



BANK OF CANADA
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Bank of Canada Monthly Research Update

March 2020

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

Chen, Heng & Chiang, Harold D. & Sasaki, Yuya, “Quantile Treatment Effects in Regression Kink Designs”, *Econometric Theory*, Vol 36(3): 25, March 2020

Forthcoming

Ahnert, Toni & Forbes, Kristin & Friedrich, Christian & Reinhardt, Dennis, “Macprudential FX Regulations: Shifting the Snowbanks of FX Vulnerability?”, *Journal of Financial Economics*

Alquist, Ron & Ellwanger, Reinhard & Jin, Jianjian, “The Effect of Oil Price Shocks on Asset Markets: Evidence from Oil Inventory News”, *Journal of Futures Markets*

Chernoff, Alex, “Firm Heterogeneity, Technology Adoption, and the Spatial Distribution of Population: Theory and Measurement”, *Canadian Journal of Economics*

Chen, Hui & Xu, Yu & Yang, Jun, “Systematic Risk, Debt Maturity and the Term Structure of Credit Spreads”, *Journal of Financial Economics*

Xie, Erhao & Aguirregabiria, Victor, “Identification of Non-Equilibrium Beliefs in Games of Incomplete Information Using Experimental Data”, *Journal of Econometric Methods*

Priftis, Romanos & Zimic, Srecko, “Sources of Borrowing and Fiscal Multipliers”, *The Economic Journal*

Kryvtsov, Oleksiy & Vincent, Nicolas, “The Cyclicalities of Sales and Aggregate Price Flexibility”, *Review of Economic Studies*

STAFF WORKING PAPERS

Martin, Ryan, “Identifying Consumer-Welfare Changes when Online Search Platforms Change Their List of Search Results”, Bank of Canada Staff Working Paper 2020-5

Diez de los Rios, Antonio, “A Portfolio-Balance Model of Inflation and Yield Curve Determination”, Bank of Canada Staff Working Paper 2020-6

- Huynh, Kim & Molnar, Jozsef & Shcherbakov, Oleksandr & Yu, Qinghui, “Demand for Payment Services and Consumer Welfare: The Introduction of a Central Bank Digital Currency”, Bank of Canada Staff Working Paper 2020-7
- Alquist, Ron & Ellwanger, Reinhard & Jin, Jianjian, “The Effect of Oil Price Shocks on Asset Markets: Evidence from Oil Inventory News”, Bank of Canada Staff Working Paper 2020-8
- Cullen, Joseph & Schutz, Nicolas & Shcherbakov, Oleksandr, “Welfare Analysis of Equilibria With and Without Early Termination Fees in the US Wireless Industry”, Bank of Canada Staff Working Paper 2020-9
- Guo, Jingtang & Johnston, Craig M.T., “Do Protectionist Trade Policies Integrate Domestic Markets? Evidence from the Canada-U.S. Softwood Lumber Dispute”, Bank of Canada Staff Working Paper 2020-10
- Davoodalhosseini, Mohammad, “Optimal Taxation in Asset Markets with Adverse Selection”, Bank of Canada Staff Working Paper 2020-11

STAFF DISCUSSION PAPERS

- Ahnert, Toni & Küncl, Martin, “Loan Insurance, Market Liquidity, and Lending Standards”, CEPR Discussion Paper DP14458

ABSTRACTS

Quantile Treatment Effects in Regression Kink Designs

The literature on regression kink designs develops identification results for average effects of continuous treatments (Nielsen et al., 2010, *American Economic Journal: Economic Policy* 2, 185–215; Card et al., 2015, *Econometrica* 83, 2453–2483), average effects of binary treatments (Dong, 2018, *Jump or Kink? Identifying Education Effects by Regression Discontinuity Design without the Discontinuity*), and quantile-wise effects of continuous treatments (Chiang and Sasaki, 2019, *Journal of Econometrics* 210, 405–433), but there has been no identification result for quantile-wise effects of binary treatments to date. In this article, we fill this void in the literature by providing an identification of quantile treatment effects in regression kink designs with binary treatment variables. For completeness, we also develop large sample theories for statistical inference, present a practical guideline on estimation and inference, conduct simulation studies, and provide an empirical illustration.

Macroprudential FX Regulations: Shifting the Snowbanks of FX Vulnerability?

Can macroprudential foreign exchange (FX) regulations on banks reduce the financial and macroeconomic vulnerabilities created by borrowing in foreign currency? To evaluate the effectiveness and unintended consequences of macroprudential FX regulations, we develop a model of bank and market lending in domestic and foreign currency, where banks can screen firm productivity while investors lend indiscriminately. We find support for the model's predictions using a rich dataset of macroprudential FX regulations. The results suggest that FX regulations: (1) are effective in terms of reducing borrowing in foreign currency by banks; (2) have the unintended consequence of simultaneously causing firms to increase FX debt issuance; (3) reduce the sensitivity of banks to exchange rate movements, but (4) are less effective at reducing the sensitivity of corporates and the broader financial market to exchange rate movements. As a result, FX regulations on banks appear to be successful in mitigating the vulnerability of banks to currency fluctuations and the global financial cycle, but partially shift the snowbanks of FX vulnerability to other sectors.

The Effect of Oil Price Shocks on Asset Markets: Evidence from Oil Inventory News

We quantify the reaction of U.S. equity, bond futures, and exchange rate returns to oil price shocks driven by oil inventory news. Across most sectors, equity prices decrease in response to higher oil prices before the 2007/08 crisis but increase after it. Positive oil price shocks cause a depreciation of the U.S. dollar against a broad range of currencies but have only a modest effect on bond futures returns. The evidence suggests that changes in risk premia help to explain the time-varying effect of oil price shocks on U.S. equity returns.

Firm Heterogeneity, Technology Adoption, and the Spatial Distribution of Population: Theory and Measurement

This paper develops a model of firm heterogeneity, technological adoption, and urbanization. In the model, welfare is measured by household real income, and urbanization is measured by population density. I use the model to derive statistics that measure the effect of a new technology on productivity, welfare, and urbanization. The empirical application of the paper estimates these effects using nineteenth-century firm-level data on mechanical steam power in the Canadian manufacturing sector, and township-level population data. The results indicate that the introduction of steam power increased productivity by 22.8 percent, and welfare by 6.0 percent. By comparing the model predicted change in urbanization to observed population density growth, I find that the introduction of mechanical steam power accounts for approximately 6.2 percent of the observed variation in urbanization during this period.

Systematic Risk, Debt Maturity and the Term Structure of Credit Spreads

We build a dynamic capital structure model to study the link between systematic risk exposure and debt maturity, as well as their joint impact on the term structure of credit spreads. Our model allows for time variation and lumpiness in the maturity structure. Relative to short-term debt, long-term debt is less prone to rollover risks, but its illiquidity raises the costs of financing. The risk premium embedded in the bankruptcy costs causes firms with high systematic risk to favour longer debt maturity, as well as a more stable maturity structure over the business cycle. Pro-cyclical debt maturity amplifies the impact of aggregate shocks on the term structure of credit spreads, especially for firms with high leverage or high beta, and for firms with a large

amount of long-term debt maturing when the aggregate shock arrives. However, endogenous maturity choice can also reduce and even reverse the effect of rollover risk on credit spreads. We provide empirical evidence for the model predictions on both debt maturity and credit spreads.

Identification of Non-Equilibrium Beliefs in Games of Incomplete Information Using Experimental Data

This paper relaxes the Bayesian Nash equilibrium (BNE) assumption commonly imposed in empirical discrete choice games with incomplete information. Instead of assuming that players have unbiased/correct expectations, my model treats a player's belief about the behavior of other players as an unrestricted unknown function. I study the joint identification of belief and payoff functions. I show that in games where one player has more actions than the other player, the payoff function is partially identified with neither equilibrium restrictions nor the usual exclusion restrictions. Furthermore, if the cardinality of players' action sets varies across games, then the payoff and belief functions are point identified up to scale normalizations and the restriction of equilibrium beliefs is testable. For games where action sets are constant across players and observations, I obtain very similar identification results without imposing restrictions on beliefs, as long as the payoff function satisfies a condition of multiplicative separability. I apply this model and its identification results to study the store hours competition between McDonald's and Kentucky Fried Chicken (KFC) in China. The null hypothesis that KFC has unbiased beliefs is rejected. Failing to account for KFC's biased beliefs generates an attenuation bias on estimated strategic effects. Finally, the estimation results of the payoff functions indicate that the decision about store hours is a type of vertical differentiation. By operating through the night, a firm not only attracts night-time consumers but also can steal competitors' day-time customers. This result has implications on the optimal regulation of stores' opening hours.

Sources of Borrowing and Fiscal Multipliers

This paper finds that debt-financed government spending multipliers vary considerably depending on the location of the debt buyer. In a sample of 33 countries, we find that government spending multipliers are larger when government purchases are financed by issuing debt to foreign investors (non-residents), compared with when government purchases are financed by issuing debt to home investors (residents).

A theoretical model (with flexible or sticky prices) shows that the location of the government creditor produces these differential responses to the extent that private investment is crowded out in each case. Increasing international capital mobility of the resident private sector decreases the difference between the two types of financing, both in the model and in the data.

The Cyclicalities of Sales and Aggregate Price Flexibility

Macroeconomists traditionally ignore temporary price markdowns (“sales”) under the assumption that they are unrelated to aggregate phenomena. We revisit this view. First, we provide robust evidence from the U.K. and U.S. CPI micro data that the frequency of sales is strongly countercyclical, as much as doubling during the Great Recession. Second, we build a general equilibrium model in which cyclical sales arise endogenously as retailers try to attract bargain hunters. The calibrated model fits well the business cycle co-movement of sales with consumption and hours worked, and the strong substitution between market work and shopping time documented in the time-use literature. The model predicts that after a monetary contraction, the heightened use of discounts by firms amplifies the fall in the aggregate price level, attenuating by almost 40% the one-year response of real consumption.

Identifying Consumer-Welfare Changes when Online Search Platforms Change Their List of Search Results

Online shopping is often guided by search platforms. Consumers type keywords into query boxes, and search platforms deliver a list of products. Consumers' attention is limited, and exhaustive searches are often impractical. Thus, the order in which products appear in search results affects the products consumers discover and ultimately purchase. In this setting, I study the identification of consumer-welfare changes in response to exogenous changes in search-result lists. I focus on the case of consumers engaging in costly searches for a single, indivisible (discrete) product among a collection of substitutes. I show that exact consumer welfare changes—that is, compensating variation and equivalent variation—can be calculated with the use of straightforward integrals of the aggregate demand. I apply my results to shopping data provided by an online travel agency (OTA). I estimate that when the OTA changes search results from random to its proprietary listing structure, welfare improves by an average of \$8.84 per user. I estimate an average welfare loss of \$20.51 per user

when the OTA removes the top five products from all of its search-result lists.

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. At the same time, because the Taylor principle implies that short-term nominal rates are adjusted more than one for one in response to changes in inflation, the real return on nominal bonds depends positively on inflation. In equilibrium, inflation increases when there is an increase in the supply of nominal bonds to compensate arbitrageurs for the additional supply they have to hold.

Demand for Payment Services and Consumer Welfare: The Introduction of a Central Bank Digital Currency

In recent years, there have been rapid technological innovations in retail payments. Such dramatic changes in the economics of payment systems have led to questions regarding whether there is consumer demand for cash. The entry of these new products and services has resulted in significant improvements in the characteristics of existing methods of payment, such as tap-and-go technology or contactless credit and debit cards. In addition, the introduction of decentralized digital currencies has raised questions about whether there is a need for a central bank digital currency (CBDC) and, if so, what its essential characteristics should be. To address these questions, we develop and estimate a structural model of demand for payment

instruments. Our model allows for rich heterogeneity in consumer preferences. Identification of the distribution of consumer heterogeneity relies on observing individual-level consumer decisions at the point of sale. Using parameter estimates, we conduct a counterfactual experiment of an introduction of CBDC and simulate post-introduction consumer adoption and usage decisions. We also provide insights into the potential welfare implications of the introduction of new payment instruments.

The Effect of Oil Price Shocks on Asset Markets: Evidence from Oil Inventory News

We quantify the reaction of U.S. equity, bond futures, and exchange rate returns to oil price shocks driven by oil inventory news. Across most sectors, equity prices decrease in response to higher oil prices before the 2007/08 crisis but increase after it. Positive oil price shocks cause a depreciation of the U.S. dollar against a broad range of currencies but have only a modest effect on bond futures returns. The evidence suggests that changes in risk premia help to explain the time-varying effect of oil price shocks on U.S. equity returns.

Welfare Analysis of Equilibria With and Without Early Termination Fees in the US Wireless Industry

We study the social welfare implications of early termination fees in the US wireless industry. It is hypothesized that the elimination of long-term contracts at the end of 2015 was a transition from one market equilibrium to another. We use a theoretical model to illustrate that the endogenous choice of consumer switching costs by service providers does not necessarily raise firms' profits or hurt consumers. The forward-looking behavior of consumers facing switching costs results in significant downward pressure on prices. Service fees may be so low that consumers are better off and firms are worse off in an equilibrium with switching costs. Empirically, we find that without early termination fees, firms would increase prices by 2 to 5 percent, on average, resulting in an unambiguous increase in consumer surplus. Firms' profits derived from monthly service fees also increase. However, if we consider additional revenues from contract termination payments, the cost of processing these payments should be large enough for producer profits to be higher in the new equilibrium.

Do Protectionist Trade Policies Integrate Domestic Markets? Evidence from the Canada-U.S. Softwood Lumber Dispute

We consider the effects of protectionist trade policies on international and domestic market integration, using evidence from the long-standing softwood lumber trade dispute between Canada and the United States. The benefits of trade liberalization are widely acknowledged, including better home-to-foreign price transmission due to reduced tariffs and lower trade costs between countries. Yet in recent years we see efforts to protect specific domestic groups, including producers, through a revival of protectionist trade policies. Such policies could improve the home-to-home price transmission

across domestic markets as consumers may seek lower-cost alternatives domestically. We investigate these ideas using a bivariate three-regime threshold vector error-correction model (TVECM) to examine the spatial price transmission between Canadian and U.S. markets and within U.S. domestic markets. We do that by introducing a structural break at the start of an effective free trade period within our sample. The results suggest that duty-free treatment for imported Canadian softwood lumber substantially lowers the transaction costs between the two nations. Prices are more easily transmitted from the Canadian market to the U.S. at a higher speed, but the speed of price transmission in the reverse direction is not statistically significant. The U.S. domestic market experienced a higher speed of price adjustment across domestic regions prior to the free trade period, which provides evidence that protectionist policies lead to better domestic market integration.

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 laissez-faire 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.

Loan Insurance, Market Liquidity, and Lending Standards

We examine loan insurance when lenders can screen at origination, learn loan quality over time, and can sell loans in secondary markets. Loan insurance reduces lending standards but improves market

liquidity. Lenders with worse screening ability insure, which commits them to not exploiting future private information about loan quality and improves the quality of uninsured loans traded. This externality implies insufficient insurance. A regulator achieves constrained efficiency by (i) guaranteeing a minimum price of uninsured loans to eliminate a welfare-dominated illiquid equilibrium; and (ii) subsidizing loan insurance in the liquid equilibrium. Our results can inform the design of government-sponsored mortgage guarantees.

UPCOMING EVENTS

***All onsite conferences and events are suspended until at least
May 15, 2020**

Ufuk Akcigit (University of Chicago, Department of Economics)
Organizer: Martin Küncl (CEA)
Date: 28 May 2020

Ryan Kellogg (University of Chicago, Harris School of Public Policy)
Organizer: Reinhard Ellwanger (INT)
Date: 5 June 2020

Karel Mertens (Federal Reserve Bank of Dallas)
Organizer: Daniela Hauser (CEA)
Date: 12 June 2020

Kozo Ueda (Waseda University, School of Political Science and
Economics)
Organizer: Ben Tomlin (INT)
Date: 24 July 2020

Dirk Krueger (University of Pennsylvania, Department of Economics)
Organizer: Katya Kartashova (CEA)
Date: 28 August 2020

Vincent Sterk (University College London, Department of Economics)
Organizer: Tom Pugh (FSD)
Date: 3 September 2020

Arlene Wong (Princeton University, Department of Economics)
Organizer: Julien Champagne (CEA)
Date: 11 September 2020

Roberto Chang (Rutgers University, Department of Economics)
Organizer: Julien Bengui (INT)
Date: 18 September 2020

Òscar Jordà (Federal Reserve Bank of San Francisco)
Organizers: Jean-Sébastien Fontaine & Bruno Feunou (FMD)
Date: 24 September 2020

Johannes Wieland (University of California San Diego, Department of Economics)

Organizer: Julien Champagne (CEA)

Date: 25 September 2020

Daniel Xu (Duke University, Department of Economics)

Organizer: Lin Shao (INT)

Date: 2 October 2020

Kaiji Chen (Emory University, Department of Economics)

Organizer: Lin Shao (INT)

Date: 16 October 2020

Leonardo Melosi (Federal Reserve Bank of Chicago)

Organizer: Romanos Priftis (CEA)

Date: 6 November 2020

Ana Maria Santacreu (Federal Reserve Bank of St. Louis)

Organizer: Pat Alexander (INT)

Date: 12 November 2020