RESEARCH HIGHLIGHTS

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

December 2024

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

- **Network analysis applied to the Central Bank of Chile's high value payment system.**
- **Aggregating distortions in networks with multi-product firms.**
- **Modelling high frequency non-financial big time series with an application to jobless claims in Chile.**

Network analysis applied to the Central Bank of Chile's high value payment system

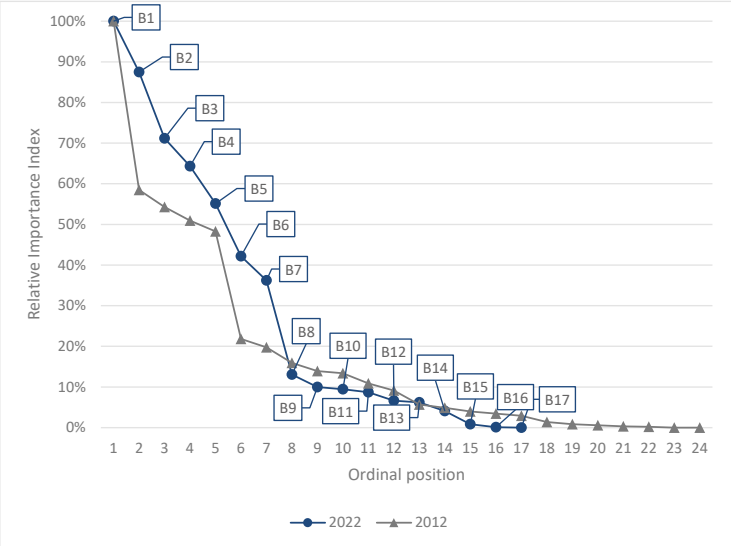
"The evolution of the indices by participant shows that the RTGS system tends to be a more resilient payment network to liquidity shocks arising from the unavailability of a single participant, as liquidity and contagion risks are less concentrated than at the beginning of the sample in 2012."

The Payment System, which is provided, managed and regulated by the Central Bank of Chile (CBC) (known as the Real Time Gross Settlement, RTGS), is fundamental to the conduct of monetary policy, financial stability and the functioning of the economy. In this system, financial institutions make payments to each other in real time. These payments have a minimal settlement risk since the payment is only transferred if the payer has funds in its current account. However, by requiring large amounts of liquid money at very short notice, payment systems are exposed to liquidity risk. A highly sensitive and sizeable payment may not be settled if the participant does not have funds at the right time, which affects the liquidity of its counterparties in the financial system to settle their own payments. Therefore, it is important to identify critically important or systemic participants in the Chilean payment system, in order to help manage efficiently the liquidity needs derived from any interruption in their payment flows.

In their article *"Análisis de redes aplicado al sistema de pagos de alto valor del BCCh (DTBC 1021)"* the CBC's team of economists composed by Álvaro González, Carmen López and María José Meléndez, evaluate the connections and importance of each bank in the network of the payment system in domestic currency administered by the CBC. For this, they use two network analysis indicators, which are calculated at the participant level and consider their capacity to concentrate liquidity risk and to propagate liquidity shocks over the rest of the system's participants.

Network analysis is a methodology that consists of analyzing the entire payment structure of the system as a large network, with links connecting some participants with others through relationships based on the payments made between them. Following Lublóy (2006)[1], liquidity risk is studied based on the calculation of two nodal centrality indicators for each participant in the payment network between 2012 and 2022. These include 1) an index that measures the degree of connection of the participant in the network (Out-proximity Centrality), and 2) another index that measures the relative importance of the size of payments of a participant in the network and, therefore, the provision of liquidity (Valued Out-degree Centrality). By multiplying these indices, the Relative Importance Index (RII) can be constructed to measure the concentration of liquidity risk.

Figure 1: IIR distribution, 2012 y 2022



Notes: The Figure shows the distribution of the Relative Importance Index following Lublóy (2006). The triangles and circles correspond to the years 2012 and 2022, respectively.

1 See Lublóy, Agnes (2006) "Topology of the Hungarian large-value tranfer system," ´ Magyar Nemzeti Bank Ocassional Papers, - (57), 30–32, https://www.mnb.hu/letoltes/op-57.pdf.

From this exercise, it follows that, with some exceptions, the indexes for each participant remain relatively stable throughout the sample. The Valued Out-degree Centrality index does not show variations and presents higher values for larger banks, although the evolution of smaller banks over larger ones stands out. The Out-proximity Centrality index is more evenly distributed among banks. It also grows slightly during the sample period, which is consistent with a more connected payment network with fewer participants. Both indices show a positive relationship in their behavior throughout the sample. Finally, from the IIR it can be concluded that liquidity risk has decreased over time, as illustrated in Figure 1—in which a value of 100% of the IIR is for the most important bank and the other values are relative to it—, tending to be distributed among more participants.

Summarizing, these results allow us to conclude that by 2022 the system tended to be a more resilient network to liquidity shocks from a single participant, as both indicators decreased their concentration, spreading among more participants.

Aggregating distortions in networks with multi-product firms

"Taking into account multi-product firms is essential for measuring aggregate resource allocation efficiency and aggregate TFP growth."

Inefficient allocation of resources among heterogeneous producers has been recognized as one of the determinants of the suboptimal level of total factor productivity (TFP). Inefficient allocation refers to how TFP would increase if productive resources flowed from firms with lower to higher marginal factor productivity. To quantify the inefficient allocation of resources, the literature overlooks the fact that most firms produce and sell multiple products. For example, in Chile, 75% of formal firms are multi-product. In their working paper entitled *"Aggregating Distortions in Networks with Multi-Product Firms (DTBC 1022)"*, co-authors Antonio Martner, BCCh-sponsored student at the University of California at Los Angeles, together with Yasutaka Koike-Mori, a PhD student at the same university, evaluate how the allocation of resources across products within firms affects the aggregate efficiency of resource allocation and, consequently, aggregate TFP.

When analyzing multi-product firms, the main challenge is to account for shared inputs between different production lines. If the products that a firm manufactures had independent production lines, each could be conceptualized as a separate firm. This is usually not the case. For example, consider an oil refinery that produces diesel and gasoline: the inputs (crude oil, labor and capital) are used to produce both products in relatively fixed proportions. To address this challenge, the authors model multi-product firms using joint production functions that connect baskets of inputs to baskets of outputs. Joint production captures the degree of flexibility of a firm to adjust its product mix, which in turn determines the efficiency of resource allocation within the firm.

This paper proposes sufficient statistics to measure changes in aggregate efficiency arising from resource allocation. The framework is general enough to include input-output relationships. The analysis then validates and implements its framework using a database of firm-to-firm transactions in Chile. The main result is that the level of aggregate allocative inefficiency is overestimated if the measurement is isolated from aggregate output.

Specifically, in the model the firms can over- or under-produce if their output gaps are high or low, respectively. These gaps encapsulate any reason why the production of goods deviates from socially optimal levels, such as taxes or subsidies, regulations, financial constraints or profit margins. As firms interact with each other, the gaps that affect the allocation of resources, and hence aggregate TFP, are those accumulated throughout their value chain.

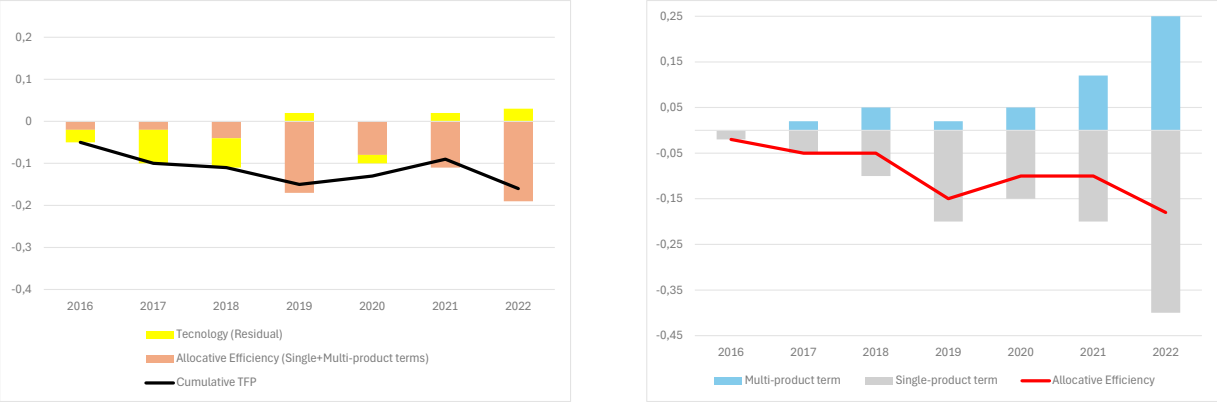
The study shows that the impact of changes in these gaps on the efficiency of resource allocation depends on the ease with which firms can adjust their product mix. To quantify this effect, the authors propose an approach using nonparametric statistics. Instead of directly estimating the parameters of the firm's production technology, they use observed changes in the firm's prices, net of the margin, to infer the firm's ability to substitute the production of one product for another. Intuitively, if prices increase for products with high cumulative output gaps in their value chain, then the scope for resource reallocation is limited. Theoretically, these price movements, net of margins, trace the production possibilities frontier, the slope of which captures the technological constraints of each firm as it adjusts its product mix. This provides a way to quantify inefficiency in resource allocation without imposing assumptions about the firms' production technologies.

This approach is implemented using confidential administrative data from the Chilean Internal Revenue Service (SII) on cross-firm transactions. The dataset contains prices at the product level, input-output relationships between firms and products, and balance sheet variables.

First, it is established that most firms in Chile have a joint production technology for the products they manufacture. Then, the paper uses the proposed statistics to perform a growth accounting exercise. Changes in aggregate allocative efficiency explain 86% of TFP growth in Chile between 2016 and 2022 (Figure 2: Left panel). Right panel of Figure 2 shows that the aggregate efficiency of resource allocation can be decomposed between the contribution of mono- and multi-product firms. Ignoring joint production (light blue bar in Figure 2: Right panel) substantially overestimates the importance of aggregate allocative efficiency in the cumulative growth of aggregate TFP.

The authors conclude that considering multi-product firms is essential for measuring aggregate resource allocation efficiency and aggregate TFP growth.

Figure 2: Cumulative TFP growth and its components



Notes: Left panel shows the cumulative TFP growth (black line), without considering the multi product firms' dimension, which is decomposed in and its components of Allocative Efficiency (orange bar) and Technology (yellow bar). Right panel considers multi product firms and so adds a new component (light-blue bar).

Modelling high frequency non-financial big time series with an application to jobless claims in Chile

The analysis of high-frequency data, such as daily unemployment insurance claims, plays a key role in the understanding of economic and labor market dynamics. These datasets provide valuable information on short-term fluctuations and patterns, but also pose considerable challenges due to their complexity, including overlapping seasonal cycles, calendar effects and sensitivity to external shocks. Traditional econometric approaches often struggle to adequately address these problems, which can result in incomplete or less accurate analyses. In this context, Guillermo Carlomagno, International Analysis Manager of the BCCh, and Antoni Espasa, from Universidad Carlos III in Madrid, in their working paper entitled *"Modelling high frequency non-financial big time series with an application to jobless claims in Chile (DTBC 1023)"* propose a methodological framework designed to overcome these challenges, with a special focus on the daily unemployment insurance claims in Chile.

"Focusing on daily, hourly, and even minute-level data, the study investigates the presence of various seasonalities and how these cycles might interrelate between them and be influenced by weather patterns and calendar variation."

Daily unemployment insurance claims in Chile show distinctive variations in weekly, monthly and annual cycles. Claims tend to increase at the beginning of the week and decrease towards Friday, and follow a similar pattern within months, with a spike at the beginning and a decrease towards the 30th. On an annual scale, applications tend to peak early in the year and decline in December. These regularities tend to be complicated by the presence of non-linear interactions, calendar effects (including holidays and long weekends) and external factors such as the Covid-19 pandemic. As a result, the data often contains unusual values that are not true outliers, but can be explained by econometric models that incorporate weather, seasonal patterns and their interactions within different regimes and structural forms.

In the face of these challenges, the authors suggest the use of Autometrics, an automated tool designed to create simpler models without losing accuracy. Unlike traditional methods that analyze seasonal effects step-by-step, this approach looks into all the relevant factors within a single model. By including seasonal patterns, calendar effects and external influences such as the weather or social uprisings, it provides a clearer picture of how these elements interact with one another.

The results reveal important changes in labor market trends in Chile. The authors identify a pronounced effect at the beginning of the month, where applications increase, influenced by whether the first working day falls on a Monday or Friday, demonstrating how calendar patterns can shape the behavior of applicants. In addition, introducing online requests during the Covid-19 pandemic brought significant changes to previously established dynamics. For example, it reduced the importance of weekly cycles, like the typical Monday peaks, and reduced sensitivity to external factors such as weather events. These changes highlight the need for flexible models that can adapt to structural changes and evolving patterns.

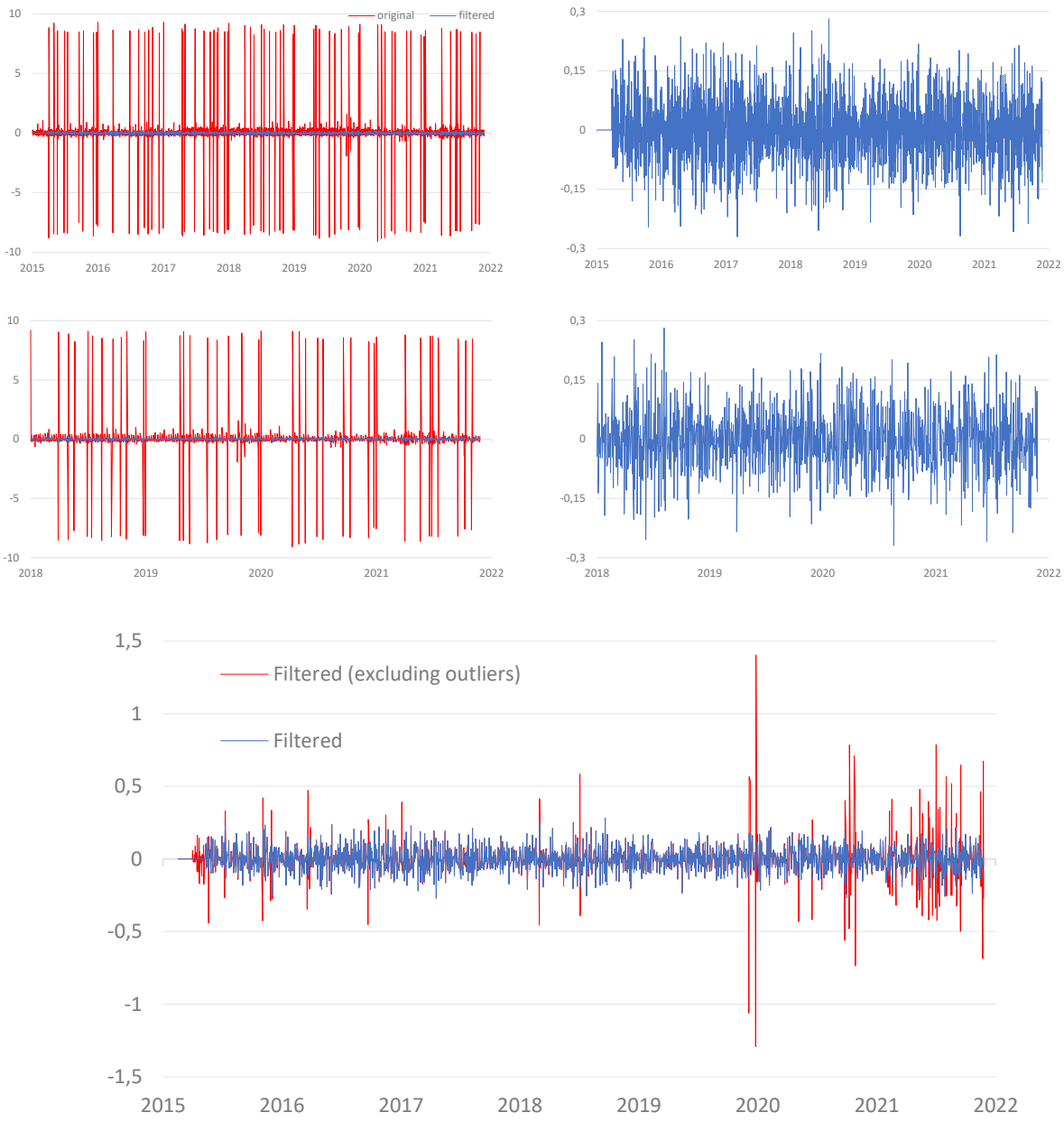
Figure 3 illustrates these findings by comparing the untreated unemployment insurance claims data with the filtered series generated by the model. The untreated data shows noticeable peaks and troughs influenced by calendar effects and external factors,

while the filtered series removes these fluctuations to reveal more clearly the underlying trends.

The findings of the study go beyond the specific case of unemployment claims in Chile. The study demonstrates that high-frequency data, when carefully modeled, can reveal trends and interactions that might otherwise go unnoticed in aggregate analyses. It underscores the importance of preserving the original detail of the data, as aggregation to lower frequencies, such as monthly averages, can obscure key patterns and reduce the reliability of the intuition obtained.

The authors also conclude that modeling using high-frequency data, while complex, offers valuable opportunities to explore economic dynamics in great detail. Their methodology provides a practical way to uncover patterns and trends that might be missed with more aggregated data and contributes to improving economic analysis and decision-making.

Figure 3: Original and filtered series



Notes: The red lines show the original series (in logarithm) of unemployment insurance claims, and the blue lines show the deviations of this with respect to the predicted model by Autometrics. The bottom panel zooms into the years 2018-2020.

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

Albagli, E., Arias, A. & Kirchner, M. (2024). "Collective Savings Pension Policy in an Economy with Heterogeneity and Informality". *Estudios de Economía*, 51(2): 325-381.

Albagli, E., Canales, M., Syverson, C., Tapia, M., & Wlasiuk, J. (2025). "Productivity Growth and Workers' Job Transitions: Evidence from Census Microdata". *The Economic Journal*, 135(666), 405-429.

Albagli, E., Hellwig, C., & Tsyvinski, A. (2024). "Information aggregation with asymmetric asset payoffs". *The Journal of Finance,* 79(4), 2715-2758.

Andreasen, E., Bauducco, S., & Dardati, E. (2024). "Capital controls and firm performance". *Journal of International Economics*, 150, 103897.

Bastos, P., & Sánchez, C. (2024). "The effects of educated leaders on policy and politics: Quasi-experimental evidence from Brazil". *Latin American Economic Review,* 33.

Beltrán, F., Durand, L., González-Frugone, M., & Moreno, J. (2024). "A preliminary assessment of the economic effects of energy and climate in Chile". *Latin American Journal of Central Banking*, 100146.

Calani, M., Margaretic, P., & Moreno, D. (2025). "Navigating trade uncertainty: The role of trade financing and the spillover effects". *Journal of International Economics*, 153, 104043.

Canales, M. & López-Martín, B. (2024). "Exchange Rates, Uncertainty, and Price-Setting: Evidence from CPI Microdata". *Economic Modelling,* 139, 106762.

Carreño, J. G., & Uras, B. (2024). "Macro welfare effects of flexible labor contracts". *European Economic Review*, 161, 104633.

Castro, J. F., & Villacorta, L. (2024). "Too Hard, Too Easy, or Just Right: The Productivity of Schooling and the Match between Child Skill and School Complexity". *The World Bank Economic Review,* lhae013, https://doi.org/10.1093/wber/lhae013.

Ceballos, L., Christensen, J. H., & Romero, D. (2025). "A post-pandemic new normal for interest rates in emerging bond markets? Evidence from Chile". *Journal of International Money and Finance*, 150, 103234.

Cifuentes, R., Gómez, T., & Jara, A. (2024). "Capital Ratios and the Weighted Average Cost of Capital: Evidence from Chilean Banks". *Latin American Journal of Central Banking*, 100143.

Cobas A, Maziotis A, Villegas A (2024). "Measurement of efficiency and its drivers in the Chilean banking industry". *PLoS ONE* 19(5): e0300019. https://doi.org/10.1371/journal.pone.0300019.

Cox, L., Müller, G. J., Pasten, E., Schoenle, R., & Weber, M. (2024). "Big G". *Journal of Political Economy*, 132(10), 3260-3297.

De Gregorio, J., García, P., Luttini, E. E., & Rojas, M. (2024). "From Dominant to Producer Currency Pricing: Dynamics of Chilean Exports". *Journal of International Economics,* 149, 103934.

García, B., & Guerra-Salas, J. (*Forthcoming*). "On the Response of Inflation and Monetary Policy to an Immigration Shock". *Journal of Human Capital.*

García, B., & Skaperdas, A. (*Forthcoming*). "Central Bank Independence at Low Interest Rates". *Journal of Money, Credit, and Banking*.

Huneeus, F., & Rogerson, R. (2024). "Heterogeneous paths of industrialization". *Review of Economic Studies*, 91(3), 1746-1774.

Madeira, C. (2024), "The impact of macroprudential policies on industrial growth". *Journal of International Money and Finance*, 2024, 145, 103106.

Romero, D. (2025). "Domestic linkages and the transmission of commodity price shocks". *Journal of International Economics*, 153, 104041.

Latest working papers of the Central Bank of Chile

Number	Title	Authors	Date
1035	Crisis Credit, Employment Protection, Indebtedness, and Risk	Federico Huneeus, Joseph Kaboski, Mauricio Larrain, Sergio L. Schmukler, Mario Vera	December 2024
1034	Emparejamiento de datos provenientes de Registros Administrativos y Encuesta de Hogares en Chile	Alfonso Barrero, César Ferreiro, Mario Giarda, Claudia Henríquez, Federico Huneeus, Manuel Taboada	December 2024
1033	Market Size in Pricing Problems on Multi-sided Matching Platforms	Jorge Arenas	December 2024
1032	Financiamiento de corto plazo de las empresas chilenas	Jorge Fernández B., Francisco Vásquez L.	December 2024
1031	International Trade Finance and Learning Dynamics	David Kohn, Emiliano Luttini, Michal Szkup, Shengxing Zhang	November 2024
1030	Climate change's impact on real estate prices in Chile	Karla Hernández, Facundo Luna, Carlos Madeira	November 2024
1029	Una mirada a la evidencia internacional en la emisión de bonos digitales	Valeria García, Leonardo Luna	November 2024
1028	Climbing the (in)formality job ladder: Determinants and Dynamics of Labour Informality in Peru	Tomás Opazo	November 2024
1027	Navigating trade uncertainty: The role of trade financing and the spillover effects	Mauricio Calani, Paula Margaretic, David Moreno	November 2024
1026	The Incidence of Distortions	David Atkin, Baptiste Bernadac, Dave Donaldson, Tishara Garg, Federico Huneeus	October 2024
1025	Strike while the Iron is Hot - Optimal Monetary Policy with a Nonlinear Phillips Curve	Peter Karadi, Anton Nakov, Galo Nuño, Ernesto Pastén, Dominik Thaler	October 2024
1024	Optimal Monetary and Fiscal Policies in Disaggregated Economies	Lydia Cox, Jiacheng Feng, Gernot Muller, Ernesto Pastén, Raphael Schoenle, Michael Weber	October 2024
1023	Modelling high frequency non-financial big time series with an application to jobless claims in Chile	Antoni Espasa, Guillermo Carlomagno	October 2024
1022	Aggregating Distortions in Networks with Multi-Product Firms	Yasutaka Koike-Mori, Antonio Martner	September 2024
1021	Análisis de redes aplicado al sistema de pagos de alto valor del BCCh	Álvaro González, Carmen López, María José Meléndez	August 2024

1020	Financial advisory firms, asset reallocation and price pressure in the FOREX market	Francisco Pinto-Avalos, Michael Bowe, Stuart Hyde	August 2024
940*	Overborrowing and Systematic Externalities in the Business Cycle Under Imperfect Information (Revisado)	Juan Herreño, Carlos Rondón-Moreno	August 2024
1019	Through Drought and Flood: the past, present and future of Climate Migration	Elias Albagli, Pablo García, Gonzalo García-Trujillo, María Antonia Yung	August 2024
1018	Supply Chain Uncertainty and Diversification	Ignacia Cuevas, Thomas Bourany, Gustavo González	June 2024
1017	Is the Information Channel of Monetary Policy Alive in Emerging Markets?	Mariana García-Schmidt	June 2024
1016	The Portfolio Choice Channel of Wealth Inequality	Mauricio Calani, Lucas Rosso	June 2024
1015	Fiscal Consolidations in Commodity-Exporting Countries: A DSGE Perspective	Manuel González-Astudillo, Juan Guerra-Salas, Avi Lipton	June 2024
1014	Accounting for Nature in Economic Models	Nicoletta Batini , Luigi Durand	May 2024
1013	Transmission Mechanisms in HANK: an Application to Chile	Benjamín García, Mario Giarda, Carlos Lizama, Ignacio Rojas	May 2024
1012	Cyclical wage premia in the informal labour market: Persistent and downwardly rigid	Daniel Guzman	May 2024
1011	Macro Implications of Inequality-driven Political Polarization	Álvaro Aguirre	May 2024
1010	Firm Shocks, Workers Earnings and the Extensive Margin	Álvaro Castillo, Ana Sofía León, Antonio Martner, Matías Tapia	March 2024
1009	Trade Policy and Reallocation: Multinational vs. Single-Country Linkages in the Tire Industry	Brian Pustilnik	March 2024
1008	The finances of Chilean households during the pandemic: an assessment from the 2021 Household Financial Survey	Enzo Cerletti, Magdalena Cortina, Alejandra Inzunza, Felipe Martínez, Patricio Toro	March 2024
1007	UIP Deviations: Insights from Event Studies	Elias Albagli, Luis Ceballos, Sebastian Claro, Damian Romero	March 2024
1006	Input price dispersion across buyers and misallocation	Ariel Burstein, Javier Cravino, Marco Rojas	January 2024
1005	The Role of Parental Altruism in Parents Consumption, College Financial Support, and Outcomes in Higher Education	Agustín Díaz	January 2024
1004	Indebtedness and labor risk sorting across consumer lender types: evidence from Chile	Carlos Madeira	January 2024