

# Bank of Canada Monthly Research Update

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May 2022

This monthly newsletter features the latest research publications by Bank of Canada economists. The report includes papers appearing in external publications and staff working papers published on the Bank of Canada's website.

## PUBLISHED PAPERS

### In-Press

Jón Daniélsson & Robert Macrae & Andreas Uthemann, “[Artificial Intelligence and Systemic Risk](#)”, *Journal of Banking and Finance*, Vol 140(SI): 9-53, July 2022

Julia Schmidt & Walter Steingress, “[No double standards: Quantifying the impact of standard harmonization on trade](#)”, *Journal of International Economics*, Vol 137, July 2022

Bulent Guler & Yasin Kürşat Önder & Temel Taskin, “[Hidden Debt](#)”, *AEA Papers and Proceedings*, Vol 112(1): 536-540, May 2022

### Forthcoming

Seyed Mohammadreza Davoodalhosseini, “[Optimal Taxation in Asset Markets with Adverse Selection](#)”, *European Economic Review*

Reinhard Ellwanger & Stephen Snudden, “[Futures prices are useful predictors of the spot price of crude oil](#)”, *Energy Journal*

## STAFF WORKING PAPERS

Radoslav Raykov & Consuelo Silva-Buston, “[Asymmetric Systemic Risk](#)”, Bank of Canada Staff Working Paper 2022-19

Michelle Alexopoulos & Xinfen Han & Oleksiy Kryvtsov & Xu Zhang, “[More Than Words: Fed Chairs’ Communication During Congressional Testimonies](#)”, Bank of Canada Staff Working Paper 2022-20

Ming Zeng & Guihai Zhao, “[Expectation-Driven Term Structure of Equity and Bond Yields](#)”, Bank of Canada Staff Working Paper 2022-21

Erhao Xie, “[Nonparametric Identification of Incomplete Information Discrete Games with Non-equilibrium Behaviors](#)”, Bank of Canada Staff Working Paper 2022-22

Anneke Kosse & Zhentong Lu, “[Transmission of Cyber Risk Through the Canadian Wholesale Payment System](#)”, Bank of Canada Staff Working Paper 2022-23

Pablo Ottonello & Wenting Song, “[Financial Intermediaries and the Macroeconomy: Evidence from a High-Frequency Identification](#)”, Bank of Canada Staff Working Paper 2022-24

## STAFF DISCUSSION PAPERS

Heng Chen & Walter Engert & Kim Huynh & Daneal O’Habib,  
“Identifying Financially Remote First Nations Reserves”, Bank of  
Canada Staff Discussion Paper 2022-11

Tony Chernis & Taylor Webley, “Nowcasting Canadian GDP with  
Density Combinations”, Bank of Canada Staff Discussion Paper  
2022-12

## ABSTRACTS

### *Artificial intelligence and systemic risk*

Artificial intelligence (AI) is rapidly changing how the financial system is operated, taking over core functions for both cost savings and operational efficiency reasons. AI will assist both risk managers and the financial authorities. However, it can destabilize the financial system, creating new tail risks and amplifying existing ones due to procyclicality, unknown-unknowns, the need for trust, and optimization against the system.

### *No double standards: Quantifying the impact of standard harmonization on trade*

This paper quantifies a novel channel that contributes to greater trade integration: the release of harmonized, voluntary product standards. Standards define product characteristics that ensure compatibility, quality and consistency. Harmonized standards unify these characteristics across countries and reduce country-specific adaption costs. We create a novel database on cross-country standards and show that harmonized standards have contributed up to 13% of the growth in global trade. We build a heterogeneous firm model where harmonized standards generate scale effects and induce firms to adopt the standard. Firm-level evidence shows that only the largest firms in the top range of the size-distribution increase their export sales. These firms benefit from higher demand, charge higher prices and sell larger volumes.

### *Hidden Debt*

We study the role of transparency in debt and default dynamics in a quantitative sovereign default model augmented with asymmetric information. We assume that the sovereign debt portfolio is not transparent and part of the debt is not observable to lenders. The quantitative model is calibrated to the Bolivian economy and matches its long-term and business cycle properties. The quantitative results show that when the government moves to a transparent reporting regime, bond prices improve and the sovereign debt portfolio shifts toward noncontingent debt with an increase in overall debt level. However, higher debt increases default frequency and reduces welfare.

### *Optimal Taxation in Asset Markets with Adverse Selection*

Constrained efficiency is characterized in an asset market, subject to search frictions, where sellers are privately informed about the type of their asset. The type determines the opportunity cost of the asset for sellers and the quality of the asset for buyers. The constrained efficient allocation can be implemented using a sales tax schedule. The role of these taxes is to redistribute resources between different types of sellers to relax incentive constraints. The optimal tax schedule strictly increases welfare compared with the laissezfaire equilibrium, can sometimes lead to an allocation that Pareto dominates the equilibrium, and can sometimes lead to the first-best allocation (i.e., taxation can correct all inefficiencies caused by adverse selection). The shape of the optimal tax schedule is also investigated. If the quality of assets for buyers is a monotonic function of the sellers' opportunity cost (e.g., more distressed sellers have lower-quality assets), the schedule requires that the trading of low-quality assets be subsidized and trading of high-quality assets be taxed, although the schedule is not necessarily monotone in the quality or price of the assets. Otherwise, trading of some low-quality assets may be taxed and trading of some high-quality assets may be subsidized.

### *Futures Prices Are Useful Predictors of the Spot Price of Crude Oil*

How well do futures prices forecast the spot price of crude oil? Contrary to the established view, futures prices significantly improve upon the accuracy of monthly no-change forecasts. This results from two innovations. First, we document that independent of the construction of futures-based forecasts, longer-horizon futures prices have become better predictors of crude oil spot prices since the mid-2000s. Second, we show that futures curves constructed using end-of-month prices instead of average prices can generate large accuracy-improvements for short-horizon forecasts of average prices. These findings are remarkably robust and apply to both WTI and Brent crude oil prices.

### *Asymmetric Systemic Risk*

Bank regulation is based on the premise that risks spill over more easily from large banks to the banking system than vice versa. On the contrary, we document that risk transmission is stronger in the system-to-bank direction. We term this asymmetric systemic risk, measure it with net exposure metrics, and explore the consequences

and channels behind it. We show that banks with positive net exposure to the system had higher default risk during the 2008 crisis, and that bank size and trading activities were the main determinants of this net exposure, which increased default risk through trading income volatility and overall profit volatility. We argue that the current banksupervision objectives can be achieved more efficiently if regulation focuses on reducing such net exposures, rather than buffering the default risks arising from them.

### *More Than Words: Fed Chairs' Communication During Congressional Testimonies*

We measure soft information contained in the congressional testimonies of U.S. Federal Reserve Chairs and analyze its effect on financial markets. Our measures of Fed Chairs' emotions expressed in words, voice and facial expressions are created using machine learning. Increases in the Chair's text-, voice-, or face-emotion indices during these testimonies generally raise the S&P500 index and lower the VIX—indicating that these cues help shape market responses to Fed communications. These effects add up and propagate after the testimony, reaching magnitudes comparable to those after a policy rate cut. Markets respond most to the Chair's emotions expressed about issues related to monetary policy.

### *Expectation-Driven Term Structure of Equity and Bond Yields*

Recent findings on the term structure of equity and bond yields pose serious challenges to existing models of equilibrium asset pricing. This paper presents a new equilibrium model of subjective expectations to explain the joint historical dynamics of equity and bond yields (and their yield spreads). The movements of equity and bond yields are driven mainly by subjective expectations of dividend and gross domestic product (GDP) growth. Yields on short-term dividend claims are more volatile because the expected short-term dividend growth meanreverts to its less volatile long-run counterpart. The procyclical slope of equity yields is due to the countercyclical slope of dividend growth expectations. The correlation between equity returns/yields and nominal bond returns/yields switched from positive to negative after the late 1990s, owing mainly to a stronger correlation between expectations of real GDP growth and real dividend growth and only partially to procyclical inflation. Dividend strip returns are predictable, and the predictive power decreases with maturity as a result of predictable forecast errors and revisions. The model is also

consistent with the data in generating persistent and volatile price-dividend ratios and excess return volatility.

### *Nonparametric Identification of Incomplete Information Discrete Games with Non-equilibrium Behaviors*

In the literature that estimates discrete games with incomplete information, researchers usually impose two assumptions. First, either the payoff function or the distribution of private information or both are restricted to follow some parametric functional forms. Second, players' behaviors are assumed to be consistent with the Bayesian Nash equilibrium. This paper jointly relaxes both assumptions. The framework non-parametrically specifies both the payoff function and the distribution of private information. In addition, each player's belief about other players' behaviors is also modeled as a nonparametric function. I allow this belief function to be any probability distribution over other players' action sets. This specification nests the equilibrium assumption when each player's belief corresponds to other players' actual choice probabilities. It also allows non-equilibrium behaviors when some players' beliefs are biased or incorrect. Under the above framework, this paper first derives a testable implication of the equilibrium condition. It then obtains the identification results for the payoff function, the belief function and the distribution of private information.

### *Transmission of Cyber Risk Through the Canadian Wholesale Payment System*

In this paper, we study how the impact of a cyber-attack that paralyzes one or multiple banks' ability to send payments would transmit to other banks through the Canadian wholesale payments system. Based on historical payment data, we simulate a wide range of scenarios and evaluate the total payment disruption in the system. We find that depending on the type and number of banks under attack, the time of the attack and the design of the payments system, the attack can quickly become systemic and result in a significant loss of liquidity in the system. For instance, a three-hour attack on one bank can in the worst case impair the payments capacity of seven other banks within less than an hour and eventually disrupt 25% of the daily payments value. We also demonstrate that the system-wide impact of an attack can be significantly reduced by contingency plans that enable attacked banks to still send high-value payments. Given the interconnectedness of banks, we conclude that the cyber-resilience of a wholesale payment system strongly depends on the

cyber-resilience of its participants and underline the importance of strong sectoral collaboration and coordination.

### *Financial Intermediaries and the Macroeconomy: Evidence from a High-Frequency Identification*

We provide empirical evidence of the causal effects of changes in financial intermediaries' net worth on the aggregate economy. Our strategy identifies financial shocks as high-frequency changes in the market value of intermediaries' net worth in a narrow window around their earnings announcements, based on US tick-by-tick data. Using these shocks, we estimate that news of a 1% decline in intermediaries' net worth leads to a 0.2% to 0.4% decrease in the market value of nonfinancial firms. These effects are more pronounced for firms with high default risk and low liquidity and when the aggregate net worth of intermediaries is low.

### *Identifying Financially Remote First Nations Reserves*

Chen et al. (2021) show that almost one-third of First Nations band offices in Canada are within 1 kilometre (km) of an automated banking machine (ABM) or financial institution (FI) branch and more than half are within 5 km. Further, over three-quarters of band offices are within 20 km of an ABM or FI branch and almost 90% are within 50 km. We focus on 49 First Nations locations that are more than 100 km away from an ABM or FI branch or do not have an identifiable travel route (by road or boat) to an ABM or FI branch. We refer to these First Nations as financially remote. We show that these locations have small populations and limited access to internet and mobile services. As a result, these First Nations have poor access to cash sources and physical delivery of financial services as well as limited access to digital payments and electronic banking.

We also assess the remoteness of these locations according to an alternative method based on measures of agglomeration (community population) and proximity to other communities. We find that, according to this measure, these 49 financially remote First Nations are generally among the most geographically remote communities in Canada. Further, we show that these First Nations are also among the lowest scoring communities in Canada according to a measure of community well-being based on indicators of educational attainment, labour force activity, income and housing.

The geographical remoteness of these 49 First Nations, their small populations, limited infrastructure and digital services, and relatively



low community well-being all likely contribute to their poor access to cash and financial services.

### *Nowcasting Canadian GDP with Density Combinations*

Assessing the state of the economy in real time is critical for policy-making, and understanding the risks to those assessments is equally important. Policy-makers are typically provided with point forecasts that contain insufficient information about risks. In contrast, predictive densities estimate the entire range of possible outcomes. This provides a method for quantifying not only the current state of the economy but also the degree of uncertainty, the tail risks and the overall balance of risks around that state. Accordingly, this paper extends the framework of Chernis and Sekkel (2018) to produce density nowcasts for Canadian real GDP growth. We compare several methods of combining predictive densities from 98 models representing four popular classes of nowcasting models. The performance of these combinations is then assessed in both real-time and pseudo-real-time out-of-sample exercises, with the limited sample real-time simulations reinforcing the importance of data revisions for nowcasting. We demonstrate that the combined densities are reliable and accurate tools for assessing the state of the economy and risks to the outlook. We highlight in particular risks at the start of the COVID-19 pandemic.

## UPCOMING EVENTS

**\* All onsite conferences and events are suspended until further notice. All events listed below will take place virtually.**

Lorenzo Magnolfi (University of Wisconsin-Madison)

Organizer: BAP Virtual Speaker

Date: 2 May 2022

Federico Huneeus (Central Bank of Chile)

Organizer: FMD FSD/EFR Seminar Series

Date: 5 May 2022

Thomas Le Barbanchon (Bocconi University)

Organizer: INT CEA/EFR Seminar Series

Date: 6 May 2022

Robert Clark (Queen's University)

Organizer: BAP Virtual Speaker

Date: 9 May 2022

Rachel Ngai (London School of Economics)

Organizer: FMD FSD/EFR Seminar Series

Date: 12 May 2022

Andrea Barbon (University of St. Gallen)

Organizer: BAP Virtual Speaker

Date: 16 May 2022

Sherry Wu (Pennsylvania State University)

Organizer: UR-CEA

Date: 18 May 2022

Javier Suarez (CEMFI)

Organizer: FMD FSD/EFR Seminar Series

Date: 19 May 2022

David Argente (Pennsylvania State University)

Organizer: CUR Seminar

Date: 25 May 2022

Kurt Mitman (Stockholm University)  
Organizer: INT CEA/EFR Seminar Series  
Date: 27 May 2022