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# Heterogeneity and Monetary Policy: A Thematic Review

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# Abstract

The heterogeneity of businesses and households impacts aggregate economic fluctuations and, in turn, is shaped by aggregate fluctuations. This view has emerged over the last decade with strong implications for the transmission and conduct of monetary policy. Our thematic review focuses on key aspects of this new theory as well as its underlying assumptions. We place the insights in a Canadian context using relevant microeconomic and macroeconomic data.



*Topics: Economic models; Monetary policy transmission; Monetary policy and uncertainty*
*JEL codes: D31, E24, E50, E52, D25, E22*

# 1 Introduction

Our understanding of the transmission mechanism of monetary policy has long relied on aggregate models that feature optimizing agents (to avoid the Lucas Critique) but little to no heterogeneity of households and businesses. Early work on heterogeneity suggested that representative agent models can match business cycle dynamics sufficiently well (Ríos-Rull 1996) and that aggregates are adequate statistics for aggregate dynamics (Krusell and Smith 1998). As a result, heterogeneity was limited mainly to the analysis of inequality and welfare issues or to the assessment of policies that have a more targeted focus—for example, fiscal and regulatory tools. Over the last decade, this consensus has been challenged, and a more nuanced view is emerging—that is, that the heterogeneity of households and businesses affects aggregate fluctuations of the economy and, in turn, is shaped by aggregate fluctuations. The fallout for monetary policy is that heterogeneity has a profound impact on the monetary policy transmission mechanism.

A confluence of advances in data, methodology and technology has contributed to this development and will continue to play a role in shaping this area of research. At the forefront is the increased availability of microdata. Researchers have learned that heterogeneity might be more important than previously believed. Consumption expenditure data (e.g., Statistics Canada's Survey of Household Spending) and income data (e.g., Statistics Canada's Labour Force Survey, Canadian Income Survey and Survey of Labour and Income Dynamics) have shown that idiosyncratic income risk is large. It appears that the ability of individuals and society to insure against this risk is incomplete or costly, since the pass-through from income to consumption is relatively high. Related to this are insights from household balance sheet data (e.g., Statistics Canada's Survey of Financial Security or the credit registry data from TransUnion and Equifax) suggesting that the composition of asset and debt portfolios affects consumption. On the business side, firm balance sheet data (mostly from tax records) have shown that business finances have an impact on the strength of the investment channel of monetary policy.

In addition to the discovery of these data insights, a second critical advance is the im-

provement of solution methodologies.[1] The key challenge with heterogeneity is the need to keep track of every entity in the economy as well as of how their behaviour changes with individual and aggregate economic circumstances. While this is simple as a concept, the actual implementation of it is computationally and technologically challenging and required new solution methods.

Neither the utilization of micro datasets nor the methodological developments were sufficient to make heterogeneity-rich models feasible. The cornerstone, on which heterogeneity research rests, was technological advancement in the form of relatively cheaply available computing power. As the speed of individual CPUs increased, the price for a given quality of CPU decreased. Similarly important, the price of computer storage also decreased, making it possible for researchers to handle models of agent-rich economies and large datasets.[2]

Combining these three advances allowed economists to raise their understanding of the interaction of monetary policy and heterogeneity. The most pertinent insight changes our understanding of the transmission mechanism. In a representative agent model, monetary policy shifts current aggregate demand mainly by influencing the savings decisions of households. Kaplan, Moll, and Violante (2018) find that this mechanism is much less relevant in a heterogeneous-agent economy, where indirect effects become dominant when income and general equilibrium forces emerge as the main conduits of monetary policy transmission. This point is generalized by Auclert (2019), who emphasizes the importance of redistribution for the monetary transmission. Both papers highlight that to understand the drivers of aggregate demand, economists must identify who is influenced by monetary policy and how it reaches them.

The idiosyncratic risk that households and firms face also interacts with monetary policy and has strong implications for the conduct of monetary policy. On the household side, a

[1] Among the early contributions are Krusell and Smith (1998), Algan, Allais, and Den Haan (2008) and Reiter (2009). An attempt to build on Reiter's work is Winberry (2018), who suggests a way to reduce the cost of capturing distributions. This is further developed in Ahn et al. (2017). Boppart, Krusell, and Mitman (2018) focus on MIT shocks. In a recent effort, Auclert et al. (2019) leverage the sequence space structure of dynamic models.

[2] The measurement of computing power is commonly associated with Gordon Moore, who formulated Moore's Law. For a discussion in the context of economics, see Flamm (2019) and Aizcorbe and Kortum (2005). In the context of financial technology, Livshits, MacGee, and Tertilt (2016) point to the importance of computating advances. Regarding the price of storage, see John A. McCallum's webpage.

number of recent papers, e.g., Ravn and Sterk (2020) and Gornemann et al. (2021), emphasize that the countercyclical nature of idiosyncratic income risk might interact with precautionary savings motives. One materialization of this effect works via unemployment risk. During an economic downturn, unemployment risk increases, raising precautionary savings. This reduces aggregate demand, leading firms to further reduce employment—hence raising the unemployment risk and closing the vicious cycle. This channel suggests that monetary policy should be more accommodating during recession episodes to break this downward spiral. On the business side, Ottonello and Winberry (2020) show that firms' balance sheets matter for the strength of monetary policy transmission to investment. The most default-risky businesses are the most likely to invest but the last ones to benefit from interest rate cuts. So, in order to stimulate investment, monetary policy needs to be extra accommodating, accepting more business sector risk.

As with previous breakthroughs in economics, these insights have created new topics that deserve further consideration. One broad area deals with the key drivers of monetary transmission in the presence of heterogeneity. Kaplan, Moll, and Violante (2018) highlight the importance of hand-to-mouth (HtM) households for the transmission mechanism of monetary policy given that they are the most responsive households to the income channel of monetary policy. Because of their central role, we need to understand the dynamic properties of these households. Is it just bad luck that leads to an HtM situation or is this related to a conscious choice? Understanding this will be critical to assessing the transmission channel's composition at any given point in time. Related to this, the dynamics of debt and asset portfolios play an important role in how much redistribution takes place. Understanding these in relation to consumption and income distributions will be critical to getting a full understanding of the redistribution channel of monetary policy.

Another broad theme of future research revolves around the right objective function for monetary policy in the presence of heterogeneity. We already touched on the notion that an effective monetary policy impulse comes at the expense of more business sector risk. So, policy-makers need to better understand the trade-off between investment stimulus and business sector risk to make informed choices. More generally, a very basic yet crucial challenge remains: What should the objective function of a central bank be? In a representative agent

model, welfare is the natural choice, but this does not work in a heterogeneous-agent model. Here, any welfare-based measure would require some form of aggregation. But there is no consensus view on this. The alternative of using an ad hoc loss function, while appealing in its simplicity, is by assumption limiting the ability of a central bank to take heterogeneity into account—for example, by including an aggregate measure of inequality.

Another topic of interest is the interaction of different policy tools. Heterogeneity attributes a prominent role to the redistribution of wealth and income, which historically is addressed via fiscal policy measures. How to find the right policy mix (monetary, fiscal, macroprudential) given economic circumstances has thus become more important than ever.

Finally, many questions about unconventional monetary policy tools require a heterogeneous-agent model framework. For example, understanding the transmission channels of quantitative easing, as well as its impact on income and wealth distributions, has received a great deal of attention from policy-makers and in the media. The literature on this topic is still in early stages and more work is needed to guide policy-makers.[3] From a practical standpoint, model developers face the challenge of determining the right level of heterogeneity, which is a compromise between the realism of micro- and macroeconomic features and the ability to generate realistic macroeconomic scenarios. Relevant to central bank projection teams is how easy it will be to map distributional impacts on the transmission mechanism into existing more aggregate frameworks.

The thematic review is organized as follows: Section 2 discusses the changing view of the transmission mechanism of monetary policy. Section 3 provides a closer look at the redistributive effects of monetary policy and how these influence aggregate consumption in theory and in a numerical example. Then, Section 4 highlights the role of idiosyncratic risk from a household perspective and Section 5 from a business perspective, both of them drawing out implications for the conduct of monetary policy. Finally, Section 6 concludes.

[3]See Cui and Sterk (2021) and Lee (2021) for the existing work in this area.

# 2 How heterogeneity changes monetary transmission

In the standard New Keynesian models, the representative agent acts like a "permanent income" consumer. Its consumption behaviour is thus characterized by (i) a strong sensitivity to changes of the real rate and (ii) a weak sensitivity to transitory changes in income. Both features are largely inconsistent with the empirical evidence.

## 2.1 Heterogeneity and consumption behaviour

Empirical work suggests instead that consumption features (i) a weak sensitivity to changes in the real rate and (ii) strong (and very heterogeneous) responses to transitory income changes (see Blundell, Pistaferri, and Preston, 2008; Broda and Parker, 2014; Fuster, Kaplan, and Zafar, 2018; Fagereng, Holm, and Natvik, 2018).[4] Heterogeneous agent models with incomplete markets can reproduce these empirical facts of consumption behaviour: the presence of a mass of households at or close to their borrowing constraint weakens the intertemporal substitution channel at the same time that it raises their overall sensitivity to transitory income changes (Carroll, 1997). These features of consumption turn out to have implications for the transmission of monetary policy, a point first highlighted in Kaplan, Moll, and Violante (2018).

## 2.2 Monetary policy with heterogeneous households

Kaplan, Moll, and Violante (2018) are among the first to develop and study monetary policy in a heterogeneous agent New Keynesian (HANK) model with empirically realistic heterogeneity in wealth and income. Crucial to their model's ability to match distributions of wealth and marginal propensities to consume (MPCs) is the two-asset structure they adopt. Importantly, the co-existence of a low-return liquid asset together with a high-return illiquid asset allows for the emergence of both wealthy and poor HtM households—an important

[4]Notably Fagereng, Holm, and Natvik (2018) use lottery winnings as an example of temporary income increases with which to study spending following transitory income shocks. They discover high spending by those with low liquid wealth. This result hides heterogeneity by the size of the lottery prize—large prizes are somewhat saved (MPC 0.2–0.4), but smaller prizes ($< 10,000$USD) are mostly spent (MPC 0.6–1.0). Similarly, Fuster, Kaplan, and Zafar (2018) find in surveys that households have heterogeneous responses to unanticipated gains and losses, while also changing consumption in advance of expected losses but not gains.

feature of the US data, as discussed in Kaplan, Violante, and Weidner (2014).[5]

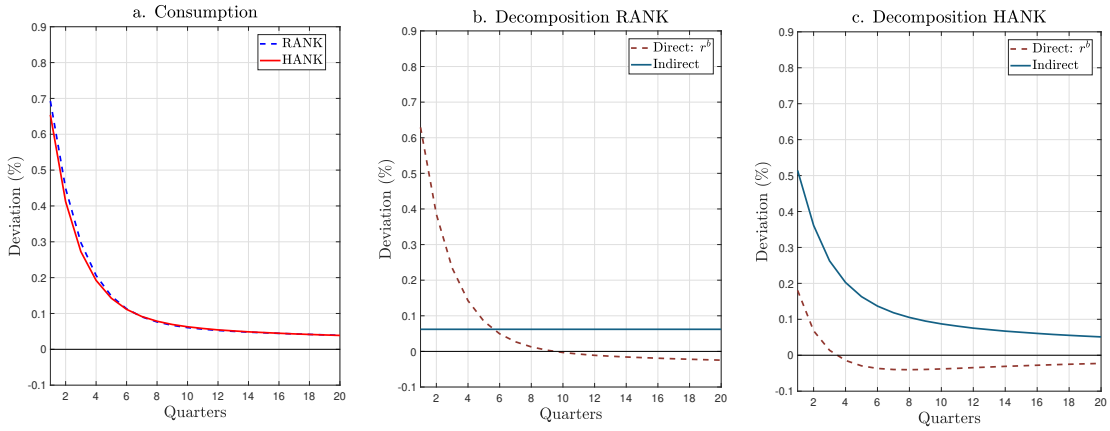
Turning to the monetary policy transmission to consumption, Kaplan, Moll, and Violante (2018) find that the general equilibrium effects of an interest rate cut, those that operate through household disposable income, outweigh the direct effects from changes to the real rate. This stands in stark contrast to the representative agent New Keynesian (RANK) model, where monetary policy operates almost exclusively through the real rate via an intertemporal substitution channel. The direct and indirect channels of monetary policy are computed by constructing counterfactual (partial-equilibrium) consumption paths. For instance, to compute the direct effects, they let the real rate adjust as in equilibrium while other prices and government transfers are kept fixed at their steady-state values. Similarly, they compute indirect effects by varying wages and transfers entering households' disposable income while holding fixed the real rate.

**Chart 1** illustrates the result of this decomposition in their two-asset HANK against a comparable RANK model.[6] In the RANK model (panel b), the direct channel coming from the reduction in the real rate accounts for virtually the entire consumption response. In contrast, the monetary policy transmission in the HANK model (panel c) is much more complex: general equilibrium forces operating through wages, transfers and other equilibrium prices play a much larger role.

[5] As we note in the following section, the Canadian economy also features a large share of liquidity constrained households.

[6] The model description, details on decomposition and the classification into direct and indirect effects follow Kaplan and Violante (2018).

Chart 1: Decomposition of an expansionary monetary policy shock in HANK and RANK into direct and indirect components




Note: HANK/RANK refer to heterogeneous and representative agent New Keynesian models, respectively.
Source: Kaplan and Violante 2018

By highlighting the contribution of general equilibrium forces to the monetary transmission, this paper (jointly with the HANK literature that emerged from it) has helped shift the monetary policy debate from movements of the real rate alone to broader concerns, such as the aggregate (and distributional) responses of employment and disposable income. An example of the latter is the role of the fiscal reaction to the overall impact of monetary policy, a topic we discuss next.

## 2.3 Monetary policy and fiscal reaction

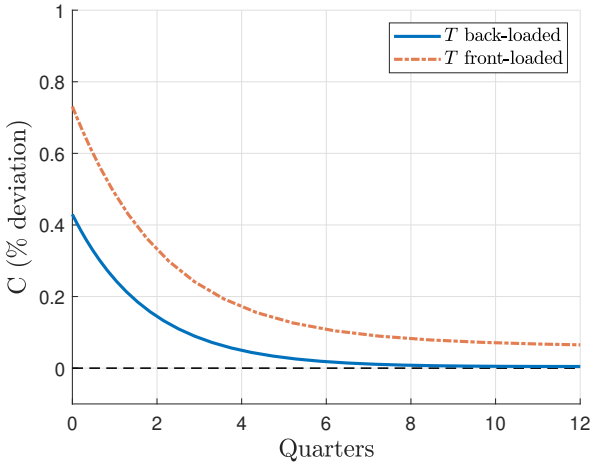
A cut to the interest rate by the monetary authority triggers a fiscal adjustment because lower interest payments and higher revenues from taxation free up resources in the government budget constraint. This mechanism does not rely on heterogeneity and is present in both RANK and HANK models. It receives little attention in RANK models since Ricardian equivalence makes the details of the fiscal adjustment irrelevant to the determination of other equilibrium variables.[7] The presence of borrowing constraints and HtM households in

[7]The consumption of the representative agent in a RANK model depends solely on the present value of its endowments (the agent is subject to a single intertemporal budget constraint). Since changing the timing of transfers leaves their present value unchanged, the different fiscal rules have no effect on the household

a HANK model breaks this result, making the assumptions on the fiscal reaction crucial for the response of aggregate consumption.

Following that insight, Alves et al. (2020) compare the consumption response with a cut in the real rate in the HANK model under two scenarios: a case where transfers $T$ are distributed to households as they become available ($T$ front-loaded) versus a case where the government delays the rebating via transfers by initially paying its debt ($T$ back-loaded). The two rules lead to very different responses in consumption, as one can see in **Chart 2**. The fiscal rule that front-loads transfers triggers an almost twice as large consumption response in the first quarter compared with the case of deferred transfers. The intuition for this result is simple: the increase in transfers raises households' disposable income, creating an additional impulse to aggregate consumption. Moreover, since transfers are modelled as a lump sum, the bump in income is especially potent for low-income HtM households.

Chart 2: Consumption (C) response to a expansionary monetary policy shock under immediate versus delayed government transfers




Source: Alves et al. 2020

## 2.4 How liquidity constrained are Canadians?

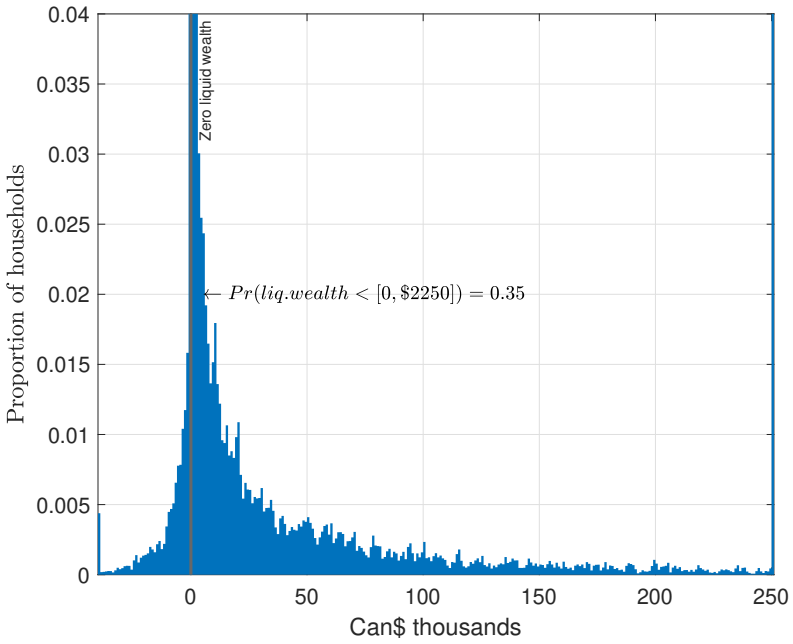
The presence of HtM households can thus have large consequences for both the transmission and the overall impact of monetary policy on consumption. Given the prominent role of these households, a natural question is how prevalent they are in Canada. We approach this

budget set and therefore on its consumption.

issue using various vintages of the Survey of Financial Security, which collects information on respondents' demographics, wealth and income.[8] We show the distribution of liquid wealth for Canadian households in **Chart 3**.

According to the survey, in 2019, 35% of Canadian households held less than $2,250 in liquid wealth, and 26.9% could be classified as HtM. The share of HtM was down from 28.3% in 2016 and 37% in 2001.[9] Of this group, one-third of households also had low total net worth—these are so-called poor HtM. The remaining two-thirds were not necessarily poor since they held some wealth in illiquid assets. So, despite their low liquid wealth holdings, this group can feature large total net worth and are therefore denoted as "wealthy HtM." For Canada, the characterization of "wealthy" is very appropriate for some, with 27.7% of HtM holding more than $500,000 in illiquid assets.

Chart 3: Density of liquid wealth distribution for Canadian households




Source: 2019 Statistics Canada's Survey of Financial Security

[8]Liquid assets are defined as money in banks, mutual funds, stocks, bonds, tax-free savings accounts and other investments. Liquid debt is credit card debt.

[9]The definition of HtM follows Kaplan, Violante, and Weidner (2014) exactly. Households are defined as HtM if (i) they hold less than half a month's income in liquid wealth, defined as liquid assets minus debt, or (ii) they hold negative liquid wealth smaller than one week of labour earnings minus a borrowing limit. For a household with $70,000 annual income, this threshold is approximately $3,000.

In conclusion, HtM households, both rich and poor, are a sizable share of Canadian households, suggesting that the general equilibrium channels of monetary policy highlighted by Kaplan, Moll, and Violante (2018) are also important for the transmission of monetary policy in Canada.

# 3 The redistribution channel: Theory and application

When evaluating the effects of changes in monetary policy rates, we find that heterogeneity across households in income and wealth affects the redistribution of wealth and the size of the individual and aggregate consumption response. We follow the approach in Auclert (2019) to show how monetary policy affects wealth redistribution and consumption.

Monetary policy can change a hourshold's wealth through three channels. Consider a one-time permanent, unexpected policy rate cut. In the standard RANK model, a policy rate cut causes (i) a rise in real wages, (ii) a rise in the nominal price level and (iii) a fall in real interest rates.[10] These changes will impact income and wealth heterogeneously across households. First, wage increases are unequal across households. Coibion et al. (2017) document that contractionary monetary policy actions systematically increase inequality in labour earnings and total income. Second, the rise in the nominal price level affects the real value of households' assets and liabilities. Since households have different levels of wealth and portfolio compositions, their net nominal position (NNP)—net nominal asset or liability position subject to revaluation with a change in the price level—also varies.[11] We can expect that the wealth effect resulting from a revaluation of assets and liabilities differs accordingly across households. Lastly, a lower real interest rate increases the real price of financial assets or debt. Auclert (2019) provides the framework that holistically captures the exposure to these price changes by considering all maturing assets minus maturing liabilities as unhedged interest rate exposures (UREs). This includes income as an asset and consumption as a liability.[12]

[10] See Appendix A.1 in Auclert (2019) for a proof.

[11] See Doepke and Schneider (2006b), Doepke and Schneider (2006a), Meh et al. (2010), Meh and Terajima (2011), Adam and Zhu (2016) and Cao et al. (2021) for the calculation of NNPs as well as the extent of redistribution from a price-level change and its impact on the economy in various countries.

[12] It may not be obvious why income and consumption should be included in the exposure measuring the

The heterogeneous changes in income and wealth through these three channels across households implies heterogeneous consumption responses. However, when we consider the effect of monetary policy on *aggregate* consumption, the consumption responses of the winners—those who gain income or wealth—and those of the losers—those who lose income or wealth—may cancel each other out. Hence, if the MPC is the same for everyone, we might expect to see little impact in the aggregate. However, the empirical literature cited has found that MPCs vary markedly across households[13] and that they depend on households' balance sheets. More specifically, in the data, winners, those who see an increase in wealth from a policy expansion, have higher MPCs than losers.

We illustrate the three redistribution channels of monetary policy by contemplating a simple example, highlighting the importance of heterogeneous MPCs. For this we consider an economy consisting of two households and derive aggregate consumption implications. The households' incomes and portfolios are equal to the Canadian average at given ages. Household 1 is in its 30s and working, while Household 2 is in its late 60s and retired. When the policy rate falls, Household 1 is likely to experience a gain through a rise in its labour income. Further, the revaluation of its net asset position will result in an increase in its value since debt is greater than assets, relative to the older household. However, the wealth effect through the UREs is likely to be negative for Household 1 because the household's net maturing assets are positive, as young Canadians accumulate wealth for retirement. Assuming that the sum of the first two effects is larger than the last, Household 1 is the winner and Household 2 is the loser. If the wealth effects cancel out and if the two households have the same MPC, then aggregate consumption will be unchanged. However, empirical evidence shows that households like Household 1 tend to have higher MPC than households like Household 2. As a result, the change in aggregate consumption will be positive. This also implies that the estimated effect of monetary policy is likely to be larger once we consider the impact of heterogeneity.

Of course, the Canadian economy consists of far more than two households, and this anal-

effects of real interest rate changes. The key idea is that a household's liabilities and assets will be balanced in the long run. If a household has a net positive position today, this household will increase consumption in the future to reduce this position. Therefore, the URE needs to include income as an asset and expenditures as liabilities.

[13] See, for example, Misra and Surico (2014), Jappelli and Pistaferri (2014) and Fagereng et al. (2021).

ysis can be extended to include all households in the economy to obtain aggregate results. For this, we use the Survey of Financial Security and compute the aggregate consumption change due to the redistribution channels and the MPC heterogeneity as explained above. We make several assumptions to keep our calculations simple and as transparent as possible. For the first channel, we use after-tax income from the data. To compute NNPs, we add deposits in financial institutions, mutual funds and other investments, bonds, tax-free savings accounts and other non-pension financial assets as assets, and subtract mortgage on a principal residence, mortgages on other real estate, lines of credit, credit card debt, installment debt, student loans, vehicle loans and other debts as liabilities. We consider the same set of assets and liabilities to compute UREs.[14] Since the URE captures only maturing assets and liabilities, we assign the duration of each item following Auclert (2019).[15] Regarding the unexpected monetary policy rate change, we analyze the implications of a rate cut of 150 basis points. We assume that the rate cut causes a 0.2% income increase for all households.[16] We further assume that the rate change brings a 0.75% fall in the real interest rate and a 1.0% rise in inflation. Finally, we use the MPC estimates of Fagereng et al. (2021).[17]

In **Chart 4**, the three panels show, from the left to right, the changes in earnings due to the policy rate decrease, the changes in wealth through the revaluation of nominal assets and debt, and the changes in wealth through UREs, respectively. It is evident that these exposures are quite dispersed. In **Chart 5**, we compare the redistribution channels implied by the 2016 household distribution with those implied by the 2019 household distribution. Since the earnings distribution and the households' balance sheet composition change over time, the redistribution of wealth caused by monetary policy also changes over time.

**Table 1** summarizes the average wealth changes via NNPs and UREs by age, the dimension of heterogeneity in MPCs that we consider to derive the average consumption change.

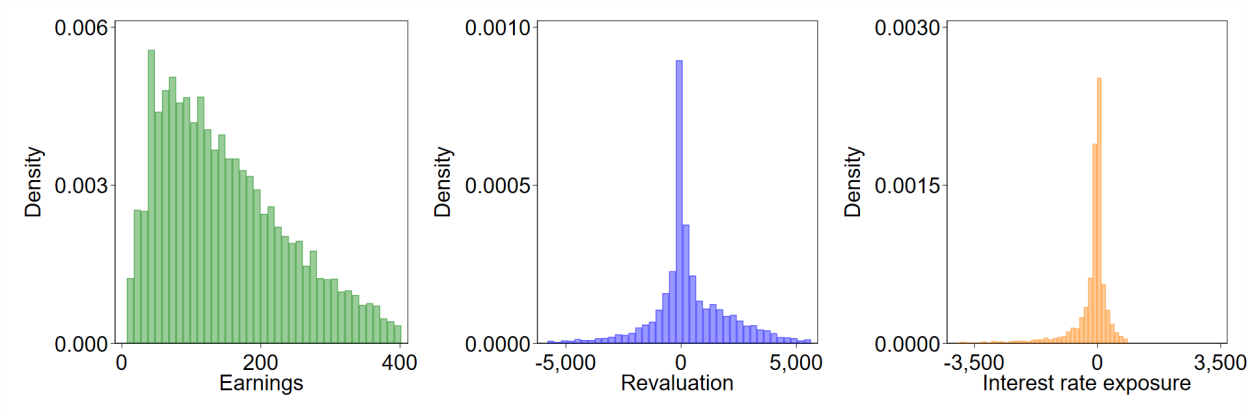
[14]We note that income is a part of assets for the URE calculation, following Auclert (2019). However, we do not include consumption as a part of liabilities, since the Survey of Financial Security does not cover consumption or expenditure information. This will bias our URE measures upward; therefore, the redistribution results of this channel will be biased downward.

[15]The maturity is set to 4 years for bonds, 5 years for mortgages and vehicle loans, and 10 years for student loans, with the maturity of other assets or debt set to 0.5 years.

[16]As we discussed in the context of Coibion et al. (2017), the wage increases would likely be unequal across households. We do not consider this in our calculations.

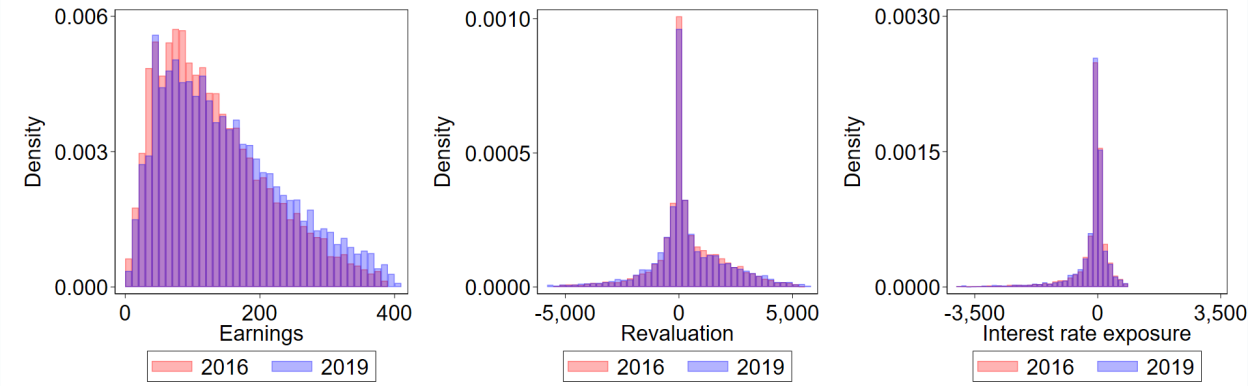
[17]We use their numbers from Table 5, panel c, across age quartiles. MPCs of the 1st to 4th quartiles are 0.565, 0.555, 0.523 and 0.441, respectively.

Chart 4: Redistribution through the three channels




Source: Survey of Financial Security (2019)

Chart 5: Redistribution through the three channels—comparison of 2016 and 2019




Source: Survey of Financial Security (2016, 2019)

Wealth changes through NNPs rise as households' net worth falls. Since the net worth tends to rise with age, wealth changes via NNPs tend to fall with the age groups. In addition, households gain through the URE channel if they have more maturing liabilities than maturing assets. Households in all categories lose in this example, partly due to the upward bias in our URE measure.

Using the changes in wealth, and using the empirical study that reports heterogeneous MPCs across households, we compute the average consumption change and compare that with the case of a representative agent who has the average balance sheet of Canadian households and their average MPC. From **Table 2**, we see that consumption increases roughly 14% more when we take into account inequality and the covariance between balance sheets and MPCs. This simple example shows that policy effects can be quite different between the

Table 1: Average wealth change through NNPs and UREs by age group ($)

| | NNP | | URE | |
|---|---|---|---|---|
| Age groups | 2016 | 2019 | 2016 | 2019 |
| 1st quartile | 829.4 | 834.7 | -13.7 | -49.9 |
| 2nd quartile | 878.2 | 979.9 | -80.2 | -69.3 |
| 3rd quartile | 282.5 | 64.0 | -187.6 | -207.4 |
| 4th quartile | -436.2 | -527.3 | -349.6 | -323.6 |

Note: NNP is net nominal position. URE is unhedged interest rate exposure. In the data, 1st quartile is 20 to 39 years, 2nd quartile is 40 to 54 years, 3rd quartile is 55 to 64 years, and 4th quartile is 65 years or older.
Source: Survey of Financial Security (2019)

Table 2: Average consumption change due to redistribution

| | Heterogeneous | Representative | *diff.* |
|---|---|---|---|
| $\Delta$ average consumption (2016) | $ 255 | $ 221 | *13%* |
| $\Delta$ average consumption (2019) | $ 243 | $ 214 | *14%* |

Source: Survey of Financial Security (2019)

representative-household case and the one that considers household heterogeneity.

# 4 Household earnings risk

A core aspect of heterogeneous-agent macroeconomics is uninsurable idiosyncratic risk. The risk that firms and households face is large relative to aggregate risk. Importantly, it varies over the business cycle; and as this and the following section show, this variation is influenced by monetary policy with implications for its conduct.

On the household side, the literature has focused on the interaction of consumption with income risk, which gives rise to precautionary savings, at least when the risk is not fully insurable. We discuss the implications of this interaction for monetary policy. Our starting point is the main mechanism outlined in Ravn and Sterk (2020). We then provide an overview of the main insights for the conduct of monetary policy established in Feiveson et al. (2020), Ravn and Sterk (2020), Acharya, Challe, and Dogra (2021), and Gornemann

et al. (2021).

## 4.1 Countercyclical endogenous earnings risk and amplification due to demand-supply interaction

Changes in precautionary asset accumulation are important for the propagation of business cycle shocks in models with flexible prices and where the strength of precautionary-saving motives is driven by countercyclical changes in unemployment risk.[18] At least at business cycle frequencies, this risk is assumed to be the main source of income fluctuations for most households.[19]

Variations in the risk of unemployment are key to understanding the countercyclical nature of earnings risk. To make this aspect visible, we plot in **Chart 6** the changes over time in the job-separation and the job-finding rates in Canada from the late 1970s until the present. Recession periods are shown as shaded areas. In recessions, the job-separation rate (in red) goes up, increasing the number of newly unemployed, while the job-finding rate for those who are already unemployed (in blue) goes down.[20] Together, these components contribute to higher unemployment risk in recessions or countercyclical earnings risk.

Because households are imperfectly insured against this idiosyncratic risk through private and public insurance channels, such as family and the government, they respond to increased earnings risk by altering their precautionary savings, creating a buffer stock of wealth. Such precautionary savings accumulation can strengthen the consumption response to aggregate shocks that affect unemployment. Consequently, self-insurance against countercyclical earnings risk through precautionary savings can alter the effectiveness of monetary policy and the prescriptions for the degree of accommodation required from monetary policy.[21]

For this result to hold, countercyclical changes in earnings risk have to arise endogenously. We provide intuition with two examples. We start with a New Keynesian setup with a

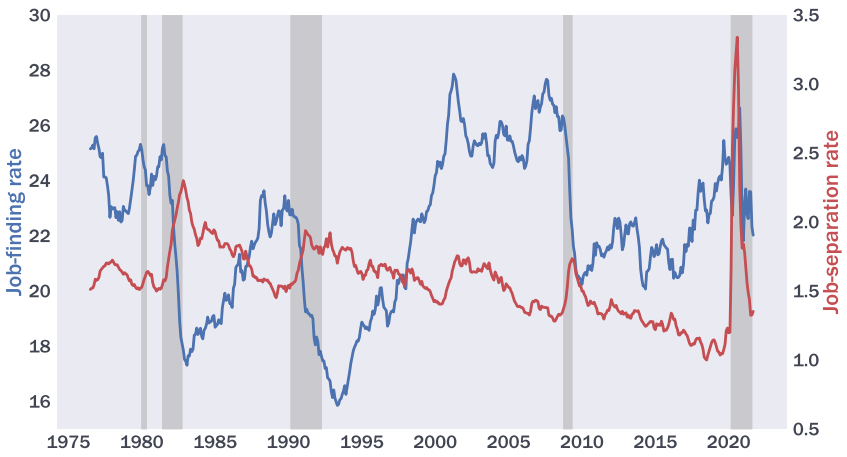
[18] Some examples of these papers include Challe and Ragot (2015) and Beaudry et al. (2017).

[19] Using data from the Canadian Survey of Financial Security, we provide in Subsection 4.2 some evidence of the varying exposures to earnings and unemployment risk.

[20] The job-finding rate is defined as the ratio of matches to the number of individuals searching for work. The job-separation rate refers to the number of matches destroyed relative to the number of employed individuals.

[21] This insight does not depend on cross-sectional variations of household MPCs.

Chart 6: Job-finding and job-separation rates over the business cycle




Note: This chart plots the monthly job-finding rate and job-separation rate in Canada. For more information, refer to the discussion in Kostyshyna and Luu (2019). Data are seasonally adjusted and expressed as a six-month moving average. Shaded regions indicate periods of recession.
Source: Labour Force Survey

countercyclical change in earnings risk that happens exogenously. We can think of the variance of idiosyncratic shocks as a parameter that takes on two values—low in booms and high in recessions—implying that the distribution of shocks becomes more fat-tailed in recessions around the same mean.[22] In the case of countercyclical earnings risk, demand contracts in recessions relative to booms because of the increased precautionary savings motive. Nominal rigidities slow the adjustment of wages in response to the lower demand for goods, forcing a quantity adjustment. This implies a lower demand for labour and employment (supply side). If the earnings risk is exogenous, it does not respond to these developments in the labour market and there is no further feedback to the demand side.[23]

The amplification of shocks that require monetary policy to act more aggressively arises when there is a feedback mechanism from the supply side to the demand side. This would be the case if lower demand for goods resulted in lower demand for labour and employment

[22] In RANK models, a common way of generating a large sudden fall in aggregate demand has been through a shock to the discount factor of the representative household, which is thought of as a stand-in for some unspecified deeper shock that acts by making the household more patient. In turn, in HANK models a fall in aggregate demand can be generated through shocks that lead to an increase in households' desire to save through mechanisms that are both more micro-founded and consistent with microdata.

[23] Introducing unemployment risk into the model would naturally lead to the countercyclicality of earnings risk. However, if a currently employed worker remains employed/becomes unemployed in the next period with exogenously specified probabilities, the same lack of feedback mechanism would result.

as before, but now it also feeds into even higher unemployment risk. For example, with an explicit labour market block in the model, lower demand for labour leads to fewer vacancy postings and a lower job-finding rate, which, as we have seen in **Chart 6**, contributes to higher unemployment risk. This even higher unemployment risk triggers its own round of negative economic effects. Overall, this channel of countercyclical endogenous earnings risk can make monetary policy shocks more powerful relative to models with exogenous risk (or complete markets), but it also rationalizes a monetary policy response that counteracts this channel through its systematic component (see also Section 4.3).

To illustrate the quantitative relevance of this mechanism, prior to the discussion of its implications for monetary policy, we show that earnings and labour market risk play an important role for a sizable proportion of the population, but risk exposures vary.

## 4.2 Amplification borne unevenly due to varying risk exposures

The consequences of the amplification channel are borne unevenly across the population. This unevenness can be illustrated by comparing income composition of households in different parts of the wealth distribution. To do so, we rely on the 2019 Survey of Financial Security, which collects information on respondents' demographics, wealth and income. In particular, we use information on respondents' net worth (excluding the value of pensions) and major income sources. **Table 3** presents the distribution of major income sources when households whose head is below the age of 65 are grouped according to their relative position in the net worth distribution.[24] We highlight some key patterns. First, while the majority of households rely on wages from employment as their major income sources, we observe significant heterogeneity across the wealth distribution: a sizable fraction of poorer households rely on income from transfers, while a sizable fraction of rich households rely on investment or business income. Second, the reliance on employment income has a hump-shaped pattern, with workers between the 40th and 80th percentile exhibiting the greatest reliance on wages. For wealth-poor households, while eligibility for transfers may dampen the severity of a job loss, their low wealth holdings also make them particularly vulnerable to income shocks because of the absence of self-insurance. Households in the middle of the distribu-

[24]The household head is defined as the major income earner of the family unit.

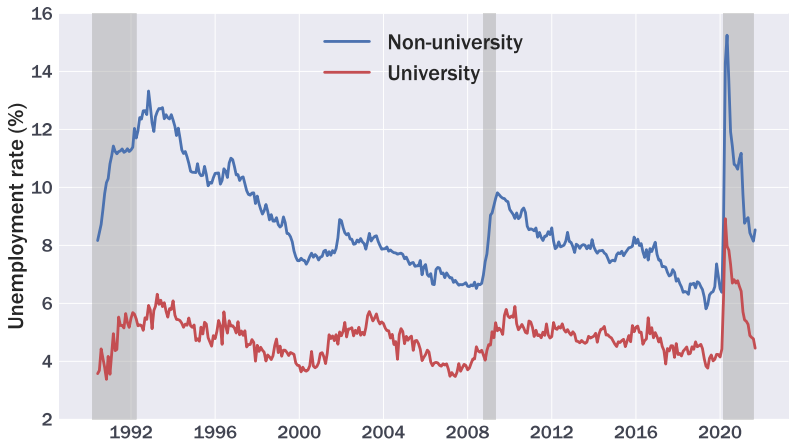
Table 3: Major income sources by wealth holdings

| Wealth quantile | 0–5 | 5–20 | 20–40 | 40–60 | 60–80 | 80–95 | 95–100 |
|---|---|---|---|---|---|---|---|
| Wages | 67 | 61 | 79 | 85 | 83 | 81 | 67 |
| Investment or self-employment | 7 | 4 | 3 | 5 | 6 | 10 | 27 |
| Transfers | 20 | 30 | 14 | 7 | 5 | 3 | 1 |
| Reitrement, other or none | 6 | 4 | 4 | 3 | 4 | 6 | 5 |

Note: This table reports the distribution of major sources of income when households in the 2019 Survey of Financial Security are grouped based on their net worth (excluding the value of pensions). The sample is restricted to households whose head is below the age of 65. For each wealth quantile, reported figures represent the fraction of households reporting that they derive a majority of their income from wages, investment or self-employment, government transfers, or retirement/other/no income.
Source: 2019 Survey of Financial Security

tion, in contrast, have the greatest reliance on wage income and thus bear a disproportionate amount of countercyclical income risk associated with unemployment fluctuations. Finally, high-wealth households at the top 5% of the net worth distribution report greater exposure to investment or self-employment income than other groups.

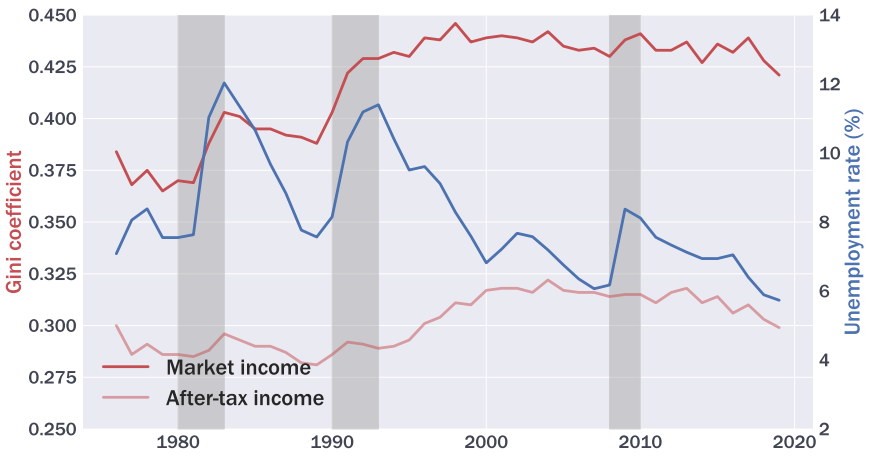
Chart 7: Unemployment rate by educational attainment




Note: This chart plots the evolution the unemployment rate among individuals with and without a university degree. Shaded regions indicate periods of recession.
Source: Labour Force Survey

The effects of the uneven exposure to employment income are made even starker when workers who rely on it the most are also the ones who experience the largest fluctuations in unemployment. While monthly data on unemployment by income or wealth are presently unavailable for Canada, we explore this factor by looking at differential fluctuations in unemployment when respondents are divided into those with and those without a university

Chart 8: Inequality over the business cycle




Note: This chart plots the evolution of the Gini coefficients of market income and after-tax income together with the dynamics of unemployment over time. Statistics Canada defines market income as the sum of earnings (from employment and net self-employment), net investment income, private retirement income, and the items under other income. After-tax income is total income less income tax, and total income is defined as income from all sources including government transfers and before deduction of federal and provincial income taxes. Shaded regions indicate periods of recession.
Source: Statistics Canada

degree.[25] We find that those without a university degree experience not only greater incidence of unemployment but also larger fluctuations, as seen in **Chart 7**.

Together, these findings are consistent with those in Gornemann et al. (2021), who use US data to show that sources of household income vary by net worth and that households who are more reliant on labour income are also those who experience more volatile labour market outcomes.

A natural implication of this uneven exposure to countercyclical income risk is that it can lead to more inequality during recessions. **Chart 8** plots the evolution of the Gini coefficients of market income and after-tax income together with the dynamics of unemployment over time.[26] We see that recessionary periods when unemployment is high coincide with periods of marked increases in market income inequality, albeit to different degrees. The evolution of

[25] In an ideal setting, this would be illustrated with the unemployment rate of individuals in various wealth or previous income quantiles. Given data limitations, we use educational attainment as a proxy to capture differences in unemployment rate dynamics across workers, as in Gornemann et al. (2021).

[26] Statistics Canada defines market income as the sum of earnings (from employment and net self-employment), net investment income, private retirement income and the items under other income. It is otherwise known as income before taxes and transfers. After-tax income is total income less income tax, where total income is defined as income from all sources including government transfers and before the deduction of federal and provincial income taxes.

the Gini coefficient of after-tax income shows that taxes and transfers do ameliorate the level of and increase in inequality. However, during recessions where the rise in unemployment is sufficiently large, we still observe a rise in inequality even when the income measure used incorporates taxes and transfers.

## 4.3 Monetary policy and inequality

The outlined amplification mechanism has implications for the conduct of monetary policy. Ravn and Sterk (2020) show that the presence of countercyclical and endogenous earnings risk would require more aggressive monetary policy to rule out the emergence of unemployment traps where reduced vacancy postings result in worse re-employment probabilities and in a further contraction of demand due to increased precautionary savings. This unemployment trap can be ruled out only if the central bank is able to arrest the negative feedback loop through interest rate cuts, as these prevent the initial deterioration of the labour market that would instigate further demand contractions. However, as discussed above, the consequences of downward spirals are often borne unevenly across the population. Hence, beyond preventing these downward spirals, monetary policy also has a role in reducing unequal outcomes that arise during recessions. Acharya, Challe, and Dogra (2021) study optimal monetary policy in an environment with incomplete markets, where agents face uninsurable and countercyclical income risk. Unlike in a RANK framework, monetary policy in a HANK model affects idiosyncratic consumption risk and inequality in addition to output and prices.

The main channels through which monetary policy can reduce consumption inequality are two-fold. First, it can reduce idiosyncratic consumption risk. When income risk is countercyclical, expansionary monetary policy can raise output to temper the increase in risk during recessions. The resulting lower rates not only lead to cheaper borrowing costs but also enable agents to better self-insure due to higher current and future labour income (as wages increase as well). Second, monetary policy can also reduce inequality that arises from uneven exposures to shocks and policy. For example, when individuals differ in terms of their wealth holdings, interest rate cuts can lower interest payments and redistribute resources from wealthy savers to poor debtors. Overall, the optimal monetary policy rule in this setting would shift weight toward output stabilization and away from the traditional output gap

and price targets. Similarly, Gornemann et al. (2021) find that accounting for differences in wealth and income sources among individuals would alter the distribution of gains and losses associated with different monetary stabilization policies. For example, they find that wealth-poor households stand to gain more from monetary policy rules that favour unemployment stabilization than from inflation-centric ones. Finally, Feiveson et al. (2020) show that models that account for income and wealth differences across households would predict larger gains from monetary policy strategies that lessen the frequency, duration and severity of recessions. In particular, they show that makeup strategies, such as average inflation targeting and price-level targeting, can prevent self-fulfilling demand contractions when interest-rate-sensitive consumers are induced to spend and the incomes of HtM individuals rise.

We conclude by noting that the monetary policy recommendation depends crucially on the fiscal policy response, emphasizing the importance of monetary-fiscal coordination.[27] The degree of accommodation required from monetary policy to address the unequal outcomes of recessions will depend largely on the extent to which redistributive fiscal policies are effective in dampening the consequences of countercyclical income risk.

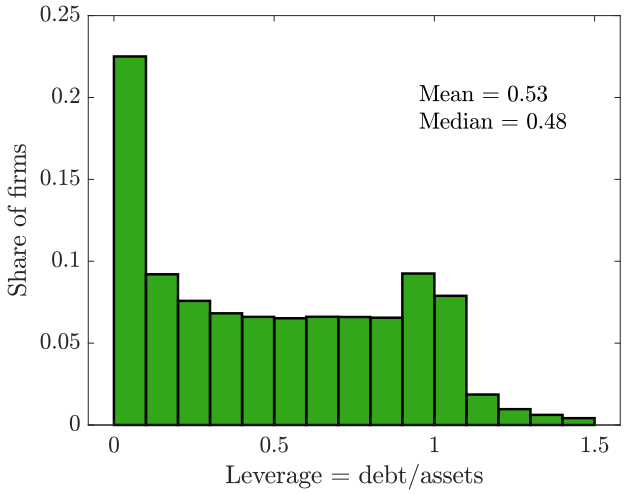
# 5 Business default risk

Businesses also face large idiosyncratic risks, reflected partially in the large investment volatility observed at the firm level. Policy actions can influence this idiosyncratic risk of the business sector, analogous to the household sector situation. The heterogeneity in firms' investment responses to monetary policy has been an important research topic since Bernanke and Gertler (1995). With the availability of more micro-level data and the development of computational methods, this literature has seen renewed growth over the past decade (e.g., Cloyne et al. (2018), Jeenas (2019), Ottonello and Winberry (2020), Guo (2020), Bustamante (2020), and Moreland and Lakdawala (2021)). A key motivation behind these studies is the vast heterogeneity observed in firms' leverage. As shown in **Chart** 9, about 23% of Canadian firms have little debt and a leverage ratio close zero, but about 20% of them are highly levered, with leverage ratios above 90%. Given this significant dispersion

[27] See Dong et al. (2021) for an in-depth review of monetary-fiscal policy complementarities.

in firms' financial positions, the heterogeneity in firms' investment responses to monetary policy could be crucial in determining the aggregate effects of monetary policy.

Chart 9: Distribution of Canadian firms' leverage ratio



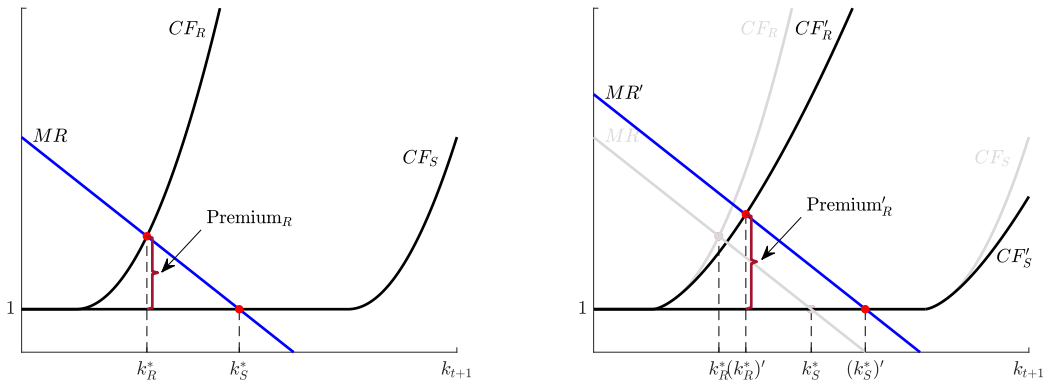

Note: Distribution of leverage ratio of Canadian firms in the National Accounts Longitudinal Micro-data File (NALMF) 2016. The leverage ratio is measured as the ratio between total liabilities and total assets.

From a theoretical perspective, the effect of a firm's financial position on its investment response is ambiguous. Following the explanation in Ottonello and Winberry (2020), we consider two hypothetical firms with the same size (capital) but different levels of debt in **Chart** 10: a risky firm, with sub-index $R$, that has a lower net worth, higher leverage and higher default risk; and a safe firm, with sub-index $S$. Firms finance their investment expenditures following a "pecking order": they first use their internal funds, and then use debt financing if they need additional funding.[28]

We illustrate how firms' financial positions would affect their investment activity in panel (a) of Chart 10. Each firm makes its investment decisions based on the trade-off between its marginal cost of financing and its marginal return on investment. As a result of the decreasing returns to scale in their production factors, firms face a downward-sloping marginal return curve ($MR$). As for the marginal cost of financing ($CF$) faced by each firm, the cost schedule is flat at lower levels of investment. At those levels of future capital, firms finance their investment expenditure with internal funds or by borrowing without any default risk, so the associated risk premium is zero and the cost of funding is equal to the risk-free rate

[28]This is an assumption, but one that is largely consistent with empirical evidence.

Chart 10: Graphical illustration of firms' investment response to a monetary policy shock




(a) Before MP shock

(b) After MP shock

(normalized to 1 in the chart). As we increase the level of future capital $k_{t+1}$, default risk starts increasing and the marginal cost schedule starts bending upward. Since the risky firm is already more leveraged, its marginal cost of financing rises more rapidly than that of the safe firm. In the equilibrium, the risky firm chooses a capital stock $k_R^*$, and pays some positive risk premium, while the safe firm can borrow at the risk-free rate to finance a capital stock $k_S^*$ (panel (a) of Chart 10).

Next, we consider the implications from an expansionary monetary policy shock, panel (b) of Chart 10, showing that it affects firms' investment unevenly. A lower interest rate increases firms' net worth and alleviates their debt burden, both of which ease default risk concerns and lead to an outward shift of marginal cost of financing curves. The new marginal cost of financing curves are $CF'_R$ and $CF'_S$. Absent general equilibrium effects on the aggregate demand, these firms would move along the marginal return curve. Because the safe firm was already operating within the flat, risk-free region, it does not respond to this new situation, while the risky firm increases its investment because it can borrow more at a lower rate. These responses follow the same logic as in Bernanke, Gertler, and Gilchrist (1999), where constrained firms respond more than unconstrained firms to monetary policy because their financial constraints are relaxed. On top of these changes, the marginal return of investment also shifts outward due to the increased aggregate demand. After accounting for all these changes, we arrive at a new set of choices for risky and safe firms, $(k_R^*)'$ and $(k_S^*)'$ respectively.

Because the risky firm faces a much steeper marginal cost curve, its response to the increase in aggregate demand is largely dampened compared with the response of the safe firm.

As documented in Ottonello and Winberry (2020), firms with higher default risk increase their investment by less than those with lower default risk following an expansionary monetary shock. This evidence indicates that the dampening effects of financial constraints dominate the financial accelerator effect arising from the relaxed financial constraints following a monetary easing shock. The structural model in Ottonello and Winberry (2020) is calibrated to capture this particular feature of the data and stresses the fact that monetary policy could be less effective during recessions if there is a large number of highly indebted firms.

# 6 Conclusion

Monetary policy models with a rich heterogeneity of households and businesses are the source of novel insights into the monetary transmission mechanism.[29] Insights from micro-data combined with increased computing power and innovative techniques have made this development possible. We learned that the interaction of general equilibrium effects with liquidity constraints is important for the monetary transmission. This is particularly relevant during periods of monetary and fiscal interactions, as experienced over the course of the COVID-19 pandemic.

With rich heterogeneity in income and wealth also come rich redistribution effects of monetary policy. We illustrated for the case of Canada that these might have non-trivial consequences for aggregate consumption. Taking heterogeneity seriously also leads to new reasons for more accommodative monetary policy during recessions. On the household side, the presence of endogenous countercyclical income risk increases precautionary savings, bearing the risk of amplifying recessions. On the business side, firms with higher default risk also face higher financing costs, requiring more stimulus to trigger investments.

While research on heterogeneity and monetary policy has gained momentum over the

[29]There are other reasons for monetary policy to consider heterogeneity. Of prime importance are those related to financial stability considerations; however, these are beyond the scope of this paper.

last decade, it has created new topics that require attention (e.g., HtM household dynamics, the redistribution channel of monetary policy) and revived old topics (e.g., fiscal-monetary coordination, portfolio choices of households). As over the last decade, progress in these areas will depend on the availability of data, the ingenuity of researchers and the evolution of computing power.

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