data to show empirically their main message. First, using OECD domestic input-output data, they show that—controlling for other important cross-country characteristics— countries in which more input-output connections are active (denser networks) display more negatively-skewed business cycles, as expressed by a more negative skewness of the cyclical component of real GDP for the period 1985-2019. Second, the authors use administrative data on Chilean firm-to-firm transactions to examine the relationship between firm-level interconnectedness, as described by the total degrees of the firm—defined as the total number of suppliers and customers the firm has—and firm level resilience to negative shocks. In particular, they measure firm-level output (sales and employment) growth skewness and show that, controlling for covariates, firms with a larger number of suppliers and customers display a more negatively skewed distribution of output growth (figure 2). They then study the performance of more interconnected firms during COVID-19. They show that, controlling for other firm-level covariates, firms that had more connections during COVID-19 experienced larger declines of sales, value-added, and employment in the second quarter of 2020. They also find that, during the recovery period, more connected firms were able to grow slightly faster than less connected ones.

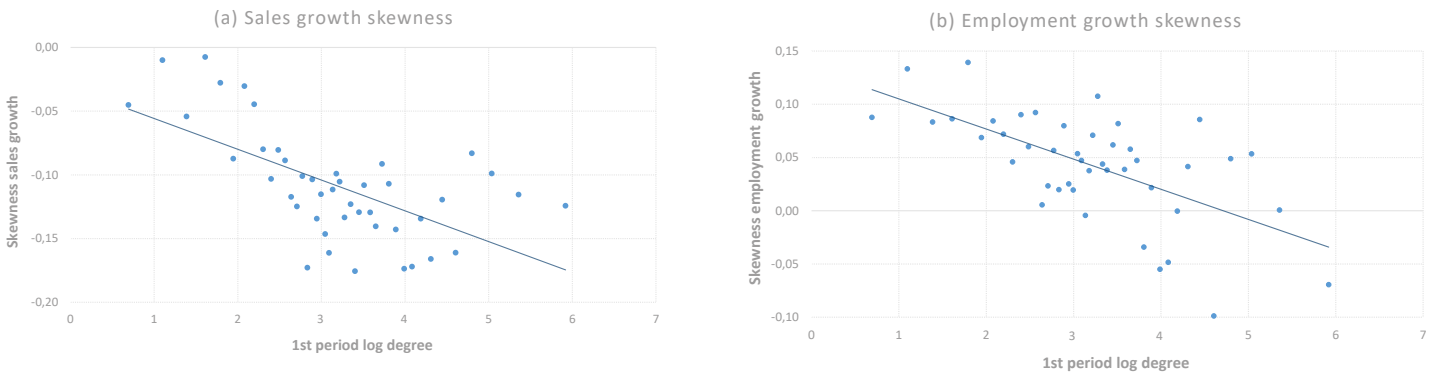
The authors go on to explain the evidence and quantify the role of networks in a production network model with firms connected through intermediate input purchases. Their approach follows closely Baqaee and Farhi (2019), in which non-linearities in production are capable of generating asymmetric business cycles out of symmetric idiosyncratic technology shocks. By extending the analysis in the cited paper, they demonstrate the role of network density—the number of active input-output links—in amplifying or mitigating negative productivity shocks. They show that more connections amplify the adverse effects of negative productivity shocks, creating a more negative skewness of output, if inputs are gross complements; the opposite holds if firms are more flexible in substituting their inputs. The intuition behind the results lies in the strength of sectoral/firm-level price and quantity adjustments. In the model, price adjustments depend only on the network structure to a first order. Quantity adjustments, also to a first order, depend on the network structure and on the flexibility in substituting inputs. If inputs are gross complements, a negative productivity shock in the dense network generates a Baumol-cost disease mechanism in which the sector hit by the negative shock becomes larger in the economy, relative to a sparser network.

They then perform two quantitative exercises to understand the drivers of macroeconomic skewness and firm-level responses to negative productivity shocks. First, they calibrate the model economy to match the production network of the 46 countries in their sample. They show that the model delivers a relationship between network density and skewness of real GDP that is qualitatively, but not quantitatively, similar to that in the data. The second quantitative exercise uses the firm-to-firm network structure of the Chilean economy before COVID-19.

They investigate the ability of the model to deliver the non-linear relationship between firm-level (in and out) degrees (the number of customers and suppliers), and output growth before, during, and after COVID-19. The model can deliver a relationship between degrees and output growth that is very similar to that in the data. They show that the magnitude of the shock is crucial to deliver these facts, and that, conditional on the size of the shock, the relationship between degrees and output growth is stronger for negative productivity shocks than for positive ones.

Therefore, the model's internal propagation is strong enough to deliver a procyclical cross-sectional skewness of output growth even if productivity shocks are symmetric. Finally, the concavity of aggregate output in this economy reconciles two seemingly contradictory facts: at the firm level, about half of the firms display positive skewness of output growth and half negative, while at the aggregate level the economy has a negatively-skewed cyclical component of output.

Figure 2: Output asymmetry and firm level networks



From Dominant to Producer Currency Pricing: Dynamics of Chilean Exports

The workhorse approach for understanding the role of exchange rates and external adjustment in the macroeconomy is the Mundell-Fleming model. In this setup, it is assumed that the price of exports is set in the currency of the producing country, and it is also referred to as the Producer Currency Paradigm (PCP). A weakening of the exchange rate, for instance, results in an increased price of the domestic good expressed in the destination currency, and an increase in the domestic-currency price of the imported good. As the price of exports (imports) becomes relatively cheaper (more expensive) in foreign markets, demand for exports (imports) increases (decreases).

The favorable characteristics of a flexible exchange rate regime under PCP have been put into question in the last decade due to the observation that the traded goods are not usually or exclusively invoiced in the currency of the producing economy. Instead, it is in the US dollar (USD) or other dominant currency, different to the ones used in the exporting or importing country. This has been referred to as the Dominant Currency Paradigm (DCP). How important are these paradigms in Chile? In *"From Dominant to Producer Currency Pricing: Dynamics of Chilean Exports"* by Pablo García, Vice Governor of the Central Bank of Chile, Marco Rojas also at the Central Bank of Chile, José De Gregorio (Universidad de Chile) and Emiliano Luttini (World Bank), shed light on this question by using administrative data from Chile's Customs Office.

The paper first presents descriptive statistics with respect to the currency of invoicing for Chilean exports between 2010 and 2019. For instance, it shows that around 90% of export value, excluding the mining sector, is invoiced in USD, and that sizable shares are invoiced in euros and pounds sterling. The dominance of the USD is almost universal in exports to China and Latin America, but it is considerably less so to destinations in Europe or Japan.

"Despite the USD predominance of invoicing in international trade, the Mundell-Fleming is still key to understand macroeconomic adjustments to exchange rate fluctuations."

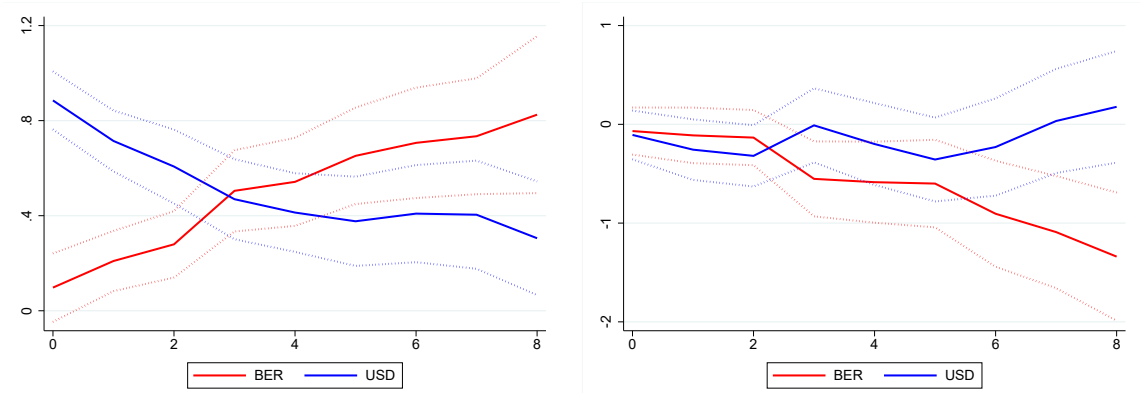
Then, the analysis moves to constructing price and quantity data for single exported products (at the 8-digit Harmonized System), by exporting firm, destination country, and currency of invoicing, from 2010 to 2019. At this level of disaggregation, the paper assumes that exchange rate movements are exogenous to non-mining firms. Therefore, exchange rate movements and their impact on prices and quantities exported are informative on the relevance of the theoretical implications of PCP or DCP. The authors explore to what extent the prices of exports, expressed in the currency of the destination economy, are sensitive to movements of its exchange rate with respect to the USD, and to bilateral exchange fluctuations, which reflect the exchange rate with respect to the Chilean peso (CLP). The authors analyze the responses of prices at several time horizons, controlling by global, destination economy, and Chilean macroeconomic factors.

The results are summarized in the figure below. Panel (a) shows that, on impact, a depreciation of the destination economy´s currency vis-à-vis the USD leads to around a 1-to-1 response of the prices of Chilean exports in the importer's currency. On the other hand, a bilateral depreciation does not have an effect on export prices at destination. These results provide strong evidence in favor of the DCP in the very short run. Over time, however, export prices change and become less sensitive to movements in the USD exchange rate, but more sensitive to movements in the exchange rate with respect to the CLP. This result provides evidence that, as time goes by, pricing of exports is better described by PCP. Taken together, these results indicate that in the short run exporters take as given the currency of invoicing, but they prefer pricing in that of their own country.

Panel (b) shows the response on export volumes. The results are also suggestive of a shift over time from DCP to PCP. Although on impact quantities do not change at all, over time there is a demand response as prices adjust to bilateral depreciation with respect to the Chilean peso. However, the volume of exports does not change much at any horizon when the destination currency depreciates with respect to the USD. Given that on impact the price of exports in this case goes up, likely reducing the demand for those exports, the observation that the quantities remain stable is suggestive that other factors are offsetting the negative effects on demand for Chilean exports. One explanation is that the increased profitability of Chilean exporters triggers compensatory positive supply effects. Since the exercise keeps constant the bilateral exchange rate fluctuations, the depreciation experienced with respect to the USD is also a depreciation of the CLP versus the USD. Even though in this case export prices are increasing, Chilean exporters observe their peso proceeds from exports go up, which is likely to generate increases in the supply of exports from the extensive and/or intensive margins.

These results combined support the idea that the Mundell-Fleming's effect of exchange rate movements on external adjustment seems to be alive and well, and it is still informative in the medium run to understand the macroeconomy. The USD is still important to understand short-run impacts, but it does not replace the role played by bilateral exchange rate fluctuations.

Figure 3: Bilateral (BER) and USD Exchange rate Pass-through and Quantities



(a) Price

(b) Quantity

Publications in academic journals by researchers of the Central Bank of Chile

Acosta-Henao, M., Pratap, S., & Taboada, M. (2023). "Four facts about relationship lending: The case of Chile 2012-2019". *Journal of Corporate Finance*, 80:102415.

Albagli, E., Contreras, G., Tapia, M., & Wlasiuk, J. M. (2022). "Earnings cyclicality of new and continuing jobs: The role of tenure and transition length". *Labour Economics*, 78, 102242.

Alegría, A., R. Alfaro, and F. Córdova (2021) "The effect of warnings published in a financial stability report on loan-to-value ratios" *Latin America Journal of Central Banking* 2(4): 100041.

Alfaro, R. and M. Drehmann "The Holt-Winters filter and the one-sided HP filter: A close correspondence" (2023) *Economics Letters* 222 (January): 110925.

Alfaro, R. and M. Piña "Estimates of the US Shadow-Rate" (2023) *Latin America Journal of Central Banking* 4(1): 100080.

Calani, M., & Paillacar, M. (2022). "The pass-through of loan-loss-provisioning on mortgage lending: Evidence from a regulatory change". *Journal of Banking & Finance,* 135, 106359.

Carlomagno, G., & Albagli, E. (2022). "Trade wars and asset prices". *Journal of International Money and Finance*, 124, 102631.

Carlomagno, G., Fornero, J; Sansone, A (2023). "A proposal for constructing and evaluating core inflation measures". *Latin American Journal of Central Banking*, Vol. 4 (3), 100094.

Ceballos, L., & Romero, D. (2022). "International portfolio bond spillovers". *Economics Letters*, 220, 110847.

Cortina, M., & Madeira, C. (2023). "Exposures to climate change's physical risks in Chile". *Latin American Journal of Central Banking*, 4(2), 100090.

Didier, T., Huneeus, F., Larrain, M., & Schmukler, S. L. (2021). "Financing firms in hibernation during the COVID-19 pandemic". *Journal of Financial Stability*, 53, 100837.

Donovan, K., Lu, W. J., & Schoellman, T. (*Forthcoming*). "Labor market dynamics and development". *Quarterly Journal of Economics*.

Huneeus, F., Larrain, B., Larrain, M., & Prem, M. (2021). "The internal labor markets of business groups". *Journal of Corporate Finance*, 69, 102017.

Madeira, C. (2023). "Adverse selection, loan access and default behavior in the Chilean consumer debt market". *Financial Innovation*, 9(1), 49.

Madeira, C. (2023). "The evolution of consumption inequality and risk-insurance in Chile". *Emerging Markets Review,* 100996.

Medel, C.A. (2022). "Searching for the Best Inflation Forecasters within an Employment Survey: Microdata Evidence from Chile". *Economía (Pontificia Universidad Católica del Perú)* 42(89): 184-216.

Miranda-Pinto, J., Silva, A., & Young, E. R. (*Forthcoming*). "Business Cycle Asymmetry and Input-Output Structure: The Role of Firm-to-Firm Networks". *Journal of Monetary Economics.*

Miranda-Pinto, J., Murphy, D., Walsh, K. J., & Young, E. R. (2023). "Saving constraints, inequality, and the credit market response to fiscal stimulus". *European Economic Review*, 151, 104355.

Pasten, E., Schoenle, R., & Weber, M. (*Forthcoming*). "Sectoral Heterogeneity in Nominal Price Rigidity and the Origin of Aggregate Fluctuations". *American Economic Journal: Macroeconomics*.

Cao, J., Hansen, C., Kozbur, D., & Villacorta, L. (2022). "Inference for Dependent Data with Learned Clusters". *Review of Economics and Statistics.*

Latest working papers of the Central Bank of Chile

Number	Title	Authors	Date
978	Startup Employment and Career Trajectories	Gonzalo García-Trujillo, Nathalie González-Prieto, Alvaro Silva	April 2023
977	Commodity Price Shocks and Production Networks in Small Open Economies	Alvaro Silva, Petre Caraiani, Jorge Miranda-Pinto, Juan Olaya-Agudelo	April 2023
976	Exposures to climate change's physical risks in Chile	Magdalena Cortina, Carlos Madeira	April 2023
975	Global monetary policy surprises and their transmission to emerging market economies: an external VAR analysis	Felipe Beltrán	April 2023
974	Use of Financial Instruments among the Chilean households	Carlos Madeira	April 2023
973	The evolution of consumption inequality and riskinsurance in Chile	Carlos Madeira	April 2023
972	Government Purchases, the Labor Earnings Gap, and Consumption DynamicsFrom Patriarchy to Partnership: Gender Equality and Household Finance	Mario Giarda	April 2023
971	Spatial Production Networks	Costas Arkolakis, Federico Huneeus, Yuhei Miyauchi	February 2023
970	From Dominant to Producer Currency Pricing: Dynamics of Chilean Exports	José De Gregorio, Pablo García, Emiliano Luttini, Marco Rojas	January 2023
969	Where is the Inflation? The Diverging Patterns of Prices of Goods and Services	Gent Bajraj, Guillermo Carlomagno, Juan M. Wlasiuk	January 2023
968	From Patriarchy to Partnership: Gender Equality and Household Finance	Luigi Guiso, Luana Zaccaria	January 2023
967	The COVID-19 Shock and Firm Financing: Government or Market? Or Both?	Miguel Acosta-Henao, Andrés Fernández, Patricia Gomez-Gonzalez, Sebnem Kalemli-Ozcan	December 2022
966	Monetary Policy in Small Open Economies and the International Zero Lower Bound	Marco Rojas	December 2022
965	Business Cycle Asymmetry and Input-Output Structure: The Role of Firm-to-Firm Networks	Jorge Miranda-Pinto, Alvaro Silva, Eric R. Young	December 2022

964	Stocks, Bonds and the US Dollar - Measuring Domestic and International Market Developments in an Emerging Market	Nicolas Eterovic, Dalibor Eterovic	October 2022
963	Global Drivers and Macroeconomic Volatility in EMEs: a Dynamic Factor, General Equilibrium Perspective	Gent Bajraj, Andrés Fernández, Miguel Fuentes, Benjamín García, Jorge Lorca, Manuel Paillacar, Juan Marcos Wlasiuk	September 2022
962	Exchange rate volatility and the effectiveness of FX interventions: the case of Chile	Alejandro Jara, Marco Piña	September 2022
961	Trade Credit and Sectoral Comovement during Recessions	Jorge Miranda-Pinto, Gang Zhang	August 2022
960	Capital Ratios and the Weighted Average Cost of Capital: Evidence from Chilean Banks	Rodrigo Cifuentes, Tomás Gómez, Alejandro Jara	August 2022
959	The Holt-Winters filter and the one-sided HP filter: A close correspondence	Rodrigo Alfaro, Mathias Drehmann	August 2022
958	The evolution of macroprudential policy use in Chile, Latin America and the OECD	Carlos Madeira	July 2022
957	Sovereign Credit Spreads, Banking Fragility, and Global Factors	Anusha Chari, Felipe Garcés, Juan Francisco Martínez, Patricio Valenzuela	May 2022
956	Four facts about relationship lending: The case of Chile 2012-2019	Miguel Acosta-Henao, Sangeeta Pratap, Manuel Taboada	May 2022
955	Modeling S&P500 returns with GARCH models	Rodrigo Alfaro, Alejandra Inzunza	May 2022
954	Unconventional credit policies during crises: A structural analysis of the Chilean experience during the COVID-19 pandemic	Benjamín García, Mario González, Sebastián Guarda, Manuel Paillacar	May 2022
953	A Macro Financial Model for the Chilean Economy	Mauricio Calani, Benjamín García, Tomás Gómez, Mario González, Sebastián Guarda, Manuel Paillacar	May 2022
952	The double impact of deep social unrest and a pandemic: Evidence from Chile	Carlos Madeira	April 2022
951	On Foreign Drivers of EMEs Fluctuations	Gent Bajraj, Jorge Lorca, Juan M. Wlasiuk	April 2022
950	Market Incompleteness, Consumption Heterogeneity and Commodity Price Shocks	Damián Romero	April 2022
949	The effects of the job retention program during the Covid pandemic on the Chilean firms and households	José Cristi, Carlos Madeira	April 2022