Mortgage Credit and Maximum Loan-to-Value Ratios: The Canadian Housing Market

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Abstract

This paper investigates the relationship in the Canadian housing market between loan-to-value ("LTV") ratios and residential mortgage credit over the 1981-2012 time period. More specifically, I look to determine whether LTV ratio regulation provides a mechanism with which to slow down the potentially overheated Canadian housing market. Due to the endogeneity of many macroeconomic variables, I use a structural vector autoregression ("SVAR") to investigate this question. Results indicate that three of the four major LTV regulation changes that occurred during this timeframe had insignificant effects on mortgage credit, while the one that did, the 1982 tightening, caused mortgage credit to increase, contrary to expectations. Therefore, regulation changes to LTV ratios are unlikely to be successful in slowing down the overheated housing market in Canada which may force central bankers to use broader monetary policy or other forms of macroprudential regulation.
1 Introduction

The focus of this paper is to investigate the effects of changes to regulatory maximum loan-to-value (“LTV”) ratios on residential mortgage credit in Canada. As the Canadian housing market continues to heat up\(^1\), both the government and Bank of Canada are looking for ways to create a soft landing. This paper analyzes the more housing-targeted LTV policy as opposed to the potentially broader monetary policy.

The contribution of this paper is twofold. First, this paper looks specifically at residential mortgage credit effects in a SVAR setting. While papers on the housing market with and without a VAR approach have been investigated,\(^2\) few if any that this paper has seen, look specifically at the part of consumer credit dealing with the housing market, namely residential credit, in a SVAR setting. This is a relevant issue to study given the importance of mortgage credit on the housing market, and the housing market as a leading indicator of economic health.

Second, the use of macroprudential regulation in housing market discussions within the SVAR framework is a relatively new area. While some papers have begun to investigate the relationship of LTV and the economy\(^3\), this paper has not seen any used within the traditional SVAR framework. Macroprudential regulation more generally has become a hot topic as economists and policymakers alike begin to look at ways to reduce systemic risk. As policymakers grapple with using macroprudential regulation versus monetary policy to respond to potential asset bubbles, this paper sheds light on these choices.

Given the endogeneity of macroeconomic variables I employ the structural vector autoregression (“SVAR”) methodology. This paper develops the SVAR model by using some standard identification setups in papers such as Kim and Roubini (2000) and Cushman and Zha (1997), as well as some novel setups in order to include housing market variables. To be able to treat LTV as an exogenous variable, I lag it by three months, or one quarter, in the primary specification.

Theoretically, an increase (decrease) in the regulatory maximum LTV ratio would cause mortgage credit to increase (decrease) as people are able to put down a smaller (larger) downpayment on their house. The four maximum regulatory LTV changes during the 1981-2012 period occurred in July 1982, January 1992, October 2006, and October 2008. The 1982 and 2008 changes were tightenings, implying lower LTV ratios and higher required downpayments; the 1992 and 2006 changes were loosenings implying the opposite. The effect of each LTV change is analyzed from the time of its implementation until the next change. Using these historical LTV changes, results indicate that three of the four LTV ratio regulation changes had no significant effects on mortgage credit. In the one instance where there were significant effects, the 1982 tightening, mortgage credit increased, contrary to expectations.

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\(^1\) The Economist (2013, August 31)


\(^3\) Lamont and Stein (1999) and Almeida, Campello, and Liu (2006)
One possible explanation for the increase in mortgage credit following the 1982 tightening was the positive supply side shock to the housing market arising from the introduction by the Canadian Mortgage Housing Corporation (“CMHC”) of the National Housing Act (“NHA”) mortgage-backed securities in 1987. This program provided people with the ability to take NHA insured mortgages, aggregate them, and sell them to investors. This program greatly increased the funding made available for Canadians in the mortgage market. Indeed, while the housing market grew by 14.8% from 1985-1986, it grew by 17.9% from 1986-1987 after the introduction of these mortgage-backed securities. These securities totaled $456 million in 1987 which was approximately 1.8% of the overall growth in the housing market.

The attempted loosening of the regulatory maximum LTV ratio in 1992 may have been ineffective due to two related items. First, the spike in mortgages during the 1980s from the mortgage-backed securities may have allowed people who otherwise would have waited for a loosening of LTV regulation to buy early thus making the LTV increase redundant. Furthermore, beginning in 1988, Canada implemented the Basel Accord, which forced chartered banks to hold capital against privately-insured mortgages, essentially acting as a negative supply side shock to the housing market. While this was implemented before the 1992 LTV regulation change, it may have continued to be a drag on mortgage credit.

The lack of significance in the 2006 loosening and 2008 tightening may be explained simultaneously by the financial crisis. The Great Recession began in the third quarter of 2007, and the 2006 loosening that produced increased mortgage credit growth in 2007, lost all those gains in the 2008 period before the tightening. This increase and subsequent decrease in mortgage credit growth can explain the insignificant results from the 2006 loosening. Similarly, by the time the October 2008 tightening occurred, large reductions in mortgage credit had already happened, seemingly making the 2008 tightening redundant. While I have accounted for real GDP in the SVAR analysis, it is unlikely that I have accounted for all factors related to the relationship between the Great Recession and mortgage credit.

These explanations, taken as a whole, point to unaccounted supply side shocks overwhelming what significant effects there are in LTV regulation changes. The implication is that the broader monetary policy tool may need to be used to generate the desired mortgage credit changes. However, caution is warranted given the broad nature of the policy rate, as a contractionary shock in this analysis is shown to have large negative spillover effects on the rest of the economy, despite causing the desired slowdown in mortgage credit. Other macroprudential instruments that affect homeowners and/or banks, such as the debt-to-income ratio and countercyclical capital requirements, could be considered as well and should be investigated in future research to determine how successful they would be in targeting a slowdown in the mortgage credit market.

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4Bank of Canada: Data and Statistics Office
5Canadian Mortgage and Housing Corporation
6Debt-to-income ratio (“DTI”) is a percentage of how much of a consumer’s monthly income is used to pay off debt. The front-end ratio portion of DTI focuses on housing costs. Countercyclical capital requirements look to force banks to hold more capital in good times to avoid balance sheet shrinkage during troubled times.
Three main robustness checks are analyzed to see whether the primary specification conclusions remain intact. First, I use a longer lag of 6 months for LTV changes to affect mortgage credit. Second, I switch from monthly to quarterly data and make appropriate adjustments to the specification. Lastly, I look at shorter windows for a particular LTV change to have its effect on mortgage credit. I allow all four changes to the LTV ratio to affect mortgage credit for two years only following the initial change. This ensures that the effect of the LTV change is not hidden by a longer period where mortgage credit adjusts to its new long-run level. The first robustness check produces identical results to the primary specification while the latter two have similar results but now even the 1982 LTV change has insignificant effects on mortgage credit.

The rest of this paper is organized as follows. Section 2 will discuss the background of the housing market in Canada while motivating reasons for performing this study. Section 3 will review the development of the SVAR as well as discuss the identification assumptions used in creating the estimation methodology. Section 4 will discuss the primary results from the estimation methods. Section 5 will look at the sensitivity analysis. Section 6 concludes.

2 Housing Market Background

2.1 Canadian Housing Market Background

The mortgage industry has significantly changed in Canada over the period under analysis. Chartered banks in 1980 represented about 28% of the residential mortgage credit. By comparison, in 2011, this total was 75%. According to Kiff (2009) this change is largely due to the 1992 Bank Act revision, which gave banks the ability to own trust and loan companies, who were leaders in the mortgage market. As of the end of 2011, deposit-taking institutions in Canada own CDN$948 billion of the CDN$1,113 billion in mortgage credit. Within the deposit-taking institutions, chartered banks own CDN$832 billion.

Mortgage insurance is an important factor in the Canadian housing market. All federally-regulated deposit-taking institutions are required to be insured against default if they take on loans that have high LTV ratios, specifically above 80%. As of 2008, Kiff (2009) notes that 45% of all chartered bank mortgages are insured. Rules on LTV ratios can apply differently depending if you are a first-time homebuyer, a refinerancer, purchasing a home for investment, or are a self-employed homebuyer. Rules can also be setup that apply to all homebuyers. For example, the maximum LTV change in 1992 was originally only for first-time homebuyers, however, in 1998, this rule was adjusted to apply to all homebuyers.

The Canadian Mortgage Housing Corporation (“CMHC”), which is owned and has its financial obligations incurred by the Government of Canada, is the main force in the mortgage insurance market. As of 2009, they represented 68% of the insurance market. The only non-CMHC companies that provide mortgage insurance are private providers Genworth Financial (“Genworth”) and
American International Group ("AIG"), which account for essentially all the rest of the market. As of 1988, the Government of Canada provides a 90% guarantee on the insurance of these private providers, implying a strong relationship between the rules set out by the Government, including LTV ratios, the private lenders as well as the insurance companies.

The standard mortgage in Canada is a five-year fixed rate, 25 year amortization. Prior to 1969, when the minimum term was dropped to five years, longer terms had been more common, including the requirement of 25 year terms for insured loans. Kiff (2009), referencing the Canadian Association of Accredited Mortgage Professional 2008 survey, shows that only about 16% of mortgages had amortization payoff schedules of more than 25 years. This same survey showed that only 10% of terms were greater than five years.

2.2 Why do we care about the Housing Market?

The importance of the housing market, as Figure 1 indicates, comes from the fact that it acts as a leading indicator for growth of the economy.\textsuperscript{7,8} This figure shows the close relationship between mortgage credit and the real economy in which a correlation of 0.955 is found.\textsuperscript{9}

![Real Economy and Mortgage Credit Relationship](image)

**Figure 1: Mortgage Credit as Leading Indicator**

However, much of the discussion concerning the housing market following the recession surrounds housing prices. Therefore it is important to determine whether there is also a close relationship between mortgage credit and housing prices. Figure 2 shows the close correlation of house prices and mortgage credit growth in Canada. The correlation between these two variables is 0.925.

\textsuperscript{7}Canada’s national statistics agency, Statistics Canada, has a Canadian Composite Leading Indicator variable which comprises ten components that lead cyclical activity in the Canadian economy, including a housing index.

\textsuperscript{8}To determine the percent change of a particular variable in this figure, as well as all remaining figures, I multiply the numbers along the y-axis by 100.

\textsuperscript{9}Residential mortgage credit comes from Statistics Canada and represents outstanding balances of major private institutional lenders. The real economy is represented by the industrial production index for Canada.
Therefore any analysis of the effects of macroprudential regulation on mortgage credit, and the economy as a whole, will have to take into consideration housing prices.

Figure 2: House Prices and Mortgage Credit

3 SVAR Model and Estimation Methodology

In this section I will develop the SVAR model and explain the identification assumptions used in the empirical estimation. To be able to structurally interpret a VAR model one needs to develop additional restrictions and/or assumptions that must be based on some form of economic theory and/or institutional knowledge. One can only evaluate structural shocks as causal once the forecast errors have been decomposed in a mutually uncorrelated way, where there is a clear economic interpretation.

3.1 Developing the SVAR

VAR modeling involves using $K$ dependent variables, each written as linear functions of $s$ of their own lags, $s$ of the lags of the other $K - 1$ variables, and may or may not include some other exogenous variables. The model in this paper includes four exogenous variables, representing the different LTV regulatory environments, lagged by one period. The model can therefore be written as:

$$y_t = v + A_1 y_{t-1} + ... + A_s y_{t-s} + H_1 x_{t-1} + u_t$$

(1)

in which $y_t = (y_{1t}, ... y_{Kt})$ is a $K \times 1$ vector of dependent variables, $x_t = (x_{1t}, ... x_{4t})$ is a $4 \times 1$ vector of independent variables, the $A_1$ to $A_s$ are $K \times K$ matrices of parameters, $H_1$ is a $K \times 4$ matrix of parameters, and the errors $u_t$ are assumed to be white noise with $E(u_t) = 0$, $E(u_t u'_s) = \Sigma$, and $E(u_t u'_s) = 0$ for $t \neq s$. 
With this reduced form estimation we cannot evaluate the effects of an exogenous shock on the dependent variables. The variance-covariance matrix is not diagonal and as such, a shock to one variable contains information about potential innovations to the other variables in the system. If this is the case, no causal interpretation of impulse response functions is possible.

To obtain the SVAR, and thus establish causation, rewrite (1) as:

\[ C y_t = g + D_1 y_{t-1} + ... + D_s y_{t-s} + M_1 x_{t-1} + B s_t \]  

(2)

where \( s_t \) is a vector of structural shocks, with \( E(s_t) = 0 \), \( E(s_t s'_t) = I_K \), and \( E(s_t s'_s) = 0 \) for \( t \neq s \). Here the variance covariance matrix is diagonal. In this case we can interpret the causal relationships following structural shocks. Pre-multiplying (2) by \( C^{-1} \) gives us equation (1) and we can estimate this equation noting that the relationships between the errors is represented by the following equation:

\[ C u_t = B s_t \]  

(3)

When estimating SVARs, we are often interested in how the variable of interest reacts to an exogenous shock to another variable. To do this, rewrite (2) in its moving average representation. First rearrange to get:

\[ C\left[(I_K - D_1 L - ... + D_s L^s) y_t\right] - (M_1 L) x_t = C u_t = B s_t \]  

(4)

where \( L \) is the lag operator. If we let \( F = C^{-1} B \), and note that \( C u_t u'_t C' = B s_t s'_t B' \), then taking expectations of both sides gives:

\[ \Sigma = FF' \]  

(5)

Going back to (1), if we rearrange we get:

\[ A(L) y_t = v + H_1 x_{t-1} + u_t \]  

(6)

which if we multiply through by \( A(L)^{-1} \), assuming stability, we get:

\[ y_t = \mu + M_1 x_{t-1} + \psi(L) u_t \]  

(7)

and, depending on how many lags, we can write the reduced form moving average representation as:
\[ y_t = \mu + M_1 x_{t-1} + \sum_{s=0}^{\infty} \psi_s u_{t-s} \]  

(8)

Matrix \( F \) allows us to rewrite (8) in the structural form that gives us causal interpretation. Letting \( \Theta_s = \psi_s F \), and rearranging (3) so that \( s_t = (C^{-1} B)^{-1} u_t = F^{-1} u_t \) we get:

\[ y_t = \mu + M_1 x_{t-1} + \sum_{s=0}^{\infty} \Theta_s s_{t-s} \]  

(9)

giving us our desired causal interpretation. This impulse response function is only possible if the underlying VAR in (1) is stable.\(^{10}\)

As the primary interest of the paper is the set of coefficients in the \( M_1 \) matrix corresponding to the mortgage credit equation, I focus on these. To obtain the appropriate standard errors for these coefficients one must use the bootstrapping procedure. I bootstrap the coefficients using 3000 simulations. However, the resulting coefficients and standard errors are with respect to the base period, i.e. the period before the first LTV change. The interest in this paper however is with respect to the LTV environment before a specific change. Therefore once the coefficients and standard errors have been determined I have to subtract each coefficient from the period before’s coefficient except for the first change which is with respect to the base period. The standard error for these new coefficients is obtained by squaring each of the two standard errors and then taking the square root.

Despite the focus on the coefficients in \( M_1 \), the structural errors \( s \) are still important. One standard deviation unit shocks in equation (9) will be used to evaluate how monetary policy shocks compare to LTV changes when looking at their affects on mortgage credit and the real economy.

I follow Ivanov and Kilian (2001) for lag length selection who suggest using the Akaike Information Criterion (“AIC”) when using monthly data. The optimal lag length when evaluating the primary specification was 2 months, however autocorrelation issues arose and so I used lag length 3 months.

### 3.2 Identification

In order to identify structural shocks and be able to interpret causal impulse response functions, one must look to economic relationships in order to set up the \( B \) and \( C \) matrices in (3) above. The setup used in this paper is as follows:

\(^{10}\)Stability implies not only that the variables are covariance stationary, but also the VAR must be invertible.
\[
\begin{pmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & a_{32} & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & a_{42} & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & a_{61} & 0 & 0 & 0 & 1 & 0 & a_{68} \\
0 & a_{72} & 0 & a_{74} & a_{75} & a_{76} & 1 & 0 \\
0 & a_{81} & 0 & 0 & 0 & 0 & 0 & 1
\end{pmatrix}
\begin{pmatrix}
u_{pc}^t \\
u_{yr}^t \\
u_{hr}^t \\
u_{tr}^t \\
u_{cc}^t \\
u_{tc}^t \\
u_{hp}^t \\
u_{ffr}^t
\end{pmatrix} =
\begin{pmatrix}
b_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & b_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & b_{33} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & b_{44} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & b_{55} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & b_{66} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & b_{77} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{88}
\end{pmatrix}
\begin{pmatrix}
u_{pc}^{t+1} \\
u_{yr}^{t+1} \\
u_{hr}^{t+1} \\
u_{tr}^{t+1} \\
u_{cc}^{t+1} \\
u_{tc}^{t+1} \\
u_{hp}^{t+1} \\
u_{ffr}^{t+1}
\end{pmatrix}
\tag{10}
\]

where \( pc \) represents the crude oil price index, \( y \) is Canadian industrial production (“IP”), \( xr \) is the Canadian real effective exchange rate, \( tc \) is an index representing total compensation per hour worked, \( hp \) is Canadian house prices, \( i \) represents the Bank of Canada’s real bank rate, \( mc \) is Canadian mortgage credit, and \( FFR \) is the US’ real federal funds rate.

The choice of some of these domestic variables for evaluating exogenous monetary policy in small open economies is standard. Cushman and Zha (1997) in their paper on identification of exogenous monetary policy in Canada use, among others, IP, exchange rate, and Bank of Canada interest rate. Kim and Roubini (2000) in their paper looking at non-US G7 countries also use, among others, IP, an exchange rate, and a small open economy interest rate. The use of some form of commodity price index in the study of small open economies is due to a set of puzzles in the VAR literature. Sims (1992) found that increases in interest rates led to increases in prices, labeled the price puzzle. Furthermore, he found that these economies also saw currency depreciations following these interest rate increases (the exchange rate puzzle). Sims (1992) proposed that the price puzzle could be due to the fact that increases in interest rates are likely due to some form of inflationary pressure and are thus endogenous. He also argued, and Grilli and Roubini (1995) show evidence of this, that this explanation of why the price puzzle occurs could also be used to explain why the exchange rate puzzle arises.\(^{12}\) To address these puzzles, I follow Kim and Roubini (2000) by including a world commodity price (oil) to represent a foreign inflationary shock. Grilli and Roubini (1995) also show that it is important to control for US monetary policy when looking at empirical models of small open economies such as Canada, in order to isolate truly exogenous monetary policy. As in Kim and Roubini (2000) I add \( FFR \) to account for this issue. I include mortgage credit, housing prices, and a total compensation per hour worked index as relevant housing market variables.

The first equation is for the commodity price variable. Following the setups of Cushman and Zha (1997), Kim and Roubini (2000), Kozluk and Mehrotra (2009), Jannsen and Klein (2011), among others, I do not allow for any variables to affect the oil price index contemporaneously.

The second and fifth equations represent the sluggish real economy. This sluggishness makes it unlikely that the real economy or housing prices can respond contemporaneously to changes in other variables, except for house prices reacting to output and output responding to oil price changes,

\(^{11}\) Represents the Canadian real economy as at a monthly frequency GDP is not available.

\(^{12}\) Exchange rate puzzle: A contractionary shock in non-US G7 countries leads to an impact depreciation, contrary to the expected appreciation.
which makes sense as oil represents a significant portion of the Canadian economy. This setup for output is used in in Kim and Roubini (2000), Karame and Olmedo (2002), Kozluk and Mehrotra (2009), Jannsen and Klein (2011), among others. A price variable only affected contemporaneously by the real economy is used in the papers mentioned above as well as Cushman and Zha (1997). The difference though is that these papers look at CPI whereas I specifically look at housing prices. I make all other variables real to account for price effects not included in housing prices. I argue that the sluggishness in CPI applies in the case of housing prices as well and that this identification setup is appropriate.

The third equation is exchange rate, which is generally identified by allowing it to be affected by all variables contemporaneously. This is largely due to the fact that it is traded on a daily basis and thus can respond instantaneously to any changes in economic variables.

The fourth equation is for total compensation. Wage-like variables are not common in the literature surrounding small, open economies. Sims and Zha (2006) however do include it for their analysis of the US. In it, they argue that the only contemporaneous effect is likely to be from the state of the economy (real GDP) and the commodity price index. Given oil’s importance to the Canadian economy, this paper believes these arguments hold here.

The sixth equation is the monetary policy reaction function. I follow papers such as Sims and Zha (2006), Kim and Roubini (2000), and Cushman and Zha (1997) who argue that monetary policy authorities set the interest rate after seeing, among other variables, world oil prices, but not contemporaneous values of real output and prices. I also follow Cushman and Zha (1997) and argue that Canada’s monetary policy is likely to respond contemporaneously to monetary policy changes made in the US. I therefore include FFR contemporaneously.

Mortgage credit is the seventh equation and I argue that it works like a money demand equation which is generally identified in the literature with contemporaneous changes to output, prices and interest rates. I also argue that total compensation (or personal income) is a factor that will affect mortgage credit contemporaneously.

The last equation is for FFR and I argue here that FFR is contemporaneously exogenous to all the Canadian variables in the system but is affected contemporaneously by what happens in the market for oil. This argument follows the setup in Kim and Roubini (2000).

4 Results

This section describes the analysis of the primary specification results where monthly data is used and LTV is lagged by three months, or one quarter. Robustness checks are then analyzed in the

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13The International Energy Agency has Canada ranked sixth in oil production in 2011.
15See Kim and Roubini (2000), Sims and Zha (2006), among others.
next section to confirm the primary specification results.

Figure 3 below shows the pattern of mortgage credit growth and the vertical lines represent each LTV intervention.

From this figure it appears that LTV does not necessarily have the effects one would expect. The first change in 1982 was a tightening meant to slow down mortgage credit. It would appear the opposite occurred. Similarly, the change in 1992 was a loosening of mortgage credit which seemed to cause mortgage credit to fall for the first bit of the period and only rise in the second half. The 2006 loosening as well as the 2008 tightening seemed to have the desired effects. Summary statistics in Table 1 support these conclusions as mortgage credit growth prior to 1982 was -0.60%, increased to 0.55% for the 1982-1992 period, fell to 0.38% in the 1992-2006 period, increased to 0.79% during the 2006-2008 timeframe, and then fell in 2008 to 0.42%. The SVAR will allow me to assess whether the mixed results for the LTV effects hold true in a model-based framework.

Table 1: Mortgage Credit Growth Summary Statistics

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<td>percent</td>
<td>-0.60</td>
<td>0.55</td>
<td>0.38</td>
<td>0.79</td>
<td>0.42</td>
</tr>
</tbody>
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Source: Statistics Canada

4.1 Main Results

4.1.1 LTV Effects

Table 7 in Appendix A describes the coefficients, \( H_i, i = 1, 2, 3, 4 \), on the four LTV variables in the mortgage credit equation when we run the unrestricted VAR. These coefficients cannot be interpreted directly as they are in their reduced-form version. To determine the structural
coefficients one must take the coefficients in the $C$ matrix from equation (2) that correspond to the mortgage credit equation and perform $C^{-1}H_i$. Once the coefficients have been calculated new standard errors must be estimated. To do this, I use the bootstrap method using 3000 simulations. However, these coefficients and standard errors are all relative to the base period between January 1981 and Dec 1982. The question I am asking is how does the regulation change affect mortgage credit from one regulation environment to the next. The implication is that the coefficient and standard error on LTV_1 is correct, however the others need to be adjusted. LTV_1 is subtracted from LTV_2 to obtain the coefficient on the 1992 change, LTV_2 is subtracted from LTV_3 to obtain the 2006 change, and LTV_3 is subtracted from LTV_4 to obtain the 2008 change. The standard errors are calculated using $\sqrt{SE_1^2 + SE_2^2}$. Table 2 shows the new structural coefficients with their accompanying standard errors.

Table 2: SVAR LTV Coefficients (in percent)

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<td>Percent</td>
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<tr>
<td>L.LTV_1</td>
<td>0.671**</td>
<td>(2.372)</td>
<td></td>
<td></td>
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<tr>
<td>L.LTV_2</td>
<td>-0.087</td>
<td>(-0.208)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.LTV_3</td>
<td>0.035</td>
<td>(0.080)</td>
<td></td>
<td></td>
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<tr>
<td>L.LTV_4</td>
<td>-0.257</td>
<td>(-0.545)</td>
<td></td>
<td></td>
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<tr>
<td>Observations</td>
<td>362</td>
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$t$ statistics in parentheses  
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As Table 2 indicates, three of the four LTV coefficients are insignificant in terms of their effects on mortgage credit. Only the 1982 tightening is significant and it causes mortgage credit to move in the opposite direction to what we would expect; a tightening should cause mortgage credit to fall but according to these results it increases. The overall implication is that changes to LTV ratio regulation are unlikely to have the desired effect on mortgage credit.

4.1.2 Explanation of LTV-Mortgage Credit Relationship Results

As Figure 3 showed earlier, and as Table 2 supports, despite tightening in LTV regulation in 1982, there is a period of increasing mortgage credit followed only towards the end by a return to initial levels. One possible reason for the increases in the early part of the period was the introduction by CMHC of NHA mortgage backed securities which provided people owning NHA insured mortgages the ability to aggregate and sell these products to investors. This program allowed for a substantial increase in available funds for mortgages in Canada. Indeed, while the housing market grew by
14.8% from 1985-1986, it grew by 17.9% from 1986-1987 after the introduction of these mortgage backed securities. These securities totaled $456 million in 1987 which was approximately 1.8% of the overall growth in the housing market. The fall towards the end of the period could potentially be explained by the introduction by the Canadian government in 1988 of the Basel Accord which forced chartered banks to hold a certain amount of capital depending on the riskiness of their assets, including privately-insured mortgages. This made privately-insured mortgages much more expensive than CMHC-insured mortgages, damaging that side of the market. This disruption, if one presumes that not all people who were denied privately-insured mortgages could simply move to CMHC-insured mortgages, could have caused the decrease in mortgage credit that can be seen in Figure 3 prior to the 1992 LTV loosening. Proof of the Basel Accord effect comes from the fact that the spike in mortgage credit growth from 1986-1987 (3.1% higher growth than 1985-1986) was completely erased to the point where the growth rate from 1987-1988 shrank by 0.3% and by another 1.6% from 1988-1989. This lowering created a new average level of mortgage credit going into the 1992 loosening. Despite the fall towards the end of the 1982-1992 period, the spikes at the beginning caused average mortgage credit to be substantially higher compared with the 1981-1982 pre-LTV tightening period, explaining the wrong sign of the coefficient.

Both the introduction of the NHA mortgage backed securities and the implementation of the Basel Accord could have also contributed to the insignificance of the LTV loosening in 1992. First, the spike in mortgages during the 1980s may have allowed people, who otherwise would have had to wait for a loosening of LTV regulation, to buy early, reducing the effectiveness of the LTV increase. Further, despite the Basel Accord being implemented before the 1992 LTV regulation change, it may have continued to act as a drag on mortgage credit growth that would have arisen with the loosening.

The insignificance of both the 2006 loosening and 2008 tightening may be explained using the same economic event, the Great Recession, which began in the third quarter of 2007. As Table 3 indicates, the 2006 loosening caused mortgage credit growth to increase in 2007 compared with 2006 as expected, however it lost all those gains in the 2008 period before the tightening. Therefore analyzing the whole period shows insignificance of the 2006 loosening. Similarly, by the time the October 2008 tightening occurred, the large reductions in mortgage credit had already taken place, which appears to make the 2008 regulation change redundant. The uniqueness of the Great Recession likely implies that accounting for real GDP in the SVAR analysis is unlikely to capture all the demand and/or supply side shocks occurring during this time that may affect mortgage credit.  

16One unaccounted demand side shock may be the foreign purchasing of Canadian homes (see Stastna (2012, March 19)) from countries less affected by the Great Recession.
4.2 Monetary Policy Effects

Given the ineffectiveness of LTV regulation changes in affecting mortgage credit, I look to see whether monetary policy could be used to cause the desired slowdown in the housing market. Figure 4 shows the effect on mortgage credit from an exogenous monetary policy shock created by my SVAR identification setup. This figure shows that mortgage credit does indeed fall, though with a lag and with no significance. However, as Figure 5 shows, the economy also contracts when this same contractionary monetary policy shock is implemented, and in fact falls earlier than mortgage credit and with significance. Therefore, using monetary policy in order to potentially slow down a housing market bubble will have to be weighed against an economic contraction.
5 Robustness Checks

I perform three sets of robustness checks to try and measure the sensitivity of the primary specification results.

5.1 Different Lag on LTV Ratio

The first check involves lagging the LTV variables by 6 months, or two quarters, instead of 3 months. This robustness check will measure the sensitivity of the results to the timing of the transmission of the LTV regulation changes onto the housing market. As can be seen by Table 4, the results are identical to the primary specification; all LTV changes were insignificant except for the 1982 tightening which had the reverse effect to what would have been expected, namely mortgage credit increases. Timing of LTV lags is therefore not an issue.

As Figures 6 and 7 show, monetary policy continues to create the desired slowing of mortgage credit, though insignificant and with a lag, as well as the undesirable slowing of the economy as a whole, which is significant and happens earlier than the mortgage credit decrease.

Figure 5: Real Economy Reaction to Contractionary Monetary Policy Shock
Table 4: SVAR LTV Coefficients (in percent)

<table>
<thead>
<tr>
<th></th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>L.LTV_1</td>
<td>0.583*</td>
</tr>
<tr>
<td></td>
<td>(1.767)</td>
</tr>
<tr>
<td>L.LTV_2</td>
<td>-0.111</td>
</tr>
<tr>
<td></td>
<td>(-0.232)</td>
</tr>
<tr>
<td>L.LTV_3</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
</tr>
<tr>
<td>L.LTV_4</td>
<td>-0.294</td>
</tr>
<tr>
<td></td>
<td>(-0.565)</td>
</tr>
<tr>
<td>Observations</td>
<td>362</td>
</tr>
</tbody>
</table>

$t$ statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 6: Mortgage Credit Reaction to Contractionary Monetary Policy Shock
5.2 Quarterly Data

The second robustness check I perform involves using quarterly data instead of monthly data. A few small changes are made to the specification to account for the longer contemporaneous period. As the matrix below shows, I allow for total compensation to also be affected contemporaneously by the sluggish real economy. For monetary policy I follow Kim and Roubini (2000) who have argued that, at the quarterly frequency, excluding GDP and prices from contemporaneously affecting monetary policy is incorrect.\(^{17}\)

\[
\begin{pmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{pmatrix}
\begin{pmatrix}
u_{1t}^{pc} \\
u_{1t}^{y} \\
u_{1t}^{xr} \\
u_{1t}^{hc} \\
u_{1t}^{jp} \\
u_{1t}^{tc} \\
u_{1t}^{hp} \\
u_{1t}^{ffr}
\end{pmatrix}
= 
\begin{pmatrix}
0 & 0 & b_{11} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & b_{22} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & b_{33} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & b_{44} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & b_{55} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & b_{66} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{77} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{88}
\end{pmatrix}
\begin{pmatrix}
\Pi_{t}^{pc} \\
\Pi_{t}^{y} \\
\Pi_{t}^{xr} \\
\Pi_{t}^{hc} \\
\Pi_{t}^{jp} \\
\Pi_{t}^{tc} \\
\Pi_{t}^{hp} \\
\Pi_{t}^{ffr}
\end{pmatrix}
\]

\[(11)\]

As Table 5 indicates, all LTV regulation changes, including the 1982 tightening, have an insignificant effect on mortgage credit. The significance of the 1982 tightening has been lost implying that what effects were there were short-lived and thus only able to be seen at a monthly frequency. Over a quarterly frequency the effects on mortgage credit were smoothed out and thus appear insignificant. Figures 8 and 9 show that monetary policy continues to give the desired slowing of mortgage credit growth but at the expense of a decrease in economy activity as a whole. However, with quarterly data the drop in mortgage credit happens prior to the real economy slowdown, has no lag, and is significant.

\(^{17}\)Jannsen and Klein (2011) also allow for domestic monetary policy to be affected by GDP and prices.
Table 5: SVAR LTV Coefficients (in percent)

<table>
<thead>
<tr>
<th>Percent</th>
<th>L.LTV_1</th>
<th>1.698</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L.LTV_2</td>
<td>0.407</td>
</tr>
<tr>
<td></td>
<td>L.LTV_3</td>
<td>0.389</td>
</tr>
<tr>
<td></td>
<td>L.LTV_4</td>
<td>-0.656</td>
</tr>
</tbody>
</table>

Observations 123

$t$ statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 8: Mortgage Credit Reaction to Contractionary Monetary Policy Shock
5.3 Shorter Timeframe for LTV Effects on Mortgage Credit

The last robustness check I perform shortens the length of time a particular LTV change has to affect mortgage credit. One potential issue in the primary specification is that a particular LTV regulation change is allowed to affect mortgage credit for the entire length of time up until the next LTV regulation change. This could potentially cause a problem in that the effect on mortgage credit during that period of time is dominated not by the change itself but by the new level of mortgage credit that occurred because of this LTV adjustment. To fix this potential problem I look at two year windows whereby the LTV dummy variable is given a '1' for two years following the shock and a zero otherwise. As Table 6 indicates, results show that none of the LTV changes are significant, once again implying the ineffectiveness of LTV regulation. Furthermore, as Figure 10 indicates, we still see a drop in mortgage credit following the monetary policy shock but the delay is long almost reaching two years. This is made worse off by the fact that the real economy, as indicated in Figure 11, declines almost immediately.
Table 6: SVAR LTV Coefficients (in percent)

<table>
<thead>
<tr>
<th>Percent</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L.LTV_1</td>
<td>0.018</td>
<td>(0.126)</td>
<td></td>
</tr>
<tr>
<td>L.LTV_2</td>
<td>-0.020</td>
<td>(-0.128)</td>
<td></td>
</tr>
<tr>
<td>L.LTV_3</td>
<td>0.119</td>
<td>(1.123)</td>
<td></td>
</tr>
<tr>
<td>L.LTV_4</td>
<td>-0.165</td>
<td>(-1.375)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>362</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$t$ statistics in parentheses  
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 10: Mortgage Credit Reaction to Contractionary Monetary Policy Shock
6 Conclusion

The purpose of this paper was to determine whether LTV ratio regulation changes could be used as effective policy in cooling off a potentially overheated Canadian housing market. Using historical data, I evaluate whether the four major regulation changes during the 1981-2012 period had significant effects on mortgage credit and caused it to move in the expected direction.

Results indicate that adjustments to the LTV ratio did not have significant effects in three of the four regulation changes: the 1992 loosening, 2006 loosening, and 2008 tightening. Only the 1982 tightening had significant effects on mortgage credit and it moved it in the opposite direction to what we would expect. The implication is then that some other tool will have to be looked at in order to slow down the housing market.

One potential option is monetary policy. Results indicate that monetary policy does cause the desired slowdown in mortgage credit. However, the benefits of slowing mortgage credit growth will have to be weighed against the costs of a slowdown in the economy as a whole, a result this paper shows to be true. Other options that target slowdowns in mortgage credit without necessarily affecting the broader economy include different macroprudential regulations that look specifically at homeowners and/or banks, including the debt-to-income ratio and countercyclical capital requirements. These tools should be analyzed in future research to determine how effective they would be in targeting a mortgage credit slowdown.

Another area for further research would be to break down the data into different cities across the country. Given the disparity in Canadian population, LTV changes probably affect mortgage credit differently in various areas of the country, which would indicate that panel data by region might provide a more robust analysis. The Canadian market has few very large markets such as Toronto, Vancouver, Montreal, and Calgary that likely have very different dynamics compared with cities.
in provinces like Saskatchewan, Manitoba and some of the atlantic provinces. Thus LTV changes may have very different effects based on region. Given the relevance of the housing market as a leading indicator of the health of an economy, this paper believes this is an issue worth continuing to study.
## Appendix

### A Unrestricted VAR Coefficients

#### Table 7: Reduced Form VAR Results - Monthly Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>L.Oil</td>
<td>-0.00333**</td>
<td>(-2.05)</td>
</tr>
<tr>
<td>L2.Oil</td>
<td>0.00792***</td>
<td>(3.29)</td>
</tr>
<tr>
<td>L3.Oil</td>
<td>-0.00748***</td>
<td>(-4.78)</td>
</tr>
<tr>
<td>L.GDP</td>
<td>0.00517</td>
<td>(0.38)</td>
</tr>
<tr>
<td>L2.GDP</td>
<td>0.0181</td>
<td>(1.05)</td>
</tr>
<tr>
<td>L3.GDP</td>
<td>-0.00820</td>
<td>(-0.57)</td>
</tr>
<tr>
<td>L.XR</td>
<td>0.0137</td>
<td>(1.59)</td>
</tr>
<tr>
<td>L2.XR</td>
<td>-0.00565</td>
<td>(-0.46)</td>
</tr>
<tr>
<td>L3.XR</td>
<td>0.00456</td>
<td>(0.55)</td>
</tr>
<tr>
<td>L.Total compensation, index, real, log</td>
<td>-0.0110</td>
<td>(-0.86)</td>
</tr>
<tr>
<td>L2.Total compensation, index, real, log</td>
<td>0.00718</td>
<td>(0.53)</td>
</tr>
<tr>
<td>L3.Total compensation, index, real, log</td>
<td>0.00451</td>
<td>(0.38)</td>
</tr>
<tr>
<td>L.House Prices</td>
<td>0.0242</td>
<td>(0.44)</td>
</tr>
<tr>
<td>L2.House Prices</td>
<td>0.0179</td>
<td>(0.18)</td>
</tr>
<tr>
<td>L3.House Prices</td>
<td>-0.0323</td>
<td>(-0.60)</td>
</tr>
<tr>
<td>L.Policy Rate</td>
<td>-0.0000117</td>
<td>(-0.03)</td>
</tr>
<tr>
<td>L2.Policy Rate</td>
<td>-0.000599</td>
<td>(-1.54)</td>
</tr>
<tr>
<td>L3.Policy Rate</td>
<td>0.000181</td>
<td>(0.54)</td>
</tr>
<tr>
<td>L.Mortgage Credit</td>
<td>1.089***</td>
<td>(23.37)</td>
</tr>
<tr>
<td>L2.Mortgage Credit</td>
<td>0.0468</td>
<td>(0.65)</td>
</tr>
<tr>
<td>L3.Mortgage Credit</td>
<td>-0.146***</td>
<td>(-2.90)</td>
</tr>
<tr>
<td>L.FFR</td>
<td>-0.000912**</td>
<td>(-2.07)</td>
</tr>
<tr>
<td>L2.FFR</td>
<td>0.000414</td>
<td>(0.71)</td>
</tr>
<tr>
<td>L3.FFR</td>
<td>0.000516</td>
<td>(1.27)</td>
</tr>
<tr>
<td>L3.LTV_1</td>
<td>0.00728***</td>
<td>(5.08)</td>
</tr>
<tr>
<td>L3.LTV_2</td>
<td>0.00677***</td>
<td>(4.04)</td>
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<tr>
<td>L3.LTV_3</td>
<td>0.00702***</td>
<td>(3.77)</td>
</tr>
<tr>
<td>L3.LTV_4</td>
<td>0.00401**</td>
<td>(2.13)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.113</td>
<td>(-1.41)</td>
</tr>
</tbody>
</table>

Observations: 362

I statistics in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01
B Data

This Appendix describes the raw data along with an explanation of the transformations made for estimation purposes. The time frequency for this analysis is monthly and I look at the period between January 1981 and May 2012. The housing price data spans the whole period of interest and comes from Multiple Listing Service (“MLS”), and is the national monthly residential average price unadjusted for seasonality. As the pricing data is unadjusted for seasonality, housing units sold are used in order to make this adjustment.

The residential mortgage credit data was monthly and gathered from Statistics Canada (“StatsCan”) and represents residential mortgage credit, outstanding balances of major private institutional lenders. The data is seasonally adjusted and spans the entire period of relevance. The data is not broken down by size of downpayment or value of the house.

The Bank of Canada’s policy rate was taken from the Bank Rate database of the Bank of Canada, specifically v122530, a monthly set. The Bank Rate is defined as the “rate of interest that the Bank of Canada charges on short-term loans to financial institutions.”\(^{18}\) The Bank of Canada specifies a target band for the market rate on overnight transactions. The Bank Rate itself is the upper band. The lower band is the rate the Bank of Canada pays on settlement balances to financial institutions participating in the system. Data is available for the entire period of analysis. The distance from lower to upper band is 50 bps with the target overnight rate in the middle.\(^{19}\)

As GDP was not available at a monthly frequency I use Canada’s industrial production index from the IMF’s International Financial Statistics (“IFS”). The data is seasonally adjusted, and spans the entire period.

CPI data is from StatsCan and is seasonally adjusted with a 2009 basket. It is monthly, spans the entire period of relevance, and includes all items except for the eight most volatile components.

Total compensation per hour data comes from IFS and represents an hourly earnings index with 2005 as a base year.

The oil price is an index available monthly and is an average of three different forms of oil namely WTI, Dated Brent, and Dubai Fateh.

The federal funds rate (“FFR”) is the rate at which deposit-taking institutions trade funds, that are held at the Federal Reserve, with each other. It is available as a monthly set.

The LTV ratio is broken into four separate dummy variables. In Canada, over the period under investigation, the regulatory maximum LTV ratio was either set at 90%, 95%, or 100%, with all changes representing 5% jumps in a given direction. There were four changes to the regulatory maximum: 1982, 1992, 2006, and 2008. From 1981-1982 the maximum was set at 95%. In 1982,

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\(^{18}\)Bank of Canada website.

\(^{19}\)Target overnight rate is the rate used in the announcements made by the Bank of Canada, which occur eight times a year.
the Federal Government raised the amount that Canadians had to put as a downpayment from 5% to 10%, implying the LTV ratio went from 95% to 90%. In 1992, CMCH brought to market the First Home Loan Insurance (“FHLI”) which had as a provision that all first time home buyers would only have to put a downpayment of 5%. In 1998, CMHC allowed for everyone, not just first time home buyers to only have to put down 5%. In October 2006, Genworth introduced insurance for LTV ratios of 100%, while in November 2006, CMHC began selling its “Flex 100” product which meant that home buyers could put zero down and get a 100% loan for a home purchase. In October 2008, in the midst of new rules for government insured mortgages, including reducing the maximum amortization period to 35 years, LTV ratios were dropped to 95%.

In terms of transformations, first the unadjusted housing prices were adjusted for seasonality by multiplying current month average price by current quarter units sold and adding this to the 11 previous months of the same calculation, then dividing this total by total units sold for those 12 months. At this point, all nominal variables were transformed into real variables, after which the logarithm was taken, except for interest rates. The nominal variables, except interest rates, were divided by CPI to make real, while inflation was subtracted from interest rates to make them real. Monthly dummies are included to account for any variables that are not seasonally adjusted. A time trend variable is included as well. 

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20 Mortgage rates are not included because they are argued here to be outcome variables of both the housing market and monetary policy variables, which are included. Further, monetary aggregates are also excluded as it has been argued that they are not a good representation of monetary policy shocks. See Bernanke (1992) and Cushman and Zha (1997).
References


