Financial Intermediaries, Regulation, and Macroeconomic Stability

by

Hélène Desgagnés

A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy
Graduate Department of Economics
University of Toronto

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Abstract

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Hélène Desgagnés
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2016

A growing share of financial transactions takes place outside the scope of financial regulation. The mortgage market is a specific example of this phenomenon. Some mortgage lenders do not face the same level of scrutiny as chartered banks or credit unions. These non-regulated financial intermediaries do not have to maintain a minimum level of bank capital (or equity) and cannot accept deposits. To finance their lending, they rely on other sources of funds such as securitization. In this thesis, I examine the impact of non-regulated mortgage lenders on the macroeconomy.

In the first chapter, I present evidence on rates in the Canadian mortgage market where traditional lenders facing a minimum capital requirement compete against non-regulated financial intermediaries. My results show that non-regulated lenders offer lower mortgage rates. Differences in the type of household they serve could explain this observation.

In Chapter 2, I build a dynamic and stochastic general equilibrium (DSGE) model to examine the impact of non-regulated financial intermediaries on the economy. My model features two types of financial intermediaries that differ in three ways: (i-) only the regulated sector faces a capital requirement, (ii-) the non-regulated sector cannot accept deposits, and (iii-) the non-regulated sector faces a more elastic demand. I also analyze the effectiveness of three regulatory tools aimed at improving macroeconomic and financial stability (often referred to as macroprudential tools). The simulations show that a larger non-regulated sector contributes to stabilizing the economy and has a non-trivial impact on the effectiveness of different macroprudential tools.

Finally, in Chapter 3, I examine the impact of non-regulated financial intermediaries on optimal monetary policy. Mortgage rates are traditionally an important channel for the transmission of monetary policy and the expansion of non-regulated lenders could interfere with this mechanism. My results suggest that a trade-off exists between minimizing the volatility of output and inflation and implementing a monetary policy rule that is robust to the growth of the non-regulated sector.
À mes parents.
I thank my thesis advisor Margarida Duarte for her guidance and patience. I am also grateful to my two other thesis committee members, Michelle Alexopoulos and Ronald Wolthoff, for their valuable feedback on my work.

I had the great opportunity of working as a PhD intern at the Bank of Canada during the summer of 2015. I made a lot of progress thanks to the support I received at the Bank and I am very excited to be soon joining the ranks. I am extremely grateful to José Dorich for his guidance, Jason Allen for teaching me about the Canadian mortgage market and sharing his data with me, Denis Gorea and Alexander Ueberfeldt for taking the time to meet with me to discuss my research, and all the Brown Bag workshop participants for their useful comments.

Je tiens à remercier Kevin Moran, mon premier mentor, pour ses encouragements du moment où j’ai entrepris les démarches de demandes d’admission au doctorat jusqu’aux toutes dernières semaines de rédaction de thèse.

I thank my classmates and colleagues for attending my talks, sharing their thoughts, and sometimes simply being there. Je suis éternellement reconnaissante envers Jessie Lamontagne, non seulement pour toutes ses suggestions et son aide avec la section empirique de ma thèse, mais surtout pour être devenue une proche confidente et avoir partagé les hauts et les bas du doctorat et de la vie en général avec moi.

I am also grateful to all the friends I made through the Toronto running community. With their presence and support, these dedicated and hard-working people helped me more than they will ever know.

Finalement, je tiens à remercier toute ma famille pour son appui inconditionnel. Je ne serais pas où je suis aujourd’hui sans le soutien de mes parents tout au court de ma vie. I am grateful to Rebecca and Liz for taking the time to proofread my thesis and to Peter for his love and constant support over the last few years.
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Chapter 1

Pricing in the Mortgage Market: Regulated Versus Non-Regulated Lenders
1.1 Introduction

A variety of lenders compete in the Canadian mortgage market. Federally regulated chartered banks and provincially regulated credit unions still own the largest share of the market, but empirical evidence suggests that another type of financial intermediary is gaining importance. In contrast to the federally or provincially regulated financial intermediaries (RFIs), these institutions cannot raise funds by accepting deposits and do not have to satisfy a capital adequacy ratio. I will refer to these financial institutions as non-regulated financial intermediaries (NRFIs).

In this chapter, I document the differences in the mortgage rates charged by the regulated and non-regulated financial intermediaries in Canada. Documenting the pricing differences is key in understanding the role and importance of non-regulated financial intermediaries and creating sensible models for policy analysis. I use data on pools of mortgages securitized by RFIs and NRFIs as an indicator of the lending conditions in each sector and run a regression of the average rate in each pool over a set of characteristics of the mortgages in the pool and an indicator of market conditions. I also compare the variance of the regression residuals, which is a measure of the unexplained price dispersion.

Price dispersion in the Canadian mortgage market has been studied by Allen, Clark, and Houde (2014). Their work is based on data they obtained from mortgage insurers on individual mortgage contracts issued between 1999 and 2004. They find evidence of price discrimination in the Canadian mortgage market which explains part of the price dispersion. Lenders offer different rates to different consumers based on their relative bargaining power or negotiation ability. The findings of Allen, Clark, and Houde (2014) explain why a lender may offer a different interest rate to different clients, but ignore the impact of the different types of lenders.

Pricing differences between different types of mortgage lenders has been explored by Hassink and Leuvensteijn (2003) who studied the Dutch mortgage market. They compare rates on insured mortgages issued by banks and insurance companies between 1996 and 2001. The authors find that banks charge a slightly lower rate and, more importantly, that the variance of rates, or price dispersion, is lower for loans issued by banks. They suggest that information frictions could explain the difference in price dispersion. Banks are more informed about their clients than life insurance companies and are able to offer better rates.

I also find significant pricing differences between the two types of mortgage lenders I analyze. However, in contrast to the findings of Hassink and Leuvensteijn (2003), my results suggest that chartered banks and other RFIs charge a higher rate than NRFIs. This observation can be explained by heterogeneity in the search costs faced by households. Households with low search costs are more likely to obtain quotes from non-regulated financial intermediaries while those with higher search costs may only obtain a quote from their primary financial institution. This hypothesis is also consistent with the evidence presented by Allen, Clark, and Houde (2014).

The remainder of this chapter is organized as follows: in Section 1.2, I give some context on the Canadian mortgage market and in Section 1.3, I describe the data. In Sections 1.4 and 1.5, I present my econometric models. I discuss the results in Section 1.6 and conclude in Section 1.7.
1.2 The Canadian Mortgage Market

Lenders in the Canadian mortgage market can be divided into three groups. The first group, the federally regulated institutions, includes chartered banks, trust and life insurance companies, as well as some specialized mortgage companies. The Office of the Superintendent of Financial Institutions (OSFI) oversees their activities and imposes a minimum capital requirement. In addition, the federal government sets the limit on the loan-to-value (LTV) ratio of mortgages. In particular, borrowers who cannot provide a down-payment of at least 20% of the value of the property must obtain mortgage insurance. Mortgage insurance is provided by private companies or by the Canadian Mortgage and Housing Corporation (CMHC), a Crown corporation of the Government of Canada. The federal government provides an explicit guarantee on all insured mortgages but imposes additional restrictions on borrowers’ eligibility and LTV ratio. As of 2010, insured mortgages cannot exceed 95% of the value of a new purchase or 80% in case of refinancing.

The second group, the provincially regulated institutions, comprises credit unions and brokers. As pointed out by Traclet (2010), provincial regulatory authorities tend to closely follow the regulation imposed by the OSFI. Moreover, borrowers who are required to obtain mortgage insurance have to meet the additional criteria set by the federal government. Mortgages issued by provincially regulated intermediaries are thus comparable to the ones issued by federally regulated institutions. For this reason, I combine federally and provincially regulated financial intermediaries in my analysis.

Non-regulated financial intermediaries constitute the third group. These lenders are not subject to a minimum capital requirement and, in principle, one could expect NRFIs to issue riskier loans; however, since NRFIs cannot finance their loans with deposits, securitization is an important source of financing. Virtually all of the securitization in Canada takes place through the National Housing Act Mortgage-Backed Securities (NHA MBS) program, a government program aimed at facilitating the funding of mortgages. Since all mortgages securitized through the NHA MBS program have to be insured, an important share of mortgages issued by NRFIs have to satisfy the LTV limit imposed by the federal government.

1.3 A First Look at the Data

There is no comprehensive publicly available data on newly issued mortgages in Canada, so I use data on securitization of mortgages as a proxy. Even though not all mortgages are securitized, securitization has become an important funding channel for financial intermediaries, in particular the non-regulated ones who do not have access to deposits.

---

1 Private lenders (also known as B lenders) could be considered as a fourth group. They primarily issue non-insured loans to households who cannot qualify for regular mortgages. Since they deal with riskier borrowers, issue non-insured mortgages, and tend to be active in specific geographic areas, I leave them aside.

2 Even though the CMHC performs a role similar to government-sponsored enterprises (GSEs) in the U.S., it remains a Crown corporation subject to a higher level of scrutiny, with an explicit guarantee from the federal government. For a detailed comparison of the housing market in Canada and the U.S., see Kiff, Mennill, and Paulin (2010) and for an overview of the U.S. housing finance system, see Hoskins, Jones, and Weiss (2013).

3 Effective February 2016, the maximum LTV ratio decreased to 90% for the portion of a loan above $500,000.

4 According to Mordel and Stephens (2015), since 2008, about a third of outstanding mortgage debt in Canada is securitized.
As I mentioned above, securitization in Canada takes place through the National Housing Act Mortgage-Backed Securities (NHA MBS) program administered by the Canadian Mortgage and Housing Corporation (CMHC). To be eligible for securitization, a mortgage has to satisfy certain criteria. In particular, the loan has to be insured against default of the borrower\(^5\) and the payments made by the borrower have to be equal throughout the amortization period (CMHC, 2013). Mortgages sharing similar characteristics (e.g. variable interest rate, individual properties, multi-family homes, etc.) are aggregated in pools by issuers.

I work with data extracted from the CMHC’s MBS Information Circulars for the period 2006 to 2013\(^6\). A circular contains information on each pool of mortgages securitized by a financial intermediary. In particular, it indicates the issuer, the date of issuance (month and year), the pool type, the total value of the mortgages in the pool, the number of mortgages in the pool, the weighted average mortgage rate, and the type of interest rate (fixed, variable, or floating). I separate the pools according to their issuer in two categories. The first category, the RFIs, includes financial institutions issuing mortgages and regulated by the OSFI or a provincial equivalent and their subsidiaries\(^7\). The other category, the NRFIs, consists of non-regulated mortgage issuers and other financial intermediaries who do not issue mortgages. Table 1.1 presents a summary of the data and Figure 1.1 shows the quarterly weighted average interest rate for each sector.

<table>
<thead>
<tr>
<th>Table 1.1: Data description. Data from the CMHC’s MBS Information Circulars (2006-2013).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NRFIs</strong></td>
</tr>
<tr>
<td>Observations (number of pools)</td>
</tr>
<tr>
<td>Average number of mortgage per pool</td>
</tr>
<tr>
<td>Proportion of fixed rate (percent)</td>
</tr>
</tbody>
</table>

An interesting pattern emerges from the data. Starting in the middle of 2009, mortgage rates in pools securitized by non-regulated financial intermediaries are lower. The spread is very large in 2010, but seems to be closing at the end of the sample. This observation would not surprise mortgage brokers. In the mortgage brokering industry, NRFIs enter the category of monoline lenders (non-deposit-taking financial intermediaries specialized in mortgages) who are viewed as offering the lowest rates on the market.

In the next section, I run a regression to measure the spread and determine whether or not it is significant. I look at the difference across sectors over time in Section 1.5 to see if the spread is really closing once we take into account other factors such as the type and value of the mortgages. In Section 1.6, I explore potential explanations to this spread.

---

\(^5\)Mortgage insurance is mandatory if a buyer purchases a house with a downpayment of less than 20% of the price of the house, but the insurance providers also offer portfolio insurance and multi-unit residential insurance. In other words, securitized mortgages are not only highly leveraged mortgages. 

\(^6\)I obtained access to this confidential dataset during my PhD Internship at the Bank of Canada. 

\(^7\)Three chartered banks have subsidiaries who securitized mortgages during the period considered here. Separating them does not affect the results.
Chapter 1. Pricing in the Mortgage Market

1.4 Regression Models

To determine whether or not the interest rate differential we observe is significant, I run a regression of the weighted average mortgage rate in pool \( i \) (\( rate_i \)) over an indicator of market conditions (daily yield on 5-year government bonds on the day of the securitization, \( yield_{5yr\_bond} \)) and characteristics of the loans in the pool: average mortgage (\( avg\_mortg_i \)) and dummies for the type of financial intermediary (\( regul_i = 1 \) if the issuer is a RFI), type of mortgage (\( fixed_i = 1 \) if the mortgages in the pool have fixed rates), and type of pool (\( pool_i \)). Model (1.1) is given by:

\[
rate_i = \beta_0 + \left( \beta_1 \log(avg\_mortg_i) \right) + \left( \beta_2 \gamma_{1i} \right) + \left( \beta_3 \Gamma_{2i} \right) + \left( \gamma_{3i} fixed_i \right) + u_i
\]

\( \text{Figure 1.1: Weighted average interest rates (quarterly average). Calculations based on data from the CMHC’s MBS Information Circulars.} \)

\( ^8 \text{Mortgages are assembled in pools and the type of pool depends on some characteristics of the loans (multiple-family or homeowner property, penalty in case of prepayment, etc.) pool}_i \) is a vector of all pool types in the sample.
Table 1.2: Regression results. Dependant variable: weighted average mortgage rate. Additional controls: pool type, constant. Standard errors clustered by issuer in parentheses. Significance levels: *=10%, **=5%, ***=1%

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model (1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>regul</td>
<td>0.366***</td>
</tr>
<tr>
<td></td>
<td>(0.113)</td>
</tr>
<tr>
<td>log(avg_mortg)</td>
<td>-0.024</td>
</tr>
<tr>
<td></td>
<td>(0.0220)</td>
</tr>
<tr>
<td>yield_5yr_bond</td>
<td>0.651***</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
</tr>
<tr>
<td>fixed</td>
<td>-0.229**</td>
</tr>
<tr>
<td></td>
<td>(0.092)</td>
</tr>
<tr>
<td>Observations</td>
<td>11,907</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.481</td>
</tr>
</tbody>
</table>

The results of the regression of Model 1.1 are presented in Table 1.2. The RFI effect is measured by the estimated coefficient for regul (\(\hat{\gamma}_1\)). The results indicate that the RFI effect is 37 basis points, which means that the weighted average mortgage rate in pools securitized by regulated financial intermediaries is 37 basis points higher than the rate in pools securitized by non-regulated financial intermediaries, and this effect is significant at the 1 percent level. The indicator of market conditions and the type of mortgage also contribute to explain the mortgage rates, but the impact of the average value of the mortgages is negligible.

To account for any potential period-specific effect, I add a dummy for the month and year of the securitization in Model (1.2):

\[
rate_i = \beta_0 + \left( \begin{array}{c} \beta_1 \\ \beta_2 \\ \end{array} \right)' \left( \begin{array}{c} \log(avg\_mortg) \\ yield\_5yr\_bond \end{array} \right) + \left( \begin{array}{c} \gamma_1 \\ \Gamma_2 \\ \gamma_3 \\ \Gamma_4 \\ \end{array} \right)' \left( \begin{array}{c} regul_i \\ pool_i \\ fixed_i \\ date_i \end{array} \right) + u_i \tag{1.2}
\]

Models (1.1) and (1.2) are based on the assumption that the daily yield on government bonds at the time of securitization is a good indicator of the market conditions at the time the mortgages were issued. Since mortgages are typically not securitized right when they are issued, the appropriate indicator of the market conditions may be the return on 5-year government bonds a few months prior to the securitization date. In order to estimate the optimal indicator of market conditions at the time of issuance, I calculate the correlation between the monthly weighted average mortgage rate and the end-of-month yield on 5-year government bonds\(^9\) over twelve months before the date of securitization. Weighted average mortgage rates exhibit the highest correlation with the return on government bonds eleven months prior to the

---

\(^9\)End-of-month yield is recorded on the last Wednesday. Source: CANSIM Table 176-0043.
securitization. Model (1.3) is given by:

\[
rate_{i,t} = \beta_0 + \left( \beta_1 \right) \log(\text{avg}_t\text{mortg}_{i,t}) + \frac{\gamma_1}{\Gamma_2} \frac{\gamma_3}{\Gamma_4} \frac{\gamma_5}{\Gamma_5} \left( \begin{array}{c} \text{regn}_{i} \\ \text{pool}_{i} \\ \text{fixed}_{i} \\ \text{date}_{i} \\ \text{IMPP}_{i} \end{array} \right) + u_i
\]

The Insured Mortgage Purchase Program (IMPP) implemented by the federal government in the Fall of 2008 to stimulate the mortgage market during the financial crisis could also affect the outcome of the estimation. The IMPP was created in October 2008 and ended at the end of March 2010. During that period, the volume of securitization exploded, suggesting that financial intermediaries took advantage of the program. It seems likely that financial intermediaries securitized older mortgages that they had kept on their balance sheet. In order to control for the effect of the IMPP, I also consider Model (1.4) which includes a IMPP dummy \( (IMPP_{t,i} = 1 \text{ if the pool was securitized during the IMPP period}) \):

\[
rate_{i,t} = \beta_0 + \left( \beta_1 \right) \log(\text{avg}_t\text{mortg}_{i,t}) + \frac{\gamma_1}{\Gamma_2} \frac{\gamma_3}{\Gamma_4} \frac{\gamma_5}{\Gamma_5} \left( \begin{array}{c} \text{regn}_{i} \\ \text{pool}_{i} \\ \text{fixed}_{i} \\ \text{date}_{i} \\ \text{IMPP}_{i} \end{array} \right) + u_i
\]

The results are reported in Table 1.3. The RFI effect decreases from 37 to 31 basis points but is still significant across all specifications. It is also interesting to notice that even though the effect of the IMPP is significant, taking it into account has no impact on the RFI effect.

Finally, it is important to remember that I observe pools rather than individual mortgages. The number of mortgages in a pool varies considerably (from one to over ten thousand) and a pool of only one mortgage has the same weight in the regression as a pool of ten thousand mortgages. An implication of the wide range of pool sizes is that pools are not equally representative of the distribution of mortgages. A larger pool is more likely to be representative of the distribution of mortgages, so I discard all pools containing less than one hundred mortgages. This trimming affects NRFIs more than RFIs; only 23.5 percent of pools securitized by NRFIs contain more than one hundred mortgages, but 51.7 percent of the pools securitized by RFIs contain more than one hundred mortgages. In Table 1.4, I present the regressions results for Models (1.2), (1.3), and (1.4) with the trimmed sample. The RFI effect remains significant at the one percent level even though the magnitude decreases to 23 basis points.

\[\text{I change the lag on the indicator of the market conditions after performing a correlation analysis excluding the period of the IMPP.}\]
Table 1.3: Regression results. Dependant variable: weighted average mortgage rate. Additional controls: pool type, month and year of securitization, constant. Standard errors clustered by issuer in parentheses. Significance levels: *=10%, **=5%, ***=1%

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model (1.2)</th>
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<th>Model (1.4)</th>
</tr>
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<tbody>
<tr>
<td>regul</td>
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<td>0.306***</td>
<td>0.306***</td>
</tr>
<tr>
<td></td>
<td>(0.083)</td>
<td>(0.083)</td>
<td>(0.083)</td>
</tr>
<tr>
<td>log(avgmortg)</td>
<td>-0.042**</td>
<td>-0.042**</td>
<td>-0.042**</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>yield_{5yr_bond_t}</td>
<td>1.141</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1.156)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>yield_{5yr_bond_{t-9}}</td>
<td>-</td>
<td>-</td>
<td>0.600***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.094)</td>
</tr>
<tr>
<td>yield_{5yr_bond_{t-11}}</td>
<td>-</td>
<td>0.528***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.083)</td>
</tr>
<tr>
<td>fixed</td>
<td>-0.375*</td>
<td>-0.364*</td>
<td>-0.364*</td>
</tr>
<tr>
<td></td>
<td>(0.204)</td>
<td>(0.198)</td>
<td>(0.198)</td>
</tr>
<tr>
<td>IMPP</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>Observations</td>
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<td>11,913</td>
<td>11,913</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.687</td>
<td>0.687</td>
<td>0.687</td>
</tr>
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</table>

Table 1.4: Regression results. Dependant variable: weighted average mortgage rate. Pools of at least 100 mortgages. Additional controls: pool type, month and year of securitization, constant. Standard errors clustered by issuer in parentheses. Significance levels: *=10%, **=5%, ***=1%

<table>
<thead>
<tr>
<th>Variables</th>
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<th>Model (1.4b)</th>
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<td>0.225***</td>
<td>0.225***</td>
</tr>
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<td>(0.047)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>log(avgmortg)</td>
<td>-0.079**</td>
<td>-0.079**</td>
<td>-0.079**</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.036)</td>
<td>(0.036)</td>
</tr>
<tr>
<td>yield_{5yr_bond_t}</td>
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<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.830)</td>
<td></td>
<td></td>
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<tr>
<td>yield_{5yr_bond_{t-9}}</td>
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<td>-</td>
<td>0.501***</td>
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<td></td>
<td></td>
<td>(0.153)</td>
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</tr>
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<td></td>
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<td></td>
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<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.124)</td>
<td>(0.120)</td>
<td>(0.124)</td>
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<td>IMPP</td>
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<td>-</td>
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<tr>
<td>Observations</td>
<td>5,113</td>
<td>5,117</td>
<td>5,117</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.734</td>
<td>0.734</td>
<td>0.734</td>
</tr>
</tbody>
</table>
1.5 Is the Spread Closing?

To determine if the decrease in the spread we observe in the data at the end of the sample is an indicator of a closing gap or due to other factors (e.g., type of rate, value of mortgage, etc.) I allow for the RFI effect to vary over time. To this end, I add interaction terms between the indicator of the type of financial intermediary \((\text{regul}_i)\) and the month and year of the securitization of pool-\(i\) \((\text{date}_i)\). Models (1.5), (1.6), and (1.7) are the alternate versions of Models (1.2), (1.3), and (1.4):

\[
\begin{align*}
\text{rate}_i &= \beta_0 + \left( \frac{\beta_1}{\beta_2} \right) \left( \log(\text{avg.mortg}_i) \right) + \left( \gamma_1 \right) \left( \text{regul}_i \right) + \left( \gamma_3 \right) \left( \text{pool}_i \right) + \left( \gamma_4 \right) \left( \text{fixed}_i \right) + \left( \gamma_5 \right) \left( \text{date}_i \right) + u_i \quad (1.5) \\
\text{rate}_{i,t} &= \beta_0 + \left( \frac{\beta_1}{\beta_2} \right) \left( \log(\text{avg.mortg}_{i,t}) \right) + \left( \gamma_1 \right) \left( \text{regul}_i \right) + \left( \gamma_3 \right) \left( \text{pool}_i \right) + \left( \gamma_4 \right) \left( \text{fixed}_i \right) + \left( \gamma_5 \right) \left( \text{date}_i \right) + u_i \quad (1.6) \\
\text{rate}_{i,t} &= \beta_0 + \left( \frac{\beta_1}{\beta_2} \right) \left( \log(\text{avg.mortg}_{i,t}) \right) + \left( \gamma_1 \right) \left( \text{regul}_i \right) + \left( \gamma_3 \right) \left( \text{pool}_i \right) + \left( \gamma_4 \right) \left( \text{fixed}_i \right) + \left( \gamma_5 \right) \left( \text{date}_i \right) + u_i \quad (1.7)
\end{align*}
\]

For instance, in Model 1.5, the RFI effect on the weighted average rate in October 2008 is given by \(\gamma_1 + \gamma^{\text{Oct}}_{5,08}\) where \(\gamma^{\text{Oct}}_{5,08}\) is the element of \(\Gamma_5\) representing October 2008. The RFI effect for a specific period can be interpreted as the spread that cannot be explained by other elements of the model (e.g., type or mortgage, average value of mortgages, etc.). In Figure 1.2, I illustrate the RFI effect over time and compare it to the actual spread. Once other factors are taken into account, the spread between the weighted average interest rate on mortgages securitized by RFIs and NRFIs is smaller during the 2010-2011 period, but does not decrease as much in 2012-2013. In other words, there is no clear trend suggesting that the spread is closing.

1.6 Discussion

In the previous sections, we saw that there is a significant difference in the rates of mortgages securitized by regulated and non-regulated financial intermediaries and that there is no evidence of convergence in these rates. Economists have suggested numerous theories to explain why we observe different prices for seemingly homogenous products and to generate such dispersion in models. Reinganum (1979) suggests a theoretical framework based on differences in firms’ marginal costs. However, there is no reason to believe that NRFIs can issue loans at a lower marginal cost than RFIs. NRFIs cannot finance their lending activities by accepting deposits or by borrowing from the central bank. Only RFIs have access to these cheaper sources of funds.
Price dispersion can also arise because of the market structure. In a monopolistically competitive industry, such as the Canadian mortgage market, sellers may be able to price discriminate between different types of consumer. Borenstein and Rose (1991) show that the pricing of airlines tickets in the U.S. is consistent with price discrimination in a monopolistically competitive industry. As mentioned above, Allen, Clark, and Houde (2014) document the price dispersion in the Canadian mortgage market and conclude that lenders set the rate based on the relative bargaining power or negotiation ability of each client.

Other papers generate price dispersion through information heterogeneity. In the model of Wilde and Schwartz (1979), consumers differ in their willingness to shop for the best price and some consumers only observe one price. In Salop and Stiglitz (1977) acquiring information is costly and the cost of becoming perfectly informed differs across consumers. Information heterogeneity can also arise \textit{ex post} as in Burdett and Judd (1983) who show that an equilibrium with price dispersion exists if there is a non-zero probability that some consumers observe only one price. Carlson and McAfee (1983) develop a model of equilibrium price dispersion due to heterogeneity in consumers’ search cost and firms’ production costs that generates testable predictions. Dahlby and West (1986) use Carlson and McAfee’s (1986) model to show that costly consumer search explains the price dispersion in the market for automobile
insurance. More empirical evidence of price dispersion due to costly consumer search is presented by Sorensen (2000) who looks at the market for prescription drugs. His results show that drugs for chronic conditions exhibit less price dispersion than other drugs that are purchased infrequently. Consumers with a chronic illness have to buy their medication regularly and have a greater incentive to search for the pharmacy offering the best price.

Heterogeneity in consumers’ search costs can explain the pricing pattern described in the previous sections. Mortgages are complex loans and the whole process associated with the purchase of a home can be very intimidating. As the findings of Allen, Clark, and Houde (2014) show, the cost of obtaining multiple quotes is high for some households and they may limit their search to their main financial institution. For other households who either hire a broker or feel more comfortable with financial negotiation, the cost of searching for the best quote is smaller and they are more likely to observe prices from regulated and non-regulated financial intermediaries. If NRFIs mostly serve consumers with lower search costs, they would have to offer better rates. Moreover, since consumers with lower search costs typically observe more prices, the equilibrium price dispersion should be lower in the non-regulated sector.

Comparing the dispersion in interest rates over time is not straightforward because changes in the economic conditions or in the types of mortgage issued could also cause variations in the observed rates. However, the variance of the residuals of the regressions presented in Section 1.4 informs us on the unexplained volatility in interest rates. In particular, since the dataset does not contain borrower specific characteristics, the residuals capture all of the effect of borrowers on the rates. If the variance of the regression residuals is not the same for each sector, it could be partially explained by heterogeneity in the types of borrower.

In Table 1.5, I present the standard deviation of the residuals from the regressions presented above conditional on the type of financial intermediary. I also give the test statistics from the Levene’s test and the Brown-Forsyth test for equal variance. There is strong evidence against the null hypothesis of equal variance for every specification. This means that the unexplained price dispersion across both sectors differs significantly.

Table 1.5: Volatility of the residuals and test statistics for the Levene and Brown-Forsyth tests. \( H_0 \): variances are equal, \( H_1 \): variances are not equal. Significance levels: *\(=10\%\), **\(=5\%\), ***\(=1\%\).

<table>
<thead>
<tr>
<th>Model</th>
<th>( \sigma_{u,RFIs} )</th>
<th>( \sigma_{u,NRFIs} )</th>
<th>Levene</th>
<th>Brown-Forsyth</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1.1)</td>
<td>0.914</td>
<td>0.791</td>
<td>148.732***</td>
<td>146.247***</td>
</tr>
<tr>
<td>(1.2)</td>
<td>0.738</td>
<td>0.535</td>
<td>379.311***</td>
<td>336.643***</td>
</tr>
<tr>
<td>(1.3) - (4)</td>
<td>0.738</td>
<td>0.535</td>
<td>378.331***</td>
<td>336.269***</td>
</tr>
<tr>
<td>(1.2b)</td>
<td>0.751</td>
<td>0.552</td>
<td>360.740***</td>
<td>322.735***</td>
</tr>
<tr>
<td>(1.3b) - (4b)</td>
<td>0.751</td>
<td>0.552</td>
<td>360.740***</td>
<td>322.812***</td>
</tr>
<tr>
<td>(1.5)</td>
<td>0.734</td>
<td>0.510</td>
<td>490.706***</td>
<td>440.559***</td>
</tr>
<tr>
<td>(1.6) - (1.7)</td>
<td>0.734</td>
<td>0.510</td>
<td>491.535***</td>
<td>441.158***</td>
</tr>
</tbody>
</table>

In Section 1.8.1 of the Appendix, I present evidence highlighting the impact of search intensity on mortgage rates and price dispersion in the United States. American households who search more

---

11Excluding risk since all mortgages are insured.
before making decisions about borrowing or obtaining credit tend to pay a lower rate on their mortgage. Moreover, the unexplained price dispersion (measured by the variance of the regression residuals) is lower in the subgroup of households who search more before borrowing money. A parallel can be made between these observations and the pricing patterns of the two types of financial intermediaries in Canada, providing additional support to the hypothesis of heterogeneity in search costs.

1.7 Concluding Remarks

The goal of this chapter was to document the differences in the pricing behaviour of regulated and non-regulated financial intermediaries in the Canadian mortgage market. I used data on pools of mortgages securitized between 2006 and 2013 as a proxy for issuance of mortgages and separated issuers into two groups: regulated and non-regulated financial intermediaries.

The regression results suggest that, after controlling for market conditions and characteristics of the pool of mortgages, the interest rate on mortgages securitized by regulated financial intermediaries are over 30 basis points higher. This observation suggests the existence of a friction, such as heterogeneity in search costs, keeping some borrowers in the regulated sector. If households with lower search costs are the ones obtaining loans from non-regulated lenders, we should observe a smaller price dispersion in the non-regulated sector. The analysis of the regression residuals and a comparison with the American evidence provide additional support to this assumption.

Other factors could explain the differences in interest rates. For instance, even though regulated financial intermediaries have access to cheaper sources of funds, they may be facing important costs to satisfy the regulation, to operate a network of branches, or to serve smaller markets. Securitization data is an imperfect proxy for mortgage issuance. Administrative data on new mortgages issued including the interest rate, the value and type of the mortgage, the leverage, and the type and location of the property are necessary to draw robust conclusions. Nevertheless, the results presented here show that the pricing differences are significant and should be taken into account when implementing regulation. In particular, if households vary in their search costs, the ones with the higher search costs are likely to be hit harder by a tightening of the regulation because regulated financial intermediaries may be able to pass on a larger proportion of the increase in their costs.

In the next chapters, I evaluate the impact of non-regulated financial intermediaries on macroeconomic fluctuations, regulation, and the design of monetary policy.
1.8 Appendix

1.8.1 Search and Rate Dispersion in the United States

The Federal Reserve’s Survey of Consumer Finances (SCF) is conducted every three years to collect data on households’ balance sheets\textsuperscript{12}. In particular, it provides information on mortgages and on the borrowing decision process (the intensity at which households search and their sources of information). The information contained in the SCF allows me to show the relationship between search intensity and mortgage rates to support the assumption of heterogeneity in search costs.

I use data from the 2013 SCF which initially covered 30,075 households. I exclude all households who do not own their principal residence or who live on a farm, a ranch, in a mobile home, or a recreational vehicle. To obtain a sample comparable to the Canadian data presented before, I also only keep households who hold an insured mortgage\textsuperscript{13} with a 30-year amortization period. This subsample includes 3,389 observations.

In Table 1.6, I present the reported search intensity of households on a scale from 1 to 5 (1 being “almost no search” and 5 being “a great deal of searching”). Almost half of the households report performing a moderate amount of searching (intensity level of 3) or less.

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>371</td>
<td>10.95</td>
</tr>
<tr>
<td>2</td>
<td>196</td>
<td>5.78</td>
</tr>
<tr>
<td>3</td>
<td>1,081</td>
<td>31.90</td>
</tr>
<tr>
<td>4</td>
<td>627</td>
<td>18.50</td>
</tr>
<tr>
<td>5</td>
<td>1,114</td>
<td>32.87</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,389</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Households are also asked to report their main sources of information. The most important source of information of these households is the internet (reported as first source by 29.29 percent). About a third of households (35.20 percent) reported asking a banker as one of their first three sources of information and only 3.28 percent reported using a broker as one of their three most important sources of information.

For the purpose of this analysis, I define a high search intensity as a reported intensity of 4 or 5. To measure the impact of search intensity on the mortgage rate, I run a regression of the rate paid by a household ($\text{rate}_i$) on the value of the loan ($\text{loan}_i$) and dummies for the search intensity ($\text{highsearch}_i$), reporting a banker or a broker as one of the first three sources of information ($\text{banker}_i$ and $\text{broker}_i$),

\textsuperscript{12}The Canadian Financial Monitor is probably the closest Canadian equivalent to the SCF, but the CFM is only available to its subscribers.

\textsuperscript{13}I define an insured mortgage as a loan guaranteed by the federal government or a mortgage insured by a private insurer.
and the year the mortgage was issued ($year_i$). Equation 1.8 summarizes the regression model:

\[
rate_i = \beta_0 + \beta_1 \text{log}(loan_i) + \left( \gamma_1 \right) \left( \begin{array}{c}
\text{highsearch}_i \\
\text{banker}_i \\
\text{broker}_i \\
year_i
\end{array} \right) + u_i.
\] (1.8)

The results of the regression are presented in Table 1.7. Households who reported a search intensity of 4 or 5 before making borrowing decisions pay on average almost 14 basis points less on their mortgage than households who search less.

Table 1.7: Regression results. Dependant variable: current annual rate of interest. Additional controls: year of the mortgage, constant. Significance levels: *=10%, **=5%, ***=1%

<table>
<thead>
<tr>
<th>Variables</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>log(loan$_i$)</td>
<td>-0.383*** (0.039)</td>
</tr>
<tr>
<td>highsearch$_i$</td>
<td>-0.137*** (0.051)</td>
</tr>
<tr>
<td>broker$_i$</td>
<td>-0.221 (0.142)</td>
</tr>
<tr>
<td>banker$_i$</td>
<td>-0.031 (0.053)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,389</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.280</td>
</tr>
</tbody>
</table>

In order to see if differences in search intensity generate variability in the unexplained volatility, I perform tests on the residuals of Model 1.8. The results in Table 1.8 indicate that there is enough evidence to reject the null hypothesis of equal unexplained volatility and accept the alternative hypothesis stating that the unexplained rate volatility is lower in the subgroup of households who search more.

Table 1.8: Volatility of the residuals and test statistics for comparison of variances. For Levene and Brown-Forsyth tests, $H_0$: variances are equal, $H_1$: variances are not equal. For variance ratio test, $H_0$: variances are equal, $H_1$: variances lower for high search intensity. Significance levels: *=10%, **=5%, ***=1%

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_{u, \text{highsearch}}$</td>
<td>1.2957</td>
</tr>
<tr>
<td>$\sigma_{u, \text{others}}$</td>
<td>1.5623</td>
</tr>
<tr>
<td>Levene</td>
<td>10.8517***</td>
</tr>
<tr>
<td>Brown-Forsyth</td>
<td>10.5834***</td>
</tr>
<tr>
<td>Variance ratio</td>
<td>1.4539***</td>
</tr>
</tbody>
</table>

The evidence presented in Tables 1.7 and 1.8 highlights the impact of search intensity on the rate paid and on the price dispersion.
Chapter 2

The Rise of Non-Regulated Financial Intermediaries in the Housing Sector and its Macroeconomic Implications
2.1 Introduction

The regulation aimed at maintaining financial stability, or macroprudential regulation, generates a lot of debate (see Admati et al. (2013), Allen et al. (2012), Angelini et al. (2011), and Santos and Elliott (2012)). On the one hand, improving the soundness of the financial system reduces the probability and cost of financial crises, but on the other hand, regulation increases the cost of financial intermediation. In a speech delivered in 2012, former member of the Board of Governors of the Federal Reserve System Elizabeth A. Duke expressed concerns regarding the impact of Basel III and the Dodd-Frank Act on small banks, in particular on their capacity to offer mortgages. Along the same line, the American Bankers Association (2014) reported that 80 percent of the surveyed members expect having to decrease their mortgage lending in response to the new regulation.

Most of this discussion ignores the impact of stricter regulation on the non-regulated sector. In Canada, federally and provincially regulated financial intermediaries still dominate the mortgage market, but the growing market share of non-regulated financial intermediaries (NRFIs) warrants some attention. A decline in the availability of funds in the regulated sector will likely push more households toward the non-regulated sector, making it harder for regulatory authorities to accurately track the volume of credit and diminishing the bite of the regulation. For these reasons, it is essential to understand the impact of non-regulated financial intermediaries on the economy and to take them into account when evaluating macroprudential regulation.

In this chapter, I investigate the macroeconomic impact of a rise in the share of non-regulated financial intermediaries in the origination of mortgages. I construct a dynamic and stochastic general equilibrium (DSGE) model featuring a housing sector and two types of financial intermediaries. The distinction between regulated and non-regulated financial intermediaries goes beyond the regulation faced by the former. There are three important differences between the two types. First, only regulated financial intermediaries (RFIs) face a capital requirement. Second, RFIs raise funds by taking in deposits, while NRFIs issue securities and sell them to RFIs; that is, they originate-to-distribute. Third, NRFIs face a more elastic demand than RFIs and thus charge a lower interest rate. In order to ensure that both sectors coexist despite the spread in the lending rates, I introduce a competitive loan aggregator who combines loans from both sectors and issues loans to households. Then, I analyze the responses to real and financial shocks of economies that differ only with respect to the share of the non-regulated sector. Finally, I assess the effectiveness of three macroprudential tools at maintaining financial stability.

The model simulations suggest that a large non-regulated sector contributes to stabilize the economy after an adverse financial shock. When a negative shock to bank capital hits the economy, the non-regulated sector steps in to limit the decline in economic activity. The simulations also reveal that the size of the non-regulated sector has a limited impact on the response of aggregate variables to a real shock.

I also use my model to compare the performance of three macroprudential tools and to determine how the size of the non-regulated sector affects the gains in terms of stabilization of macro-financial variables. A time-varying capital requirement is the most effective tool to reduce the volatility of the real price of housing, aggregate lending, and loan-to-output ratio. However, the performance of this tool deteriorates when the size of the non-regulated sector increases. In contrast, the gains of lowering the
maximum loan-to-value (LTV) ratio are invariant to the size of the non-regulated sector.

The remainder of this chapter goes as follows. In Section 2.2, I present an overview of the relevant existing literature. I provide empirical evidence on the expansion of NRFIs in the Canadian housing sector in Section 2.3. In Sections 2.4 and 2.5, I present the model and the simulations. I examine the implications for macroprudential policies in Section 2.6 and conclude in Section 2.7.

2.2 Existing Literature

This chapter builds on four strands of literature. First, it explores price dispersion in the Canadian mortgage market. Allen, Clark, and Houde (2014) show that part of the price dispersion observed in the Canadian mortgage market is due to price discrimination between customers who differ in their information and search costs, a practice known as discounting. However, their work focuses on households’ characteristics as one of the main drivers of price dispersion rather than on the type of lenders.

Second, this chapter adds to the large body of literature incorporating a housing sector to a DSGE model. Most of the existing models are based on Iacoviello’s (2005) seminal paper. His model features heterogeneous households, household debt, and a housing sector. Patient households lend to impatient households and entrepreneurs who use the value of their housing stock as collateral. Through its effect on the borrowing constraint, a change in the real price of housing significantly affects the macroeconomic dynamics. Here, I follow the extensions of Gerali et al. (2010) who incorporate a monopolistically competitive banking sector and Alpanda and Zubairy (2013) who add, among other things, housing producers.

Third, this chapter contributes to the literature examining the implications of the non-regulated, or shadow, financial sector on the macroeconomy that emerged in the aftermath of the Great Recession. A notable contribution comes from Meeks, Nelson, and Alessandri (2013). In their model, regular banks sell their risky loans to the shadow sector. Shadow banks then transform these loans into liquid assets through securitization. They demonstrate that securitization can have a stabilizing effect on the economy by ensuring a steady supply of credit; however, excessive leverage can be a major source of instability. Meh and Moran (2015) also show that the presence of a shadow sector can improve the efficiency of the banking sector, but it reduces the incentive to conduct proper screening. In contrast with these papers, I focus on the origination of loans rather than the securitization process. In that respect, my work is closer to the work of Verona, Martins, and Drumond (2013). They incorporate a shadow sector that finances entrepreneurs to an otherwise standard DSGE model and are able to generate financial boom-bust cycles. An important distinction between my work and the three papers cited above is the absence of idiosyncratic risk because I focus on insured mortgages guaranteed by the federal government.

Finally, this chapter relates to other work using macroeconomic models to evaluate macroprudential policies. For example, Alpanda, Cateau, and Meh (2014) present a model featuring both loan-to-value (LTV) limits on loans and a capital requirement. Christensen, Meh, and Moran (2011) and Angelini, Neri, Panetta (2014) show that a time-varying capital requirement can stabilize the economy, in particular if financial shocks are important drivers of business cycles.
2.3 The Facts

As explained in the previous chapter, given the lack of accurate data on newly issued mortgages in the regulated and non-regulated sectors, I use securitization as a proxy for issuance. I work with data from the CMHC’s MBS Information Circulars.

Table 2.1: Total securitization. Calculations based on data from the CMHC’s MBS Information Circulars.

<table>
<thead>
<tr>
<th>Year</th>
<th>Share (in percent)</th>
<th>Growth rate (in percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regulated</td>
<td>Non-regulated</td>
</tr>
<tr>
<td>2006</td>
<td>97.96</td>
<td>2.04</td>
</tr>
<tr>
<td>2007</td>
<td>92.99</td>
<td>7.01</td>
</tr>
<tr>
<td>2008</td>
<td>93.85</td>
<td>6.15</td>
</tr>
<tr>
<td>2009</td>
<td>89.14</td>
<td>10.86</td>
</tr>
<tr>
<td>2010</td>
<td>87.79</td>
<td>12.21</td>
</tr>
<tr>
<td>2011</td>
<td>90.24</td>
<td>9.76</td>
</tr>
<tr>
<td>2012</td>
<td>91.45</td>
<td>8.55</td>
</tr>
<tr>
<td>2013</td>
<td>86.97</td>
<td>13.03</td>
</tr>
</tbody>
</table>

Table 2.1 shows the share of total securitization of each sector as well as the growth rate of the volume of mortgages securitized. The share of the non-regulated sector grew from 2.04% in 2006 to 13.03% in 2013. The average annual growth rate over this period is also significantly larger than the growth rate of total securitization. Total securitization exploded in 2008 after the implementation of the Insured Mortgage Purchase Program (IMPP)\(^1\).

In the previous chapter, I presented evidence suggesting that rates on mortgages issued by NRFIs are significantly lower. In that context, it may seem surprising that NRFIs have not grown even faster. This finding could be explained by the existence of explicit or implicit frictions on the demand side of the market. As highlighted in Allen, Clark, and Houde (2014), households differ in their information and search costs, which allows financial intermediaries to price discriminate between consumers. They also show that households who hire a broker obtain a better price than those who shop on their own. Brokers are familiar with the market and the negotiation process and since households borrowing from NRFIs need to go through a broker, it is reasonable to assume that NRFIs face a different demand function. In the remainder of this chapter, I will assume that the mortgage market is monopolistically competitive and NRFIs face a more elastic demand than RFIs. A direct implication of this assumption is that there is a positive spread between the lending rate in the regulated sector and the lending rate in the non-regulated sector.

\(^1\)The program implemented by the federal government in response to the financial crisis was aimed at increasing the availability of credit in the mortgage market. The program was announced in October 2008 and ended in March 2010.
2.4 Model

Building on the empirical evidence presented previously, I develop a DSGE model featuring regulated and non-regulated financial intermediaries. Regulated financial intermediaries accept deposits from patient households and issue loans. They also purchase securities sold by the non-regulated financial intermediaries\(^2\). Securities are the only source of funds for the NRFIs. In other words, NRFIs originate-to-distribute. In order to have an interest rate differential, I assume that the demand faced by NRFIs is more elastic than the demand faced by RFIs.

A loan aggregator combines loans issued by regulated and non-regulated financial intermediaries to create a composite lending product for impatient households. This assumption allows the two sectors to coexist despite the difference in interest rates. As in Iacoviello (2005), heterogeneity among households ensures a positive flow of funds between creditors (patient households) and borrowers (impatient households) in equilibrium. Figure 2.1 illustrates the structure of the economy.

Figure 2.1: Structure of the economy

2.4.1 Regulated Financial Intermediaries

I base the regulated sector on the banking model of Gerali et al. (2010). They model the banking sector as a monopolistically competitive industry, an assumption consistent with the findings of Allen.\(^2\) In Canada, banks own most of the NHA MBS issued because they are considered as high quality assets by the OSFI in the calculation of their minimum level of bank capital.

Banks offer differentiated services, giving them market power over their deposit and lending rates. Each RFI is divided into three units: (i-) the headquarters in charge of managing the bank capital, (ii-) a deposit branch, and (iii-) a loan branch.

**Headquarters**

Let \( i \in [0, 1] \) be the index of RFIs. The headquarters manages the bank capital \( K_t^B(i) \), purchases securities from the non-regulated financial intermediaries \( B_t(i) \) and chooses the total amount of deposits \( D_t(i) \) to accept and loans \( L_t^R(i) \) to issue to satisfy the balance sheet identity:

\[
L_t^R(i) + B_t(i) = D_t(i) + K_t^B(i). \tag{2.1}
\]

Let \( P_t \) represents the aggregate price level and \( \pi_t = \frac{P_t}{P_{t-1}} \) be the inflation rate. The real values of loans, securities, deposits, and bank capital are given by

\[
L_t^R(i) \equiv \frac{L_t^R(i)}{\pi_t}, \quad b_t(i) \equiv \frac{B_t(i)}{\pi_t}, \quad d_t(i) \equiv \frac{D_t(i)}{\pi_t}, \quad \text{and} \quad k_t^B(i) \equiv \frac{K_t^B(i)}{\pi_t}.
\]

Given \( R_t^W \), the wholesale lending rate, \( R_t^B \), the rate of return of securities, and \( R_t^F \), the financing cost of banks in the wholesale market, the headquarters chooses \( L_t^R(i) \), \( b_t(i) \), and \( d_t(i) \) to maximize the cash flow:

\[
E_t \sum_{\tau=1}^{\infty} \beta^\tau \frac{\Lambda_t^P}{\Lambda_t^P} \left[ R_t^W \frac{L_t^R(i)}{\pi_t} + R_t^B \frac{b_{\tau-1}(i)}{\pi_t} - R_{\tau-1} \frac{d_{\tau-1}(i)}{\pi_t} - \text{adj\_cost}_t^{HQ}(i) \right]
\]

where \( \beta^\tau \frac{\Lambda_t^P}{\Lambda_t^P} \) is the discount rate of patient households, the owners of RFIs. The term \( \text{adj\_cost}_t^{HQ}(i) \) is an adjustment cost faced by the headquarters whenever the capital-to-assets ratio deviates from \( \nu_t \), the capital requirement imposed by the regulatory authority:

\[
\text{adj\_cost}_t^{HQ}(i) = \frac{\kappa_{KB}}{2} \left( \frac{k_t^B(i)}{\nu_t l_t^R(i)} + (1 - \nu_t)b_t(i) - \nu_t \right)^2 k_t^B(i). \tag{2.2}
\]

The parameter \( \nu_t \) represents the relative weight of loans in the bank’s leverage calculation. In Canada, the weight on NHA MBS is zero\(^3\), so we can write the adjustment cost (2.2) more simply as:

\[
\text{adj\_cost}_t^{HQ}(i) = \frac{\kappa_{KB}}{2} \left( \frac{k_t^B(i)}{l_t^R(i)} - \nu_t \right)^2 k_t^B(i). \tag{2.3}
\]

The optimal choices of the headquarters lead to the two conditions below:

\[
R_t^W - R_t^F = -\kappa_{KB} \frac{\Lambda_t^P \pi_{t+1}}{\beta^P \Lambda_{t+1}^P} \left( \frac{k_t^B(i)}{l_t^R(i)} - \nu_t \right)^2 \left( \frac{k_t^B(i)}{l_t^R(i)} \right)^2. \tag{2.4}
\]

\(^3\)In Section 2.6, I look at the impact of having \( \nu_t \in (0, 1) \).
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\[ R_t^B = R_t^W + \kappa_{KB} \frac{\Lambda_t^P \pi_{t+1}}{\beta_p \Lambda_t^P} \left( \frac{k_t^B(i)}{l_t^B(i)} - \nu_t \right) \left( \frac{k_t^B(i)}{l_t^B(i)} \right)^2. \]  \tag{2.5}

Following Gerali et al. (2010), I assume that RFIs have access to central bank liquidity. Since a RFI can always borrow at the policy rate \( R_t \), I replace the wholesale rate on deposits \( R_t^F \) by the policy rate \( R_t \) and rewrite equation (2.4) as:

\[ R_t^W - R_t = -\kappa_{KB} \frac{\Lambda_t^P \pi_{t+1}}{\beta_p \Lambda_t^P} \left( \frac{k_t^B(i)}{l_t^B(i)} - \nu_t \right) \left( \frac{k_t^B(i)}{l_t^B(i)} \right)^2. \]  \tag{2.6}

Condition (2.6) implies that whenever the capital-to-assets ratio of a RFI is below the capital requirement \( \nu_t \), either due to a drop in the value of bank capital or an increase of the minimum capital requirement, the wholesale lending rate increases, causing a decrease in the volume of loans issued.

By combining equations (2.5) and (2.6), we obtain:

\[ R_t^B = R_t. \]  \tag{2.7}

In other words, RFIs purchase securities until the return earned \( (R_t^B) \) equals the cost of funds \( (R_t) \).

Deposit Branch

Patient households hold a portfolio of deposits at multiple RFIs. They allocate their total deposits \( D_t \) across all institutions to maximize the total return on their savings. Deposits are assembled according to a Dixit-Stiglitz aggregator:

\[ D_t = \left( \int_0^1 D_t(i) \frac{\epsilon_d - 1}{\epsilon_d} di \right)^{\frac{\epsilon_d}{\epsilon_d - 1}} \]  \tag{2.8}

where \( \epsilon_d < 0 \) is the elasticity of substitution between deposits at different institutions.

Each deposit branch chooses the interest rate \( R_t^D(i) \) to maximize the flow of net earnings:

\[ \max_{R_t^D(i)} \left[ (R_t - R_t^D(i)) \frac{D_t(i)}{P_t} \right] \]

subject to the demand for retail deposits \( D_t(i) \):

\[ D_t(i) = D_t \left( \frac{R_t^D(i)}{R_t^B} \right)^{-\epsilon_d} \]  \tag{2.9}

where \( R_t^B \) represents the aggregate interest rate on deposits.

The optimal rate is a constant markup over \( R_t \):

\[ R_t^D(i) = \frac{\epsilon_d}{\epsilon_d - 1} R_t. \]  \tag{2.10}
Using equations (2.8) and (2.9), we derive the aggregate interest rate:

\[ R^D_t = \left( \int_0^1 R^D_t(i)^{1-\epsilon_D} \, di \right)^{\frac{1}{1-\epsilon_D}}. \]  

(2.11)

**Loan Branch**

The loan branch solves a problem analogous to the one of the deposit branch. Loans are also assembled according to a Dixit-Stiglitz aggregator:

\[ L^R_t = \left( \int_0^1 L^R_t(i)^{\frac{\epsilon_{BR}-1}{\epsilon_{BR}}} \, di \right)^{\frac{\epsilon_{BR}}{\epsilon_{BR}-1}} \]  

(2.12)

where the parameter \( \epsilon_{BR} > 0 \) represents the elasticity of demand for regulated loans.

Given the wholesale rate on loans \( R^W_t \), the branch sets the lending rate \( R^R_t(i) \) to maximize the flow of net earnings:

\[ \max_{R^R_t(i)} \left\{ \left( R^R_t(i) - R^W_t \right) \frac{L^R_t(i)}{P_t} \right\} \]

subject to the demand for loans \( L^R_t(i) \):

\[ L^R_t(i) = L^R_t \left( \frac{R^R_t(i)}{R^R_t} \right)^{-\epsilon_{BR}}. \]  

(2.13)

where \( L^R_t \) and \( R^R_t \) are respectively the total amount of loans issued by the regulated sector and the average lending rate in the regulated sector.

The loan branch’s optimal choice of rate is a constant markup over the wholesale rate:

\[ R^R_t(i) = \frac{\epsilon_{BR}}{\epsilon_{BR} - 1} R^W_t. \]  

(2.14)

Using equations (2.12) and (2.13), we derive the aggregate interest rate:

\[ R^R_t = \left( \int_0^1 R^R_t(i)^{1-\epsilon_{BR}} \, di \right)^{\frac{1}{1-\epsilon_{BR}}}. \]  

(2.15)

**Bank Capital**

The RFI’s bank capital \( K^B_t(i) \) can only be increased through retained earnings. Let \( j^B_t(i) \) represent the real total profit from the three branches net of the adjustment cost \( adj\_cost^HQ_t(i) \):

\[ j^B_t(i) = R^B_t(i) R^R_t(i) + R^B_t b_t(i) - R^D_t(i) d_t(i) - adj\_cost^HQ_t(i). \]  

(2.16)
Following Gerali et al. (2010), I assume that the RFI retains all of the profits. Under this assumption, the bank capital evolves according to the following law of motion:

\[
\pi_t k_t^B (i) = (1 - \delta_B) \frac{k_{t-1}^B (i)}{\eta_{t}^B} + j_{t-1}^B (i)
\]  
(2.17)

where \( \delta_B \) represents the cost of managing the bank capital. The term \( \eta_t^B \) represents a shock to the bank capital:

\[
\log(\eta_t^B) = \rho_{KB} \log(\eta_{t-1}^B) + \epsilon_{t}^KB
\]  
(2.18)

where \( \epsilon_{t}^KB \) is a zero-mean normally distributed innovation with standard deviation \( \sigma_{KB} \).

2.4.2 Non-Regulated Financial Intermediaries

A continuum of non-regulated financial intermediaries owned by patient households forms the non-regulated sector. NRFIs issue loans, but in contrast with regulated financial intermediaries, they do not face a capital requirement regulation and cannot finance their lending with retail deposits or borrow from the central bank. Instead, they issue securities and sell them to regulated financial intermediaries. I assume the market for those securities is perfectly competitive, but the market for loans from NRFIs is monopolistically competitive. This assumption follows Verona, Martins, and Drumond (2013) who model their shadow sector as monopolistically competitive in the lending market, but perfectly competitive in the market for financing.

Let \( j \in [0, 1] \) be the index of NRFIs and \( L_t^{NR} \) be the total amount of loans issued by non-regulated financial intermediaries. Loans issued by NRFIs are assembled according to a Dixit-Stiglitz aggregator:

\[
L_t^{NR} = \left( \int_0^1 L_t^{NR} (j) \frac{\epsilon_{BNR}^{^{-1}}}{\epsilon_{BNR}} dj \right)^{\frac{\epsilon_{BNR}^{^{-1}}}{\epsilon_{BNR}}}
\]  
(2.19)

and the average interest rate \( R_t^{NR} \) is given by:

\[
R_t^{NR} = \left( \int_0^1 R_t^{NR} (j) \frac{1}{1 - \epsilon_{BNR}} dj \right)^{\frac{1}{1 - \epsilon_{BNR}}}
\]  
(2.20)

where \( L_t^{NR} \) and \( R_t^{NR} \) are the total amount of loans issued by the non-regulated sector and the average rate on these loans. The parameter \( \epsilon_{BNR} \) represents the elasticity of substitution between the loans issued by the different NRFIs. I assume that \( \epsilon_{BNR} > \epsilon_{BR} \) meaning that the demand for loans is more elastic in the non-regulated sector than in the regulated sector. This assumption guarantees that the lending rate in the non-regulated sector is lower than in the regulated sector in steady-state.

Each NRFI sets the interest rate on loans \( R_t^{NR} (j) \) to maximize profits discounted at the patient households’ rate taking as given the market rate on securities \( R_t^B \) and the demand for securities \( B_t(j) \):

\[
\max_{R_t^{NR}(j)} \sum_{\tau=t}^{\infty} \beta^\tau \frac{\Lambda^P}{\Lambda_t} \left[ R_{\tau-1}^{NR} (j) \frac{L_{\tau}^{NR} (j)}{P^\tau} - R_{\tau-1}^B \frac{B_{\tau-1} (j)}{P^\tau} \right]
\]
subject to the demand for loans $L^N_R(j)$:

$$L^N_R(j) = L^N_R \left( \frac{R^N_R(j)}{R^N_R} \right)^{-\epsilon_{BNR}}. \quad (2.21)$$

The rate chosen by the NRFI is a constant markup over the return on securities it has to pay:

$$R^N_R(j) = \frac{\epsilon_{BNR}}{\epsilon_{BNR} - 1} R^B. \quad (2.22)$$

From equation (2.7) we know that the equilibrium rate on securities is equal to the policy rate. Moreover, equation (2.10) implies that the interest rate on deposits is lower than the policy rate. This means that it is more costly for NRFIs to raise funds than it is for RFIs. Despite facing a higher financing cost, NRFIs charge a lower interest rate on loans as shown by equations (2.14) and (2.22).

### 2.4.3 Loan Aggregator

A perfectly competitive loan aggregator owned by patient households possesses the technology to combine loans issued by the regulated and non-regulated sectors to create a composite loan product $L_t$ for the impatient households.

Let $l_t \equiv \frac{L^R_t}{P_t}, \quad l^R_t \equiv \frac{L^R_t}{P_t}, \quad$ and $\quad l^N_R \equiv \frac{L^N_R}{P_t}$ be the real values of aggregate lending, loans from the regulated sector, and loans from the non-regulated sector. The problem of the aggregator consists in choosing how much to borrow from each sector to maximize profits:

$$\max_{l^R_t, l^N_R} E_t \sum_{\tau=1}^{\infty} \beta^\tau \frac{N^P}{N^P} \left[ (1 + R^L_t) l^L_t - (1 + R^R_t) l^R_t - (1 + R^N_R) l^N_R \right]$$

subject to the technology:

$$l_t = \left( \tau \frac{\epsilon_L}{1 - \epsilon_L} l^R_t \frac{\epsilon_L - 1}{1 - \epsilon_L} + (1 - \tau) \frac{\epsilon_L}{1 - \epsilon_L} l^N_R \frac{\epsilon_L - 1}{1 - \epsilon_L} \right)^{\epsilon_L/(\epsilon_L - 1)} \quad (2.23)$$

where $\tau$ is a measure of the relative size of the regulated sector. In equilibrium, the lending rate faced by households, $R^L_t$, is given by:

$$(1 + R^L_t)^{1-\epsilon_L} = \tau (1 + R^R_t)^{1-\epsilon_L} + (1 - \tau) (1 + R^N_R)^{1-\epsilon_L}. \quad (2.24)$$

This specification implies that the loan obtained by a household is a combination of funds coming from both sectors. This assumption is based on the fact that there is virtually no difference, from the point of view of a consumer, between loans issued by the regulated and the non-regulated sectors.

### 2.4.4 Patient Households

As in Iacoviello (2005) and Gerali et al. (2010), patient households are the ultimate lenders in the economy. In each period, a continuum of patient households chooses their savings (bank deposits in real terms $d_t(k)$ and investment in physical capital $i_t(k)$) and their consumption of goods and housing ($c^P_t(k)$)
and \( h_t^P(k) \) to maximize the following intertemporal utility function:

\[
\max_{\delta_t(k), s_t(k), c^P_t(k), h_t^P(k)} E_0 \sum_{t=0}^{\infty} \beta_t \left[ \log c^P_t(k) + \phi h_t^P(k) \log h_t^P(k) - \phi n_t^P(k) n_t^P(k)^\gamma \right]
\]

where \( n_t^P(k) \) represents a shock to the preference for housing evolving according to:

\[
\log(n_t^P(k)) = \rho_n \log(n_{t-1}^P(k)) + \epsilon_t^P
\]

with \( \epsilon_t^P \) being a zero-mean normally distributed disturbance with standard deviation \( \sigma_n \).

The stock of physical capital \( k_t(k) \) and housing \( h_t^P(k) \) of a patient household are both subject to depreciation and installation costs. Let \( q_t^k \) and \( q_t^h \) represent respectively the real costs of capital and housing. The net total expenditure on physical capital and housing are given by:

\[
q_t^k (k_t(k) - (1 - \delta_t)k_{t-1}(k)) + \frac{\psi_k}{2\delta_t} \left( \frac{k_t(k)}{k_{t-1}(i)} - 1 \right)^2 q_t^h k_{t-1}(k)
\]

and:

\[
q_t^h (h_t^P(k) - (1 - \delta_t)h_{t-1}^P(k)) + \frac{\psi_h}{2\delta_h} \left( \frac{h_t^P(k)}{h_{t-1}^P(k)} - 1 \right)^2 q_t^h h_{t-1}^P(k).
\]

On the income side of the budget constraint, a patient household earns an interest \( R_{t+1}^P \) on their deposits and rents their stock of capital to firms at rate \( r_t^k \). Each household supplies a differentiated labour service giving them market power over the nominal wage \( W_t^P(k) \). The household faces a constant probability \( (1 - \varphi_w) \) of being able to update the nominal wage rate subject to the demand for their labour services:

\[
n_t^P(k) = n_t^P \left( \frac{W_t^P(k)}{W_t^P} \right)^{-\epsilon_P}.
\]

Let \( w_t^{P*}(k) \equiv \frac{W_t^{P*}(k)}{P_t} \) be the wage chosen by a patient household in real terms:

\[
w_t^{P*}(k) = \frac{\epsilon_P \phi^P}{\epsilon_P - 1} \frac{E_t \sum_{t=0}^{\infty} (\beta P_t \varphi_w)^{\tau - t} n_t^P(k)^\gamma}{E_t \sum_{t=0}^{\infty} (\beta P_t \varphi_w)^{\tau - t} \Lambda_t^P n_t^P(k) \prod_{s=1}^{\tau} \pi_{t+s-1}^{-1}} \tag{2.26}
\]

In a symmetric equilibrium, \( w_t^{P*}(k) = w_t^{P*} \) without loss of generality. We thus obtain a patient households real wage index \( w_t^P \):

\[
w_t^P(1-\epsilon_P) = \varphi_w \left( \frac{w_t^{P-1}}{\pi_t} \right)^{(1-\epsilon_P)} + (1 - \varphi_w) w_t^{P*}(1-\epsilon_P). \tag{2.27}
\]

Finally, patient households receive all the profits of the firms and financial intermediaries, but pay lump-sum taxes \( t_t^P(k) \equiv \frac{T_t^P(k)}{P_t} \).
2.4.5 Impatient Households

The economy is also populated by a continuum of impatient households. In contrast to the patient households, impatient households do not own physical capital and borrow from the loan aggregator. In each period, an impatient household chooses their consumption $c^I_t(l)$, the amount to borrow $l_t(l)$ (in real terms), and a stock of housing $h^I_t(l)$ to maximize their lifetime utility:

$$\max_{c^I_t(l), l_t(l), h^I_t(l)} E_0 \sum_{t=0}^{\infty} \beta_t^I \left[ \log c^I_t(l) + \phi^h h^I_t(l) \log h^I_t(l) - \phi^n h^I_t(l)^\gamma \right].$$

As in Iacoviello (2005), the discount factor of the impatient households ($\beta^I_t$) is smaller than the discount factor of the patient households ($\beta^P_t$). This condition ensures a positive flow of funds between lenders (patient households) and borrowers (impatient households) in equilibrium.

In addition to their budget constraint, impatient households face a borrowing constraint akin to Iacoviello (2005):

$$l_t(l) \leq \chi_t \frac{l_{t-1}(l)}{\pi_t} + (1 - \chi_t) mq^I h^I_t(l).$$

(2.28)

The parameter $m$ represents the maximum loan-to-value ratio set by the regulatory authority\footnote{In theory, NRFIs could issue loans for 100% of the value of the stock of housing; however, it is worth mentioning that the qualitative results are not sensitive to a change in the LTV limits in the households' borrowing constraint.} and $\chi_t$ is a smoothing parameter. As in Iacoviello (2005), I assume that the constraint is always binding in the neighbourhood of the steady-state.

The rest of the problem of an impatient household, in particular the wage setting decision, is analogous to the problem of a patient household. A detailed description can be found in Section 2.8.1 of the Appendix.

2.4.6 Goods Production

A competitive firm assembles intermediate goods to produce the final good $y_t$ according to the technology:

$$y_t = \left( \int_0^1 y_t(m)^{1-\epsilon_y} dm \right)^{1/\epsilon_y}$$

(2.29)

where $y_t(m)$ with $m \in [0, 1]$ represents one of the intermediate goods and $\epsilon_y$ is the elasticity of substitution between the intermediate goods. The demand for $y_t(m)$ is:

$$y_t(m) = y_t \left( \frac{P_t(m)}{P_t} \right)^{-\epsilon_y}$$

(2.30)

where $P_t(m)$ is the price of the intermediate good and $P_t$ is the aggregate price index:

$$P_t = \left( \int_0^1 P_t(m)^{1-\epsilon_y} dm \right)^{1/\epsilon_y}.$$
Monopolistically competitive firms owned by patient households employ the labour services of patient and impatient households \((n^p_t(m))\) and rent capital \(k_{t-1}(m)\) from patient households to produce intermediate goods according to the production function:

\[
y_t(m) = A_t \left( u_t^k(m) k_{t-1}(m) \right)^{\alpha} \left( n^p_t(m)^\theta n^l_t(m)^{1-\theta} \right)^{1-\alpha}.
\] (2.32)

The production function (3.19) is similar to the one in Iacoviello (2005). The parameter \(\alpha\) represents the relative share of capital and \(\theta\) is a measure of the share of patient households in the labour force. The variable \(u^k_t(m)\) is a capital utilization rate similar to Alpanda and Zubairy (2013) and Alpanda, Cateau, and Meh (2014). The total factor productivity, \(A_t\), evolves according to:

\[
\log(A_t) = \rho A_t \log(A_{t-1}) + \varepsilon_t^A
\] (2.33)

where \(\varepsilon_t^A\) is a zero-mean normally distributed technology shock with standard deviation \(\sigma_A\).

In each period, the firm chooses the level of capital and capital utilization \((k_{t-1}, u^k_t)\) and labour \((n^p_t, n^l_t)\) to maximize the discounted sum of real profits:

\[
\max_{u^k_t, k_{t-1}, n^p_t, n^l_t} E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \frac{\Lambda^P_{\tau}}{\Lambda^P_t} \Pi_t(m)
\]

with:

\[
\Pi_t(m) = \frac{P_t(m)}{P_t} y_t(m) - w^p_t n^p_t(m) - w^l_t n^l_t(m) - \kappa u^k_t + ku^k_{t-1}(m)
\]

The firm’s choices are constrained by the technology (2.32) and the demand for good \(y_t(m)\) (2.30).

Each firm has market power over \(P_t(m)\), the price of its good, but can only re-optimize with probability \((1 - \varphi_p)\) in any given period. In a symmetric equilibrium, the optimal pricing decision of firms leads to the following expression for the aggregate price level:

\[
P_t^{1-\varepsilon_y} = \varphi_p P_{t-1}^{1-\varepsilon_y} + (1 - \varphi_p) P_t^* (1-\varepsilon_y)
\] (2.34)

where \(P_t^*\) is, without loss of generality, the optimal price chosen by firms who are reoptimizing in the current period.

### 2.4.7 Housing and Capital Producers

Along the lines of Alpanda and Zubairy (2013) and Alpanda, Cateau, and Meh (2014), competitive firms owned by the patient households produce housing and physical capital. At each period, the housing producer purchases all of the existing undepreciated stock of housing and increases it through
investment. It chooses the housing investment level $i^h_t$ to maximize profits:

$$E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \frac{\Lambda^P}{\Lambda^h_t} \left[ q^h_{\tau} h_{\tau} - q^h_{\tau} (1 - \delta_h) h_{\tau-1} - i^h_{\tau} \right]$$

subject to the law of motion for the stock of housing:

$$h_t = (1 - \delta_h) h_{t-1} + \left[ 1 - \frac{\kappa_h}{2} \left( \frac{i^h_t}{i^h_{t-1}} - 1 \right)^2 \right] i^h_t. \quad (2.35)$$

Similarly, the capital producer chooses the real investment level $i^k_t$ to maximize profit:

$$E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \frac{\Lambda^P}{\Lambda^k_t} \left[ q^k_{\tau} k_{\tau} - q^k_{\tau} (1 - \delta_k) k_{\tau-1} - i^k_{\tau} \right]$$

subject to the law of motion for the stock of physical capital:

$$k_t = (1 - \delta_k) k_{t-1} + \left[ 1 - \frac{\kappa_k}{2} \left( \frac{i^k_t}{i^k_{t-1}} - 1 \right)^2 \right] i^k_t. \quad (2.36)$$

### 2.4.8 Policy Rules

The monetary authority adjusts the policy rate $R_t$ in response to deviations of inflation and output from the steady-state level ($\pi$ and $y$):

$$\log \left( \frac{1 + R_t}{1 + R} \right) = \chi_R \log \left( \frac{1 + R_{t-1}}{1 + R} \right) + (1 - \chi_R) \left( \mu_y \log \left( \frac{y_t}{y} \right) + \mu_\pi \log \left( \frac{\pi_t}{\pi} \right) \right) + \epsilon^R_t \quad (2.37)$$

where $R$ is the neutral interest rate and $\epsilon^R_t$ represents a zero-mean normally distributed monetary policy shock with standard deviation $\sigma_R$.

In the baseline model, I assume that the minimum capital requirement of regulated financial intermediaries follows a simple auto-regressive process, allowing for temporary changes to its level:

$$\log(\nu_t) = \chi_\nu \log(\nu_{t-1}) + (1 - \chi_\nu) \log(\nu) + \epsilon^\nu_t \quad (2.38)$$

where $\epsilon^\nu_t$ represents a zero-mean normally distributed prudential shock with standard deviation $\sigma_\nu$.

The government spends $g_t$ financed with lump-sum taxes paid by households and the budget always balances:

$$g_t = t^p_t + t^I_t. \quad (2.39)$$

Patient and impatient households pay the same amount in taxes. In other words, $t^p_t = t^I_t$.

Government spending is exogenous and follows an AR(1) process:

$$\log(g_t) = (1 - \rho_g) \log(g) + \rho_g \log(g_{t-1}) + \epsilon^g_t \quad (2.40)$$
where \( \varepsilon_g^t \) represents a zero-mean normally distributed fiscal policy shock with standard deviation \( \sigma_g \).

### 2.4.9 Closing the Model

The final good \( y_t \) serves as consumption good for households, investment good for housing and capital producers, and government good:

\[
y_t = c_t^P + c_t^I + i_t^k + i_t^h + g_t.
\]

(2.41)

Patient and impatient households own all the stock of housing \( h_t \) at the end of the period:

\[
h_t = h_t^P + h_t^I.
\]

(2.42)

Finally, in the symmetric equilibrium, the prices and allocation of resources maximize the utility of all households and profits of all firms and financial intermediaries subject to their respective constraints. All agents of a given type make the same decisions and all markets clear.

### 2.4.10 Calibration and Solution of the Model

The parameters are calibrated to represent the Canadian economy. A complete list of all parameters and their value can be found in Section 2.8.2 of the Appendix.

The parameter \( \tau \) representing the weight on loans from the regulated sector in the loan aggregation technology (2.23) is one of the key parameters. I set its value to target different relative sizes of the regulated sector in the simulations. The elasticity of substitution between regulated and non-regulated loans in the aggregation, \( \epsilon_L \), is arbitrarily large, to capture the fact that there is very little difference between the two types of loans beyond the interest rate.

Using equation (2.10), I set the elasticity of substitution of demand for deposits, \( \epsilon_D \), to match the average ratio of the rate on 90-day term deposits to the return on 5-year government bonds between 1995 and 2015. Similarly, \( \epsilon_{BR} \) targets the ratio of 5-year conventional mortgage rates of chartered banks to the return on 5-year government bonds. I choose the value of the elasticity of demand in the non-regulated sector, \( \epsilon_{BNR} \), to have a steady-state annual spread of 37 basis points between the regulated and the non-regulated sectors.

I assume a very high cost of deviating from the capital requirement \( (\kappa_{KB} = 100) \) and set the value of the parameter \( \delta_{KB} \) representing the cost of managing the bank capital to have a steady-state bank capital-to-loan ratio of 0.06, a value consistent with the rules of the OSFI.

The smoothing parameter in the impatient households’ borrowing constraint, \( \chi_I \), equals 0.85 as in Alpanda and Zubairy (2013). The maximum loan-to-value ratio, \( m \), is 0.9, in line with the maximum loan-to-value ratio for mortgage refinancing in Canada.

The discount rate of patient households is consistent with an annual interest rate on deposits of 1.6% and the discount rate of impatient households ensures a positive flow of funds between lenders and
borrowers in steady state. I set $\sigma$ to 15.28, in line with the estimated wage elasticity of labour supply in Canada (Dorich et al. (2013)). To calibrate the other preference parameters ($\phi^h$ and $\phi^n$) and the share of patient households in the production function ($\theta$), I target ratios presented in Alpanda, Cateau, and Meh (2014) (impatient households in aggregate consumption $c^I/(c^n + c^I)$, impatient households in housing $h^I/h$, and housing investment in total output $i^h/y$).

The housing and capital production adjustment costs, $\kappa_h$ and $\kappa_k$, and the parameter measuring the cost of capital utilization, $\omega$, are borrowed from Alpanda, Cateau, and Meh (2014). The depreciation rate of capital and housing, $\delta_k$ and $\delta_h$, are set to match the steady-state capital-to-output and housing-to-output of Alpanda, Cateau, and Meh (2014).

I set the share of government spending, $\alpha_g$ and the Calvo parameters for the price and wage decisions to the equivalent values in ToTEM II, the Bank of Canada’s quarterly projection model (see Dorich et al., 2013). The weights in the Taylor rule are from Alpanda, Cateau, and Meh (2014).

Finally, the model is log-linearized and solved using Dynare. A comparison of the simulated second moments of the model with the data is available in Section 2.8.3 of the Appendix.

2.5 Simulation

In this section, I analyze the impact of the relative size of the non-regulated financial sector on the responses of the economy to real and financial shocks. I compare the impulse response functions of economies with different values for the parameter $\tau$, the weight of the regulated sector in the loan aggregation technology. In the benchmark economy, $\tau$ equals 0.95, which means that the relative share of the non-regulated sector is around 5%. This value is in line with the estimated share of NRFIs in 2006. In the two other specifications, I set the relative size of the non-regulated sector to about 15% ($\tau = 0.85$) and 50% ($\tau = 0.5$). The impulse response functions represents responses to a 1 percent positive shock. All figures can be found in Section 2.8.4 of the Appendix.

2.5.1 Shocks in the Financial Sector

I first look at the impact of shocks originating in the financial sector. The impulse response functions of a financial shock (destruction of bank capital) and an unexpected temporary increase in the capital requirement are presented in Figures 2.2 and 2.3.

In both cases, we observe a decline in output, inflation, and aggregate lending. This is in line with the findings of Alpanda, Cateau, and Meh (2014) and Anglini, Neri, and Panetta (2014)\textsuperscript{5}. However, we observe a rise in investment and the real price of housing in my model. All these variables decrease in Alpanda, Cateau, and Meh (2014). This discrepancy can be explained by two important differences. First, patient households are more responsive in my model because they own all of the physical capital (versus less than half in Alpanda, Cateau, and Meh, 2014). Patient households take advantage of the slowdown to increase their stocks of housing and physical capital which causes an increase in investment.

\textsuperscript{5}In Angelini, Neri, and Panetta (2014), inflation increases on impact, but eventually drops below its steady-state value.
and puts pressures on the real price of housing.

Second, the downturn is not as important in my model because of the presence of NRFIs. A large non-regulated sector considerably dampens the negative effect of an adverse financial shock. When lending in the regulated sector contracts, NRFIs step in and fill the gap. This result is consistent with the findings of Meeks, Nelson, and Alessandri (2013) who show that the shadow financial sector can reduce economic fluctuations by stabilizing the supply of credit.

### 2.5.2 Technology Shock

As we can see from Figure 2.4, in response to a technology shock, output, aggregate consumption, and investment expand. The increase in housing prices combined with the decline in inflation relaxes the borrowing constraint and stimulates aggregate lending. This is the amplification mechanism of Iacoviello (2005).

In Gerali et al. (2010), the technology shock causes a drop in the bank capital. The same thing happens here because the decrease in interest rates reduces the profits of RFIs. In order to satisfy their capital requirement, regulated intermediaries cannot increase lending as much as they want. As a result, NRFIs temporarily gain market shares and aggregate lending increases more in an economy with a large non-regulated sector. The impact of this increase in aggregate lending on the real variables is however small in comparison to the impact of the shock. This is why a larger non-regulated sector has a negligible impact on the dynamics of output, inflation, aggregate consumption, aggregate investment, and the policy rate.

The size of the non-regulated sector has a small impact on the important macroeconomic variables in response to a real shock because only impatient households borrow in the model. Variations in aggregate lending may have a significant impact on the consumption and stock of housing of impatient households, but are relatively small compared to aggregate output. Moreover, the size of the non-regulated sector affects how funds are distributed in the financial sector, but does not increase the total amount of funds deposited in the banking sector by the patient households.

### 2.5.3 Demand Shocks

There are three sources of demand shocks in the model: a fiscal shock (Figure 2.5), a monetary policy shock (Figure 2.6), and a shock to the preference for housing (Figure 2.7). The fiscal shock represents a temporary increase in government spending. It increases both output and inflation, causing a rise of the policy rate. Financial intermediaries respond to the increase in the policy rate by increasing their lending rate which discourages households from borrowing. To avoid costly excess reserves, RFIs offer loans at a lower interest rate than NRFIs and temporarily increase their market share. This phenomenon is amplified by a larger non-regulated sector, but the variation in aggregate lending is not large enough to noticeably affect the real macroeconomic variables.

---

6In steady-state, impatient households own a quarter of the total stock of housing and their consumption represents 17 percent of total output.
The responses to a contractionary monetary policy shocks are in line with Iacoviello (2005) and Gerali et al. (2010). The monetary policy shock has a similar impact on the bank capital as the fiscal shock, but, once again, the size of the non-regulated sector has virtually no impact on the responses of the real side of the economy.

The impact of a shock to the preference for housing is more significant because it directly affects the demand for loans. Financial intermediaries need to raise more funds in order to satisfy the larger demand, but NRFIs face higher funding costs than RFIs. Consequently, the average lending rate increases more in an economy with a larger non-regulated sector, containing the rise in aggregate lending and inflation.

### 2.6 Implications for Macroprudential Regulation

In this second exercise, I analyze how the size of the non-regulated sector affects the effectiveness of macroprudential regulation and its transmission mechanism. I consider three tools: a change in the calculation of banks’ leverage ratio, a time-varying capital requirement, and a decrease in the maximum loan-to-value ratio. The first two tools are part of the policy toolkit proposed in Basel III (see Basel Committee on Banking Supervision (2010)) while the last option is an example of policy that was implemented in Canada in 2008 in response to the financial crisis (see Traclet (2010)).

The purpose of macroprudential regulation is to maintain financial stability. I measure financial stability as a decrease in the volatility of important macro-financial variables (real price of housing, aggregate lending, and loan-to-output ratio). As Christensen, Meh, and Moran (2011) explain, a macro-prudential tool can also affect real variables and have implications for the conduct of monetary policy. For this reason, I also look at the change in volatility of the policy rate and two variables of interest for monetary authorities, namely output and inflation.

#### 2.6.1 Leverage Ratio

Basel III suggests a revision of the calculation of the leverage ratio of banks to reflect more accurately their leverage position. In order to introduce this change in the model in a simple manner, I use the definition of adjustments costs faced by the bank’s headquarters given by (2.2) and set equal weights on loans and securities (i.e. $\nu_l = 0.5$).

When only loans are included in the leverage of banks, RFIs can expand their balance sheet by purchasing securities without having to raise more bank capital. This, in turn, stimulates lending in the non-regulated sector. If securities are included in the calculation of leverage, it reduces the marginal benefit of securities for RFIs and directly affects the supply of funds of the non-regulated sector.

In Table 2.2, I report the simulation results. A number smaller than 1.00 means that the volatility of the variable declined after implementing the policy.
Table 2.2: Impact of a change in bank’s leverage calculation on the second moments (ratio). Simulated moments.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Financial shock</th>
<th>Technology shock</th>
<th>Preference shock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\tau = 0.95$</td>
<td>$\tau = 0.85$</td>
<td>$\tau = 0.95$</td>
</tr>
<tr>
<td>$q^h$</td>
<td>0.376</td>
<td>0.521</td>
<td>1.036</td>
</tr>
<tr>
<td>$l$</td>
<td>0.340</td>
<td>0.489</td>
<td>1.162</td>
</tr>
<tr>
<td>$\frac{l}{y}$</td>
<td>0.340</td>
<td>0.489</td>
<td>1.205</td>
</tr>
<tr>
<td>$y$</td>
<td>0.408</td>
<td>0.588</td>
<td>0.993</td>
</tr>
<tr>
<td>$\pi$</td>
<td>0.364</td>
<td>0.513</td>
<td>1.008</td>
</tr>
<tr>
<td>$R$</td>
<td>0.346</td>
<td>0.489</td>
<td>0.975</td>
</tr>
</tbody>
</table>

As the results indicate, the gains of a change in the calculation of leverage depends on the source of shocks. The most important gains are obtained in response to a financial shock. The volatility of all the variables presented decreases by about 60 percent. We also observe small gains in response to a preference shock. However, if technology shocks are an important source of fluctuations, a change in the calculation of the leverage ratio increases the volatility of the macro-financial variables.

In the economy with a larger non-regulated sector, the gains in response to a financial shock are smaller, but the increase in the volatility of the macro-financial variables in response to a technology shock is much lower.

2.6.2 Time-Varying Capital Requirement

A time-varying capital requirement, or countercyclical buffer, is another example of the new tools proposed by Basel III. The purpose of a minimum capital requirement changing over the business cycle is to contain the growth of lending in good times and stimulate it during a downturn. Christensen, Meh, and Moran (2011) and Angelini, Neri, and Panetta (2014) have also studied the impact of time-varying capital requirements, but their work ignores the presence of non-regulated financial intermediaries.

I introduce the time-varying capital requirement in the model by modifying equation (2.38) to take into account the loan-to-output ratio:

$$\log(\nu_t) = \chi\nu \left(\log(\nu_{t-1}) + \xi \left(\frac{l_t}{y_t} \frac{1}{l/y}\right)\right) + (1 - \chi\nu) \log(\nu) + \varepsilon_t^\nu. \quad (2.43)$$

The results are presented in Table 2.3.

---

7 The quantitative results depend on the value assumed for $\xi$, but the qualitative implications are robust within a reasonable range.
Table 2.3: Impact of a time-varying capital requirement on the second moments (ratio). $\xi = 2$. Simulated moments.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Financial shock $\tau = 0.95$</th>
<th>$\tau = 0.85$</th>
<th>Technology shock $\tau = 0.95$</th>
<th>$\tau = 0.85$</th>
<th>Preference shock $\tau = 0.95$</th>
<th>$\tau = 0.85$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q^h$</td>
<td>1.137</td>
<td>1.112</td>
<td>0.971</td>
<td>0.971</td>
<td>0.980</td>
<td>0.984</td>
</tr>
<tr>
<td>$l$</td>
<td>0.895</td>
<td>0.910</td>
<td>0.813</td>
<td>0.834</td>
<td>0.807</td>
<td>0.828</td>
</tr>
<tr>
<td>$\frac{1}{y}$</td>
<td>0.896</td>
<td>0.911</td>
<td>0.753</td>
<td>0.789</td>
<td>0.804</td>
<td>0.825</td>
</tr>
<tr>
<td>$y$</td>
<td>1.061</td>
<td>1.050</td>
<td>1.001</td>
<td>1.001</td>
<td>0.927</td>
<td>0.942</td>
</tr>
<tr>
<td>$\pi$</td>
<td>1.036</td>
<td>1.030</td>
<td>0.998</td>
<td>0.997</td>
<td>0.962</td>
<td>0.973</td>
</tr>
<tr>
<td>$R$</td>
<td>1.010</td>
<td>1.009</td>
<td>1.010</td>
<td>1.009</td>
<td>0.962</td>
<td>0.972</td>
</tr>
</tbody>
</table>

Christensen, Meh, and Moran (2011) and Angelini, Neri, and Panetta (2014) conclude that a time-varying capital requirement is an effective stabilization tool in response to financial shocks, but the gains are modest if technology shocks are an important driver of business cycles. My results show a decrease of about 10 percent in the volatility of the loan-to-output ratio and aggregate lending in response to a financial shock. However, the gain is twice as large in response to a technology shock. This discrepancy can be explained by the impact of NRFIs on aggregate lending. NRFIs contribute to stabilize the economy in response to financial shocks (see Figure 2.2), but cause more volatility in the response of financial variables to a technology shock (see Figure 2.4).

The time-varying capital requirement performs better in response to real shocks than in response to a financial shock. For instance, it leads to a decrease of 2 percent in the volatility of the real price of housing in response to the preference shock, but causes an increase of over 13 percent in response to a financial shock. Moreover, the performance of the time-varying capital requirement policy decreases slightly when the share of the non-regulated sector increases.

### 2.6.3 LTV Ratio

Between 2008 and 2010, the maximum LTV ratio for insured mortgages was lowered by 5 percentage points (from 100% to 95% for new mortgages and from 95% to 90% for refinancing). This last policy experiment is inspired by this regulatory change. More specifically, I measure the change in volatility following a decrease in the maximum loan-to-value ratio from 90% to 80%. This policy effectively limits the capacity of households to borrow for a given value of their housing stock. In contrast to the two other tools considered, a change in the maximum LTV ratio affects both the regulated and the non-regulated sectors.

A change in the LTV ratio modifies the steady-state of the model. In Table 2.4, I report the mean of a variable under the low LTV ratio ($m = 0.8$) relative to its mean under the high LTV ratio ($m = 0.9$) and in Table 2.5, I present the ratio of volatilities.

---

*To compute the ratio of the coefficient of variations, one can simply divide the ratio of the standard deviations by the ratio of the means.*
Table 2.4: Impact of a decrease in LTV on the first moments (ratio). Simulated moments.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\tau = 0.95$</th>
<th>$\tau = 0.85$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q^h$</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>$l$</td>
<td>0.8887</td>
<td>0.8884</td>
</tr>
<tr>
<td>$l/y$</td>
<td>0.8889</td>
<td>0.8886</td>
</tr>
<tr>
<td>$y$</td>
<td>0.9998</td>
<td>0.9998</td>
</tr>
<tr>
<td>$\pi$</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>$R$</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Table 2.5: Impact of a decrease in LTV on the second moments (ratio). Simulated moments.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Financial shock</th>
<th>Technology shock</th>
<th>Preference shock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\tau = 0.95$</td>
<td>$\tau = 0.85$</td>
<td>$\tau = 0.95$</td>
</tr>
<tr>
<td>$q^h$</td>
<td>0.799</td>
<td>0.806</td>
<td>1.019</td>
</tr>
<tr>
<td>$l$</td>
<td>0.783</td>
<td>0.788</td>
<td>0.839</td>
</tr>
<tr>
<td>$l/y$</td>
<td>0.783</td>
<td>0.788</td>
<td>0.825</td>
</tr>
<tr>
<td>$y$</td>
<td>0.800</td>
<td>0.800</td>
<td>1.002</td>
</tr>
<tr>
<td>$\pi$</td>
<td>0.834</td>
<td>0.839</td>
<td>1.027</td>
</tr>
<tr>
<td>$R$</td>
<td>0.851</td>
<td>0.857</td>
<td>1.037</td>
</tr>
</tbody>
</table>

In the benchmark economy ($\tau = 0.95$), we observe a decline in the volatility of the loan-to-output ratio and the volatility of aggregate lending in response to all shocks, but at the cost of an increase in the volatility of the real price of housing and output when the economy is hit by real shocks. The tool performs better in response to financial shocks than real shocks, but gains are nonetheless significant for all three shocks considered.

The performance of a lower LTV ratio remains similar when the share of the non-regulated sector increases. This result should not be surprising since all loans are affected by a tightening of the borrowing constraint.

### 2.7 Concluding Remarks

In this chapter, I built a DSGE model with housing, household debt, and two types of financial intermediaries to analyze the macroeconomic impact of the rise of non-regulated financial intermediaries in the Canadian housing market. In my model, regulated and non-regulated financial intermediaries differ in three respects. First, RFIs raise funds with retail deposits. NRFIs, however, cannot accept deposits and have to issue securities to finance their lending. Second, the demand faced by NRFIs is more elastic. This assumption implies that the interest rate on mortgages is lower in the non-regulated sector, an assumption consistent with the empirical evidence. Third, RFIs have to hold bank capital in order to
satisfy the capital requirement imposed by a regulatory authority, but NRFIs are not subject to this regulation.

First, I compared the responses of the economy to real and financial shocks under three specifications of the model. In the benchmark specification, the non-regulated sector issues about 5% of the loans in steady-state. This number roughly matches the estimated share of the non-regulated sector in 2006. In the two other specifications, the share of the non-regulated sector is about 15% and 50%. The simulations suggest that a larger non-regulated sector reduces the magnitude of the economic slowdown following an adverse financial shock, and has very little impact on the dynamics of the main macroeconomic variables in response to a real shock. In other words, the presence of non-regulated financial intermediaries in the housing market appears to improve stability and should not be a concern for regulatory authorities.

Second, I assessed the impact of the relative size of the non-regulated sector on the effectiveness of three different prudential tools: a change in the calculation of banks’ leverage ratio, the introduction of a time-varying capital requirement, and a decrease in the maximum loan-to-value ratio. To measure the effectiveness of each tool, I looked at their effect on the volatility of key variables. My results show that a time-varying capital requirement is the only tool that reduces the volatility of all the macro-financial variables without increasing the volatility of output and inflation. This tool performs well in response to real and financial shocks, but the gains are reduced by a larger non-regulated sector. Lowering the maximum LTV ratio, on the other hand, can cause an increase in the volatility of the real price of housing, output, and inflation, but the effectiveness of the tool is robust to a change in the share of the non-regulated sector.

Non-regulated financial intermediaries became an important player in the Canadian mortgage market. They can contribute to macroeconomic stability, but their role should be taken into consideration when implementing macroprudential regulation. In the next chapter, I discuss the implications of a growing non-regulated financial sector on the design of monetary policy.
2.8 Appendix

2.8.1 Detailed Model Description

Regulated Financial Intermediaries

Problem of a representative headquarters (in real terms):

\[
\max_{l_t, b_t, d_t} E_t \sum_{\tau=t}^{\infty} \beta_t \frac{\Lambda^P}{\Lambda_t} [\text{cashflow}_\tau]
\]

subject to:

\[
b_t + l_t^R = d_t + k_t B
\]  

(2.44)

where

\[
\text{cashflow}_t = (1 + R_t^W) \frac{l_t^{B-1}}{\pi_t} + (1 + R_t^{B-1}) \frac{b_t^{B-1}}{\pi_t} - (1 + R_t^{F-1}) \frac{d_t^{F-1}}{\pi_t} + d_t - l_t^R - b_t
\]

\[
+ \left(k_t - \frac{k_t^{B-1}}{\pi_t}\right) - \frac{\kappa K B}{2} \left(\frac{k_t}{l_t} - \nu_t\right)^2 k_t
\]

The first order conditions are:

\[
R_t^W - R_t^F = -\kappa K B \frac{\Lambda_t^P}{\beta_t \Lambda_{t+1}} \left(\frac{k_t}{l_t} - \nu_t K B\right) \left(\frac{k_t}{l_t}\right)^2
\]

\[
R_t^B = R_t^W - \kappa K B \frac{\Lambda_t^P}{\beta_t \Lambda_{t+1}} \left(\nu_t K B - \frac{k_t}{l_t}\right) \left(\frac{k_t}{l_t}\right)^2.
\]

The first order conditions can be respectively rewritten as:

\[
R_t^W - R_t = -\kappa K B \frac{\Lambda_t^P}{\beta_t \Lambda_{t+1}} \left(\frac{k_t}{l_t} - \nu_t K B\right) \left(\frac{k_t}{l_t}\right)^2
\]

(2.45)

and

\[
R_t^B = R_t
\]

(2.46)

where \(R_t\) is the policy rate.

Problem on the deposit branch:

\[
\max_{R_t^P(i)} \left[(R_t - R_t^P(i))d_t(i)\right]
\]
subject to:

\[ d_t(i) = d_t \left( \frac{R^D_t(i)}{R^D_t} \right)^{-\epsilon_D}. \]

The problem of the loan branch is similar. The equilibrium optimal rates on deposits and loans are (in a symmetric equilibrium):

\[ R^D_t = \frac{\epsilon_D}{\epsilon_D - 1} R_t \]  
\[ R^R_t = \frac{\epsilon_{BR}}{\epsilon_{BR} - 1} R^W_t. \]  

The bank capital is accumulated through retained earnings:

\[ \pi_t k^B_t = (1 - \delta_K) \frac{k^B_{t-1}}{\eta^K_B} + j^B_t \]  
\[ j^B_t = R^R t_i^R + R^B b_t - R^D_t d_t - \frac{k^K_B}{2} \left( \frac{k^B_t}{R^R_t} - \nu_t \right)^2 k^B_t \]

where \( \eta^K_B \) is a shock to the real stock of bank capital:

\[ \log(\eta^K_B) = \rho_K \log(\eta^K_{B-1}) + \varepsilon^K_B. \]  

Non-Regulated Financial Intermediaries

Problem of a representative NRFI:

\[ \max_{R^N R_t} \mathbb{E}_t \sum_{\tau=t}^{\infty} \beta^\tau \frac{\Lambda^P_t}{\Lambda^P} \left[ (1 + R^N R_{\tau-1}(j)) \frac{l^N R_{\tau-1}(j)}{\pi_t} - (1 + R^B_{\tau-1}) \frac{b_{\tau-1}(j)}{\pi_t} + b_{\tau}(j) - l^N R_{\tau}(j) \right] \]

subject to:

\[ l^N R_t(j) = b_t(j) \]
\[ l^N R_t(j) = l^N R_t \left( \frac{R^N R_t(j)}{R^N R_t} \right)^{-\epsilon_{BNR}}. \]

Optimal choice (in a symmetric equilibrium):

\[ R^N R_t = \frac{\epsilon_{BNR}}{\epsilon_{BNR} - 1} R^B_t. \]

Loan Aggregator

Problem of the loan aggregator:

\[ \max_{l^L_t, l^N R_t} \mathbb{E}_t \sum_{\tau=t}^{\infty} \beta^\tau \frac{\Lambda^P_t}{\Lambda^P} \left[ (1 + R^L_t) l_{\tau} - (1 + R^M_t) l^R_{\tau} - (1 + R^N R_t) l^N R_{\tau} \right] \]
subject to:

\[ l_t = \left( \frac{\tau L_t^{R \epsilon L_t-1}}{1 - \epsilon L_t} + (1 - \tau) \frac{\epsilon L_t^{NR \epsilon L_t-1}}{1 - \epsilon L_t} \right) \frac{\epsilon L_t}{1 - \epsilon L_t}. \]

The optimal demand functions are:

\[ l^R_t = \tau l_t \left( \frac{1 + R^R_t}{1 + L_t^R} \right)^{-\epsilon L_t} \]  \hspace{1cm} (2.53)

\[ l^{NR}_t = (1 - \tau) l_t \left( \frac{1 + R^{NR}_t}{1 + L_t} \right)^{-\epsilon L_t} \]  \hspace{1cm} (2.54)

and the lending rate faced by impatient households is given by:

\[ (1 + R^L_t) = \left[ \tau (1 + R^R_t)^{1 - \epsilon L_t} + (1 - \tau) (1 + R^{NR}_t)^{1 - \epsilon L_t} \right] \frac{1}{1 - \epsilon L_t}. \]  \hspace{1cm} (2.55)

**Patient Households**

Problem of a representative patient household (lender):

\[
\max_{c_t^P, d_t^P, k_t^P} E_0 \sum_{t=0}^{\infty} \beta E_t \left[ \log c_t^P + \phi^h \eta_t^h \log h_t^P - \phi^m \frac{n_t^P}{\sigma} \right]
\]

subject to:

\[ w_t^P h_t^P + (1 + R_{t-1}^P) \frac{d_t-1}{\pi_t} + r_t^k k_{t-1} + div_t ... \]

\[ = c_t^P + d_t + t_t^P + q_t^h (h_t^P - (1 - \delta) h_{t-1}^P) + \frac{\psi_h}{2 \delta_h} \left( \frac{h_t^P}{h_{t-1}^P} - 1 \right)^2 q_t^h h_{t-1}^P ... \]

\[ + q_t^k (k_t - (1 - \delta_k) k_{t-1}) + \frac{\psi_k}{2 \delta_k} \left( \frac{k_t}{k_{t-1}} - 1 \right)^2 q_t^k k_{t-1} \]

with

\[ \log(\eta_t^h) = \rho_h \log(\eta_{t-1}^h) + \epsilon_t^h. \]  \hspace{1cm} (2.56)

Let \( \Lambda_t^P \) be the Lagrange multiplier associated with the patient household’s budget constraint. The first order conditions are:

\[ \Lambda_t^P = \frac{1}{c_t^P} \]  \hspace{1cm} (2.57)

\[ \Lambda_t^P = \beta P E_t \Lambda_{t+1}^P \left( \frac{1 + R_t^P}{\pi_t+1} \right) \]  \hspace{1cm} (2.58)

\[ \eta_t^h \frac{\phi^h}{h_t^P} + \beta P E_t \Lambda_{t+1}^P \eta_t^h \left[ (1 - \delta h) + \frac{\psi_h}{\delta_h} \left( \frac{h_{t+1}^P}{h_t^P} - 1 \right) \left( \frac{h_{t+1}^P}{h_t^P} - 1 \right) \right] \]
The demand for a patient household’s labour services is:

$$n_t^p(k) = n_t^p \left( \frac{W_t^p(k)}{W_t^{\pi}} \right)^{-\epsilon_p}.$$  

In a symmetric equilibrium, the optimal real wage rate $w_t^{P^*}$ is:

$$w_t^{P^*} = \frac{\epsilon_p \phi^p_0}{\epsilon_p - 1} \frac{E_t \sum_{t=1}^{\infty} (\beta P^p)^{t-1} n_t^{P^*}}{E_t \sum_{t=1}^{\infty} (\beta P^p)^{t-1} \Lambda_t^P n_t^P \prod_{s=1}^{t} \pi_{t+s+1}^{-1}}$$

and wage index of patient households is:

$$w_t^{P(1-\epsilon_p)} = \varphi_w \left( \frac{w_{t-1}^{P^*}}{\pi_t} \right)^{(1-\epsilon_p)} + (1 - \varphi_w) w_t^{P^*(1-\epsilon_p)}.$$  

**Impatient Households**

The problem of the representative impatient household is given by:

$$\max_{c_t^I, l_t, h_t^I} E_0 \sum_{t=0}^{\infty} \beta_t^I \left[ \log c_t^I + \phi^I h_t^I \log h_t^I - \phi^I n_t^I \right]$$

subject to:

$$w_t^I n_t^I + l_t = c_t^I + t_t^I + (1 + R_t^I) l_{t-1}^I + q_t^I \left( h_t^I - (1 - \delta_h) h_{t-1}^I \right)$$

$$\quad \quad + \frac{\psi h}{\psi h} \left( \frac{h_t^I}{h_{t-1}^I} - 1 \right)^2 q_t^I h_{t-1}^I$$  

$$l_t \leq \chi l_{t-1}^I + (1 - \chi) m q_t^I h_t^I$$

Let $\Lambda_t^I$ and $\mu_t^I$ be respectively the multipliers associated with the budget and the borrowing constraints. The first order conditions are:

$$\Lambda_t^I = \frac{1}{c_t^I}$$  

$$\Lambda_t^I (1 - \mu_t^I) = \beta_I E_t \Lambda_{t+1}^I \left( 1 + R_t^I - \chi \mu_{t+1}^I \right)$$

$$n_t^I \Phi_t^h h_t^I + \beta_I E_t \Lambda_{t+1}^I g_{t+1}^I \left[ (1 - \delta_h) + \frac{\psi h}{\psi h} \left( \frac{h_{t+1}^I}{h_t^I} - 1 \right) \left( \frac{h_{t+1}^I}{h_t^I} - 1 \right) \right]$$
\[ = \Lambda_t^h q_t^h \left[ 1 + \frac{\psi}{\delta_t} \left( \frac{h_t^l}{h_{t-1}^l} - 1 \right) - \mu_t^l (1 - \chi_t) m \right] \]  

(2.67)

The wage setting problem of impatient households is analogous to the problem of patient households:

\[
w_t^* = \frac{\epsilon_t^\alpha}{\epsilon_t - 1} E_t \sum_{\tau = t}^\infty (\beta \varphi_w)^{\tau-t} n_t^l \sigma_t \prod_{s=1}^{\tau-t} \pi_t - \mu_t^l \left( \frac{1 - \chi_t}{m} \right)
\]

(2.68)

\[
w_t^{(1-\epsilon_t)} = \varphi_w \left( \frac{w_{t-1}}{\pi_t} \right)^{(1-\epsilon_t)} + (1 - \varphi_w) w_t^* (1-\epsilon_t)
\]

(2.69)

**Goods Production**

The technology for producing the final good \( y_t \) and the aggregate price index \( P_t \) are:

\[
y_t = \left( \int_0^1 y_t(i) \frac{v_t - 1}{v_t} di \right)^{\frac{\alpha}{v_t - 1}}
\]

\[
P_t = \left( \int_0^1 P_t(i) 1 - v_t di \right)^{\frac{1}{1-v_t}}
\]

Problem of an intermediate good producer:

\[
\max_{k_{t-1}(m), u_t^k(m), n_t^l(m), n_t^l(m)} E_t \sum_{\tau = t}^\infty \beta \frac{P^m_{\tau-t} \Pi_{\tau}(m)}{\Lambda^m_t} \Pi_{\tau}(m)
\]

with

\[
\Pi_{\tau}(m) = \frac{P_t(m)}{P_t} y_t(m) - r_t^f k_{t-1}(m) - w_t^P n_t^P(m) - w_t^l n_t^l(m)
\]

\[ - \frac{\kappa_t}{1 + \omega} \left[ u_t^k(m) (1+\omega) - 1 \right] k_{t-1}(m)
\]

subject to the technology:

\[
y_t(m) = A_t \left( u_t^k(m) k_{t-1}(m) \right)^\alpha \left( n_t^P(m)^\theta n_t^l(m)^{(1-\theta)} \right)^{(1-\alpha)}
\]

(2.70)

\[
\log(A_t) = \rho_A \log(A_{t-1}) + \epsilon_t^A
\]

(2.71)

and the demand:

\[
y_t(m) = y_t \left( \frac{P_t(m)}{P_t} \right)^{-\epsilon_t^y}
\]

Let \( s_t(m) \) be the marginal cost (or the Lagrange-multiplier associated with the technology). In a sym-
metric equilibrium, without loss of generality, the first order conditions are:

\[ r^k_t + \frac{\kappa_u}{1 + \omega} \left[ u^k_t (1 + \omega) - 1 \right] = s_t \alpha \frac{y_t}{k_{t-1}} \]  
(2.72)

\[ \kappa_u u^k_t \omega k_{t-1} = s_t \alpha \frac{y_t}{u^k_t} \]  
(2.73)

\[ w^P_t = s_t \theta (1 - \alpha) \frac{y_t}{n^P_t} \]  
(2.74)

\[ w^I_t = s_t (1 - \theta) (1 - \alpha) \frac{y_t}{n^I_t} \]  
(2.75)

Intermediate good producers face a constant probability \((1 - \varphi_p)\) of being able to re-optimize their price. Without loss of generality, the optimal pricing decision is:

\[ P^*_t = \frac{\varepsilon_y}{\varepsilon_y - 1} \frac{E_t \sum_{\tau=t}^{\infty} (\beta^P \varphi^P_p)^{\tau-t} \Lambda^P_\tau s_\tau y_\tau P_\tau}{E_t \sum_{\tau=t}^{\infty} (\beta^P \varphi^P_p)^{\tau-t} \Lambda^P_\tau y_\tau} \]

and the aggregate price level can be written as:

\[ P_t^{(1 - \varepsilon_y)} = \varphi_p P_{t-1}^{(1 - \varepsilon_y)} + (1 - \varphi_p) P^*_t \]

### Housing and Capital Producers

Problem of the housing producer:

\[
\max_{i^h_t} E_t \sum_{\tau=t}^{\infty} \beta^P_\tau (\beta^P \varphi^P_p)^{\tau-t} \Lambda^P_\tau \left[ q^h_\tau h_\tau - q^h_\tau (1 - \delta_h) h_{\tau-1} - i^h_\tau \right]
\]

subject to:

\[ h_\tau = (1 - \delta_h) h_{\tau-1} + \left[ 1 - \frac{\kappa_h}{2} \left( \frac{i^h_\tau}{i^h_\tau-1} - 1 \right) \right] i^h_\tau \]  
(2.76)

The optimal choice of the housing producer satisfies:

\[ q^h_\tau - 1 = \kappa_h q^h_\tau \left( \frac{i^h_\tau}{i^h_\tau-1} - 1 \right) + \frac{\kappa_h}{2} q^h_\tau \left( \frac{i^h_\tau}{i^h_\tau-1} - 1 \right)^2 - \beta^P \kappa_h q^h_{\tau+1} \Lambda^P_{\tau+1} \left( \frac{i^h_{\tau+1}}{i^h_\tau} - 1 \right) \left( \frac{i^h_{\tau+1}}{i^h_\tau} \right)^2. \]  
(2.77)

Problem of the capital producer:

\[
\max_{i^k_t} E_t \sum_{\tau=t}^{\infty} \beta^P_\tau (\beta^P \varphi^P_p)^{\tau-t} \Lambda^P_\tau \left[ q^k_\tau k_\tau - q^k_\tau (1 - \delta_k) k_{\tau-1} - i^k_\tau \right]
\]

subject to:

\[ k_\tau = (1 - \delta_k) k_{\tau-1} + \left[ 1 - \frac{\kappa_k}{2} \left( \frac{i^k_\tau}{i^k_\tau-1} - 1 \right) \right] i^k_\tau \]  
(2.78)
The optimal choice of the capital producer satisfies:
\[
q^k_t - 1 = \kappa k q_t \left( \frac{t^k_t}{t^k_{t-1}} - 1 \right) + \frac{\kappa k}{2} q_t \left( \frac{t^k_t}{t^k_{t-1}} - 1 \right)^2 \\
-\beta P \kappa q_{t+1} \Lambda_{t+1}^P \left( \frac{t^{k+1}_t}{t^k_t} - 1 \right) \left( \frac{t^{k+1}_t}{t^k_t} \right)^2.
\]

(2.79)

Closing the Model

Monetary policy:
\[
\log \left( \frac{1 + R_t}{1 + R} \right) = \chi_R \log \left( \frac{1 + R_{t-1}}{1 + R} \right) + (1 - \chi_R) \left( \mu_y \log \left( \frac{y_t}{y} \right) + \mu_\pi \log \left( \frac{\pi_t}{\pi} \right) \right) + \varepsilon^R_t
\]

(2.80)

Prudential policy:
\[
\log(\nu_t) = \chi_\nu \log(\nu_{t-1}) + (1 - \chi_\nu) \log(\nu) + \varepsilon^\nu_t
\]

(2.81)

Fiscal policy:
\[
g_t = t^P_t + t^I_t
\]

(2.82)
\[
t^P_t = t^I_t
\]

(2.83)
\[
\log(g_t) = (1 - \rho_g) \log(g) + \rho_g \log(g_{t-1}) + \varepsilon^g_t.
\]

(2.84)
### 2.8.2 Complete Calibration

#### Table 2.6: Calibrated Parameters

<table>
<thead>
<tr>
<th>Financial sector</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\epsilon_{BR}, \epsilon_{BRR}, \epsilon_L, \epsilon_D$</td>
<td>2.493, 2.746, 100, -0.71</td>
</tr>
<tr>
<td>$\kappa_{KB}$</td>
<td>100</td>
</tr>
<tr>
<td>$\delta_{KB}$</td>
<td>To get $\frac{k^0}{P} = \nu$</td>
</tr>
<tr>
<td>$\chi_l, m, \nu$</td>
<td>0.85, 0.9, 0.06</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Preferences</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_P, \beta_I$</td>
<td>0.996, 0.98</td>
</tr>
<tr>
<td>$\phi^h, \phi^n, \sigma$</td>
<td>0.235, 1, 15.28</td>
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</table>

<table>
<thead>
<tr>
<th>Goods, capital, housing sectors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha, \theta$</td>
<td>0.3, 0.5</td>
</tr>
<tr>
<td>$\psi_k, \psi_h$</td>
<td>2.0, 0.0</td>
</tr>
<tr>
<td>$\kappa_k, \kappa_h$</td>
<td>6.0, 6.0</td>
</tr>
<tr>
<td>$\delta_h, \delta_k$</td>
<td>0.01, to get $\frac{k}{y} = 8$</td>
</tr>
<tr>
<td>$\alpha_g$</td>
<td>0.25</td>
</tr>
<tr>
<td>$\omega, \kappa_u$</td>
<td>5.0, to get $u = 1$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pricing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varphi_p, \varphi_w$</td>
<td>0.75, 0.59</td>
</tr>
<tr>
<td>$\epsilon_y, \epsilon_P, \epsilon_I$</td>
<td>21.0, 5.0, 5.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Policy rules</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>$\chi_R, \mu_y, \mu_\pi$</td>
<td>0.75, 0.0, 2.5</td>
</tr>
<tr>
<td>$\chi_\nu$</td>
<td>0.75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shocks</th>
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</thead>
<tbody>
<tr>
<td>$\rho_A, \rho_b, \rho_{KB}, \rho_{\nu}, \rho_g$</td>
<td>0.9228, 0.9, 0.1, 0.95, 0.905</td>
</tr>
<tr>
<td>$\sigma_A, \sigma_b, \sigma_{KB}, \sigma_R, \sigma_\nu, \sigma_g$</td>
<td>0.004, 0.001, 0.001, 0.0019, 0.001, 0.0035</td>
</tr>
</tbody>
</table>

Data sources:

- CANSIM Tables 176-0043, 380-0064
- CMHC MBS Information Circulars
2.8.3 Second Moments

Table 2.7: Volatility of variables relative to the volatility of output. Simulated moments are for the benchmark case ($\tau = 0.95$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Empirical moments</th>
<th>Simulated moments</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>$c^P + c^I$</td>
<td>0.62</td>
<td>1.38</td>
</tr>
<tr>
<td>$s^h$</td>
<td>3.64</td>
<td>5.98</td>
</tr>
<tr>
<td>$l^R$</td>
<td>5.50</td>
<td>3.54</td>
</tr>
<tr>
<td>$d$</td>
<td>2.27</td>
<td>4.26</td>
</tr>
<tr>
<td>$k^B$</td>
<td>2.71</td>
<td>16.24</td>
</tr>
</tbody>
</table>

Data sources:

- CANSIM Tables 176-0043, 380-0064
2.8.4 Impulse Response Functions

Figure 2.2: Financial shock (1 percent shock to $\varepsilon^{KB}$ in $t = 0$). Solid black line: $\tau = 0.95$, blue dashed line: $\tau = 0.85$, red dotted line: $\tau = 0.5$. 
Figure 2.3: Prudential shock (1 percent shock to $\varepsilon^{\nu}$ in $t=0$). Solid black line: $\tau = 0.95$, blue dashed line: $\tau = 0.85$, red dotted line: $\tau = 0.5$. 
Figure 2.4: Technology shock (1 percent shock to $\varepsilon^A$ in $t = 0$). Solid black line: $\tau = 0.95$, blue dashed line: $\tau = 0.85$, red dotted line: $\tau = 0.5$. 

Figure 2.5: Fiscal shock (1 percent shock to $\varepsilon^g$ in $t = 0$). Solid black line: $\tau = 0.95$, blue dashed line: $\tau = 0.85$, red dotted line: $\tau = 0.5$. 
Figure 2.6: Monetary policy shock (1 percent shock to $\varepsilon^R$ in $t = 0$). Solid black line: $\tau = 0.95$, blue dashed line: $\tau = 0.85$, red dotted line: $\tau = 0.5$. 
Figure 2.7: Housing preference shock (1 percent shock to $\varepsilon^h$ in $t = 0$). Solid black line: $\tau = 0.95$, blue dashed line: $\tau = 0.85$, red dotted line: $\tau = 0.5$. 
Chapter 3

Monetary Policy with Non-Regulated Financial Intermediaries
3.1 Introduction

In the previous chapters, I presented facts about non-regulated financial intermediaries (NRFIs) in the Canadian mortgage market and analyzed the impact of NRFIs on the economy and on the effectiveness of macroprudential regulation. I built a dynamic and stochastic general equilibrium (DSGE) model featuring two types of financial intermediaries and calibrated the model to represent the Canadian economy. Two conclusions emerged from this work. First, NRFIs contribute to stabilize the economy, in particular if financial shocks are important drivers of business cycles. By providing an alternative source of credit to households, a large non-regulated sector decreases the volatility of output and inflation. Second, the effectiveness of different macroprudential tools depends on the relative size of NRFIs. For instance, implementing a time-varying bank capital requirement reduces the volatility of macro-financial variables, but the performance of this tool declines as the non-regulated sector becomes larger. In contrast, the gains of lowering the maximum loan-to-value (LTV) ratio on mortgages are smaller, but they are robust to a change in the size of the non-regulated sector.

The expansion of NRFIs may be of interest to monetary authorities for two reasons. First, the mortgage market is an important channel for the transmission of monetary policy. Second, the relative size of NRFIs affects the volatility of output and inflation, two variables that are key in the conduct of monetary policy. In this chapter, I look more closely at the impact of the non-regulated sector on the conduct of monetary policy by evaluating the impact of an increase in the relative size of NRFIs on optimal simple rules. I derive optimal simple rules and see how the parameters of these rules change as the share of the non-regulated sector increases. I also compute a measure of the cost of following a rule designed for an economy with a virtually nonexistent non-regulated sector when NRFIs actually own a significant market share.

The role of financial intermediaries in the propagation of monetary policy has been examined by Gerali et al. (2010). They conclude that the banking sector attenuates the impact of a monetary policy shock. Angelini, Neri, and Panetta (2014) extend their model to add a macroprudential tool (a time-varying capital requirement) in order to study the interactions between monetary and macroprudential policies. They derive optimal rules for different levels of cooperation between the monetary authority and the financial regulator. Cúrdia and Woodford (2010) modify the standard Taylor rule to allow the monetary authority to respond to financial conditions measured by the size of the credit spread. They show that the modified rule can outperform the standard Taylor rule, but they keep all the other parameters of the standard rule constant. Other papers analyze the interactions between monetary policy and macroprudential regulation (e.g. Christensen, Meh, and Moran (2011), Quint and Rabanal (2013), and Antipa and Matheron (2014)), but these papers focus on financial stability and ignore the volume of financial intermediation taking place outside the oversight of financial regulators. My goal here is different. I want to determine whether or not the monetary authority should be concerned by the growth of NRFIs and take it into account in the design of monetary policy. I abstract from financial stability considerations and assume that the goal of the monetary authority is to keep inflation and the output gap stable.

My results show that monetary authorities would benefit from monitoring the growth of NRFIs and adjusting their policy rule accordingly. NRFIs enhance the effectiveness of monetary policy but to reap the full benefits of the stabilizing effect of NRFIs, the policy rule needs to be optimized for the size of the
non-regulated sector. For instance, the optimal backward-looking monetary policy rule responds more aggressively to the output gap as the relative size of NRFIs increases. In contrast, an interest-feedback rule is not as sensitive to the size of the non-regulated sector and may be the best option if the size of NRFIs is hard to estimate or fluctuates too much.

In the next section, I go over the important features of the model. I present the optimal rules in Section 3.3 and test the robustness of my findings in Section 3.4. I conclude in Section 3.5.

### 3.2 Model

I use the dynamic and stochastic general equilibrium (DSGE) model presented in the previous chapter. Following the work of Iacoviello (2005), the model features two types of households: patient households (the lenders), and impatient households (the borrowers). Housing provides a service to all households and serves as collateral. A monopolistically competitive regulated banking sector à la Gerali et al. (2010) accepts deposits from patient households and issues loans. I add non-regulated financial intermediaries who also issue loans, but raise funds by selling securities to the regulated financial intermediaries. A loan aggregator combines loans from the regulated and the non-regulated sectors and issues loans to the impatient households.

In what follows, I briefly describe the model and the important mechanisms for the transmission of monetary policy. Upper case letters represent nominal variables and lower case letters represent real variables. For a complete description of the model, please refer to the previous chapter.

#### 3.2.1 Regulated Financial Intermediaries

A continuum of regulated financial intermediaries (RFIs) accepts deposits from patient households and issues loans. Each RFI is divided into three units: a headquarters and two retail branches. The headquarters manages the bank capital and makes decisions regarding the volume of deposits, loans, and securities. The deposit branch sets the interest rate on deposits and the loan branch sets the interest rate on loans.

Let \( i \in [0,1] \) be the index of RFIs, \( P_t \) be the aggregate price level, and \( \pi_t \equiv \frac{P_t}{P_{t-1}} \) be the inflation rate. The bank capital at the beginning of the period \( (k_t^B(i)) \) evolves according to the following law of motion:

\[
\pi_t k_t^B(i) = (1 - \delta^B) \frac{k^B_{t-1}(i)}{\eta^K_B} + j^B_{t-1}(i) \tag{3.1}
\]

where \( \delta^B \) can be interpreted as the cost of managing the bank capital, \( j^B_{t-1}(i) \) represents the profits generated by all three units of the RFI, and \( \eta^K_B \) is a financial shock that affects bank capital:

\[
\log (\eta^K_B) = \rho_K \log (\eta^K_B) + \epsilon^K_B \tag{3.2}
\]

\[
\epsilon^K_B \sim N(0, \sigma^2_K).
\]

The headquarters chooses total lending \( (l^R_t(i)) \), total deposits \( (d_t(i)) \), and how many securities to
purchase \((b_t(i))\) to maximize the cash flow:

\[
E_t \sum_{\tau=1}^{\infty} \beta^\tau \frac{N^P}{\pi^P} \left[ R^W_{\tau-1} \frac{\beta^\tau}{\pi^\tau} - R^B_{\tau-1} \frac{b_{\tau-1}(i)}{\pi^\tau} - R^F_{\tau-1} \frac{d_{\tau-1}(i)}{\pi^\tau} - \text{adj. cost}^{HQ}_t(i) \right]
\]

subject to the balance sheet identity:

\[
b_t(i) + l_t^R(i) = d_t(i) + k_t^B(i).
\] (3.3)

The term \(\beta^\tau \frac{N^P}{\pi^P}\) represents the discount rate of patient households who are the owners of RFIs, \(R^B_t\) is the return on securities, \(R^W_t\) and \(R^F_t\) are respectively the lending and financing rates in the wholesale market, and \(\text{adj. cost}^{HQ}_t(i)\) is a quadratic cost the RFIs has to pay if the capital-to-loans ratio deviates from \(\nu_t\), the level imposed by a regulatory authority:

\[
\text{adj. cost}^{HQ}_t(i) = \frac{\kappa_{KB}}{2} \left( \frac{k_t^B(i)}{l_t^R(i)} - \nu_t \right)^2 k_t^B(i).
\] (3.4)

The capital-to-loans ratio (or capital requirement) is exogenous and evolves according to:

\[
\log (\nu_t) = \chi \nu \log (\nu_{t-1}) + (1 - \chi \nu) \log (\nu) + \varepsilon_t^{\nu}
\]

\[
\varepsilon_t^{\nu} \sim N(0, \sigma^2_{\nu}).
\] (3.5)

The two conditions below summarize the optimal choices of the headquarters:

\[
R^W_t - R^F_t = -\kappa_{KB} \frac{N^P \pi_{t+1}}{\beta^P N^P \pi_{t+1}} \left( \frac{k_t^B}{l_t^R} - \nu_t \right)^2 k_t^B(i).
\] (3.6)

\[
R_t^B - R_t^W = -\kappa_{KB} \frac{N^P \pi_{t+1}}{\beta^P N^P \pi_{t+1}} \left( \nu_t - k_t^B(i) \right)^2 \frac{k_t^B}{l_t^R}.
\] (3.7)

Since RFIs can always borrow from the central bank at the policy rate \((R_t)\), we have \(R_t^F = R_t\) in equilibrium. A change in the policy rate affects the cost of raising funds which in turn affects the level of loans and deposits the RFI is willing to issue and accept. Using this equilibrium condition in equations (3.6) and (3.7) we obtain:

\[
R_t^W - R_t = -\kappa_{KB} \frac{N^P \pi_{t+1}}{\beta^P N^P \pi_{t+1}} \left( k_t^B(i) \right)^2 \left( \frac{k_t^B}{l_t^R} - \nu_t \right)^2 k_t^B(i).
\] (3.8)

\[
R_t^B = R_t.
\] (3.9)

An implication of equation (3.9) is that, even though non-regulated financial intermediaries do not have access to central bank liquidity, monetary policy still has a direct impact on their funding cost.

Following Gerali et al. (2010), I assume that the banking sector is monopolistically competitive. This assumption implies that the loan aggregator obtains loans from all institutions and patient households own a portfolio of deposits at each institution. The demand for deposits faced by a RFI \((d_t(i))\) depends on the total volume of deposits \((d_t)\), the average rate on deposits \((R_t^D)\), the RFI’s rate on deposits
Chapter 3. Monetary Policy with Non-Regulated Financial Intermediaries

\((R^D_t(i))\), and the elasticity of substitution between deposits at different institutions \((\epsilon_D)\):

\[
d_t(i) = d_t \left( \frac{R^D_t(i)}{R^D_t} \right)^{-\epsilon_D}.
\]  \hspace{1cm} (3.10)

The deposit branch sets \(R^D_t(i)\) to maximize the flow of net earnings:

\[
\max_{R^D_t(i)} \left[ (R_t - R^D_t(i))d_t(i) \right]
\]

subject to the demand (3.10) and a quadratic adjustment cost:

\[
\text{adj} \text{cost}^D_t(i) = \frac{\kappa_{RD}}{2} \left( \frac{R^D_t(i)}{R^D_{t-1}(i)} - 1 \right)^2 R^D_t(i)d_t(i).
\]

Once we linearized the first order condition for the choice of \(R^D_t(i)\) we obtain:

\[
\hat{R}^D_t(i) = \frac{(1 - \epsilon_D)}{1 - \epsilon_D + \kappa_{RD}(1 + \beta_P)} \hat{R}_t + \frac{\kappa_{RD}}{1 - \epsilon_D + \kappa_{RD}(1 + \beta_P)} \hat{R}^D_{t-1}(i)
\]

\[
+ \frac{\beta P_{RD}}{1 - \epsilon_D + \kappa_{RD}(1 + \beta_P)} E_t \hat{R}^D_{t+1}(i)
\]

where a hatted variable represents the deviation around this variable’s steady-state. Along the lines of Kwapil and Scharler (2010), \(-\frac{(1 - \epsilon_D)}{1 - \epsilon_D + \kappa_{RD}(1 + \beta_P)}\) represents the immediate pass-through. A one percentage point change in the policy rate translates into a \(-\frac{(1 - \epsilon_D)}{1 - \epsilon_D + \kappa_{RD}(1 + \beta_P)}\) percentage point change in the deposit rate.

Similarly, the loan branch sets \(R^R_t(i)\) to maximize:

\[
\max_{R^R_t(i)} \left[ (R_t - R^R_t(i))l_t(i) \right]
\]

subject to the demand:

\[
l_t^R(i) = l_t^R \left( \frac{R^R_t(i)}{R^R_t} \right)^{-\epsilon_{BR}}.
\]  \hspace{1cm} (3.12)

and a quadratic adjustment cost:

\[
\text{adj} \text{cost}^L_t(i) = \frac{\kappa_{RR}}{2} \left( \frac{R^R_t(i)}{R^R_{t-1}(i)} - 1 \right)^2 R^R_t(i)l_t(i).
\]

The linearized first order condition for the choice of \(R^R_t(i)\) is:

\[
\hat{R}^R_t(i) = \frac{(\epsilon_{BR} - 1)}{\epsilon_{BR} - 1 + \kappa_{RR}(1 + \beta_P)} \hat{R}^W_t + \frac{\kappa_{RR}}{\epsilon_{BR} - 1 + \kappa_{RR}(1 + \beta_P)} \hat{R}^R_{t-1}(i)
\]

\[
+ \frac{\beta P_{RR}}{\epsilon_{BR} - 1 + \kappa_{RR}(1 + \beta_P)} E_t \hat{R}^R_{t+1}(i).
\]  \hspace{1cm} (3.13)
3.2.2 Non-Regulated Financial Intermediaries

The economy also features a continuum of non-regulated financial intermediaries (NRFIs). There are three important distinctions between RFIs and NRFIs in the model. First, NRFIs cannot accept deposits from households. Instead, they raise funds by issuing securities \( b_t \) and selling them to RFIs. Second, NRFIs are not subject to a minimum capital requirement. They can issue as many loans as they want without holding any bank capital. Third, the demand function they face is more elastic than the demand for loans in the regulated sector. Let \( j \in [0,1] \) be the index of NRFIs. The demand function faced by a NRFI \( (t_{t}^{NR}(j)) \) depends on the volume of loans in the non-regulated sector \( t_{t}^{NR} \), and interest rate charged by the NRFI \( (R_{t}^{NR}(j)) \) relative to the average interest rate in the non-regulated sector \( (R_{t}^{NR}) \):

\[
l_{t}^{NR}(j) = l_{t}^{NR} \left( \frac{R_{t}^{NR}(j)}{R_{t}^{NR}} \right)^{-\epsilon_{BNR}}
\]

where \( \epsilon_{BNR} > \epsilon_{BR} \). A consequence of this assumption is that, in steady-state, the interest rate on loans issued by the non-regulated sector is lower than the interest rate on loans issued by the regulated sector. I discuss in more details the evidence behind this assumption in the previous chapters.

NRFIs are monopolistically competitive in the market for loans, but perfectly competitive in the market for securities. That is, they take the interest on bonds \( (R_{t}^{B}) \) and the demand for loans \( (l_{t}^{NR}(j)) \) as given when setting their lending rate \( (R_{t}^{NR}(j)) \). Like the RFIs, NRFIs have to pay a quadratic adjustment cost to change their lending rate:

\[
\text{adj cost}_t^{LNR} = \frac{\kappa_{RNR}}{2} \left( R_{t}^{NR}(j) - 1 \right)^2 R_{t}^{NR}(j)l_{t}^{NR}(j).
\]

The linearized first order condition for the choice of \( R_{t}^{NR}(j) \) is:

\[
\hat{R}_{t}^{NR}(j) = \left( \frac{\epsilon_{BNR} - 1}{\epsilon_{BNR} - 1 + \kappa_{RNR}(1 + \beta P)} \hat{R}_{t}^{B} + \frac{\kappa_{RNR}}{\epsilon_{BNR} - 1 + \kappa_{RNR}(1 + \beta P)} \hat{R}_{t-1}^{NR} \right) + \frac{\beta P \kappa_{RNR}}{\epsilon_{BNR} - 1 + \kappa_{RNR}(1 + \beta P)} E_t \hat{R}_{t+1}^{NR}(j).
\]

3.2.3 Loan Aggregator

The perfectly competitive loan aggregator possesses the technology to combine loans from RFIs and NRFIs to create a lending product for households. Let \( l_t \) be the volume of loans issued to households and \( R_t^L \) be the lending rate paid by households. The aggregator chooses \( l_t^R \) and \( l_t^{NR} \) to maximize profits subject to the technology:

\[
l_t = \left( \tau \frac{1}{\lambda} l_t^R \frac{\lambda_{t-1}}{\lambda_t} + (1 - \tau) \frac{1}{\lambda} l_t^{NR} \frac{\lambda_{t-1}}{\lambda_t} \right)^{\frac{\tau}{1 - \tau}}
\]

where \( \tau \) is a measure of the relative size of the regulated sector and \( \epsilon_L \) in the elasticity of substitution between loans from the regulated and the non-regulated sectors.
3.2.4 Real Side of the Economy

The economy is populated by two types of households: patient households and impatient households. Both types have similar preferences over consumption ($c_t$), housing ($h_t$), and labour ($n_t$), but the discount rate of patient households ($\beta_P$) is higher than the discount rate of impatient households ($\beta_I$). Their preferences are given by:

$$E_0 \sum_{t=0}^{\infty} \beta_t^l \left[ \log c_t^l + \phi^h h_t^l \log h_t^l - \phi^\sigma n_t^l \sigma \right]$$

where $\eta_t^h$ is a shock to the preference for housing:

$$\log(\eta_t^h) = \rho_h \log(\eta_{t-1}^h) + \varepsilon_t^h$$

$$\varepsilon_t^h \sim N(0, \sigma^2_h).$$

Patient households own all the firms and financial intermediaries in the model. They have access to two saving vehicles: physical capital ($k_{t-1}$) that can be rented out to firms at rate $r^k_t$ and bank deposits ($d_t$) paying an interest $R^D_t$ in the next period. In each period, a representative patient household chooses consumption ($c^P_t$), housing ($h^P_t$), deposits ($d_t$), and investment in physical capital ($i_t$) to maximize the lifetime utility subject to their budget constraint. Households supply differentiated labour services giving them market power over their nominal wage $W^P_t$ that can be adjusted with probability $(1 - \phi^w)$ in each period.

Impatient households do not own capital and borrow $l_t$ at rate $R^L_t$. An impatient household cannot borrow more than a fraction $m$ of the value of their stock of housing ($h^I_t$). Let $q_t^h$ be the real price of housing. The borrowing constraint can be written as follow:

$$l_t \leq \chi(l_{t-1}^l + (1 - \chi)mq_t^h h_t^I).$$

The rest of the problem of an impatient household is analogous to the problem of a patient household.

Monopolistically competitive firms hire both types of households and rent physical capital to produce intermediate goods. Let $m \in [0, 1]$ be the index of intermediate goods firms. The intermediate good $y_t(m)$ is produced according to the following technology:

$$y_t(m) = A_t \left( u^k_t(m) k_{t-1}(m) \right)^{\alpha} \left( n^P_t(m) \theta n^I_t(m) \right)^{\beta}.$$
Intermediate goods are assembled by a competitive firm to produce to final good $y_t$:

\[ y_t = \left( \int_0^1 y_t(m)^{\epsilon_y-1} \frac{dm}{m^{\frac{\epsilon_y}{\epsilon_y-1}}} \right)^{\frac{1}{\epsilon_y-1}}. \] (3.21)

Competitive housing and capital producers have the technology to transform the final good into housing and physical capital. Once the production of the final good takes place, they purchase all of the existing stock of housing and capital, increase it through investment ($i_t^h$ for housing and $i_t^k$ for capital), and resell the new stock to households.

Finally, the government spends $g_t$ in goods and services and finances this spending with lump-sum taxes paid by households. Government spending is exogenous and follows an AR(1) process:

\[ \log (g_t) = (1 - \rho_g) \log (g) + \rho_g \log (g_{t-1}) + \epsilon^g_t \] (3.22)

\[ \epsilon^g_t \sim N(0, \sigma^2_g). \]

### 3.2.5 Closing the Model

The monetary authority sets its instrument ($R_t$) according to a Taylor-type rule:

\[ R_t = F(R_{t-1}, \pi_{t-1}, y_{t-1}, \pi_t, y_t) + \epsilon^R_t \] (3.23)

\[ \epsilon^R_t \sim N(0, \sigma^2_R). \]

I discuss the specification of the rule in Section 3.3.

The unique final good serves as consumption good ($c_t^P + c_t^I$), investment good ($i_t^h + i_t^k$) and government good ($g_t$):

\[ y_t = c_t^P + c_t^I + i_t^k + i_t^h + g_t. \] (3.24)

There are six sources of uncertainty in the model (technology, preferences, fiscal policy, financial environment, financial regulation, and monetary policy) and all shocks are normally distributed around a zero mean. In the symmetric equilibrium, all agents of a given type make the same decisions. All households maximize their utility subject to their budget and borrowing constraints, all firms and financial intermediaries maximize their profits subject to their respective constraints, and all markets clear.

### 3.2.6 Interest Rate Stickiness

The inclusion of interest rate adjustment costs is the main departure from the model presented in the previous chapter. Gerali et al. (2010) and Kwapiil and Scharler (2010) cite empirical evidence of incomplete monetary policy pass-through (see, among others, Borio and Frizt (1995) or Sørensen and Werner (2006)) to motivate interest rate stickiness. Sticky interest rates interfere with the transmission of monetary policy, making it an important element to consider when assessing optimal policy.

I set the adjustment cost parameters to have an immediate pass-through of 35% on the deposit rate,
50% on the lending rate in the regulated sector, and 75% in the non-regulated sector\(^1\)\(^2\). In Table 3.1, I present the relative second moments of the model with flexible and sticky rates and compare them to the empirical second moments\(^3\). Interest rate adjustment costs reduce the relative volatility of the banking variables and interest rates.

Table 3.1: Volatility of variables relative to the volatility of output. Simulated moments are for the benchmark case \((\tau = 0.95)\) and the backward-looking monetary policy rule. Source: CANSIM Tables 176-0003, 176-0015, 380-0064.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Empirical moments</th>
<th>Simulated moments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(y)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>(c^P + c^I)</td>
<td>0.63</td>
<td>1.39</td>
</tr>
<tr>
<td>(i^b)</td>
<td>3.51</td>
<td>6.01</td>
</tr>
<tr>
<td>(i^k)</td>
<td>5.71</td>
<td>0.62</td>
</tr>
<tr>
<td>(\pi)</td>
<td>0.49</td>
<td>0.39</td>
</tr>
<tr>
<td>(l^R)</td>
<td>5.08</td>
<td>3.55</td>
</tr>
<tr>
<td>(d)</td>
<td>2.40</td>
<td>4.28</td>
</tr>
<tr>
<td>(k^B)</td>
<td>3.12</td>
<td>16.30</td>
</tr>
<tr>
<td>(R)</td>
<td>12.88</td>
<td>61.70</td>
</tr>
<tr>
<td>(R^L)</td>
<td>6.39</td>
<td>39.00</td>
</tr>
<tr>
<td>(R^R)</td>
<td>6.22</td>
<td>38.14</td>
</tr>
<tr>
<td>(R^D)</td>
<td>66.57</td>
<td>61.70</td>
</tr>
</tbody>
</table>

\[3.2.7\] Compact Form

The model can be written in the following compact form:

\[\mathbf{A} \mathbf{E}_t \mathbf{Y}_{t+1} = \mathbf{B} \mathbf{Y}_t + \mathbf{C} \mathbf{E}_t \mathbf{X}_{t+1}\]  \(3.25\)

where the vectors \(\mathbf{Y}_t\) and \(\mathbf{X}_t\) contain respectively all the endogenous and exogenous variables of the model, and the matrices \(\mathbf{A}\), \(\mathbf{B}\), and \(\mathbf{C}\) contain the parameters.

\[3.3\] Optimized Simple Rules

Optimal monetary policy has two angles. The first one is to assume the central bank always sets its instrument optimally given the current economic conditions. This case is referred to as monetary policy under discretion. The alternative, monetary policy under commitment, assumes the central bank commits to setting its instrument according to a rule that is known and understood by all agents in the economy. The rule responds to deviation of key macroeconomic indicators from their target (e.g. inflation, output). That is, in contrast to the discretion case, the monetary authority relies on a finite

\(^1\)\(\kappa_{RD} = 1.6, \kappa_{RR} = 0.75,\) and \(\kappa_{RNR} = 0.29.\)
\(^2\)For a description of the approach I used to obtain these estimates, see Section 3.6.1 of the Appendix.
\(^3\)Except for the interest rate adjustments costs, the calibration is the same as in the previous chapter.
set of indicators rather than on all of the available information\textsuperscript{4}. Here, I follow the second approach. No central bank would ever make the commitment to follow a systemic rule and monetary policy will always contain some level of discretion. However, monetary policy under commitment is more predictable and easier to communicate to the public. Moreover, as Woodford (2001), Woodford and Giannoni (2002), and Williams (2003) show, simple Taylor-type monetary policy rules can perform as well as fully optimized discretionary policies and are more robust to model misspecification (Orphanides and Williams, 2008).

To determine the impact of the size of the non-regulated sector on the optimal conduct of monetary policy, I compute optimized simple rules for different values of $\tau$, the parameter measuring the relative size of the regulated sector.

Following the work of Schmitt-Grohé and Uribe (2007), I assume that the monetary authority sets the policy rate $R_t$ according to a Taylor-type rule given by:

$$
\log \left( \frac{1 + R_t}{1 + R_{t-1}} \right) = \chi_R \log \left( \frac{1 + R_{t-1}}{1 + R_{t-2}} \right) + \mu_\pi \log \left( \frac{\pi_{t+i}}{\pi} \right) + \mu_y \log \left( \frac{y_{t+i}}{y} \right)
$$

(3.26)

where $\pi$ and $y$ represent the long-run levels of inflation and output\textsuperscript{5}, $R$ is the neutral interest rate, and the index $i$ can take two values: -1 (backward looking rule) or 0 (contemporaneous rule)\textsuperscript{6}. I also consider the following interest-feedback rule:

$$
\log \left( \frac{1 + R_t}{1 + R_{t-1}} \right) = \mu_\pi \log \left( \frac{\pi_{t-1}}{\pi} \right) + \mu_y \log \left( \frac{y_{t-1}}{y_{t-2}} \right).
$$

(3.27)

As pointed out by Schmitt-Grohé and Uribe (2007), the interest-feedback rule is interesting because of its ease of implementation. The policymaker does not need to estimate the potential output and the neutral rate of interest, or forecast current output and inflation.

The optimization problem consists in finding the parameters of the monetary policy rule ($\chi_R, \mu_\pi,$ and $\mu_y$) to minimize the following (scaled) expected intertemporal quadratic loss function:

$$
(1 - \beta_{CB})E_t \sum_{j=t}^{\infty} \beta_{CB}^{j-t} \left( \mathbf{Y}_t^T \mathbf{W} \mathbf{Y}_t \right)
$$

(3.28)

subject to the model (3.25). The parameter $\beta_{CB}$ represents the discount factor of the monetary authority, $\mathbf{W}$ is a diagonal weighting matrix, and $\mathbf{Y}_t$ is the vector containing all of the endogenous variables of the model.

Along the lines of Rudebusch and Svensson (1999), I assume that the monetary authority is concerned with deviations of inflation from its target ($\tilde{\pi}_t = \pi_t - \pi$), the output gap ($\tilde{y}_t$), and the variability of the policy instrument ($\Delta R_t = R_t - R_{t-1}$). The variables $\tilde{\pi}_t$, $\tilde{y}_t$, and $\Delta R_t$ are elements of $\mathbf{Y}_t$ and I

\textsuperscript{4}See McCallum (1997) or Dotsey (2004) for a more detailed comparison of monetary policy under discretion versus commitment.

\textsuperscript{5}Under the benchmark assumptions of the model, there is no growth and the long-run net inflation rate is zero.

\textsuperscript{6}I do not consider the forward-looking rule ($i = +1$) because as $\tau$ decreases, finding a global optimum becomes troublesome.
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denote the corresponding elements of $W$ by $\lambda_{\tilde{\pi}}$, $\lambda_{\tilde{y}}$, and $\lambda_{\Delta R}$. All the other elements on the diagonal of $W$ are zero.

If $\beta_{CB} \rightarrow 1$, the expected intertemporal loss function can be expressed in terms of the unconditional variances of the non-zero-weighted variables:

$$E[L_t] = \lambda_{\tilde{\pi}} \sigma_{\tilde{\pi}}^2 + \lambda_{\tilde{y}} \sigma_{\tilde{y}}^2 + \lambda_{\Delta R} \sigma_{\Delta R}^2. \tag{3.29}$$

I set $\lambda_{\tilde{\pi}} = \lambda_{\tilde{y}} = 1$ and $\lambda_{\Delta R} = 0.5$, meaning that the monetary authority is equally concerned with deviations of output and inflation from their respective target, but not as much with the variability of the policy rate. This is a common specification used, among others, by Rudebusch and Svensson (1999) and Cayen, Corbett, and Perrier (2006). Table 3.2 reports the results of the simulations for the three specifications of the monetary policy rule and for different values of $\tau$ (the relative size of the regulated sector in equation (3.16)). The first three columns show the coefficients of the optimal rule and the fourth column gives the value of the loss under the optimized rule. In the last column, I give the cost (in terms of increased loss) of implementing the rule optimized for $\tau = 0.99$ when the share of the non-regulated sector is higher.

<table>
<thead>
<tr>
<th>$\chi_R$</th>
<th>$\mu_{\pi}$</th>
<th>$\mu_{\gamma}$</th>
<th>Loss ($\times 10^{-4}$)</th>
<th>Cost (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$i = -1$ Backward-looking rule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tau = 0.99$</td>
<td>0.910</td>
<td>1.086</td>
<td>0.496</td>
<td>6.169</td>
</tr>
<tr>
<td>$\tau = 0.95$</td>
<td>0.958</td>
<td>1.110</td>
<td>0.593</td>
<td>6.109</td>
</tr>
<tr>
<td>$\tau = 0.85$</td>
<td>1.102</td>
<td>1.159</td>
<td>0.880</td>
<td>5.963</td>
</tr>
<tr>
<td>$\tau = 0.75$</td>
<td>1.265</td>
<td>1.187</td>
<td>1.211</td>
<td>5.824</td>
</tr>
<tr>
<td>$i = 0$ Contemporaneous rule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tau = 0.99$</td>
<td>20.739</td>
<td>2.612</td>
<td>29.586</td>
<td>5.920</td>
</tr>
<tr>
<td>$\tau = 0.95$</td>
<td>16.606</td>
<td>2.188</td>
<td>25.105</td>
<td>5.851</td>
</tr>
<tr>
<td>$\tau = 0.85$</td>
<td>10.489</td>
<td>1.554</td>
<td>17.659</td>
<td>5.677</td>
</tr>
<tr>
<td>$\tau = 0.75$</td>
<td>7.373</td>
<td>1.255</td>
<td>13.320</td>
<td>5.505</td>
</tr>
<tr>
<td>Interest-feedback rule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tau = 0.99$</td>
<td>-</td>
<td>0.970</td>
<td>2.819</td>
<td>6.355</td>
</tr>
<tr>
<td>$\tau = 0.95$</td>
<td>-</td>
<td>0.973</td>
<td>2.821</td>
<td>6.351</td>
</tr>
<tr>
<td>$\tau = 0.85$</td>
<td>-</td>
<td>0.979</td>
<td>2.828</td>
<td>6.343</td>
</tr>
<tr>
<td>$\tau = 0.75$</td>
<td>-</td>
<td>0.987</td>
<td>2.834</td>
<td>6.334</td>
</tr>
</tbody>
</table>

Three important points can summarize the results presented above. First, even though the coefficients of the rules change, the size of the non-regulated sector does not affect the ranking of the rules. The contemporaneous rule outperforms the backward-looking and interest-feedback specifications for any size of the non-regulated sector. However, the interest-feedback rule is the least sensitive to changes in $\tau$ and leads to the smallest cost of using a misspecified policy rule. Thus, there is a tradeoff between minimizing the loss and minimizing the welfare cost of using a misspecified rule.
Second, the size of the non-regulated sector affects the coefficients on each component of the optimal monetary policy rule. It is, however, more interesting to look at the relative weight on each variable as they are easier to compare across the different specifications\(^7\). For both the backward-looking and the contemporaneous specifications, the relative weight on the past interest rate decreases as the relative size of NRFIs increases. In other words, the optimal policy becomes less smooth and more responsive to the two other components. The change in the relative weight of inflation and the output gap depends on the specification. A backward-looking rule should respond more aggressively to the output gap as \(\tau\) decreases, but with a contemporaneous rule, it is the weight on inflation that increases.

Finally, for all specifications considered, the loss decreases as the relative size of the non-regulated sector increases (\(\tau\) decreases). As shown in the previous chapter, NRFIs help to stabilize output and inflation, two important variables in the central bank’s loss function. We can also see that the cost of using a misspecified rule (i.e. one optimized for \(\tau = 0.99\)) increases with the size of the non-regulated sector. This suggests that the gain of tracking the growth of NRFIs and adjusting the coefficients of the monetary policy rules accordingly are important.

### 3.4 Robustness

As stressed out by McCallum (1997) and Taylor and Williams (2011), an optimal rule should not be model dependant. Thus, in the optimal monetary policy literature, a robust rule is a rule that performs well under various model specifications. However, my focus is on the impact of the non-regulated sector on optimal rules and I am not looking for a specific optimal rule. Therefore, my robustness analysis consists in making sure the general results described above hold under different assumptions regarding the loss function, the measure of the output gap, and the interest rate stickiness\(^8\).

#### 3.4.1 Loss Function

For this first test, I change the relative weight on inflation, the output gap, and the variability of the policy rate in the loss function given by equation (3.29). I consider the case of a central bank more concerned with inflation than with the output gap and the volatility of the policy rate (i.e. \(\lambda_\pi = 1, \lambda_y = 0.5, \lambda_\Delta R = 0.5\)).

The optimal policy rules obtained with the alternative loss function are smoother (\(\chi_R\) is relatively higher), but the conclusions described above still hold.

#### 3.4.2 Alternative Measure of the Output Gap

In Section 3.3, I defined the output gap as the difference between actual output and steady-state output. This definition can be referred to as the trend output gap. For the second robustness test, I use the definition of Smets and Wouters (2007). I define the output gap as the difference between actual output

\[^7\text{For instance, the relative weight on the past interest rate would be } \frac{\chi R}{\chi R + \mu \pi + \mu y}.\]

\[^8\text{I use the backward-looking specification as my benchmark because the optimization converges faster for all values of } \tau. \text{ Even though I only present the backward-looking specification, I experimented with other specifications and nothing suggests the conclusions would change.}\]
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Table 3.3: Optimized simple rules and loss for an alternative loss function. \( \lambda_\pi = 1, \lambda_y = 0.5, \lambda_{\Delta R} = 0.5. \)

<table>
<thead>
<tr>
<th>( \chi_R )</th>
<th>( \mu_\pi )</th>
<th>( \mu_y )</th>
<th>Loss ((\times 10^{-4}))</th>
<th>Cost (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( i = -1 )</td>
<td>( \tau = 0.99 )</td>
<td>0.992</td>
<td>1.037</td>
<td>0.353</td>
</tr>
<tr>
<td></td>
<td>( \tau = 0.95 )</td>
<td>1.039</td>
<td>1.064</td>
<td>0.417</td>
</tr>
<tr>
<td></td>
<td>( \tau = 0.85 )</td>
<td>1.178</td>
<td>1.134</td>
<td>0.609</td>
</tr>
<tr>
<td></td>
<td>( \tau = 0.75 )</td>
<td>1.347</td>
<td>1.206</td>
<td>0.856</td>
</tr>
</tbody>
</table>

and the output we would observe if prices, wages, and interest rates were fully flexible. This is the flexible prices output gap. As Adolffson et al. (2011) show, the definition of the output gap used in the computation of optimal policies is not always straightforward and can have important implications. For instance, in response to a positive technology shock, the trend output gap increases, but the flexible prices output gap declines.

The output gap enters the optimal policy problems through two channels: the policy rule itself since it is one of the variables to which the policy rate responds in equation (3.26), and the loss function of the monetary authority given by equation (3.29).

Let \( y_t^{\text{flex}} \) be the flexible prices output. The flexible prices output gap is \( \tilde{y}_t^{\text{flex}} = y_t - y_t^{\text{flex}} \) and the monetary policy rule (3.26) becomes

\[
\log \left( \frac{1 + R_t}{1 + \hat{R}} \right) = \chi_R \log \left( \frac{1 + R_{t-1}}{1 + \hat{R}} \right) + \mu_\pi \log \left( \frac{\pi_t + i}{\pi} \right) + \mu_y \log \left( \frac{y_t + i}{y_t + i} \right).
\]

In Section 3.6.2 of the Appendix, I present the response of the flexible prices output gap to four of the shocks for the benchmark calibration. In Table 3.4, I compare the volatility of the trend output gap and the flexible prices output gap for different values of \( \tau \). The volatility of the trend output gap decreases when the size of the non-regulated sector increases (\( \tau \) decreases), but the volatility of the flexible prices output gap increases when the size of the non-regulated sector increases. It is important to keep in mind this property when analyzing the optimized rules reported in Table 3.5.

Table 3.4: Volatility of different measures of the output gap for different values of \( \tau \) relative to the case \( \tau = 0.99 \). Simulated moments, benchmark calibration.

<table>
<thead>
<tr>
<th>( \hat{y} )</th>
<th>( \tilde{y}^{\text{flex}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \tau = 0.99 )</td>
<td>1.000</td>
</tr>
<tr>
<td>( \tau = 0.95 )</td>
<td>0.999</td>
</tr>
<tr>
<td>( \tau = 0.85 )</td>
<td>0.996</td>
</tr>
<tr>
<td>( \tau = 0.75 )</td>
<td>0.994</td>
</tr>
</tbody>
</table>

Since the flexible prices output gap is less volatile than the trend output gap, the value of the loss is significantly lower. However, because the size of the non-regulated sector increases the volatility of the
flexible prices output gap, the loss increases as $\tau$ decreases. That being said, the cost of a misspecified rule is not as high because the relative weights on each component of the optimized policy rules are not as sensitive to the value of $\tau$. The most striking result is probably the relative weight on inflation relative to the output gap which is much smaller, even negative. Everything else being equal, the output gap is more volatile than inflation and both variables tend to move in the same direction. Therefore, by mostly targeting the output gap, the monetary authority is able to achieve its stabilization objective.

Table 3.5: Optimized simple rules and loss for an alternative measure of the output gap. $\lambda_\pi = 1$, $\lambda_\pi^{flex} = 1$, $\lambda_{\Delta R} = 0$.

<table>
<thead>
<tr>
<th>$\chi R$</th>
<th>$\mu_\pi$</th>
<th>$\mu_y$</th>
<th>Loss ($\times 10^{-6}$)</th>
<th>Cost (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i = $-1$ Backward-looking rule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tau = 0.99$</td>
<td>2.018</td>
<td>-0.092</td>
<td>6.686</td>
<td>9.334</td>
</tr>
<tr>
<td>$\tau = 0.95$</td>
<td>2.016</td>
<td>-0.135</td>
<td>6.663</td>
<td>9.436</td>
</tr>
<tr>
<td>$\tau = 0.85$</td>
<td>2.022</td>
<td>-0.191</td>
<td>6.635</td>
<td>9.675</td>
</tr>
<tr>
<td>$\tau = 0.75$</td>
<td>2.038</td>
<td>-0.187</td>
<td>6.629</td>
<td>9.898</td>
</tr>
</tbody>
</table>

These results highlight the fact that the choice between alternative definitions of the output gap is not trivial. A large non-regulated sector limits the fluctuations of output and reduces the volatility of the output gap measured as the difference between actual and trend output. However, if one defines the output gap as the difference between actual output and the flexible prices output, the non-regulated sector leads to more volatility, which has non-negligible implications on the optimal rules, in particular on the response to deviations of inflation from the target.

### 3.4.3 The Role of Interest Rate Adjustment Costs

As discussed in Section 3.2.6, sticky interest rates interfere with the propagation of monetary policy. Large variations in rates are costly for financial intermediaries, so they adjust their rates gradually in response to a change of the policy rate. This causes an incomplete pass-through of monetary policy.

In order to assess the role of the incomplete pass-through of monetary policy on the optimal policy, I compute the optimal rules assuming that there is no interest rates adjustment costs. The optimized backward-looking monetary policy rules are presented in Table 3.6. The conclusions presented in the previous section still holds. In addition, we can see that without adjustment costs, monetary policy is more efficient and the loss is smaller. However, the cost of a misspecified policy rule is higher because the optimal rules respond more aggressively to the output gap.
3.5 Concluding Remarks

The mortgage market is an important channel for the transmission of monetary policy. For this reason, a structural change in the market such as the expansion of the non-regulated sector should be a concern for monetary authorities. In this chapter, I assessed the impact of non-regulated financial intermediaries on the conduct of monetary policy by deriving optimal simple rules for different sizes of the non-regulated sector. This approach allows me to determine how the parameters of the monetary policy rule should be adjusted as the NRFIs gain market shares. I am also able to measure the welfare cost of using a rule optimized for an economy with a smaller non-regulated sector.

The relative size of NRFIs has no impact on the ranking of alternatives rules, but it affects the relative weight on each component of the policy rule. For instance, as the share of the non-regulated sector increases, the policy rule should be responding less aggressively to deviations of inflation from its target. Moreover, specifications of the monetary policy rule are not equally sensitive to a change in the share of the non-regulated sector. The interest-feedback rule ranks last in terms of minimizing the central bank’s loss, but the cost of using a misspecified rule is the lowest under this specification. This result suggests the existence of a tradeoff between minimizing the loss and implementing a rule robust to changes in the financial environment.
3.6 Appendix

3.6.1 Estimation of the Interest Rate Pass-Through

To estimate the interest rate pass-through, I use the univariate error correction model of de Bondt (2005). To illustrate the approach, I will use the deposit rate $R^D_t$. First, I assume that the current value of $R^D_t$ is determined by the policy rate $R_t$, the lagged values of the deposit and policy rates ($R^D_{t-1}$ and $R_{t-1}$), and an error term $\epsilon^R_t$:

$$R^D_t = \alpha_0 + \alpha_1 R_t + \alpha_2 R_{t-1} + \alpha_3 R^D_{t-1} + \epsilon^R_t \quad (3.31)$$

To have an expression in terms of stationary variables, I re-arrange the previous equation:

$$\Delta R^D_t = \alpha_0 + \alpha_1 \Delta R_t + (\alpha_1 + \alpha_2) R_{t-1} - (1 - \alpha_3) R^D_{t-1} + \epsilon^R_t \quad (3.32)$$

$$\Delta R^D_t = \alpha_0 + \alpha_1 \Delta R_t - \beta_1 (R^D_{t-1} - \beta_2 R_{t-1}) + \epsilon^R_t \quad (3.33)$$

which can be re-written as:

$$\Delta R^D_t = \alpha_0 + \alpha_1 \Delta R_t - \beta_1 (R^D_{t-1} - \beta_2 R_{t-1}) + \epsilon^R_t \quad (3.34)$$

where $\beta_1 \equiv (1 - \alpha_3)$ and $\beta_2 \equiv (1 - \alpha_3)^{-1}(\alpha_1 + \alpha_2)$. The parameter $\alpha_1$ represents the immediate (or within the period) pass-through. I estimate the model given by equation 3.34 by ordinary least square using quarterly average of the 90-day term deposits and 5-year yield on federal government bonds between 1995 and 2015\(^9\). The estimated coefficient $\alpha_1$ is 0.3519 (significant at the 1% level).

To estimate the pass-through on mortgage rates in the regulated sector, I use the average 5-year rate on conventional mortgages (estimated $\alpha_1$ of 0.4455, significant at the 1% level) and the 5-year rate on conventional mortgages by chartered banks only (estimated $\alpha_1$ of 0.5935, significant at the 1% level).

Finally, to estimate the pass-through on mortgage rates in the non-regulated sector, I compute the correlation between the rates in the regulated and the non-regulated sectors (quarterly averages) and find that the coefficient of correlation is very high (around 0.95). By trials, I find that a pass-through of 75% leads to a coefficient of correlation of 0.9320 between $R^R_t$ and $R^{NR}_t$ in the model.

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\(^9\)Source: CANSIM Table 176-0043
3.6.2 Output Gap

Figure 3.1: Responses of the flexible prices output gap to one-standard deviation shocks. Model solved by performing a first-order linear approximation around the steady-state with the benchmark calibration.
Bibliography


