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Interaction of Macroprudential and Monetary Policies: Practice Ahead of Theory

by Thibaut Duprey,[1] Yaz Terajima[1] and Jing Yang[2]

[1] Financial Stability Department
Bank of Canada

[2] Economic and Financial Research Department
Bank of Canada

tduprey@bankofcanada.ca, yterajima@bankofcanada.ca, jyang@bankofcanada.ca

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Abstract

This paper examines how monetary and macroprudential policies interact and possibly complement each other in achieving their respective price and financial stability objectives. We first review the Canadian experience of housing market cycles and highlight the need to coordinate the two sets of policies. Then, to deepen our understanding of policy interactions, we discuss current research work being done at the Bank of Canada and recent studies in the literature. Finally, for central bank and academic researchers, we emphasize remaining gaps in developing a modelling framework that unifies both price and financial stability objectives with explicit interactions between monetary and macroprudential policies.

Topics: Monetary policy; Financial stability
JEL codes: E52, E37, E58, E61, G01, G21, G28

Résumé

Dans cette étude, nous examinons comment les politiques monétaire et macroprudentielle interagissent et peuvent se compléter pour atteindre leurs objectifs respectifs en matière de stabilité des prix et de stabilité financière. Nous nous penchons d'abord sur les cycles passés du marché du logement canadien et soulignons la nécessité de coordonner les deux types de politiques. Puis, afin de mieux comprendre les interactions de ces politiques, nous examinons les travaux de recherche qui se font actuellement à la Banque du Canada ainsi que les études récentes dans le domaine. Enfin, pour les chercheurs du milieu universitaire et de banques centrales, nous mettons en relief les lacunes qui subsistent dans l'élaboration d'un cadre de modélisation regroupant les objectifs de stabilité des prix et de stabilité financière et montrant explicitement les interactions entre les politiques monétaire et macroprudentielle.

Sujets : Politique monétaire; Stabilité financière
Codes JEL : E52, E37, E58, E61, G01, G21, G28

1. Introduction

The 2008–09 global financial crisis and recent experience from the COVID-19 pandemic highlighted the intrinsic link between price stability and financial stability. One cannot be achieved without the other. If monetary policy aims to stabilize growth through price stability, then macroprudential policy aims to make growth more resilient to disruptive financial cycles. Monetary and macroprudential policy could either complement each other or appear to partially offset each other, depending on the shocks the economy faces. In recent years, central banks around the world have recognized the importance of this interaction between the two types of policies. For example, in 2020, Mark Carney, then the Governor of the Bank of England, delivered a speech arguing for the importance of having a unified framework to assess how each policy may contribute to a trade-off between price stability and financial stability (Carney 2020). Yet, gaps remain in practice regarding how central banks weigh this trade-off and how they optimally use the two policies. Indeed, many central banks list questions surrounding these issues as their research priority (Bank of Canada 2022; Bank of England 2024; European Central Bank 2024).

In this context, in this paper we draw on practical experiences and the academic literature to review two sets of questions.

First, how do monetary policy actions affect financial stability (in practice and in macroeconomic models)? Specifically, how can we upgrade our models to reflect the impact of monetary policy on risk taking and house price booms? Recent work highlights the possibility that monetary policy induces a trade-off between its impact on short-term economic growth and its impact on medium- to long-term tail risk for economic growth.

Second, if monetary policy induces undesirable risk taking such that macroprudential policy is required, how do we quantify the impact of macroprudential policies and feed this assessment into monetary policy decisions? Under some macroeconomic states, monetary and macroprudential policies can complement each other, in that the pursuit of one policy's objective supports the objective of the other in the short run. However, under other states, the two policies can appear to offset each other, in that the pursuit of one policy's objective conflicts with that of the other in the short run. We argue that this puzzling appearance can be explained by considering the tail risk of economic growth over a longer horizon—this is the *intertemporal complementarity* between monetary and macroprudential policies. Such intertemporal complementarity highlights the need for a policy model that incorporates this trade-off—the so-called grand unifying theory of monetary and macroprudential policies. But the grand theory is yet to be unified, and this is a promising area for further research.

We rely on historical experience in Canada while highlighting research done at the Bank of Canada on the link between price and financial stability on the one hand and the use of monetary and macroprudential policies on the other. There are two reasons why the Canadian experience is a useful case study. First, macroprudential and monetary policies in Canada reside within separate agencies with no formal policy coordination framework.[1] As a result, the authority in charge of one mandate takes the actions of the other as given. This clear separation of policy objectives makes it easier to describe possible interactions

[1] The Bank of Canada takes macroprudential policies as given when making its monetary policy decisions and applies the risk management approach in its monetary policy decisions (Poloz 2020). In this approach, risks associated with financial vulnerabilities are particularly important for the central bank to consider "to make tactical decisions to avoid unintentionally making financial stability concerns worse" (Poloz 2020).

than it would be under an alternative governance structure with dual mandates in price and financial stability. Second, Canada has a rich history of using macroprudential policies, which helps us to understand the relative effectiveness of these measures. Borrower-side and lender-side measures have been activated at least 60 times since 2000.

The rest of the paper is structured as follows. Section 2 documents and discusses how monetary policy actions impact financial stability. Section 3 looks at how macroprudential policies impact monetary policy decisions. Section 4 revisits Governor Carney's grand unifying theory and relevant ongoing work at the Bank of Canada. Section 5 concludes with some thoughts about open areas where the policy-making community would welcome further research.

2. How do monetary policy actions affect financial stability?

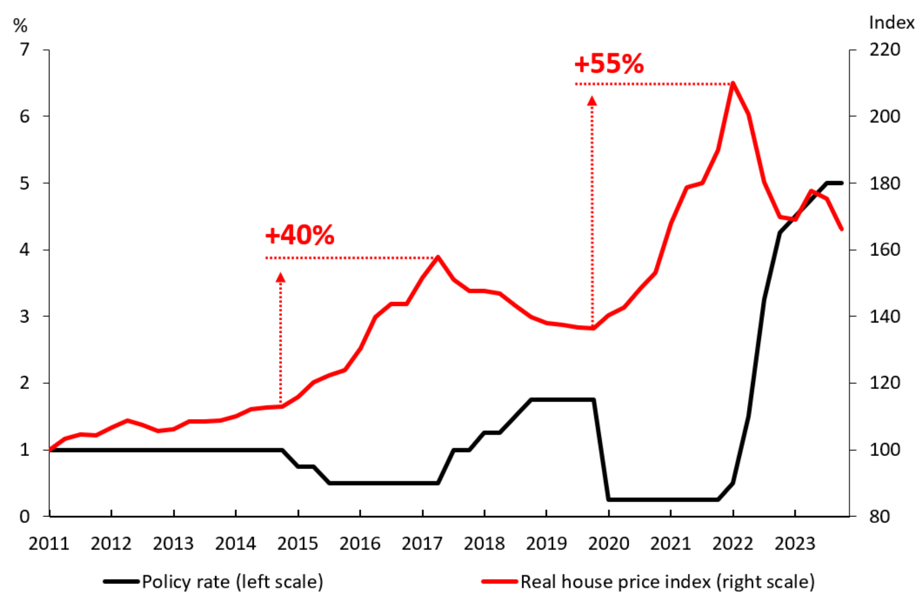
Central bankers now largely share the view that monetary policy impacts financial stability. One of the main channels through which this happens is the housing market, where house prices can respond to monetary policy actions, potentially leading to a boom-bust cycle. This section reviews the historical relationship between house prices and monetary policy in Canada and examines relevant research work aiming to understand it.

2.1. Two large housing booms coincided with periods of low rates

Chart 1 illustrates the link between monetary policy (black line) and housing booms (red line). The two largest housing booms in recent Canadian history coincided with two periods of ultra loose monetary policy. The first period followed the oil price shock in 2015. To respond to the large negative terms-of-trade shock, the Bank quickly lowered its policy interest rate to 0.5% to support the economy. Over two years, real house prices rose by 40% while household credit growth increased by 12%. The second period followed the much deeper shock caused by the pandemic. In this period, the policy rate hit the lower bound at 0.25%, and the Bank implemented quantitative easing.[2] Extraordinary monetary policy, together with the policies of financial and fiscal authorities, led to excess household savings, a desire for larger living spaces, and strong housing demand. Real house prices surged by 55% in just two years, with a two-year growth in real household credit of 15%.

Chart 1: Low interest rates coincided with two large housing booms

Quarterly data, index: 2011Q1 = 100



Sources: Federal Reserve Bank of Dallas and Bank of Canada Last observation: 2023Q4

[2] The Bank also implemented extraordinary forward guidance, indicating that it would keep rates at 0.25% until economic slack is absorbed and the 2% inflation target is sustainably achieved.

There is substantial empirical evidence that monetary policy can amplify boom-bust cycles. A range of international and US estimates (reported in Table 1 in Williams 2016) indicate that after two years, the effect on house prices of a 1 percentage point decrease in the policy interest rate may range from 1 to 10 percentage points.

Several channels could amplify boom-bust cycles, for instance:

- the credit channel with excessive leverage when rates are low for a long time (Grimm et al. 2023)
- the risk-taking channel for both borrowers and lenders (Borio and Zhu 2012; Martinez-Miera and Repullo 2017; Coimbra and Rey 2023; Altavilla, Laeven and Peydr 2020)
- the risk mispricing channel due to perceived low risks (Danielsson et al. 2023) and extrapolative expectations, especially for house prices (Adam, Kuang and Marcet 2012; Gelain, Lansing and Mendicino 2013; Adam and Woodford 2018)

Despite the overwhelming empirical evidence for risk taking in a low-rate environment, typical workhorse macroeconomic models that central banks use generally do not capture boom-bust cycles. For instance, in the usual dynamic stochastic general equilibrium (DSGE) models that central banks use, the elasticity of house prices to monetary policy shocks is typically at the lower bound of empirical estimates. Thus, newer models try to incorporate some aspects of the boom-bust cycle of the housing market into central banking macroeconomic models. Next, we consider in turn two areas with ongoing efforts to tackle this issue.

2.2. Low rates and housing booms highlight the possible role of extrapolative expectations in central banking models

One way forward is to depart from rational expectations in central bank macroeconomic models to capture the extrapolative nature of house price expectations. Extrapolative expectation rests on the belief that higher prices today lead to even higher prices tomorrow.

Emenogu, Hommes and Khan (2021) build on Bolt et al. (2019) to develop an exuberance index using a heterogeneous agent model with the presence of extrapolative expectations. The index infers the time-varying fraction of households that are extrapolative. They first estimate a proxy for the fundamental real house price $p_{i,t}^H$ as the fitted value $\widehat{p_{i,t}^H}$ of the following equation:

$$\log\left(p_{i,t}^H\right) = \gamma_i + \beta_1 \log(y_t) + \beta_2 \log\left(\nu_{i,t}\right) + \beta_3 \log\left(e_{i,t}\right) + \beta_4 r_{i,t} + \epsilon_{i,t}, \tag{1}$$

where real house prices are a function of real disposable income per capita y_t, the city-level population $\nu_{i,t}$, the city-level employment rate $e_{i,t}$ and the real effective mortgage rate minus the eight-quarter moving average of the provincial total inflation rate $r_{i,t}$. The equation is estimated over a quarterly panel of nine Canadian cities, indexed by i, over the period from the first quarter of 1988 to the fourth quarter of 2019 with city fixed effects γ_i. The resulting real house price gap is decomposed in equation (2) with a nonlinear autoregressive—AR(1)—model into the contributions from two types of households with heterogeneous beliefs about the speed of convergence of house prices to fundamentals:

$$\frac{p_{i,t}^H - \widehat{p_{i,t}^H}}{\widehat{p_{i,t}^H}} = \underbrace{\alpha(\varphi_t \Phi_1 + (1-\varphi_t)\Phi_2)}_{exuberance\ index} \frac{p_{i,t-1}^H - \widehat{p_{i,t-1}^H}}{\widehat{p_{i,t-1}^H}} + \xi_{i,t}. \tag{2}$$

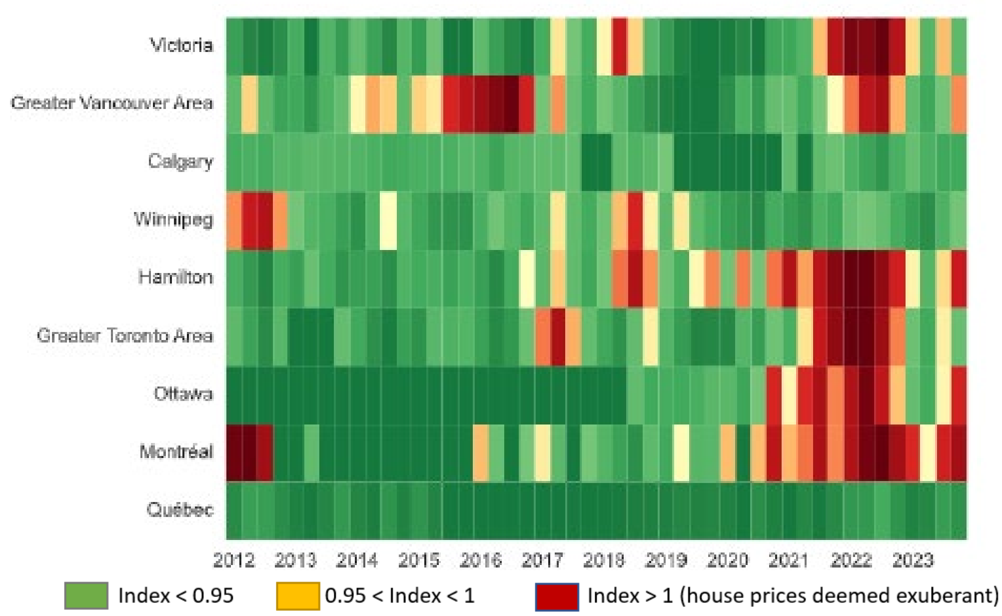
Households either believe in mean reversion with autoregressive parameter $\Phi_1 < 1$ or have extrapolative trend-following expectations with $\Phi_2 > 1$. The parameter α is calibrated to reflect the combined effect of the growth rates of rent, the mortgage rate, housing maintenance costs and the housing risk premium. The share of extrapolative households evolves endogenously according to the relative accuracy of each group's forecasting rule as shown in equation (3). That is, φ_t depends on the relative accuracy of the extrapolative versus the rational forecasting rule, where u^2 and u^1 are the housing price forecast errors from using only extrapolative or only mean-reverting forecasting rules, respectively:

$$\varphi_t = (1-\rho)\frac{\exp(\delta \exp(|u_{t-1}^2|))}{\exp(\delta \exp(|u_{t-1}^2|))+\exp(\delta \exp(|u_{t-1}^1|))} + \rho\varphi_{t-1}. \tag{3}$$

The house price exuberance index is the resulting time-varying coefficient of equation (2) combining the two groups of households.

The colour map in **Chart 2** displays the exuberance index for Canadian cities. When the index is at or above 1, this means that an average household needs to have a unit root in the expectation for the observed house prices to be replicated. For the major Canadian cities, including Toronto, Montreal and Vancouver, the model suggests a significant presence of extrapolative behaviours (in red) around the two periods of ultra-low monetary policy rates. Using data from the Toronto region, Emenogu, Hommes and Khan (2021) find that the exuberance indicator is closely correlated with the share of houses sold above their asking price.

Chart 2: Extrapolative expectations may drive house prices in some Canadian cities



Note: House price exuberance index recovered from the nonlinear heterogeneous agent model filtering Canadian data.
Source: Emenogu, Hommes and Khan (2021)

Duprey and Harding (2024) embed such an extrapolative-expectations mechanism into an otherwise standard New Keynesian DSGE model. The economy is populated by two types of households: patient lenders and impatient borrowers. Patient households own the firms producing the final good, and housing is in fixed supply. Impatient households want to buy a home but face an occasionally binding loan-to-value (LTV) borrowing constraint.

The model assumes that a share φ_t of (patient and impatient) households are rational, while a share $(1 - \varphi_t)$ of households have extrapolative expectations about house prices (all other variables are predicted rationally). Non-rational households observe the current price of housing but do not know the true mapping between economic conditions and house prices. They form their expectations based on an AR(1) recursive learning algorithm, with expectations denoted E_t^{AR1}:

$$E_t^{AR1} p_{t+1}^H = \beta_0^t + \beta_1^t p_t^H \equiv Z_t' \beta^t. \qquad (4)$$

For $Z_t = \begin{bmatrix} 1 \\ p_t^H \end{bmatrix}$, $\beta^t = \begin{bmatrix} \beta_0^t \\ \beta_1^t \end{bmatrix}$, and g the learning gain, the recursive learning algorithm is:

$$\beta^t = \beta^{t-1} + g R_t^{-1} Z_{t-1} \left(p_t^H - {\beta^{t-1}}^T Z_{t-1} \right)$$

$$R_t = R_{t-1} + g(Z_{t-1} Z_{t-1}^T - R_{t-1}).$$

Hence, economy-wide expectations for house prices E_t^H are given by:

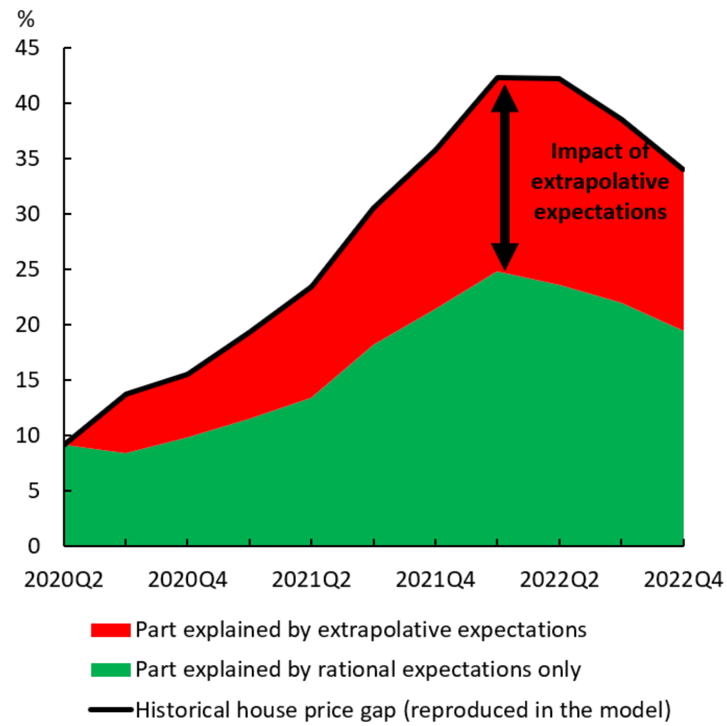
$$E_t^H p_{t+1}^H = \varphi_t E_t p_{t+1}^H + (1 - \varphi_t) E_t^{AR1} p_{t+1}^H. \qquad (5)$$

The share of each type of agent, φ_t, still follows equation (3), such that the model is calibrated to match the time series of the estimated share of extrapolative households by Emenogu, Hommes and Khan (2021). The housing shock process and the learning gain parameter that pins down the speed of changes in expectations are estimated with a non-linear filter.

Extrapolative expectations for house prices can explain a large fraction of the observed increase in house prices. **Chart 3** (black line) shows the actual house price gap—the percentage difference between actual house prices and fundamental house prices—around the post-pandemic ultra-low interest rate period, replicated through the lens of the model with extrapolative expectations. The simulation of the model with the same filtered shocks but now under rational expectations generates a lower house price increase (**Chart 3**, green area). Without the endogenous mechanism associated with extrapolative expectations, a typical macroeconomic DSGE model would need larger positive house price shocks to explain the house price boom in the data. Eventually, the decomposition shows that the model can assign about 40% of the increase in the house price gap to extrapolative expectations (**Chart 3**, red area).

Chart 3: Extrapolative expectations can explain a large part of the house price gap

House price gap, deviation from estimated fundamental



Note: The DSGE model from Duprey and Harding (2024) includes extrapolative house prices and occasionally binding constraint. History is simulated assuming the extrapolative expectations model is true. The green area is a counterfactual with no extrapolative component.

2.3. Monetary policy introduces a trade-off between stabilizing median growth and widening tail risks

Another analytical effort to frame policy discussions around the risks associated with loose monetary policy leverages the notion of growth at risk. Cecchetti and Li (2008) and Adrian, Boyarchenko and Giannone (2019) define growth at risk as the growth of gross domestic product (GDP) below which a realization could occur only with a 5% probability, namely the fifth percentile of the density forecast of GDP growth. In this framework, monetary policy influences both median growth and GDP at risk, giving rise to an intertemporal trade-off: monetary policy easing can soften the impact of a recession today and support a credit-driven recovery, but by doing so, it may sow the seed of tomorrow's crisis, opening the door for macroprudential policy actions.

The intertemporal trade-off is illustrated by the local projection quantile regressions of Duprey and Ueberfeldt (2020), who combine the two main drivers of the tail of GDP growth. In equation (6), the distribution of year-over-year GDP growth y_{t+h} at horizon $h = \{1, \ldots, 12\}$ depends on systemic financial market stress ($\text{fsi}_{c,t}$ as suggested by Adrian, Boyarchenko and Giannone 2019) and the two-year growth of household credit ($d_{c,t}$ as suggested by Schularick and Taylor 2012):

$$\boldsymbol{Q}\big(y_{c,t+h}\big|\tau\big) = \alpha(\tau) + \alpha_c(\tau) + \gamma_1(\tau)\mathrm{fsi}_{c,t} + \gamma_2(\tau)d_{c,t} + \gamma_3(\tau)y_{c,t} + \gamma_4(\tau)\pi_{c,t} + \gamma_5(\tau)R_{c,t} + \gamma_6(\tau)\widetilde{p^H_{c,t}}. \quad (6)$$

We estimate the model for each horizon h over the period from 1983 to 2018 for a panel of $C = 15$ developed economies,[3] with $\boldsymbol{Q}(\cdot\,|\tau)$ denoting the quantile operator for percentile τ estimated as in Koenker and Bassett (1978). The panel dimension implies the use of the cross-country systemic financial stress indexes of Duprey, Klaus and Peltonen (2017) characterized by spreads, volatilities and co-movement of asset prices. The estimation controls for country fixed effects (α_c), the initial growth of GDP ($y_{c,t}$), the change in the policy rate ($R_{c,t}$), the inflation rate ($\pi_{c,t}$) and the real house price gap ($\widetilde{p^H_{c,t}}$) are all expressed in year-over-year growth.

Chart 4 reports estimates of the impact of changes in systemic financial market stress (γ_1) and changes in the two-year growth of credit (γ_2) on the distribution of future GDP growth represented by the 5th and 50th percentiles ($\tau = \{.05;\ .50\}$). Given those elasticities, how would a monetary policy shock influence the distribution of GDP growth? In the short run, monetary policy easing supports GDP growth in at least two ways. First, it eases financial conditions during stressful times, with the reduction in systemic financial stress improving GDP at risk (**Chart 4**, panel a, red line). Second, monetary policy easing boosts credit, with sustained credit growth increasing median GDP growth (**Chart 4**, panel b, black line). Introducing monetary policy shocks directly into the quantile local projection, Loria, Matthes and Zhang (2019) find that a monetary policy easing shock improves the 10th percentile more than the median or the 90th percentile. Those effects start to dissipate beyond one year.

In the medium run, loose financial conditions worsen downside risks (Adrian et al. 2022), primarily through the credit channel effect of monetary policy on GDP at risk (Duprey and Ueberfeldt 2018, 2020). Monetary policy that is low for a long time supports excessive (mortgage) credit growth and a house price boom that is associated with higher probabilities of subsequent financial crises (Schularick and Taylor 2012; Jordà, Schularick and Taylor 2015, 2016). **Chart 4** (panel b, red line) shows this negative impact of credit on GDP tail risk more than two years ahead.

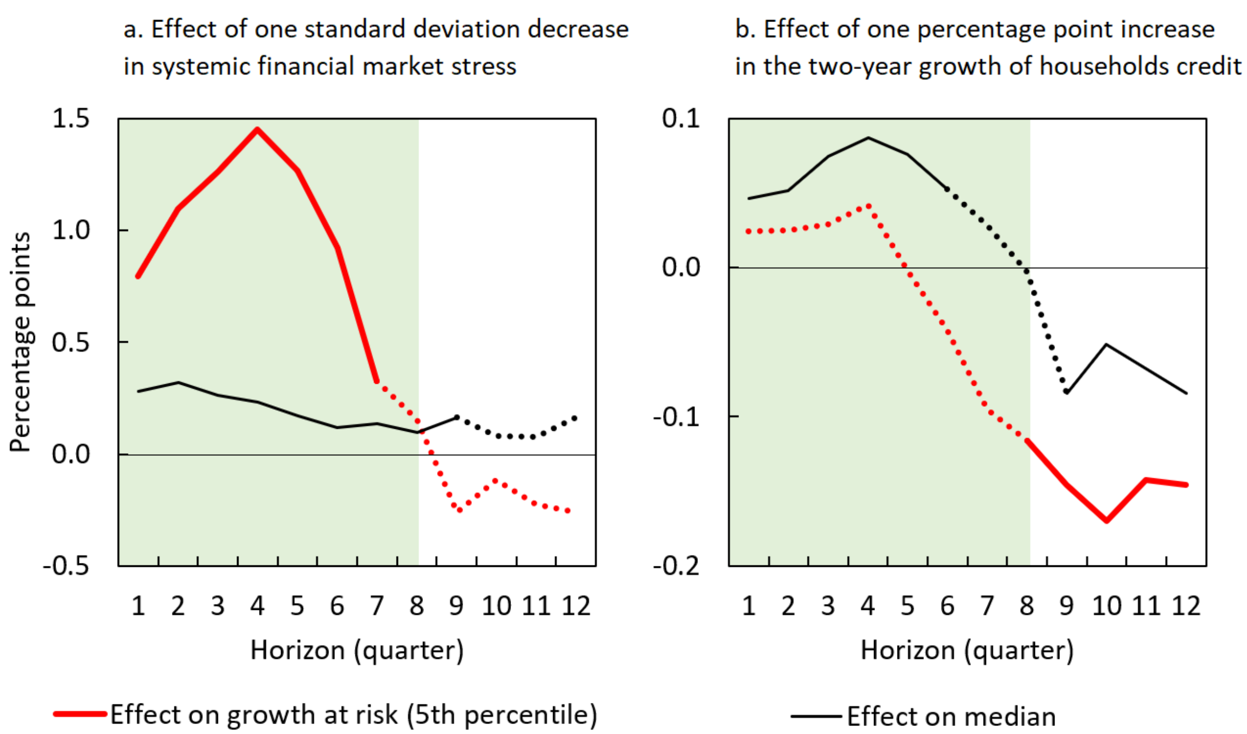
Eventually the policy choice is down to a trade-off between stabilization of the output gap and widening tail risks. This is what former Bank of Canada Governor Stephen S. Poloz called the risk-management framework (Poloz 2014, 2020; Meh and Poloz 2018; Beaudry 2020). In this situation, the central bank would mostly target the median of the distribution of GDP growth, although this could worsen growth at risk. And for a given median GDP growth, macroprudential policy could be used to minimize the size of the tail of GDP growth, even if doing so hurts median GDP growth by slowing down credit and cooling house prices. Indeed, macroprudential policy targeting either the supply or the demand for credit can reduce GDP tail risk (Franta and Gambacorta 2020; Galan 2020; Allen et al. 2020; Duprey and Ueberfeldt 2020; Aikman et al. 2021; Cecchetti and Suarez 2022), possibly targeting a given gap between the median and growth at risk (Duprey and Ueberfeldt 2020; Suarez 2022). When the median is anchored by inflation targeting, macroprudential policy may work in part by reducing systemic banking risk (Belkhir et al. 2023).

[3] The developed economies in the sample are Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States.

In practice, this intertemporal trade-off is hard to take into account in policy-making.[4] First, typical central banking models used for projection do not have the relevant features. Second, monetary policy easing may cause downside risks to worsen more than two years later, beyond the typical macroeconomic forecast horizon (represented by the green shaded area in **Chart 4**). Third, it may be difficult in practice to correctly quantify the weights in a policy-maker objective function. Eventually, tightening the flow of credit implies accepting the certainty of lower GDP growth today in the hope of reducing the probability of a future event, which may lead to additional political economy challenges.

Chart 4: Financial conditions generate an intertemporal trade-off

Year-over-year real GDP growth



Note: The green shaded area corresponds to the typical two-year forecast horizon used for macroeconomic projections. Cross-country quantile regressions are reproduced from the appendix of Duprey and Ueberfeldt (2020). A solid line indicates the effect is significant.

[4] For an example of an application of the growth-at-risk framework during a period of low monetary policy rates characterized by extrapolative expectations, see Chart 18 and Chart 19 in the 2021 Financial System Review (Bank of Canada 2021). In this example, the Bank's macroeconomic projections and policy rate expectations were fed into Duprey and Harding's (2024) DSGE model with extrapolative expectations, and the resulting scenario was combined with the growth-at-risk elasticities of Duprey and Ueberfeldt (2020).

3. How do macroprudential policies impact the transmission of monetary policy?

The recent developments discussed so far have allowed for a better assessment of downside risks coming from monetary policy easing and its implications for financial stability. If monetary policy aims to stabilizing median growth, macroprudential policy ensures that growth is more resilient by reducing risks that are systemic in nature. But, in turn, how do macroprudential policies impact monetary policy decisions? Do the two types of policies complement or offset each other?

3.1. Canada has a long history of macroprudential policy decisions

Over the last 40 years, Canada has been proactive in implementing macroprudential policy. **Chart 5** displays the total number of macroprudential policy measures announced and implemented. The index is normalized in 1980, with +1 for one tightening measure and -1 for one easing measure. Altogether, there have been at least 83 measures.[5]

On the lender side (**Chart 5**, yellow dashed line), after removing the reserve requirements in the early 1980s and 1990s, Canada implemented the various Basel regulations (capital conservation buffer, capital surcharge for domestic systemically important banks, the Canadian version of the countercyclical capital buffer, the leverage ratio and liquidity requirements) as well as other accounting changes (rules around loan loss provisioning, dividends, loss given default, and deferrals).

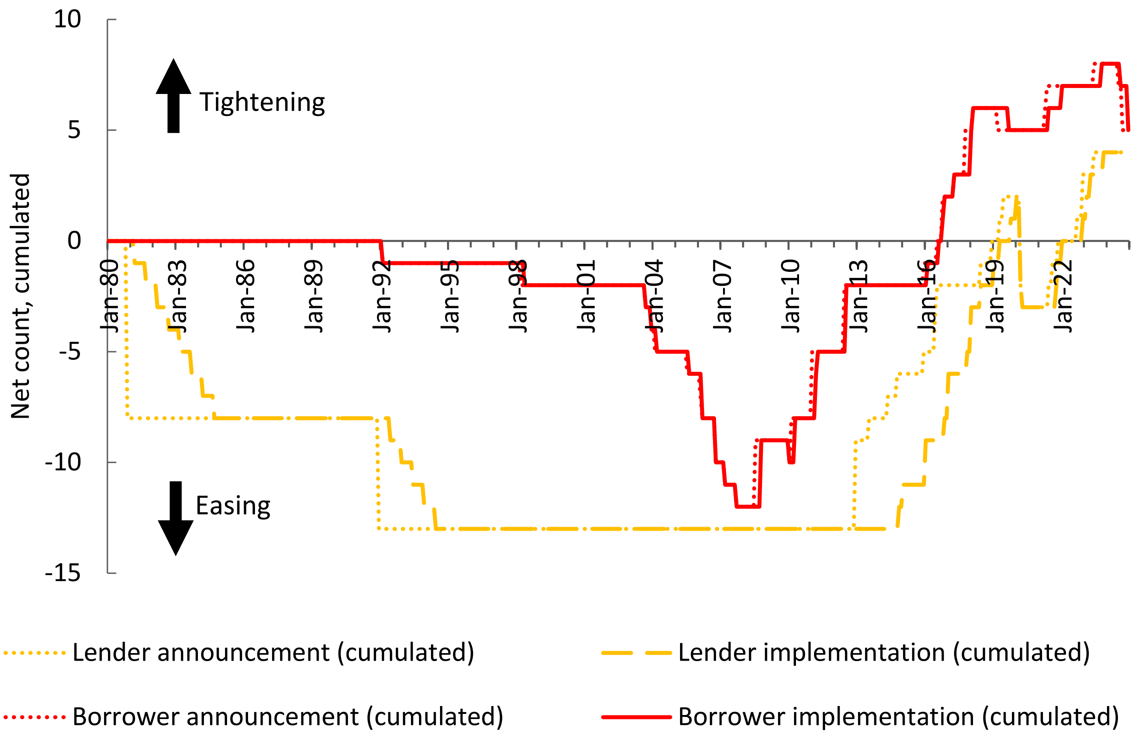
On the borrower side (**Chart 5**, red line), Canada initially eased rules to support housing affordability (these rule changes were not labelled as macroprudential at the time). After the 2008–09 global financial crisis, tightening aimed at cooling the housing market and limiting households' credit vulnerabilities (loan-to-value or debt-service ratios, limits on amortization, rules to qualify for a mortgage, premium for access to mortgage insurance, and taxes on foreign house buyers or vacant homes). One borrower-side policy that has received a lot of attention in Canada is the mortgage qualifying rate (MQR), which regulates the mortgage underwriting standards for lenders so that potentially risky mortgage borrowers do not qualify for a loan. The idea of the MQR is that borrowers must prove they have enough income to face a possible increase in their mortgage rate above their contractual mortgage rate. Features of MQR have developed and changed since its institution in 2010. Currently, the MQR is defined as the maximum of two components, a floor of 5.25% and a buffer of 200 basis points (bps) above the contractual rate.[6]

Since 2015, with two episodes of very low monetary policy rates, Canada has taken two major sets of macroprudential policy actions that have had clear implications for monetary policy, either complementing or apparently offsetting it.

[5] **Table B-1** and **Table B-2** in Appendix B list all the measures.
[6] See Appendix A for more information.

Chart 5: Canada has a long history of macroprudential policy changes

Number of macroprudential easing events minus number of macroprudential tightening events since 1980



Note: One macroprudential easing event is -1; one macroprudential tightening event is +1. The chart displays the cumulated number of easing and tightening events normalized to 0 in 1980. Dotted lines indicate a policy announcement; solid or dashed lines indicate implementation.

Sources: Duprey and Tuzcuoglu (forthcoming), Duprey and Ueberfeldt (2020) and Alam et al. (2019)

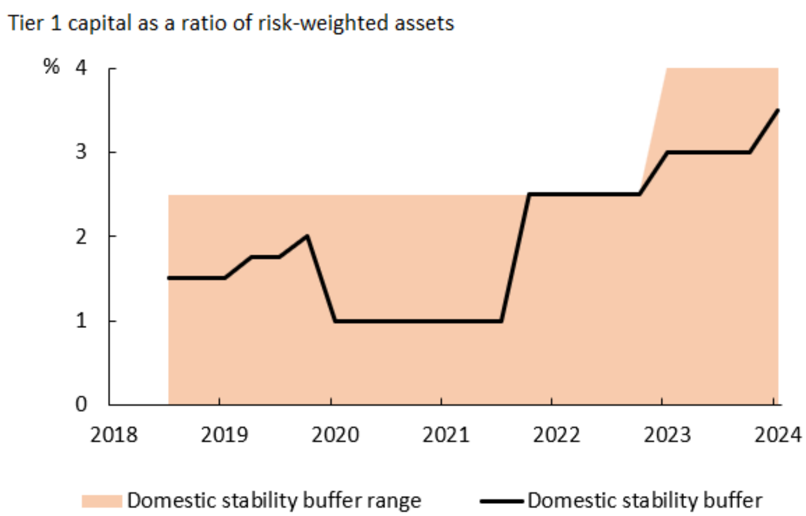
3.2. Monetary and macroprudential policies are complementary during the COVID-19 pandemic

Domestic macroeconomic and financial conditions after the pandemic shock required a synchronized easing in both monetary and macroprudential policies. The domestic stability buffer (DSB) is the Canadian version of dynamic capital requirements for domestically systemic banks, similar to the Basel III countercyclical capital buffer (CCyB).[7] When the pandemic struck, the Bank of Canada, like many advanced-economy central banks, decisively dropped its monetary policy rate to its effective lower bound. Like the United Kingdom and the other nine jurisdictions that had built a positive CCyB, Canada immediately lowered the countercyclical bank capital buffer to 1% (**Chart 6**). When the economy bounced

[7] The DSB differs from the CCyB because it applies to all banks' exposures, not only those of domestic banks. The CCyB, in contrast, applies to domestic exposures and, through reciprocal arrangements, across jurisdictions. The DSB is not associated with automatic dividend restrictions if the buffer is breached, whereas the CCyB is.

back strongly from the pandemic, Canada was the first country to rebuild its countercyclical capital buffer to as high as 3.5%. Indeed, Canada announced a new upper limit of 4%, which is much more stringent than the current 2.5% ceiling under Basel III's CCyB. Overall, the larger cyclical capital buffer represents a significant step in strengthening the resilience of the Canadian financial sector. At the same time, in a series of hikes, the Bank rapidly raised the monetary policy rate to 5%.

Chart 6: The domestic stability buffer was raised from 2.5% to 3.5% in 2023, with a ceiling at 4%



Note: The domestic stability buffer is the Canadian equivalent to the Basel III countercyclical capital buffer.

Source: Office of the Superintendent of Financial Institutions

In both cases, macroprudential and monetary policies were pulling in the same direction to support the economy and overall credit at the beginning of the pandemic and to fight high inflation and strong credit growth during the recovery phase. Thus, the two are complements. Tightening the supply of credit with macroprudential policy has a cooling effect on the real economy just like monetary policy tightening does. This implies that, all else being equal, monetary policy may not need to be tightened as much to reach the same inflation outcome if macroprudential policy is also tightening at the same time.

But then what is the equivalence between macroprudential and monetary policy tightening? Several models can be used to map the impact on the monetary policy rate space of a 100 bps increase in cyclical capital requirements. Building on Halaj and Priazhkina (2021), Hipp (2024) constructs a heterogeneous banks model to quantify the impact of the macroprudential policy change on credit. The model differs in several ways from typical DSGE or stress-testing models sometimes used for such assessment. First, unlike a typical representative bank DSGE model, Hipp's (2024) model uses the heterogeneity and granularity of banks' balance sheets. However, it contains only seven different asset classes and four types of liabilities, while bank stress-testing models often display more granularity.

Second, instead of using accounting-based rules typically employed in stress-testing models, in Hipp's (2024) model banks optimize their balance sheets and consider the impact of their competitors. Specifically, banks maximize their utility u associated with their expected return over equity, where x_t and $\tilde{r}_{t+1}$ are vectors containing the possible adjustments and returns for each balance sheet item, respectively:

$$u(x_t) = E\left(\tilde{r}_{t+1}(x_t)\right)' x_t + \lambda\, log(\tau_b(x_t) - \overline{\tau_{min}}) + \gamma(x_t). \quad (7)$$

The function $\gamma(x_t)$ corresponds to balance sheet adjustment costs specific to each item of the balance sheet.

Third, whereas typical banking DSGE models assume binding capital requirements, in Hipp's (2024) model, banks receive positive utility from holding a managerial capital buffer above the regulatory minimum as estimated over history. This is introduced with the parameter λ, which drives the trade-off between holding higher bank capital ratios and holding a more profitable (but potentially riskier) loan portfolio. The trade-off can be interpreted as a bank's aversion to see its capital ratio $\tau_b(x_t)$ hit the minimum regulatory constraint $\overline{\tau_{min}}$.

Fourth, Hipp's model is estimated on regulatory returns of each of Canada's six largest banks (e.g., the parameters λ and the functions γ) to ensure that banks' behaviour is consistent with observed patterns. In contrast, in typical banking DSGE models, stress-testing tools are often calibrated with limited scope for external calibration.

Last, while typical agent-based models use heuristic fire-sale rules, in Hipp's (2024) model banks' behaviours affect asset and liability prices that are set by a Nash equilibrium. This also implies that banks are aware of each other's behaviour and, for instance, can partly offset a decrease in lending by a competitor if they find it profitable to do so. This is more important and easier to model in a concentrated banking market like Canada, where six major banks account for most of the banking sector.

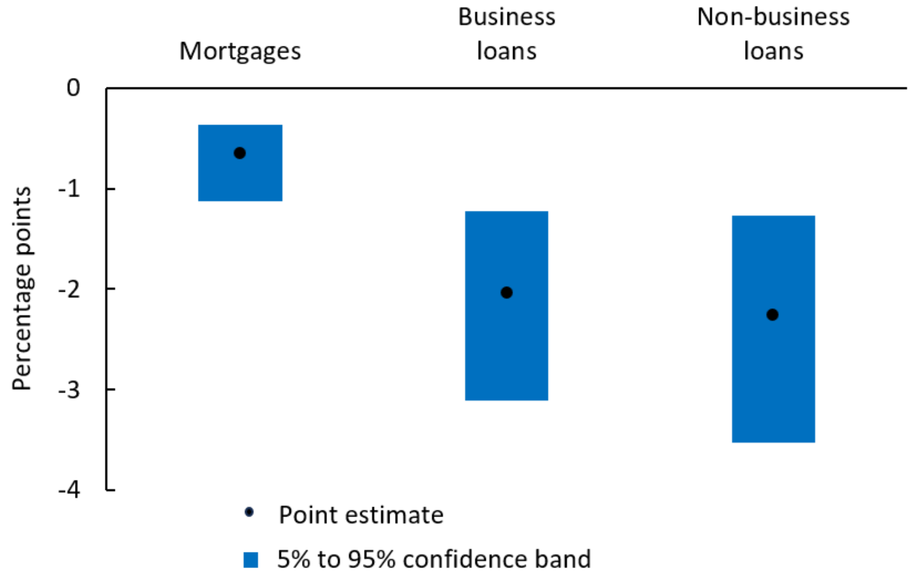
The heterogeneous banks model is a partial equilibrium, which means it needs to be complemented by another macroeconomic model to draw macroeconomic implications for GDP. In addition, although the heterogeneous banks model includes a central bank that can do open market operations, it is completed by the DSGE of Alpanda, Cateau and Meh (2018) to draw implications for the effect of monetary policy. This macroeconomic model captures the balance sheet dynamics of firms, households and banks with leverage constraints for each agent.

Chart 7 shows the results from simulating the possible effect of the increase in cyclical bank capital by 100 bps in 2023. This is expected to lead to a larger reduction in business credit and a moderate reduction in household credit, in part because the former has a shorter maturity and riskier profile than the latter. Such adjustment of lending over a two-year horizon is consistent with a 25 bps reduction in the monetary policy rate, as inferred by using the DSGE model of Alpanda, Cateau and Meh (2018).

This pattern is also in line with Espic, Kerdelhue and Matheron (2024), who show in a DSGE model with household defaults that moving to higher bank capital requirements from Basel II to Basel III had the effect of smoothing the economic cycle, thereby giving more room for monetary policy to fight inflation during the post-pandemic period. Similarly, Boissay, Borio et al. (2023) find empirically that tighter bank capital regulation helps avoid financial stress associated with tighter monetary policy, giving more room for monetary policy actions. Using microdata, Altavilla, Laeven and Peydr (2020) find that strengthening the capitalization of the weaker banks amplifies the complementarity between monetary and macroprudential policies.

Chart 7: The increase in the domestic stability buffer is expected to reduce credit

Effect of raising the domestic stability buffer from 2.5% to 3.5% by the end of 2025



Note: The domestic stability buffer is the Canadian equivalent to the Basel III countercyclical capital buffer.

Source: Hipp (2024)

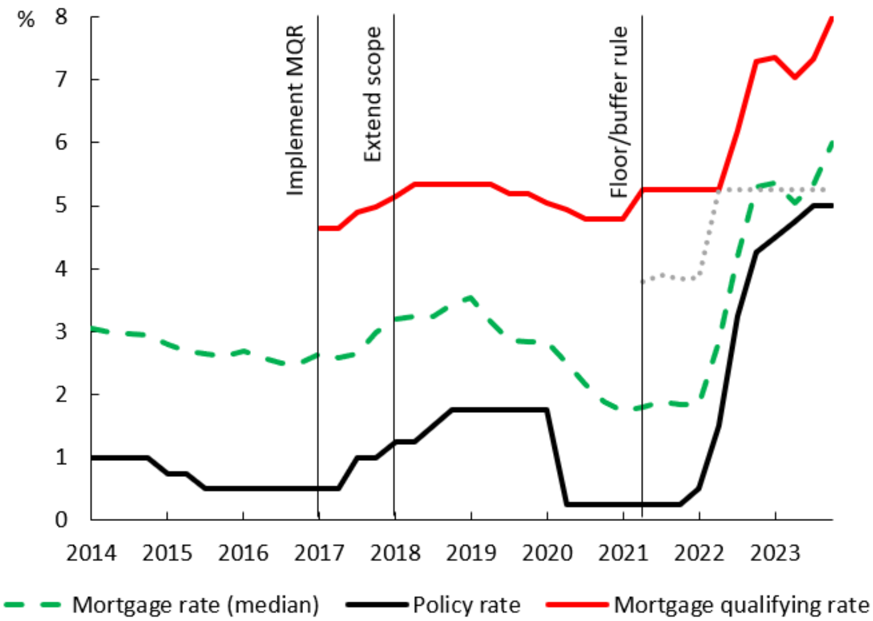
3.3. Monetary policy is expansionary while macroprudential policy is restrictive during the oil price shock

Monetary and macroprudential policies can also appear to work in opposite directions. This is particularly the case when a negative demand shock calls for loose monetary policy, but the associated surge in household debt and risk taking in housing markets calls for tighter macroprudential policy.

One example is the oil price shock in 2015–16: the Bank cut the monetary policy rate down to 50 bps, and the rate stayed low for two years. As a result, while the low rate supported the economic recovery, it may also have amplified the surge in real house prices. In the same period, house prices in Canada rose by 40%.

Against this backdrop of persistent house price increases, macroprudential policy was tightened, causing house prices to peak and then start to decline in 2017. The maximum LTV ratio was reduced from 95% to 90% for houses worth more than $1 million, foreign-buyer taxes were introduced, and, more importantly, stress testing by MQR was expanded to cover all mortgages (**Chart 8**). Borrowers were required to prove that they could still service their mortgage if the interest rate were 200 bps higher than their contractual mortgage rate. This MQR served to limit risk taking by both borrowers and lenders.

Chart 8: The mortgage qualifying rate stress-tests borrowers against higher payments



Note: This chart focuses on mortgages with loan-to-value ratios above 80%—those subject to the mortgage qualifying rate (MQR) after the 2016 announcement. The dashed green line is the median mortgage rate at origination. The red line approximates the mortgage qualifying rate active at the time. That initially corresponds to the benchmark five-year fixed posted rate of Canada's six largest banks; after 2021Q2 it is the maximum between a floor rate of 5.25% and a buffer rate of 2% above the contractual mortgage rate (the red line denotes the floor or buffer that is binding, and the dotted grey line is the floor or buffer that is not binding).

Sources: Department of Finance Canada, Office of the Superintendent of Financial Institutions and Bank of Canada calculations

The second house price boom, which occurred during the COVID-19 pandemic period, offers another, similar example. The bleak macroeconomic outlook after the COVID-19 shock prompted the Bank of Canada to cut the policy rate to 25 bps and introduce forward guidance to influence the expectation that rates would stay low for a sustained period. The house price boom that followed led to a tightening of the MQR. Given the extremely low mortgage rates at the time, requiring borrowers to prove that they could cope with an increase of 200 bps in their contractual mortgage rate was not deemed restrictive enough. Thus, a floor was introduced, which required borrowers to prove they have enough income to face a mortgage rate of at least 5.25% or 200 basis points above their contractual mortgage rate, whichever is higher.

Tighter macroprudential policies in these periods of low rates helped to limit risk taking in housing markets and to backstop the highly leveraged borrowing. However, this may have come at the cost of muting some of the expansionary effects of loose monetary policy. To quantify the macroeconomic impact of the interaction between the MQR and monetary policy, Duprey et al. (2024) rely in ongoing work on a DSGE model with two types of households. The first group of households is constrained by either payment-to-income or loan-to-value constraints, as in Greenwald (2018), but they have no trouble qualifying for a mortgage. The second group of households are additionally constrained by their difficulty to qualify for a mortgage. The authors show that when a large fraction of households face a binding qualifying-rate constraint, that reduces the mortgage credit and house price growth associated with monetary policy easing. If tighter macroprudential policy occurs during a cycle of monetary policy easing, it means that macroprudential policy can mute the transmission of monetary policy, so monetary policy has to ease more to stimulate demand by a similar amount.

In such episodes, although the restrictive macroprudential policy and expansionary monetary policy partially offset each other's macroeconomic impacts, this policy combination can be socially desirable. Monetary policy is a blunt tool intended to boost aggregate demand across all sectors of the economy, even if one sector is overheated while the others are all super cool. In contrast, macroprudential policies can target certain sectors (primarily the housing sector) with precision. This is particularly helpful when tighter macroprudential policies can be used to guard against excessive risk taking in the housing market when rates need to remain low for a long time. In a welfare sense, the best policy mix may well be a blend of expansionary monetary policy and restrictive macroprudential policy.

3.4. Tighter macroprudential policies in a low-rate environment reduce tail risk

As discussed in section 2.3, monetary policy may introduce an intertemporal trade-off beyond the typical projection horizon considered by forecasters. After a negative demand shock, loose monetary policy to support GDP growth and stabilize inflation today may increase the odds of subsequent disorderly disruptions to the economy in the case of excessive leverage when future shocks hit. Thus, tighter macroprudential policy during a period of loose monetary policy may avoid a future worsening of GDP at risk and therefore make monetary policy more effective at stabilizing the economy in the future. This could be true even if it is not an explicit objective of macroprudential policies.

This is exactly what happened with the introduction and subsequent tightening of the MQR in Canada. Higher qualifying rates today make it harder for borrowers to get a mortgage at a low rate today, but they also ensure that borrowers are in a better financial position in the future if rates go back up. Following the very low rates in 2015 and again in 2020, mortgage rates had to go back up, and the MQR ensured that mortgage holders could absorb an increase in their mortgage payments of at least 200 bps above their mortgage rate at origination. When rates did eventually go up, the MQR freed up monetary policy to focus on the fight against inflation without additional concerns regarding the ability of households to absorb the required monetary policy normalization.

However, empirical analysis on the intertemporal interaction between monetary and macroprudential policies is scarce. Hartley and Paixão (2024) provide one piece of evidence supporting the intertemporal complementarity. They exploit geographical variation in exposure to the tightening of MQR policies and show how the MQR that was introduced during the periods of low policy rates helped decrease mortgage delinquencies during the subsequent cycle of monetary policy tightening.[8]

More specifically, using anonymized household-level microdata from TransUnion and the Office of the Superintendent of Financial Institutions, Hartley and Paixão (2024) measure a geographical location's exposure to the policy as the fraction of mortgages issued in that region, within the 12-month period before each of the 2016 and 2018 MQR changes, that would have been disqualified under the new policy rules. The policy changes in 2016 impacted only high-LTV mortgages, while changes in 2018 impacted only low-LTV mortgages. **Chart 9** (blue bars) shows the distribution of a counterfactual total debt service (TDS)

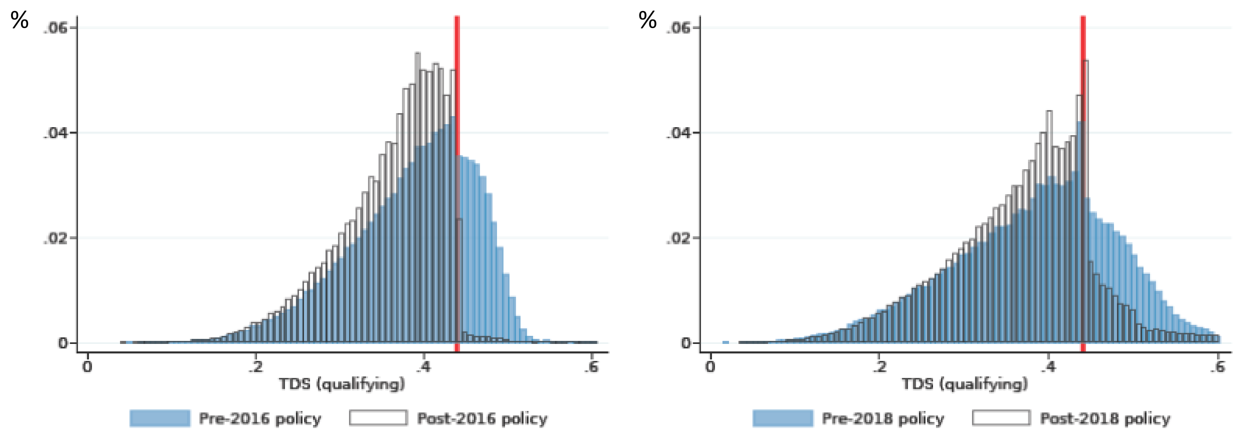
[8] For urban areas, a location is defined by census agglomeration (CA), roughly corresponding to a city. For rural areas, a location is the forward sortation area (FSA). FSAs are identified by the first three digits of the postal code.

ratio under the new rules for the mortgages issued in the year before each policy change. Nationwide, 26% of the high-LTV mortgages issued one year before October 2016 would have failed to qualify under the new rules (the qualifying threshold of 44% is indicated by the red vertical bar, **Chart 9**, panel a). For the 2018 policy change, 29% of the low-LTV mortgages issued between January 2017 and December 2017 would have had a qualifying TDS ratio above 44% (**Chart 9**, panel b).

Chart 9: Changes to the mortgage qualifying rate in 2016 affected only high-LTV ratio mortgages, while those in 2018 affected low-LTV ratio mortgages

a. 2016 MQR change affected high LTV ratio mortgages

b. 2018 MQR change affected low LTV ratio mortgages



Note: MQR is mortgage qualifying rate. Panel a shows the distribution of total debt service (TDS) ratios before and after the 2016 macroprudential policy change for mortgages with a loan-to-value (LTV) ratio above 80% (mortgages affected by the policy change). Panel b shows the distribution of TDS ratios before and after the 2018 change for mortgages with an LTV ratio below 80%. The distribution of TDS ratios for these mortgages clearly shifted from above 44% to below the 44% threshold after the 2016 policy and partially so after the 2018 policy change.

Source: Hartley and Paixão (2024)

By quantifying the disqualified share of mortgages across locations, Hartley and Paixão (2024) estimate how such differential exposures to the MQR changes impacted the performance of household credit during the post-pandemic period of monetary policy tightening. More specifically, they estimate the following regression:

$$(\text{90+ day delinquencies})_{c,t} = \beta_0 + \beta_1(\text{disqualified share})_c \cdot (\text{MP tightening})_t + \theta_c + \gamma_{p,t} + \varepsilon_{c,t}, \qquad (9)$$

where $(\text{MP tightening})_t = 1$ for months when the Bank of Canada was raising the policy rate from March 2022 to October 2023, and $(\text{MP tightening})_t = 0$ in the time prior to the hike between January 2021 and March 2022; θ_c are the location fixed effects; and $\gamma_{p,t}$ are the province time fixed effects.

Table 1 summarizes the main findings. The third column under each MQR change (2016 and 2018) presents the results from the baseline regression model above. The first and second columns show that the main results are robust to changes in the fixed-effects specifications. Overall, the table provides empirical evidence of the intertemporal complementary role of monetary and macroprudential policies. The 2016 policy change led to a smaller increase in the local aggregate share of 90-plus day delinquencies in areas more exposed to the policy, compared with less exposed areas, during the recent period of monetary policy tightening that began in 2022. Specifically, in the baseline regression model, delinquencies grew 3.6 bp less in the 90th percentile of the *disqualified share* relative to the 10th percentile, which corresponds approximately to 61% of the average increase in delinquencies across locations in this period.[9] In contrast, we find that the 2018 MQR change had no significant impact on delinquencies during the monetary tightening period, partly because low-LTV mortgage holders are less risky and financially more robust.[10]

Overall, constraints from tighter qualifying rates improve households' resilience by reducing highly indebted demand. By making demand more resilient and reducing tail risk, macroprudential policy frees up monetary policy to focus on the inflation target both in the short run and over the longer run beyond the typical macroeconomic projection horizon. In practice, even in the absence of a formal coordination framework between monetary policy and macroprudential policies in Canada, both policies can work in tandem. We used text analytics to examine almost 30 years of the Bank's *Monetary Policy Report*. We find that financial stability is often referred to using words like "indebtedness" and "leverage," or the *Monetary Policy Report* makes explicit references to the Bank's *Financial Stability Report*. This is especially the case around stressful events or periods characterized by heightened financial vulnerabilities and active macroprudential policies. However, there is currently no established analytical framework to wholistically quantify the possible intertemporal benefit of monetary and macroprudential policy coordination. This is the main challenge we turn to now.

Table 1: Impact of monetary policy tightening and the mortgage qualifying rate on household credit delinquencies

	2016 MQR			2018 MQR		
Monetary policy tightening	0.140***			0.139***		
	(0.006)			(0.006)		
MQR	0.012			-0.047**		
	(0.020)			(0.023)		
Monetary policy tightening x MQR	-0.017***	-0.017***	-0.014**	-0.004	-0.004	0.003
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
Observations	14,688	14,688	14,654	14,790	14,790	14,756
Adjusted R^2	0.025	0.951	0.959	0.037	0.950	0.958
Location fixed effects	N	Y	Y	N	Y	Y
Time fixed effects	N	Y	N	N	Y	N
Province and month fixed effects	N	N	Y	N	N	Y

Note: MQR is mortgage qualifying rate. This table reports regression results for the macroprudential policy–monetary policy interaction effects on 90-plus day delinquencies, specifically results for all 90-plus day delinquencies across all products. ***, **, and * indicate coefficients that are statistically significant at the 1%, 5% and 10% levels, respectively. The coefficients of interest are statistically significant and negative for the 2016 policy as well as the combined 2016 and 2018 policies specification. This shows that the areas most constrained by the 2016 macroprudential policy, which targeted higher LTV mortgages (> 80%), experienced fewer 90-plus day delinquencies when the Bank of Canada was tightening monetary policy in 2022–23.

Source: Hartley and Paixão (2024)

[9] The disqualified share is standardized, such that the locations in the 10th and 90th percentiles of the standardized disqualified share distribution have the values of -1.376 and 1.174 associated with them in 2016. The growth difference in 90-plus day delinquencies between these two locations is 0.014 x (1.174-(-1.376)). The average 90-plus day delinquency ratio across locations grew from 1.27% in 2021 to 1.33% in 2023.

[10] As described in Appendix A, the 2018 changes primarily implemented the MQR for uninsured mortgages. Those low-LTV mortgages are, by definition, not subject to mortgage insurance rules, i.e. there is no binding maximum loan-to-value or debt-to-payment ratio. This implies that lenders can have a more liberal application of the MQR, and borrowers in this group are likely unconstrained in the debt service ratio space. Hence, the results showing that the 2018 changes had no significant impacts on delinquencies as monetary policy changed suggest that mortgage holders who would have been impacted by the 2018 changes were financially more robust.

4. Toward a grand unifying theory?

Given their different objective functions, macroprudential and monetary policies may complement or offset each other, depending on the nature of the shocks and the horizon being considered. But without a model, it is hard to quantify policy trade-offs and assess the optimal policy mix.

In his last speech as Governor of the Bank of England, Mark Carney, also a former Bank of Canada governor, outlined a grand unifying theory combining monetary and macroprudential policy debates into a common policy framework (Carney 2020). He envisioned a unified framework where monetary policy would aim to support growth and stabilize inflation, while macroprudential policy would aim to reduce tail risk.

Although it has garnered a lot of attention, the grand theory is yet to be unified. So what would such a unified model look like? In a nutshell, we need a structural model to generate, first, the trade-off between median growth and tail risk when monetary policy is loose, and second, the intertemporal trade-off between short-run costs and medium-run gains when macroprudential policy is tight for longer than central banks' typical two-year forecast horizon. Such a model is most likely to be non-linear if we want to capture the boom and bust in housing markets that are not in steady state. And all this must be operational enough to be used flexibly for policy advice.

Recent literature has already taken a few steps in this direction to produce the link between low rates today and an increase in downside risk in the future. Adrian and Duarte (2018) build a general equilibrium model where financial intermediaries face an occasionally binding value-at-risk constraint. Their model generates low risk and high growth when financial conditions are loose. In their framework, the optimal monetary policy rule depends on financial vulnerabilities, partly because financial vulnerabilities endogenously affect the future volatility of output and inflation. Adrian et al.'s (2020a, 2020b) New Keynesian vulnerability model adds to the three-equation New Keynesian model an endogenous process for financial conditions, with current and expected economic booms associated with lax financial conditions that, in turn, support the boom. This ensures that downside risk increases when financial conditions are loose, as in the literature on growth at risk. Boissay et al. (2021) develop a microfoundation of crisis risk in a New Keynesian model where endogenous crises arrive at the end of a protracted economic boom when the marginal productivity of additional capital can no longer cover the loan costs that borrowing firms accrue. In their set-up, monetary policy affects the probability of a crisis in both the short and the medium run due to the slow effect on firm capital accumulation. The model is consistent with empirical estimates of monetary policy tightening increasing financial stress when inflation is driven by supply, pointing to a tension between price and financial stability (Boissay, Collard et al. 2023).

Features of the growth-at-risk literature can also be replicated with an empirical Markov-switching process (Caldara et al. 2021). Thus, a Markov-switching DSGE model could be a relevant structural counterpart to the empirical growth-at-risk model to analyze monetary and macroprudential policy interactions in the presence of tail risks. Similarly, Harding and Wouters (2022) show how an endogenous regime-switching model can generate amplification effects that are caused by variations in financial conditions. And Akinci et al. (2020) show that a policy rate cut increases the risk of a transition into a crisis regime due to excessive risk taking by financial intermediaries when financial conditions are loose: simulated GDP growth after a monetary policy easing displays a downside skew.

Duprey and Ueberfeldt's (2020) two-period regime-switching general equilibrium model provides intuition about the possible benefit of a monetary and macroprudential policy coordination in the presence of GDP tail risk. In their model, an integrated central bank aware of the crisis risk and responding to overall welfare considerations would set interest rates slightly higher to avoid some of the future tail risks induced by low initial rates. Alternatively, a macroprudential policy-maker could tighten its regulations to limit the risk-taking behaviour associated with the future tail risks from low rates. When monetary and macroprudential policy authorities are allowed to react to each other, welfare would be maximized with a Nash equilibrium where each policy is focused on a different objective: interest rates can remain relatively low to support consumption only if macroprudential policy is also tight enough to prevent excess risk taking due to lower rates. This implies that an active macroprudential authority focusing on tail risks may free up the monetary policy authority to focus on its primary objective, price stability.

In ongoing work, Boutros and Duprey (2024) show how Markov-switching DSGE models can already replicate a few stylized features of the grand unifying theory in a tractable policy model calibrated to Canada. They model the distribution of future GDP growth using two regimes. For consistency, the basic features of the economy and calibration are the same as those in Duprey and Harding (2024), but without the extrapolative expectations. In addition, the authors assume that households always borrow up to the loan-to-value constraint. The difference from a standard DSGE model is that the economy can switch endogenously between a normal regime and a crisis regime. The crisis regime is introduced by a persistent demand shock, namely a decrease in households' discount factor. The economy can be in two states, good G or crisis B, with persistent discount factor changes around a good or crisis value (a_G or a_B) as well as transitory shocks ξ_t^a.

$$a_t = \begin{cases} (1-\rho_{a,G})\overline{a_G} + \rho_{a,G}a_{t-1} + \sigma_{a,G}\xi_t^a & \text{if states} = G \\ (1-\rho_{a,B})\overline{a_B} + \rho_{a,B}a_{t-1} + \sigma_{a,B}\xi_t^a & \text{if states} = B \end{cases} \tag{10}$$

The economy occasionally moves to a crisis regime characterized by lower GDP due to lower demand ($\bar{a}_B > \bar{a}_G$) to match the skewness in the lower tail of GDP growth, a quick entry into a recession and a slow recovery from a recession (pinned down by $\rho_{a,G} > \rho_{a,B}$), and a possibly higher variance ($\sigma_{a,B} > \sigma_{a,G}$) to ensure that the upper percentiles of the GDP growth distribution are relatively more stable over time. Those parameters are chosen to match the unconditional distribution of GDP growth in Canada and generate features consistent with the growth-at-risk literature (Adrian, Boyarchenko and Giannone 2019).

Finally, the probability of moving to the crisis regime is modelled as a time-varying Markov process with the probability increasing in the lagged level of debt. This is to ensure that more debt today worsens tail risks later, as suggested by Schularick and Taylor (2012). The probability of moving from the good regime (G) to the crisis regime (B) follows a logistic form with an exogenous component $\alpha_0^{G\to B}$ calibrated to match the empirical frequency of each regime and an endogenous component ($\alpha_1^{G\to B}$) that depends on households' mortgage debt (d_t) deviation from the steady state ($\bar{d}$). The calibration is informed by the logistic regression estimates of Schularick and Taylor (2012) and the Markov-switching estimates of Duprey and Klaus (2022).

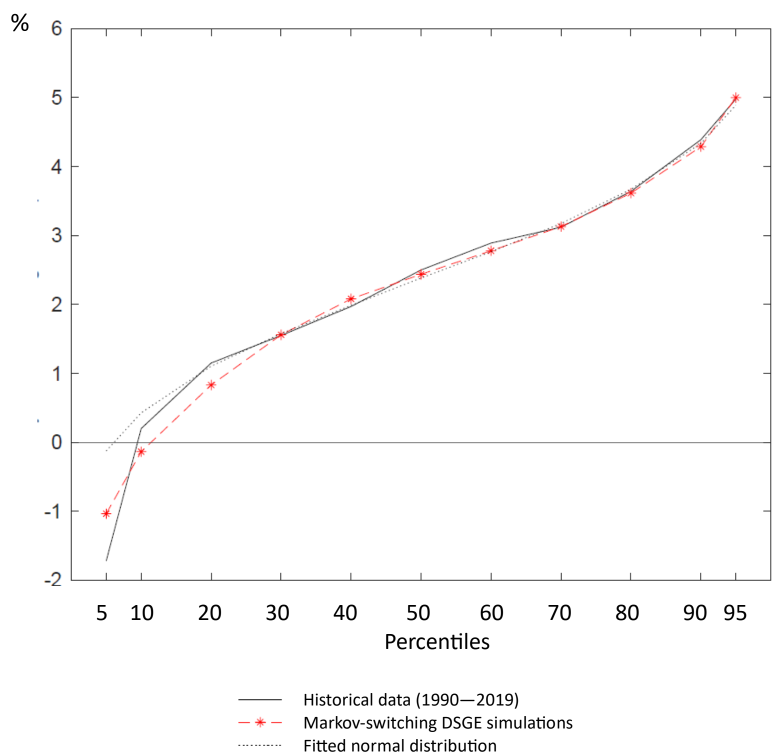
$$\Pr(s_t = B | s_{t-1} = G) = \frac{1}{1+exp\left(\alpha_0^{G\to B} + \alpha_1^{G\to B}\left(\frac{d_t - \bar{d}}{\bar{d}}\right)\right)}$$

$$\Pr(s_t = G | s_{t-1} = B) = \frac{1}{1+exp\left(\alpha_0^{B\to G} - \alpha_1^{B\to G}\left(\frac{d_t - \bar{d}}{\bar{d}}\right)\right)} \tag{11}$$

The Markov-switching model is solved using the perturbation method of Maih (2015) by linearizing around the non-stochastic steady state in each regime. The solution method takes into account that the agents know that, with a certain probability, the economy finds itself in one state or the other. That is, the agents know, in a simplified way, that they face a skewed distribution of possible output growth. **Chart 10** shows that this simple framework can approximate well the skewness in the historical distribution of year-over-year GDP growth. This suggests that Markov-switching models could be an important feature of policy models to generate realistic distributions of GDP growth characterized by non-Gaussian patterns.

Chart 11 shows the impact of a monetary policy easing shock in this framework. Given the preliminary calibration of the model, the reader should focus primarily on the qualitative results as a guide for possible future work. Monetary policy easing leads to an increase in debt that generates an increase in the probability of moving to the crisis regime. In addition, higher indebtedness when the economy enters the crisis regime further slows the recovery. In the short run, monetary policy easing increases GDP growth, but beyond two years, the distribution of possible year-over-year GDP growth is more negatively skewed. In other words, lower policy rates can lead to a debt boom that supports growth in the short run but worsens future GDP tail risk, thereby replicating the stylized fact of **Chart 4**, panel b. This example is only one step toward building a unified theory. The next step would be to consider the possible benefit of introducing macroprudential policy to curb the accumulation of tail risks induced by monetary policy.

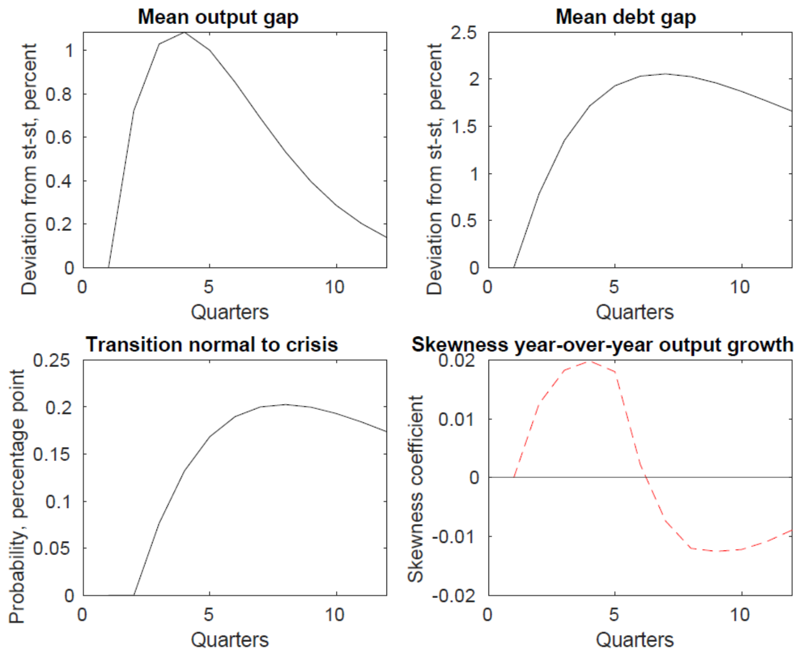
Chart 10: Regime-switching models can approximate the tail of GDP growth
Year-over-year real GDP growth



Note: Preliminary calibration obtained using a grid of points over the parameters $\overline{a_G}, \overline{a_B}, \rho_{a,G}, \rho_{a,B}, \sigma_{a,G}, \sigma_{a,B}$ from equation (10) to match the demeaned lower 5th and 10th and upper 90th and 95th percentiles of the demeaned distribution of year-over-year real GDP growth from 1990Q1 to 2019Q4.

Source: Boutros and Duprey (2024)

Chart 11: Monetary policy easing generates an intertemporal trade-off



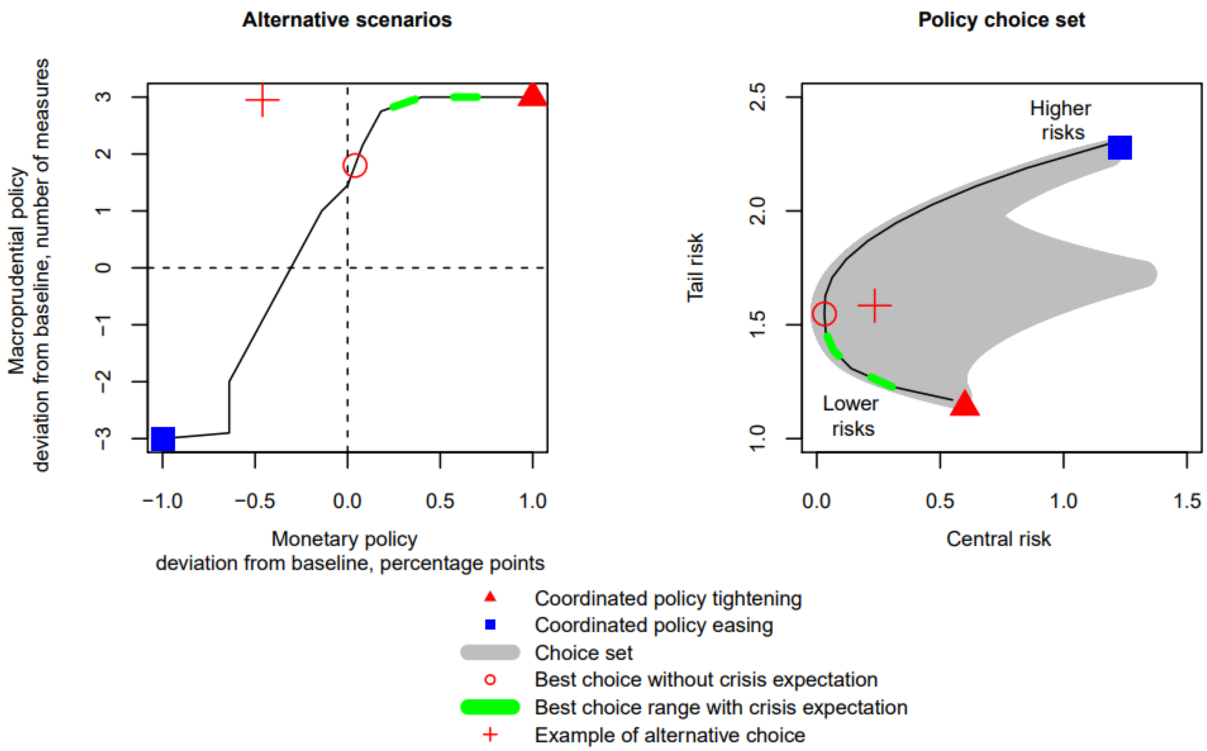
Note: The chart shows monetary policy easing of -100 basis points in a Markov-switching DSGE model where the mortgage debt boom increases the probability of switching to a crisis regime, thereby worsening growth at risk.

Source: Boutros and Duprey (2024)

What are the implications for policies? Although currently outside the above-mentioned Markov-switching DSGE framework, the resulting worsening GDP risks from low rates would influence policy choices and their coordination. A grand unifying theory of monetary and macroprudential policies could be cast in a chart like **Chart 12**, reproduced from Duprey and Ueberfeldt (2020), that shows an example for the fourth quarter of 2017, a period of joint monetary and macroprudential policy tightening. Alternative combinations of monetary and macroprudential policies (left panel, in deviation from market forecasts at the time) would be associated with alternative price and financial stability over some horizon (right panel, where tail risk reflects a measure of the skewness of GDP growth and central risk refers to the stability of mean GDP growth around its potential). If policy-makers were unconcerned about GDP tail risk and able to coordinate, as of the fourth quarter of 2017, the best policy mix to minimize the central risk would be to tighten macroprudential policy by about one time the historical average amount and follow the baseline policy rate path already expected by the markets (**Chart 12**, red circle). If instead policy-makers were equally concerned about GDP tail risk and able to coordinate, then they would choose a point on the lower arm of the choice set, with both tighter monetary and macroprudential policies (**Chart 12**, thick dashed green line on both panels). In the absence of coordination, or if the monetary and macroprudential policy-makers have different objectives regarding the GDP growth distribution, then the outcome would be within the choice set in the right panel. For instance, if the monetary policy authority sets the rate 0.5 percentage points lower, the macroprudential authority would have to tighten macroprudential measures twice as much (**Chart 12**, red cross versus red circle) to maintain the same level of tail risk.

We have made significant progress toward a unified theory. Its main features should include the presence of monetary policy and macroprudential policies to assess the balance between price and financial stabilities (as discussed in section 4). More specifically, when monetary policy is loose, households may take more risks, which generates a housing boom-bust cycle. This results in short-run GDP growth stabilization and longer-run tail risk in the GDP growth distribution (as discussed in section 2). Meanwhile, a unified theory should have macroprudential policies limit risk taking by influencing for both the demand and the supply side of credit markets (section 3).

Chart 12: Illustration of price and financial stability in Canada under alternative monetary and macroprudential policies in 2017Q4



Note: Reproduction from Figure 14 of Duprey and Ueberfeldt (2020) and inspired by Figure 1 of Poloz (2014). The economy is simulated using a combination of a vector autoregressive model upgraded with an index of macroprudential policy measures similar to Chart 5 above and a quantile regression model similar to equation 6 above. The simulation starts with data as of 2018Q1. The model is projecting tail risk (defined as the deviation between median GDP growth and growth at risk) and central risk (defined as the deviation between mean and potential GDP growth). Tail and central risks are displayed as averages over the forecast horizon, 2018Q1 to 2021Q4.

5. Conclusion

We examine Canada's experience with the use of monetary and macroprudential policies, research work done at the Bank of Canada and studies in the literature to highlight issues around the interaction of the two kinds of policies. Given their different objective functions, macroprudential and monetary policies may either complement or appear to offset each other, depending on the nature of the shocks the economy is facing. Canadian experience illustrates both scenarios. The puzzling appearance of these policies offsetting each other can be rationalized when we consider the tail risk of economic growth over a longer horizon, i.e., *intertemporal complementarity* between monetary and macroprudential policies. However, when monetary and macroprudential policies are required to take different stands at the same time, the issue of policy coordination arises. While easing monetary policy can boost near-term growth via indebted demand, it worsens future GDP tail risk. When monetary and macroprudential policy authorities coordinate, welfare can be maximized such that interest rates can remain relatively low to support consumption, but only if macroprudential policy is tight enough to prevent excess risk taking due to lower rates. This implies that an active macroprudential authority focusing on tail risks may free up monetary policy to focus on its primary objective, price stability.

Bringing the policy coordination practice into a unified framework remains an ambitious agenda. This paper identifies the key elements and suggests a way to progress toward the framework. If practice is ahead of theory, the hope is that theory will eventually catch up.

Appendix

A. The mortgage qualifying rate experience in Canada

Residential mortgages are the largest asset category for banks and other regulated lenders in Canada and therefore a source of credit risk. They are also a large share of Canadian gross domestic product. Thus, it is important for banks to use sound mortgage underwriting practices and carefully examine whether borrowers are able to repay their loans. Canada has a maximum loan-to-value (LTV) ratio (95%) and a maximum debt payments–to–income ratio but only for *insured mortgages* (39% if gross debt or 44% if total debt). Over the last decade, federal authorities have also required that lenders test borrowers' capacity to pay their mortgage in the event of adverse conditions. This mortgage qualifying rate (MQR) was a particularly relevant macroprudential tool used by Canadian policy-makers following the COVID-19 pandemic to tame the housing market during the low-rate environment and increase its resilience for the subsequent period of monetary policy tightening. Over time, federal authorities have tightened the rate and the scope of the MQR.

The qualifying rate was first introduced on insured mortgages with variable rates or terms of less than five years in April 2010 by the Department of Finance Canada to stress test mortgage-loan applicants. The MQR was initially the benchmark rate, the mode of the five-year mortgage rate posted by the six largest Canadian banks, that is, the rate banks are advertising publicly, which may be higher than the negotiated contractual mortgage rate. More recently, the MQR has evolved to be the maximum between two components, the buffer on top of the contract rate (2 percentage points introduced in 2018) and the floor (5.25 percentage points introduced in 2021). As described in the June 2021 decision by the Office of the Superintendent of Financial Institutions (OSFI), the buffer builds in a margin of safety that demonstrates that borrowers can be resilient to a variety of changes to their financial circumstances, such as a reduction in income or a rise in mortgage interest rates. The floor accounts for risks to the borrower that can result from fluctuations in the broader economy and financial vulnerabilities, for instance high household indebtedness and house price imbalances in a low-rate environment. OSFI also committed to review the calibration of the MQR at least annually,[11] bringing it closer to a cyclical macroprudential tool (OSFI 2021). This is in contrast to payments-to-income or loan-to-income regulatory constraints that are not directly a function of the mortgage loan rate or financial vulnerabilities and are not typically modified over the cycle.

Most of the mortgage market became subject to the MQR rules when five-year mortgages—the most popular product—became subject to the MQR in 2016 for insured mortgages and in 2018 for uninsured mortgages. Federally mandated stress tests do not extend to mortgages from non-federally regulated lenders unless those loans are subject to mortgage insurance rules, that is, for LTV above 80%. So households that do not have a binding debt service limit may take out loans from lenders that are more liberal with their qualifying ratios in order to get higher mortgage loan amounts. This may be particularly valuable for high loan-to-income (LTI) borrowers who spend a significant portion of their income on debt servicing. Thus, changes to the MQR rules may impact only a subset of households, and the MQR may bind only for households with high LTI.

[11] See Minimum Qualifying Rate - Letter (2021) - Office of the Superintendent of Financial Institutions (osfi-bsif.gc.ca)

B. List of macroprudential policy uses in Canada

Table B-1: Lender-side macroprudential policy changes in Canada

Type	Event	Announcement	Implementation	Description of the measure
Easing*	Reserves	11/1980	02/1981	Lower requirements for Canadian-dollar notice deposits
Tightening*	Reserves	11/1980	02/1981	Introduce 3% on foreign currency deposits
Easing*	Reserves	11/1980	03/1981	Lower requirements for Canadian-dollar demand and notice deposits
Easing*	Reserves	11/1980	09/1981	Lower requirements for Canadian-dollar demand and notice deposits
Easing*	Reserves	11/1980	03/1982	Lower requirements for Canadian-dollar demand and notice deposits
Easing*	Reserves	11/1980	09/1982	Lower requirements for Canadian-dollar demand and notice deposits
Easing*	Reserves	11/1980	03/1983	Lower requirements for Canadian-dollar demand and notice deposits
Easing*	Reserves	11/1980	09/1983	Lower requirements for Canadian-dollar demand and notice deposits
Easing*	Reserves	11/1980	03/1984	Lower requirements for Canadian-dollar demand and notice deposits
Easing*	Reserves	11/1980	09/1984	Lower requirements for Canadian-dollar demand and notice deposits
Easing*	Reserves	12/1991	06/1992	Gradual phase-out of reserve requirements
Easing*	Reserves	12/1991	12/1992	Gradual phase-out of reserve requirements
Easing*	Reserves	12/1991	06/1993	Gradual phase-out of reserve requirements
Easing*	Reserves	12/1991	12/1993	Gradual phase-out of reserve requirements
Easing*	Reserves	12/1991	06/1994	Reserve requirements completely eliminated
Tightening	Leverage	30/10/2014	01/11/2014	Leverage ratio that meets or exceeds 3% of Tier 1 capital/exposure
Tightening**	LCR	30/05/2014	01/01/2015	Liquidity coverage ratio of 100% minimum
Tightening	DSIBs	02/07/2013	01/01/2016	DSIBs common equity Tier 1 surcharge equal to 1% of risk-weighted assets
Tightening**	CCB	10/12/2012	01/01/2016	Set at 0.625% of risk-weighted assets
Tightening	LGD	11/12/2015	01/11/2016	Minimum house price correction to calculate downturn loss given default for uninsured mortgages
Tightening	Sectoral	07/07/2016	01/01/2017	Updated capital requirements for federally regulated mortgage insurers
Tightening**	CCB	10/12/2012	01/01/2017	From 0.625% to 1.25% of risk-weighted assets
Tightening	LLP	21/06/2016	01/11/2017	Domestic systemically important banks adopt IFRS 9, introducing expected loan loss provisioning
Tightening	LLP	21/06/2016	01/01/2018	Other federally regulated entities adopt IFRS 9, introducing expected loan loss provisioning
Tightening**	CCB	10/12/2012	01/01/2018	From 1.25% to 1.875% of risk-weighted assets
Tightening	DSB	20/06/2018	20/06/2018	Set at 1.5% of risk-weighted assets
tightening**	CCB	10/12/2012	01/01/2019	From 1.875% to 2.50% of risk-weighted assets
Tightening	DSB	12/12/2018	30/04/2019	From 1.5% to 1.75% of risk-weighted assets
Tightening	DSB	04/06/2019	31/10/2019	From 1.75% to 2.00% of risk-weighted assets
Tightening	DSB	10/12/2019		From 2.00% to 2.25% of risk-weighted assets; to be effective April 30, 2020 but DSB release before the implementation
Easing	Deferrals	27/03/2020	27/03/2020	Loans subject to payment deferrals will temporarily continue to be treated as performing loans
Tightening	NSFR	11/04/2019	01/01/2020	NSFR becomes effective as a minimum regulatory requirement for Canadian D-SIBs
Easing	DSB	13/03/2020	13/03/2020	From 2.25% to 1.00% of risk-weighted assets
Easing	DSB	13/03/2020	13/03/2020	Any subsequent increases not for at least 18 months
Tightening	Dividends	13/03/2020	13/03/2020	Restriction of no dividend increase or future share buybacks
Easing	Basel	27/03/2020	27/03/2020	Implementation of revisions to the Basel market risk framework delayed until 2023–24
Easing	Leverage	09/04/2020	09/04/2020	Exclude central bank reserves and sovereign-issued securities from banks' leverage ratio calculations
Tightening	DSB	17/06/2021	31/10/2021	From 1.00% to 2.50% of risk-weighted assets
Easing	Dividends	04/11/2021	04/11/2021	Restriction on dividend increase or future share buybacks unwound
Tightening	Leverage	12/08/2021	01/01/2022	End of exclusion of sovereign bonds for the leverage ratio calculation
Tightening	DSB	08/12/2022	08/12/2022	Changes to the framework with range expanded from 0%–2.5% to 0%–4%
Tightening	DSB	08/12/2022	01/02/2023	From 2.50% to 3.00% of risk-weighted assets
Tightening	Leverage	13/09/2022	01/04/2023	End of exclusion of central bank reserves for the leverage ratio calculation
Tightening	DSB	20/06/2023	01/11/2023	From 3.00% to 3.50% of risk-weighted assets

*Announcement and implementation days are not available. **The announcement date from Office of the Superintendent of Financial Institutions is different than the date when the Bank for International Settlements published its recommendation, in December 2010 and June 2011.
Note: LCR is liquidity coverage ratio; DSIB is domestic systemically important bank; CCB is capital conservation buffer; LGD is loss given default; LLP is loan loss provision; DSB is domestic stability buffer; NFSR is net stable funding ratio.
Sources: Duprey and Tuzcuoglu (forthcoming). Builds on Alam et al. (2019); Kuttner and Shim (2016); Clinton (1997); and public records on the websites of the Office of the Superintendent of Financial Institutions, the Bank of Canada, the Canadian Legal Information Institute; and various news articles released at the time of the policy confirming the date of the event.

Table B-2: Borrower-side macroprudential policy changes in Canada

Type	Event	Announcement	Implementation	Description of the measure
Easing	LTV	01/02/1992	15/02/1992	From 90% to 95% for first time home buyers; First Home Loan Insurance Program (1992)
Easing	LTV	31/03/1998	11/05/1998	From 90% to 95% to all homebuyers within regional house price limits
Easing	Insurance access	22/12/2003	22/12/2003	Minimum down payment of 5% can be borrowed (Genworth) for mortgage insurance applications
Easing	Insurance access	19/09/2003	22/09/2003	Removal of regional house-price caps on mortgage insurance access
Easing	Insurance access	23/02/2004	01/03/2004	Minimum down payment of 5% can be borrowed (CMHC) for mortgage insurance applications
Easing	LTV	27/07/2005	12/08/2005	From 90% to 95% for variable rate mortgages
Easing*	Amortization	25/02/2003	03/03/2003	From 25 to 30 years for insured mortgages
Easing*	Amortization	16/03/2006	20/03/2006	From 25 to 30 and 35 years for insured mortgages
Easing*	LTV	02/10/2006	02/10/2006	From 95% to 100%
Easing*	Amortization	10/10/2006	10/10/2006	From 35 to 40 years for insured mortgages
Easing	Insurance access	06/03/2007	30/03/2007	Insured mortgages for self-employed by CMHC
Easing	LTV	21/09/2007	21/09/2007	From 90% to 95% for refinancing
Tightening	LTV	09/07/2008	15/10/2008	From 100% to 95% (limit for new mortgages)
Tightening	Amortization	09/07/2008	15/10/2008	From 40 to 35 years for insured mortgages
Tightening	DSR	09/07/2008	15/10/2008	Total debt service ratio set at 45%
Easing	Taxes	27/01/2009	28/01/2009	Tax credit for first time home buyers and renovations
Tightening	LTV	16/02/2010	19/04/2010	From 95% to 90% for refinancing and from 95% to 80% for investment properties
Tightening	MQR	16/02/2010	19/04/2010	Stressed DSR for mortgages with LTV > 80% with variable rate or rate fixed for less than five years; must qualify using the benchmark five-year fixed posted rate of the Big Six banks
Tightening	Amortization	17/01/2011	18/03/2011	From 35 to 30 years for insured mortgages
Tightening	LTV	17/01/2011	18/03/2011	From 90% to 85% for refinancing
Tightening	Insurance access	17/01/2011	18/04/2011	No insurance for non-amortizing lines of credit secured by homes
Tightening	LTV	21/06/2012	09/07/2012	From 95% to 80% for house prices over $1 million and from 85% to 80% for refinancing
Tightening	Amortization	21/06/2012	09/07/2012	From 30 to 25 years for insured mortgages
Tightening	DSR	21/06/2012	09/07/2012	Set at 39% (gross) and 44% (total)
Tightening	LTV	11/12/2015	15/02/2016	From 95% to 90% for house prices between $0.5 million and $1 million
Tightening	Taxes	25/07/2016	02/08/2016	Foreign buyer tax in Vancouver of 15%
Tightening	MQR	03/10/2016	17/10/2016	Stressed DSR for all mortgages with LTV > 80%; must qualify using the benchmark five-year fixed posted rate of the Big Six banks
Tightening	Insurance access	03/10/2016	30/11/2016	Rules for access to government insurance of mortgages with high LTV ratios applied to low LTV
Tightening	Taxes	20/04/2017	21/04/2017	Foreign buyer tax in the Greater Golden Horseshoe area (around Toronto) of 15%
Tightening	Taxes	20/02/2018	21/02/2018	Foreign buyer tax in Vancouver from 15% to 20% with extended geographical coverage
Tightening	MQR	17/10/2017	01/01/2018	Stressed DSR for mortgages with LTV < 80%; must qualify at the greater of the contractual mortgage rate plus 2 percentage points or the benchmark five-year fixed posted rate of the Big Six banks
Tightening	LTV	17/10/2017	01/01/2018	Set at 65% for non-conforming loans
Easing	Taxes	19/03/2019	02/09/2019	Subsidy by CMHC for mortgage of first-time home buyers (5%–10% shared mortgage equity)
Tightening	MQR	20/05/2021	01/06/2021	Stressed DSR for all uninsured mortgages; must qualify using the higher of a 5.25% floor or contractual mortgage rate plus 2 percentage points
Tightening	Taxes	19/04/2021	01/01/2022	Federal tax at 1% on the ownership of vacant or underused housing
Tightening	LTV	28/06/2023	31/10/2023**	Maximum LTV set at 65% for combined loan plans (loans with shared equity features and reverse mortgages)
Easing	Amortization	29/07/2024	01/08/2024	From 25 to 30 years, for insured mortgage amortizations for first-time homebuyers purchasing new builds
Easing	Amortization	16/09/2024	15/12/2024	From 25 to 30 years, for insured mortgages to all first-time homebuyers and to all buyers of new builds
Easing	Insurance access	16/09/2024	15/12/2024	Maximum house price cap from $1 to $1.5 million to qualify for an insured mortgage (i.e. LTV>80%)

* The reported implementation date is the earliest one between CMHC and Genworth. ** Or 31/12/2023 depending on the end of fiscal year of each financial institution.

Note: LTV is the loan-to-value ratio; DSR is the debt service ratio; MQR is the mortgage qualifying rate.

Sources: Duprey and Tuzcuoglu (forthcoming). Builds on Table 3 of Duprey and Ueberfeldt (2020), Alam et al. (2019), Krznar and Morsink (2014), Cheung (2014), Allen et al. (2020), Kuttner and Shim (2016) and Cerutti et al. (2017). Also draws on public records on the websites of the Office of the Superintendent of Financial Institutions, the Government of Canada, the Department of Finance Canada, the Government of British Columbia, the Government of Ontario, the House of Commons, the Canada Mortgage and Housing Corporation and Genworth Financial Canada and on various news article released at the time of the policy confirming the date of the event.

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