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Bank of Canada Quarterly Research Update

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This quarterly 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.

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Alberto Cavallo & **Oleksiy Kryvtsov**, "Price Discounts and Cheapflation during the Post-pandemic Inflation Surge", *Journal of Monetary Economics*, July 2024

Johannes Hoelzemann & Ryan Webb & **Erhao Xie**, "Non-Parametric Identification and Testing of Quantal Response Equilibrium", *Games and Economic Behavior*, July 2024

Monica Jain & **Olena Kostyshyna** & **Xu Zhang**, "How Do People View Wage and Price Inflation?", *Journal of Monetary Economics*, Vol. 145, July 2024

Youngmin Park & Lance Lochner, "Earnings Dynamics and Intergenerational Transmission of Skill", *Journal of Econometrics*, Vol. 243(1-2), July 2024

Joel Rodrigue & Dan Sheng & Yong Tan, "Exporting, Abatement, and Firm-Level Emissions: Evidence from China's Accession to the WTO", *Review of Economics and Statistics*, Vol. 106(4): 1064-1082, July 2024

Daniela Balutel & **Walter Engert** & **Christopher S. Henry** & **Kim P. Huynh** & Marcel Voia, "Explaining Bitcoin Ownership in Canada: Trends from 2016 to 2021", *Canadian Journal of Economics*, Vol. 57(3): 777-798, August 2024

Forthcoming

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Bingxin Ann Xing & **Bruno Feunou** & Morvan Nongni-Donfack & **Rodrigo Sekkel**, "U.S. Macroeconomic News and Low-Frequency Changes in Bond Yields in Canada, Sweden and the U.K.", *Journal of Banking & Finance*

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Antonio Diez De Los Rios, "A Portfolio-Balance Model of Inflation and Yield Curve Determination", *Review of Asset Pricing Studies*

Wei Dong & Shutao Cao, "Production Networks and the Macroeconomic Impacts of Commodity Price Shocks", *Canadian Journal of Economics*

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Christos Makridis & **Tao Wang**, "Learning from Friends in a Pandemic: Social Networks and the Macroeconomic Response of Consumption", *European Economic Review*

Tudor Schlager & **Lena Suchanek** & **Jonathan Swarbrick** & **Joel Wagner** & **Yang Zhang**, "Does the Sequence Matter: Interest Rates, Quantitative Easing or Forward Guidance?", *International Journal of Central Banking*

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ABSTRACTS

IN-PRESS PUBLISHED PAPERS

Price Discounts and Cheapflation during the Post-pandemic Inflation Surge

We study how within-store price variation changes with inflation, and whether households exploit it to attenuate the inflation burden. We use micro price data for food products sold by 91 large multi-channel retailers in ten countries between 2018 and 2024. Measuring unit prices within narrowly defined product categories, we analyze two key sources of variation in prices within a store: temporary price discounts and differences across similar products. Price changes associated with discounts grew at a much lower average rate than regular prices, helping to mitigate the inflation burden. By contrast, *cheapflation* – a faster rise in prices of cheaper goods relative to prices of more expensive varieties of the same good – exacerbated it. Using Canadian Homescan Panel Data, we estimate that spending on discounts reduced the change in the average unit price by 4.1 percentage points, but expenditure switching to cheaper brands raised it by 2.8 percentage points.

Non-Parametric Identification and Testing of Quantal Response Equilibrium

This paper studies the falsifiability and identification of Quantal Response Equilibrium (QRE) when each player's utility and error distribution are relaxed to be unknown non-parametric functions. Using the variation of players' choices across a series of games, we first show that both the utility function and the distribution of errors are non-parametrically over-identified. This over-identification result further suggests a straightforward testing procedure for QRE which achieves the desired type-1 error and maintains a small type-2 error. To apply this methodology, we conduct an experimental study of the matching pennies game. Our non-parametric estimates strongly reject the conventional Logit choice probability. Moreover, when the utility and the error distribution are sufficiently flexible and heterogeneous, the quantal response hypothesis cannot be rejected for 70% of participants. However, strong assumptions such as linear utility, logistically distributed errors, and homogeneity lead to substantially higher rejection rates.

How Do People View Wage and Price Inflation?

Using household-level data from the Canadian Survey of Consumer Expectations over 2014Q4–2023Q2, we study wage growth expectations and their link with inflation expectations. We document novel facts about wage growth expectations and the uncertainty around them. Households associate higher wage growth with a stronger economy. The link between wage and inflation expectations is weak, but stronger during the high-inflation period, in tighter labour markets, among new hires, for workers with above-inflation wage gains or higher levels of education or income. Uncertainty about wage gains is strongly positively linked to uncertainty about expected inflation, particularly during the high-inflation period.

Earnings Dynamics and Intergenerational Transmission of Skill

This paper develops and estimates a two-factor model of intergenerational skill transmission when earnings inequality reflects differences in individual skills and other non-skill shocks. We consider heterogeneity in both initial skills and skill growth rates, allowing variation in skill growth to change over the lifecycle. Using administrative tax data on two linked generations of Canadians covering 37 years, we exploit covariances in log earnings (at different ages) both across and within generations to identify and estimate the intergenerational correlation structure for initial skills and skill growth rates, lifecycle skill growth profiles, and the dynamics of non-skill earnings shocks.

We estimate low intergenerational elasticities (IGEs) for earnings in Canada; however, skill IGEs are typically 2–3 times larger due to considerable (and persistent) variation in earnings conditional on skills. Both earnings and skill IGEs decline for more recent child cohorts and are lower for children born to younger fathers. Intergenerational transmission of both initial skills and skill growth rates explains up to 40% of children's skill variation. Skills become a more important determinant of earnings over the first part of workers' careers; however, intergenerational transmission of skills becomes less important as children age, because skill growth rates are not well-predicted by parental skills. Parents' initial skills and skill growth rates are equally important determinants of children's skills, largely because both strongly influence children's initial skills.

Finally, we study intergenerational mobility for the 35 largest cities in Canada, documenting the extent to which considerable differences in

earnings and skill IGEs vary with the extent of local heterogeneity in parental skills vs. earnings instability.

Exporting, Abatement, and Firm-Level Emissions: Evidence from China's Accession to the WTO

This paper studies the joint impact of exporting and abatement on the environmental performance of Chinese manufacturers. For two common air pollutants (SO_2 and industrial dust) we document that (a) exporters are significantly less emissions-intensive relative to their nonexporting counterparts and (b) this difference cannot be explained by differential rates of abatement alone. Employing variation in trade and environmental conditions across time and space, we quantify the impact of endogenous export and abatement decisions on firm-level emissions. We find that exporting reduces emissions by at least 36% across pollutants. We explore underlying determinants of export-driven reductions in emissions intensity.

Explaining Bitcoin Ownership in Canada: Trends from 2016 to 2021

This paper studies the dynamics of bitcoin ownership from 2016 to 2021, using the Bank of Canada's Bitcoin Omnibus Surveys. The estimated rate of bitcoin ownership jumped to 13% in 2021, up from the 5% observed in the previous three years. On one hand, this increase reflected broader economic trends related to increased savings and investment of Canadians during the COVID-19 pandemic, along with financial technology companies providing accessible and user-friendly platforms for buying bitcoin. Looking deeper, we use econometric models to quantify several specific ways in which bitcoin became more mainstream as an investment in 2021. Finally, we investigate the high cash holdings of bitcoin owners across time.

FORTHCOMING PAPERS

International Portfolio Rebalancing and Fiscal Policy Spillovers

We theoretically and empirically evaluate the spillover effects of debt-financed fiscal policy interventions of the United States on other economies. We first consider a two-country dynamic stochastic general equilibrium model with international portfolio rebalancing effects arising from an imperfect substitutability between short- and long-term domestic and foreign bonds. We show that the model predicts fiscal multipliers for the US similar to those found in the literature. For international spillovers, the model shows that US fiscal expansions financed by long-term debt issuance would, on net,

hinder economic activity in the rest of the world (ROW). This is despite the standard trade channel's net positive effect on the ROW economy given the depreciation in the ROW currency. The fall in ROW output occurs mainly due to the increase in the ROW term premiums and long-term rates through the portfolio rebalancing channel, as the relative demand for ROW long-term bonds decreases following the increase in the supply of US long-term bonds accompanying the fiscal expansion. Testing the predictions of our theoretical model by using panel regressions and vector autoregressions, we find empirical support for the trade and portfolio balance channels of fiscal spillovers and for the negative relationship between ROW output and US fiscal policy shocks.

U.S. Macroeconomic News and Low-Frequency Changes in Bond Yields in Canada, Sweden and the U.K.

This paper investigates the importance of U.S. macroeconomic news in driving low-frequency fluctuations in the term structure of interest rates in Canada, Sweden, and the U.K. We follow two complementary approaches: First, we apply a regression-based framework that aggregates the impact of daily macroeconomic news on bond yields to a lower quarterly frequency. Next, we estimate a macro-finance affine term structure model linking the daily news to lower-frequency changes in bond yields and its expectations and term premia components. Both approaches show that U.S. macroeconomic news is an important source of lower-frequency quarterly fluctuations in bond yields in these open economies, and even more important than their respective domestic macroeconomic news. Furthermore, the macro-finance model shows that U.S. macroeconomic news is particularly important in explaining low-frequency changes in the expectation components of the nominal, real, and break-even inflation rates.

Letting Job Postings Talk: Recent Trends in Digitalization

We construct a novel dataset of Canadian online job postings, classified by occupation. The data, provided by Indeed, an online job board, represents vacancies advertised by employers across Canada. We have classified these job postings into standard occupations using text analytics. This dataset has been used to study changes in the demand for jobs linked to digitalization over the COVID-19 pandemic. To this end, we leverage time-series and cross-sectional variations in COVID-19 containment policies, examining their impact on jobs broadly related to digitalization. Our findings reveal that vacancies in digital production jobs increased more

substantially than in traditional jobs during the reopening phases. However, no substantial differences were observed when considering different types of vacancies according to the use of digital technologies (i.e., occupations at low risk of automation or those that allow remote work). Overall, our results do not support the popular idea that the COVID-19 pandemic marked a significant turning point in digitalization trends, but rather document a modest shift in this direction.

Estimating Policy Functions in Payment Systems Using Reinforcement Learning

This paper uses reinforcement learning (RL) to approximate the policy rules of banks participating in a high-value payment system (HVPS). The objective of the RL agents is to learn a policy function for the choice of amount of liquidity provided to the system at the beginning of the day and the rate at which to pay intraday payments. Individual choices have complex strategic effects precluding a closed form solution of the optimal policy, except in simple cases. We show that in a stylized two-agent setting, RL agents learn the optimal policy that minimizes the cost of processing their individual payments—without complete knowledge of the environment. We further demonstrate that in more complex settings, both agents learn to reduce the cost of processing their payments and effectively respond to liquidity-delay trade-off. Our results show the potential of RL to solve liquidity management problems in HVPS and provide new tools to assist policymakers in their mandates of ensuring safety and improving the efficiency of payment systems.

An Overview of Indigenous Economies Within Canada

Attempts to measure aspects of Indigenous economies within Canada are limited by data availability and quality. Drawing on the most recent data sources and research, we provide an overview of such economies and their relationship to the economy of Canada. This includes a discussion of labour markets and the characteristics of Indigenous-owned businesses. While several measures suggest economic outcomes have improved for Indigenous Peoples in recent decades, some institutional settings and gaps in infrastructure and financing continue to hinder economic progress. The creation of new institutions is helping Indigenous communities to overcome these historic barriers. However, continued progress is needed to improve data on Indigenous economies to enable Indigenous and Canadian policy-makers to make informed decisions.

Trade Flows and Exchange Rates: Importers, Exporters and Products

Using highly-disaggregated transaction-level trade data, we document the importance of new firm-level trade partner relationships and the addition of new products to existing relationships in driving aggregate trade flows. Moreover, we find that these margins are sensitive to movements in the exchange rate and that larger firms are substantially more responsive in terms of both the number of trade partners and products. These findings are then rationalized in a model of international trade with endogenous matching between heterogeneous importers and exporters. Simulations of the model highlight: (1) a new channel through which exchange rates influence short-run trade flows; and (2) the importance of firm heterogeneity—on both sides of trade transactions—in the adjustment process.

A Portfolio-Balance Model of Inflation and Yield Curve Determination

We propose a portfolio-balance model of the yield curve in which inflation is determined through an interest rate rule that satisfies the Taylor principle. because arbitrageurs care about their real wealth, they only absorb an increase in the supply of nominal bonds if they are compensated with an increase in their real rates of return. Since the Taylor principle implies that the real return on nominal bonds depends positively on inflation, inflation increases in equilibrium when there is an increase in the supply of nominal bonds to compensate arbitrageurs for the additional supply they have to hold.

Production Networks and the Macroeconomic Impacts of Commodity Price Shocks

We examine the macro implications of commodity price shocks in a small open economy model with input-output linkages for a commodity-exporting small open economy. In the model, fluctuations in commodity prices have impacts on aggregate output not only through resource reallocation, currency value changes and monetary policy reaction, but also through upstream and downstream input-output linkages (both domestically and with the rest of the world). We show the importance of input-output linkages as a shock transmission mechanism. We find that production linkages with the rest of the world play a significant role in amplifying the shock's aggregate impact.

Consumer Credit with Over-Optimistic Borrowers

Do cognitive biases call for regulation to limit the use of credit? We incorporate over-optimistic and rational borrowers into an incomplete markets model with consumer bankruptcy. Over-optimists face worse

income risk but incorrectly believe they are rational. Thus, both types behave identically. Lenders price loans forming beliefs—type scores—about borrower types. This gives rise to a tractable theory of type scoring. As lenders cannot screen types, borrowers are partially pooled. Over-optimists face cross-subsidized interest rates but make financial mistakes: borrowing too much and defaulting too little. In equilibrium, the welfare losses from mistakes are more than compensated by cross-subsidization. We calibrate the model to the US and quantitatively evaluate policies to address these frictions: financial literacy education, reducing default cost, increasing borrowing costs, and debt limits. While some policies lower debt and filings, only reducing default costs and financial literacy education improve welfare. However, financial literacy education benefits only rationals at the expense of over-optimists. Score-dependent borrowing limits can reduce financial mistakes but lower welfare.

The Intergenerational Correlation of Employment: Mothers as Role Models?

Linking data from the National Longitudinal Survey of Youth 1979 (NLSY79) and the NLSY79 Children and Young Adults, we document a substantial positive correlation of employment status between mothers and their offspring in the United States. After controlling for ability, education, fertility and wealth, offspring of permanently employed mothers have an 11 percentage-point higher probability to be employed in each given year than those of never employed mothers. The intergenerational transmission of maternal employment is stronger to daughters but significant also to sons. Investigating potential mechanisms, we provide suggestive evidence for a role model channel, through which labor force participation may be transmitted. Offspring seem to emulate the example of their mother when they observe her working. By contrast, we are able to rule out alternative candidate explanations such as network effects, occupation-specific human capital and local conditions of the labor market.

Macroprudential Capital Requirements, Monetary Policy, and Financial Crises

How should bank capital requirements be designed in order to reduce the frequency and severity of financial crises? What is the role of monetary policy in this context? To answer these questions, we develop a New-Keynesian dynamic stochastic general equilibrium (DSGE) model in which the economy endogenously switches between normal times and financially turbulent times. Banks do not

internalize that lower leverage contributes to the stability of the entire financial system. This creates a role for bank capital regulation. The proposed model replicates many of the dynamics observed during US financial crises. Basel-III-style capital buffers reduce the probability and length of financial crises while also reducing the size of the financial and non-financial sectors. Monetary policies that are more accommodative during financial crises can moderate economic downturns, thereby lowering the durations of financial distress. A combination of a small countercyclical capital buffer accompanied by a relief measure and an accommodative monetary policy during crises increases welfare.

Learning from Friends in a Pandemic: Social Networks and the Macroeconomic Response of Consumption

Aggregate events often start locally, with households learning about the unfolding of events through social communication. Using plausibly exogenous variation in counties' social network exposure to geographically remote regions during the COVID-19 pandemic, we quantify the propagation of idiosyncratic COVID-19 social network weighted shocks to consumption spending. We present a wide array of tests that directly control for the role of physical mobility, and physical distance, and isolate the role of geographically distant counties to show that the detected consumption responses were primarily through the channel of expectations, rather than physical infection risks or other common economic and policy shocks.

Does the Sequence Matter: Interest Rates, Quantitative Easing or Forward Guidance?

We study the role of unconventional monetary policies during a pandemic, focusing on the implementation sequencing of policies when there is a social containment period. Using the Bank of Canada's main projection model (ToTEM), we compare the efficacy of a suite of extended monetary policies (EMPs), finding that the immediate implementation of forward guidance and quantitative easing, followed by credit easing when containment measures are lifted delivers the best outcome. We also quantify the fiscal response needed to offset the gap in gross domestic product created by the effective lower bound, given operational limitations in scaling up EMPs.

Nonlinear Transmission of International Financial Stress

This paper investigates nonlinear international financial stress spillovers on a small open economy. The literature provides evidence

that financial stress may amplify the effects of adverse shocks. Using monthly data from the US and Canada over the period 1983–2019, we estimate a two-country threshold vector autoregressive model, where economies can be in either a financially tranquil or stressful regime. In times of high financial stress, we find macro-financial fragility between the real economy and financial stress in the US that generates a risk amplification mechanism deepening economic downturns. Additionally, when both countries are in a high-stress regime, US financial shocks are transmitted more strongly to the Canadian financial system and they are more detrimental for a large number of Canadian macro-financial variables. Finally, simulations suggest that our regime-switching model better captures the economic downturn in Canada during the 2007–2008 financial crisis, compared with a linear model.

STAFF WORKING PAPERS

Untapped Potential: Mobile Device Ownership and Mobile Payments in Canada

Mobile phones are ubiquitous around the world, making them obvious conduits for innovative payment technologies, or mobile payments. In Canada, five out of six adults regularly use a mobile phone. However, they have not started to use mobile payments at the same rate as other payment innovations, such as contactless card payments. In this paper, we present a two-stage model of mobile phone and mobile payment use.

An important feature of the model is that it controls for selectivity due to mobile device adoption. Controlling for selection into mobile phone usage reveals unobserved factors that have negative effects on mobile phone usage but a positive effect on the propensity to use mobile-type payments. These factors could be preferences or constraints.

We present empirical evidence that providing people without a mobile phone access to payments with features similar to mobile payments could result in usage rates exceeding the current use among mobile phone owners. Therefore, people who are unable to acquire or choose not to own a mobile device might have unmet payment needs.

Credit Card Minimum Payment Restrictions

We study a government policy that restricts repayment choices with the aim of reducing credit card debt. The policy requires the minimum

payment on credit card balances in Quebec to be at least 2% of the statement balance for cards opened before August 2019 and at least 5% for cards opened after August 2019. The rest of Canada is unaffected. We estimate this policy's effects by applying a difference-in-differences methodology to comprehensive, Canadian consumer credit-reporting data. The policy causes a persistent increase in minimum payments. The policy has trade-offs: reducing revolving debt comes at a cost of reducing credit access, and potentially increasing delinquency.

Central Bank Digital Currency and Transmission of Monetary Policy

How does the transmission of monetary policy change when a central bank digital currency (CBDC) is introduced in the economy? Do aspects of CBDC design, such as how substitutable it is with bank deposits and whether it is interest bearing, matter? We study these questions in a general equilibrium model with nominal rigidities, liquidity frictions, and a banking sector where commercial banks face a leverage constraint. In the model, CBDC and commercial bank deposits can be used as a means of payments, and they provide liquidity services to households. Banks issue deposits and extend loans to firms, and bank deposits are backed by loans and central bank reserves. We find that the effects of a canonical monetary policy shock, a shock to the Taylor rule that governs interest on central bank reserves, is magnified with the introduction of a fixed-interest-rate CBDC. More generally, whether CBDC magnifies or abates the response of the economy depends on the type of shock (e.g., interest rate or quantity of reserves shock). We also find that the response of the economy depends on the monetary policy framework—whether the central bank implements monetary policy through reserves or through CBDC—as well as central bank balance sheet rules that govern the quantity of CBDC and reserves.

Housing Affordability and Parental Income Support

In many countries, the cost of housing has greatly outpaced income growth, leading to a housing affordability crisis. Leveraging Canadian loan-level data and quasi-experimental variation in payment-to-income constraints, we document an increasing reliance of first-time homebuyers on financial help from their parents, through mortgage co-signing. We show that parental support can effectively relax borrowing constraints—potentially to riskier borrowers.

Entry and Exit in Treasury Auctions

Many financial markets are populated by dealers, who commit to participate regularly in the market, and non-dealers, who do not commit. This market structure introduces a trade-off between competition and volatility, which we study using data on Canadian treasury auctions. We document a consistent exit trend by dealers and increasing, but irregular, participation by non-dealer hedge funds. Using a structural model, we evaluate the impact of dealer exit on hedge fund participation and its consequences for market competition and volatility. We find that hedge fund entry was partially driven by dealer exit, and that gains thanks to stronger competition associated with hedge fund entry are offset by losses due to the irregular market participation of hedge funds. We propose an issuance policy that stabilizes hedge fund participation at a sufficiently high average level and achieves revenue gains.

Decision Synthesis in Monetary Policy

The macroeconomy is a complicated dynamic system with significant uncertainties that make modelling difficult. Consequently, decision-makers consider multiple models that provide different predictions and policy recommendations and then synthesize that information into a policy decision. We use Bayesian predictive decision synthesis (BPDS) as a way formalize this monetary policy decision-making process. BPDS draws on recent developments in model combination and statistical decision theory that make it possible to combine models in a manner that incorporates decision goals, expectations and outcomes. We develop a BPDS procedure for a case study of monetary policy decision-making with an inflation-targeting central bank and compare the results against standard model-combination approaches.

Price Discounts and Cheapflation during the Post-Pandemic Inflation Surge

We study how within-store price variation changes with inflation, and whether households exploit it to attenuate the inflation burden. We use micro price data for food products sold by 91 large multi-channel retailers in 10 countries between 2018 and 2024. Measuring unit prices within narrowly defined product categories, we analyze two key sources of variation in prices within a store: temporary price discounts and differences across similar products. Price changes associated with discounts grew at a much lower average rate than regular prices, helping to mitigate the inflation burden. By contrast, *cheapflation*—a

faster rise in prices of cheaper goods relative to prices of more expensive varieties of the same good—exacerbated it. Using Canadian Homescan Panel data, we estimate that spending on discounts reduced the change in the average unit price by 4.1 percentage points, but expenditure switching to cheaper brands raised it by 2.8 percentage points.

Let's Get Physical: Impacts of Climate Change Physical Risks on Provincial Employment

We analyze 40 years' worth of natural disaster shocks in Canada, using a local projection framework to assess their impact on provincial labour markets. We find that disasters decrease hours worked within a week and lower wage growth in the medium run. The impact is driven by periods of employment slack, which suggests that disasters act as a catalyst for already weak local economies. We also find a more tempered response over time, possibly due to adaptation or stronger federal financial support. Finally, we document substantial heterogeneity across disaster types. Overall, our study highlights that natural disasters can detrimentally affect vulnerable workers through the income channel.

Household Food Inflation in Canada

We use Canadian home scanner data to study household food inflation rates during periods of low and high inflation. We find that during the post-pandemic surge in inflation, the actual inflation rates experienced by different households varied more widely. Low-income households faced higher inflation than high-income households. We find that during the high-inflation period, households used several strategies to lower the impact of inflation, including shopping more frequently, shopping at more stores or buying more on sale. Canadian households also substituted more toward low-priced products when inflation increased.

STAFF DISCUSSION PAPERS

Analysis of Defi Oracles

This paper presents OVer, a framework designed to automatically analyze the behaviour of decentralized finance (DeFi) protocols when subjected to a "skewed" oracle input. OVer firstly performs a symbolic analysis on the given contract and constructs a model of constraints. Then, the framework leverages a satisfiability modulo theory solver to identify parameters that allow its secure operation. Furthermore, guard statements can be generated for smart contracts that may use

the oracle values, thus effectively preventing oracle manipulation attacks. Empirical results show that OVer can successfully analyze all 10 benchmarks collected, which encompass a diverse range of DeFi protocols. Additionally, this paper illustrates that current parameters used in the majority of benchmarks are inadequate to ensure safety when confronted with significant oracle deviations. It shows that existing ad-hoc control mechanisms such as introducing delays are often insufficient or even detrimental to protect the DeFi protocols against the oracle deviation in the real world. Moreover, this paper delves into the design considerations of price oracles within a potential blockchain-based digital currency.

The Role of Public Money in the Digital Age

A well-functioning monetary system is characterized by public and private forms of money that exchange at par as value flows freely between them. This is essential for efficient transacting and contracting in a market economy. A relevant retail public money—whether in the form of cash, a central bank digital currency or both—is a necessary component of such a monetary system. Some of the other necessary components include financial regulation, deposit insurance, a monetary policy framework and lender of last resort facilities. A monetary system without retail public money would be prone to fragmentation, where different types of private money do not trade at par, and to market failures arising from the network effects of payment platforms.

The Ecology of Automated Market Makers

This paper describes the ecology of automated market makers (AMMs), which are the most popular decentralized exchange model for the pricing and trading of crypto assets within decentralized finance. We use blockchain data to identify trends in user adoption and trading volumes of AMMs. Given the range of AMMs available and the diversity of their designs, we perform case studies on four platforms—Uniswap, Curve, Sushiswap and Balancer—to represent the AMM market. We describe the designs of these four AMMs in terms of their products or services, governance, incentives for participation and risks. Finally, we describe the characteristics of AMMs that require considerations with respect to the application of a regulatory framework to AMMs. Findings are presented for information and do not represent any formal legal analysis or opinion.

Ecosystem Models for a Central Bank Digital Currency: Analysis Framework and Potential Models

For an intermediated central bank digital currency (CBDC) to be successful, central banks will need to develop sustainable economic models where intermediaries and end users derive value and central banks achieve their policy goals. This note presents a framework for analyzing different economic models of CBDC ecosystems. We analyze the trade-offs of three main CBDC ecosystem models, each with different levels of central bank involvement in activities of the ecosystem and the usage of different policy levers. The policy levers considered in the framework are control over intermediary access to the CBDC network, prices and quality standards. Our analysis suggests that a central bank provision of network infrastructure enables direct control over intermediary access requirements, prices and quality standards upstream. Providing a central bank digital wallet increases development costs but allows the central bank to set quality standards downstream and to promote competition. Delegating the network service to a regulated entity reduces costs for the central bank but may limit its strategic autonomy to control upstream pricing and intermediary access. Our analysis also suggests several areas of future research: central bank pricing models, intermediary revenue models, and quality and privacy standards.

Monetary Policy Governance: Bank of Canada Practices to Support Policy Effectiveness

Monetary policy governance—how monetary policy objectives are determined, how decisions are made and who makes them—determines the quality and effectiveness of monetary policy decisions. In this paper, we examine some desirable and some adverse outcomes associated with different governance structures. We discuss the roles of legislation, institutional features, and processes and practices in establishing various aspects of governance. We highlight the importance of the domestic context in determining what governance structure works best for a given central bank. Finally, we provide an update on monetary policy governance at the Bank of Canada and how it has evolved over time.

The Output-Inflation Trade-Off in Canada

We explain how the Bank of Canada's policy models capture the trade-off between output and inflation in Canada. We start by briefly revisiting the determinants of the New Keynesian Phillips curve. Next,

we provide an overview of the Phillips curves that are currently embedded in the two main policy models the Bank uses for macroeconomic projections and analysis, known for short as ToTEM and LENS. We then discuss the challenges in identifying the trade-off between output and inflation and provide new estimates of the trade-off using recently proposed methods. Finally, we contrast these estimates with the ones in the Bank's policy models.

2023 Methods-of-Payment Survey Report: The Resilience of Cash

We present key results from the 2023 Methods-of-Payment (MOP) Survey, including updated payment shares based on a three-day shopping diary. Results show that measures of cash management and use have remained fairly stable since 2020, along with the estimated share of payments made online. In 2023, Canadians increased their adoption of payment alternatives such as mobile apps and Interac e-Transfer. New questions were introduced into the MOP survey instrument in 2023 to measure perceived access to cash from automated banking machines and banks.

Deriving Longer-Term Inflation Expectations and Inflation Risk Premium Measures for Canada

We present two models for long-term inflation expectations and inflation risk premiums for Canada. First, we estimate inflation expectations using a vector autoregressive model based on the relationship of inflation with both the unemployment gap and the term structure of the Government of Canada nominal bond yields. Then we estimate the inflation risk premium by regressing the nominal term premium on a set of inflation risk factors. We find that our model-implied measure of inflation expectations generally follows a trend similar to that of break-even inflation rates. We also find that the estimated inflation risk premium is negative or near zero through most of the sample period because most of this period was dominated by low inflation and low growth, with investors concerned about deflation. However, the model-implied inflation risk premium becomes positive in 2021. Because real return bonds will eventually disappear in Canada, a market-derived indicator for long-term inflation expectations is particularly relevant for central bankers. Similarly, capturing the individual components of the nominal term premium can be highly useful from a policy perspective.

UPCOMING EVENTS

Torben Andersen (Kellog School of Management)
Organizer: FMD/FSD EFR Seminar Series
Date: 1 October 2024

Krishna Pendakur (Simon Fraser University) &
Ravi Pendakur (University of Ottawa)
Organizer: EFR Seminar Series
Date: 1 October 2024

Sergio Alves (Carleton University)
Organizer: EFR Seminar Series
Date: 4 October 2024

Sephorah Mangin (Australian National University)
Organizer: EFR CEA Speaker
Date: 8 October 2024

Hsuan Fu (Laval University)
Organizer: FMD/FSD EFR Seminar Series
Date: 8 October 2024

Gary Koop (University of Strathclyde)
Organizer: EFR CEA Speaker
Date: 15 October 2024

Giovanni Dell'Ariccia (International Monetary Fund)
Organizer: BAP Seminars
Date: 22 October 2024

Michael Choi (University of California, Irvine)
Organizer: FMD/FSD EFR Seminar Series
Date: 22 October 2024

Ciaran Rogers (HEC Paris)
Organizer: BAP/EFR EFR Seminar Series
Date: 29 October 2024

Nils Wehrhöfer (Deutsche Bundesbank)
Organizer: CSCE Working Group Seminar Series
Date: 31 October 2024