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Do Loan-to-Value Ratio Regulation Changes Affect Canadian Mortgage Credit?*

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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 either had insignificant effects on mortgage credit, or caused it to move contrary to expectations. Only the 2008 tightening of LTV was weakly significant. 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.

Keywords: Mortgage credit, macroprudential regulation, loan-to-value, monetary policy

JEL Classification: G21, G28, E52

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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 housing-targeted LTV policy as a way of slowing down the housing market without affecting the rest of the real economy. I find that, despite the targeted nature of LTV policy, the effects on mortgage credit are mostly insignificant or contrary to expectations. This result indicates that either this policy tool is ineffective, or supply and demand shocks that are difficult to completely account for are outweighing the regulation changes.

The contribution of this paper is that it takes an empirical look at the effects on residential mortgage credit in Canada from the four major LTV policy changes that occurred over the 1981-2012 time period, and does it in a structural vector autoregression ("SVAR") setting. While plenty of papers on the housing market 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. Furthermore, while some papers have begun to investigate the relationship between LTV and the economy[3,4], this paper has not seen any analyzed, specifically for Canada, within the traditional SVAR framework, looked at as far back as this paper does. By using a SVAR, one can analyze both the effects of the past exogenous LTV macroprudential regulation, as well as forecasting the potential impact of broader monetary policy shocks, which are generated using the endogenous relationships between a set of macroeconomic variables. As policymakers grapple with using macroprudential regulation versus monetary policy to respond to potential asset bubbles, this paper sheds light on these choices for Canada.

The SVAR model is developed in this paper using some standard identification setups from 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 either had no significant effects on mortgage credit

[1] The Economist (2013, August 31)

[2] Iacoviello (2002), Goodhart and Hofmann (2008), Elbourne (2008)

[3] Lamont and Stein (1999) and Almeida, Campello, and Liu (2006)

[4] Kuttner and Shim (2013) do a panel regression of 57 countries where LTV's effects on house prices and mortgage credit are investigated.

or caused this variable to move contrary to expectations. The 2008 tightening was the one LTV regulation change that had significance and moved in the expected direction; however, it was only weakly significant. The mostly ineffective results for LTV on mortgage credit are inline with the Kuttner and Shim (2013) findings in their 57 country panel regression.

There are multiple ways of interpreting the insignificant findings. The first possibility is that there are a set of supply and demand shocks that are overwhelming the LTV effects and are difficult to control for. 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.[5]

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 was only enforced by law beginning in 1992, and it therefore may have continued to be a drag on mortgage credit.

The lack of significance in the 2006 loosening may be explained 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, leveled off in the 2008 period before the tightening. This lack of continued increase in mortgage credit growth may explain the insignificant results from the 2006 loosening. While I have accounted for real economic variables 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.

Another interpretation of the results is that even if these shocks were completely controlled for, LTV effects on mortgage credit would still be insignificant. One possible explanation for why this is true starts with the fact that if LTV ratios are tightened, the slowdown in mortgage credit revenue for lenders occurs at the point where the maximum has changed, e.g. those that were able to put down 5% no longer are able to if the upper bound on LTV ratios is changed to 90%. However, lenders may compensate by lowering lending rates for people putting down larger downpayments, causing an increase in mortgage credit at these levels. If true, the overall effect of the LTV tightening could be negated. A similar story would be true for a LTV regulation loosening. By gaining a riskier consumer, if lenders can't charge rates they would like due to competition for this new market, they may compensate by increasing lending rates at other downpayment levels, negating some of

[5]Bank of Canada: Data and Statistics Office

the loosening effects. Without disaggregated mortgage credit data, no further testing of this theory is feasible.

No matter which interpretation is chosen, the implication is that it is not clear that LTV regulation changes will be effective. Therefore the broader monetary policy tool may need to be used if slowing down mortgage credit is truly desired. However, caution is warranted given the broad nature of the policy rate, as a contractionary monetary policy shock in this analysis is shown to have large negative spillover effects on the rest of the economy, despite being somewhat successful in slowing down mortgage credit. Other macroprudential instruments that affect homeowners and/or banks, such as the debt-to-income ratio and countercyclical capital requirements[6], could be considered as well and should be investigated in future research in order to potentially avoid use of the broad monetary policy tool.

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 perform sensitivity analyses. 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 owned CDN$948 billion of the CDN$1,113 billion in mortgage credit. Within the deposit-taking institutions, chartered banks owned 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 refinancer, 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.

[6]Debt-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.

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, and 100% of their insurance is guaranteed by the Government of Canada. 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. The implication of these guarantees is that there is a strong relationship between the rules set out by the Government, including LTV ratios, the insurance companies, and the chartered banks.

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 currently 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.[7] This figure shows the close relationship between mortgage credit and the real economy in which a correlation of 0.955 is found.[8]

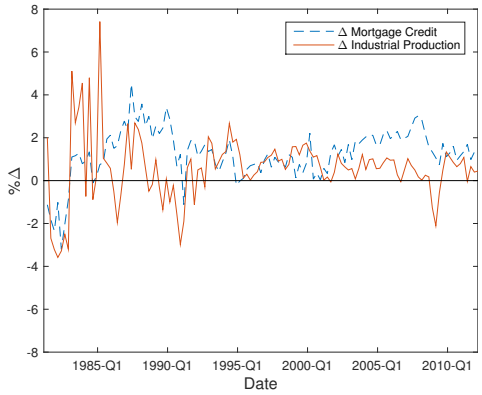

Figure 1: Mortgage Credit as Leading Indicator

Furthermore, as much of the discussion concerning the housing market following the recession has been about housing prices, it is important to determine whether there is also a close relationship

[7] Canada's national statistics agency, Statistics Canada, had a Canadian Composite Leading Indicator variable over the period under analysis, which comprises ten components that lead cyclical activity in the Canadian economy, including a housing index.

[8] 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.

between mortgage credit and housing prices. Figure 2 shows that there is in fact a close correlation between house prices and mortgage credit growth in Canada with a correlation coefficient of 0.925. This is consistent with Tsounta (2009) who finds that the growth rate of housing prices is positively affected by mortgage credit growth. If changes to mortgage credit are driving housing prices, and mortgage credit represents the vulnerabilities of households, it is important to understand how macroprudential regulation, such as LTV ratios, will affect this variable.

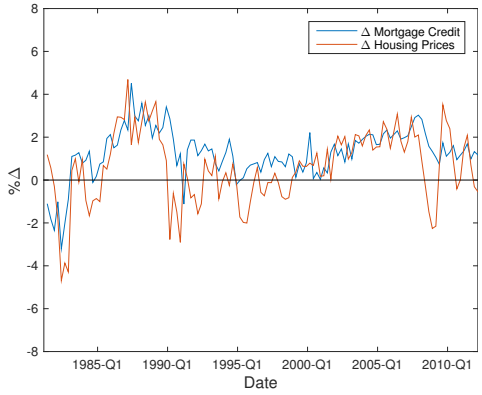

Figure 2: House Prices and Mortgage Credit Relationship

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. Furthermore, this paper is unique in its evaluation of the exogenous variables in a SVAR model, and as such, the methodology, while based off standard bootstrapping, is novel in this framework.

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:

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

in which $\mathbf{y_t} = (y_{1t}, ...y_{Kt})$ is a $K \times 1$ vector of dependent variables, $x_t = (x_{1t}, ...x_{4t})$ is a 4×1 vector of independent variables, the $\mathbf{A_1}$ to $\mathbf{A_s}$ are $K \times K$ matrices of parameters, $\mathbf{H_1}$ is a $K \times 4$ matrix of parameters, and the errors $\mathbf{u_t}$ are assumed to be white noise with $\mathbf{E(u_t)} = \mathbf{0}$, $\mathbf{E(u_t u_t^{'})} = \mathbf{\Sigma}$, and $\mathbf{E(u_t u_s^{'})} = \mathbf{0}$ for $t \neq s$.

With this reduced form estimation one 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:

$$\mathbf{C y_t} = \mathbf{g} + \mathbf{D_1 y_{t-1}} + ... + \mathbf{D_s y_{t-s}} + \mathbf{M_1 x_{t-1}} + \mathbf{B s_t} \tag{2}$$

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

$$\mathbf{C u_t} = \mathbf{B s_t} \tag{3}$$

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:

$$\mathbf{C}[(\mathbf{I_K} - \mathbf{D_1 L} - ... + \mathbf{D_s L^s})\mathbf{y_t}] - (\mathbf{M_1 L})\mathbf{x_t} = \mathbf{C u_t} = \mathbf{B s_t} \tag{4}$$

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

$$\mathbf{\Sigma} = \mathbf{F F}^{'} \tag{5}$$

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

$$\mathbf{A(L) y_t} = \mathbf{v} + \mathbf{H_1 x_{t-1}} + \mathbf{u_t} \tag{6}$$

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

$$\mathbf{y_t} = \mu + \mathbf{M_1 x_{t-1}} + \psi(\mathbf{L})\mathbf{u_t} \tag{7}$$

and, depending on how many lags, we can write the reduced form moving average representation as:

$$\mathbf{y_t} = \mu + \mathbf{M_1 x_{t-1}} + \sum_{\mathbf{s=0}}^{\infty} \psi_{\mathbf{s}} \mathbf{u_{t-s}} \tag{8}$$

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

$$\mathbf{y_t} = \mu + \mathbf{M_1 x_{t-1}} + \sum_{\mathbf{s=0}}^{\infty} \mathbf{\Theta_s s_{t-s}} \tag{9}$$

giving the desired causal interpretation. This impulse response function is only possible if the underlying VAR in (1) is stable.[9]

As the primary interest of this paper is the set of coefficients on the LTV terms in the exogenous M_1 matrix corresponding to the mortgage credit equation, I focus on these.[10] The LTV ratio is broken into four separate dummy variables, LTV_i, where $i = 1, 2, 3, 4$, and a 1 is given during a particular regulation period with a zero otherwise, with the base period being before the first regulation change. 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: July 1982, January 1992, October 2006, and October 2008. From 1981-1982 the maximum was set at 95%. In 1982, 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, CMHC 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%.

Furthermore, when evaluating the M_1 matrix, 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 how mortgage credit changes from one LTV ratio regulation to the next. Therefore once the coefficients and standard errors have been determined I have to subtract each coefficient from

[9] Stability implies not only that the variables are covariance stationary, but also the VAR must be invertible.

[10] Despite pervasive use of lagging variables as a way around endogeneity, including by Kuttner and Shim (2013) in the LTV/housing market literature, it is acknowledged here that it remains possible that policymakers may make regulation changes in response to expectations about future mortgage credit growth or because of omitted variables that are correlated with this credit.

the period before's coefficient except for the first change, which is with respect to the base period. Furthermore, the standard errors for these new coefficients will come from the formula:

$$\begin{aligned} Var(X-Y) &= Var(X)+Var(Y)-2Cov(X,Y) \\ St.\,Error(X-Y) &= \sqrt{(St.\,Error(X))^2+(St.\,Error(Y))^2-2Cov(X,Y)} \end{aligned} \tag{10}$$

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 the housing market 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 using AIC was 2 months, however autocorrelation issues arose and so I used a lag length of 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:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{33} & a_{35} & a_{36} & a_{37} & a_{38} \\ a_{41} & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & a_{52} & 0 & 0 & 1 & 0 & 0 & 0 \\ a_{61} & 0 & 0 & 0 & 0 & 1 & 0 & a_{68} \\ 0 & a_{72} & 0 & a_{74} & a_{75} & a_{76} & 1 & 0 \\ a_{81} & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} u_t^{pc} \\ u_t^{y} \\ u_t^{xr} \\ u_t^{tc} \\ u_t^{hp} \\ u_t^{i} \\ u_t^{mc} \\ u_t^{ffr} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{88} \end{pmatrix} \begin{pmatrix} s_t^{pc} \\ s_t^{y} \\ s_t^{xr} \\ s_t^{tc} \\ s_t^{hp} \\ s_t^{i} \\ s_t^{mc} \\ s_t^{ffr} \end{pmatrix} \tag{11}$$

where pc represents the crude oil price index, y is Canadian industrial production ("IP")[11], 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. Data information on all variables can be found in Appendix C.

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 the Bank of Canada interest rate. Kim and Roubini (2000) in their paper looking at non-US G7 countries also use, among

[11] Represents the Canadian real economy as at a monthly frequency GDP is not available.

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, in contrast to the expected appreciations: 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 supply shock pressures, both domestic and foreign, and are thus endogenous. He also argued, and Grilli and Roubini (1995) show evidence of this, that this inflationary explanation of why the price puzzle occurs could also be used to explain why depreciations occur despite interest rate increases. To address these puzzles, I follow Kim and Roubini (2000) by including a world commodity price (oil) to proxy for foreign inflationary shocks. 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, which makes sense as oil represents a significant portion of the Canadian economy.[12] This setup for output is used in papers such as Kim and Roubini (2000), Karame and Olmedo (2002), Kozluk and Mehrotra (2009), and Jannsen and Klein (2011). 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 for the 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.[13]

The fourth equation is for total compensation. Sims and Zha (2006) argue that, in the case of the US, 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

[12]The International Energy Agency has Canada ranked sixth in oil production in 2011.

[13]Cushman and Zha (1997), Kim and Roubini (2000), Kozluk and Mehrotra (2009), and Jannsen and Klein (2011).

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 when considering monthly data. 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.[14] 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, to make exogenous. Robustness checks are then analyzed in the 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.

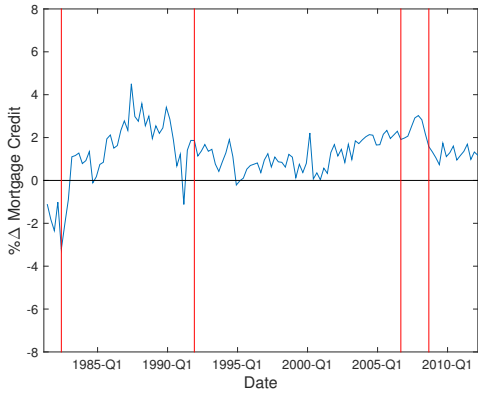

Figure 3: Mortgage Credit Growth and LTV Regulation Changes

From this figure it appears that LTV does not necessarily have the effects one would expect; at least for the earlier regulation changes. The first change in 1982 was a tightening meant to slow

[14] See Kim and Roubini (2000) and Sims and Zha (2006).

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 after 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

Monthly Average	**1981-1982**	**1982-1992**	**1992-2006**	**2006-2008**	**2008-2012**
percent	-0.60	0.55	0.38	0.79	0.42

Source: Statistics Canada

4.1 Main Results

4.1.1 LTV Effects

Table 7 in Appendix A describes all the unrestricted VAR coefficients in (1) for the mortgage credit equation including H_i, $i = 1, 2, 3, 4$, on the four LTV variables. These coefficients cannot be interpreted directly as they are in reduced-form. To determine the structural coefficients one must take the coefficients estimated in the C matrix from equation (2) that correspond to the mortgage credit equation and perform $C^{-1}H_i$, which gives you the M_1 matrix in equation (9). 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, as shown in Appendix B, are all relative to the base period between January 1981 and December 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 in Appendix B 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 equation (10) above. Table 2 shows the new structural coefficients for the LTV effects on mortgage credit, with their accompanying t-statistics.

As Table 2 indicates, three of the four LTV coefficients are either insignificant in terms of their effects on mortgage credit, or cause mortgage credit to move in the opposite direction to what is expected; the 1982 tightening should have caused mortgage credit to fall but according to these results it increased significantly. The one significant LTV regulation change in the appropriate direction is the 2008 tightening, which caused a weakly significant fall in mortgage credit. The overall

Table 2: SVAR LTV Coefficients (in percent)

	(1)
	Percent
LTV_1	0.671**
	(2.372)
LTV_2	-0.087
	(-0.736)
LTV_3	0.035
	(0.394)
LTV_4	-0.257*
	(-1.713)
Observations	362

t statistics in parentheses

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

implication is that changes to LTV ratio regulation are unlikely to have the desired significant effects on mortgage credit.[15]

4.1.2 Explanation of LTV-Mortgage Credit Relationship Results

One possible explanation for why LTV effects are largely insignificant or in the wrong direction is it may be difficult to account for all demand and supply-side shocks occurring simultaneously. 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 tapering off. 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.

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 significantly 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 growth that can be seen in Figure 3 prior to the 1992

[15] I note that evaluating LTV effects on housing prices also produces mostly insignificant results. Only the 1992 LTV loosening had a significant impact on housing prices causing them to increase. Therefore, the results are not sensitive to the housing market variable used.

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. Despite this 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 on 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, as the Basel Accord only began to be enforced by law in 1992, despite being implemented in 1988, it may have continued to act as a drag on mortgage credit growth that would have arisen with the loosening.

The insignificance of the 2006 loosening may be explained using the Great Recession, which began in the third quarter of 2007. As Table 3 indicates, after the 2006 loosening, mortgage credit growth increased in 2007 compared with 2006 as expected, however there were no significant continued gains in the 2008 period before the tightening. Therefore analyzing the whole period may not produce enough LTV-related growth to create significance as a result of the 2006 loosening. The uniqueness of the Great Recession implies that accounting for the real economy variables that I have 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.

Table 3: Mortgage Credit Growth After 2006 Loosening

Year over Year	**2006**	**2007**	**2008**
percent	8.29	9.45	9.60

Source: Statistics Canada

It is perhaps true that if it was possible to account for all these demand and supply shocks, LTV would have a significant effect on mortgage credit, and in the direction one would expect. However, there is reason to suspect that this may not be the case. It could be that lenders adjust their lending rates after a LTV regulation change. Specifically, if LTV is tightened, lenders will lose out on loans that were given to people at the old maximum LTV ratio. In reaction to this, lenders may decrease rates to stimulate demand for people who can afford larger downpayments. If they do lower rates, mortgage credit may appear to not change at all. A similar story could emerge if LTV regulation is instead loosened. The new market obtained by lenders when LTV is loosened will likely be riskier. To compensate for this additional risk, lenders would like to charge a higher interest rate. If their ideal rate is not possible due to strong competition for this new market, lenders may increase interest rates at other LTV ratio levels, thereby negating some of the loosening effect. Without disaggregated mortgage credit data by size of downpayment, investigating this option further is not

currently feasible.

No matter where one falls on the possible explanations described in this section for the insignificant effects of LTV regulation changes on mortgage credit, it appears unlikely that they will be effective in slowing down mortgage credit.

4.2 Monetary Policy Effects

Given the ineffectiveness of LTV regulation changes on 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.[16] Figure 5 indicates that the housing market can be significantly slowed with monetary policy shocks if housing prices are evaluated. However, Figure 5 also indicates that even if slowing down the housing market is considered a success according to the mortgage credit and housing prices figures, they come at the expense of a decrease in the real economy. Therefore, replacing LTV regulation changes with monetary policy in order to potentially slow down a housing market bubble will have to be weighed against the economic contractions that will occur.

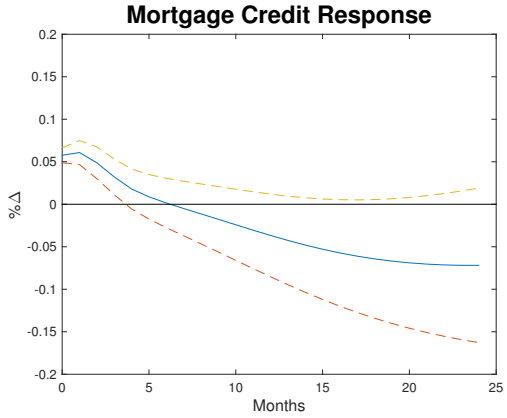

Figure 4: Mortgage Credit Reaction to Contractionary Monetary Policy Shock

[16]Significance throughout this paper is based off 68% confidence bands calculated using asymptotic standard errors.

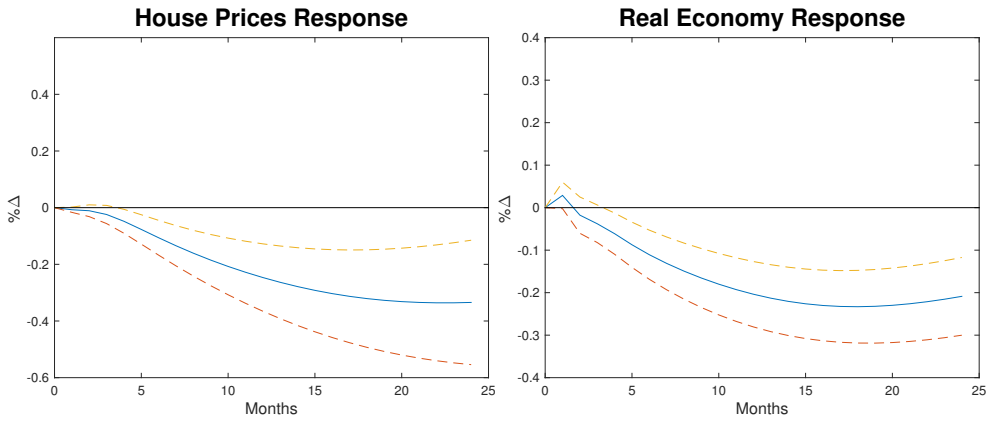

Figure 5: Housing Prices and Real Economy Reaction to Contractionary Monetary Policy Shock

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 similar to the primary specification; all LTV changes except the 2008 tightening either had insignificant effects on mortgage credit or moved it in the wrong direction. One change is that the 2008 tightening is more significant than in the primary results. Overall though, the timing of LTV lags is not an issue.

As Figure 6 shows, monetary policy continues to cause mortgage credit to slow, though it is insignificant and with a lag, while Figure 7 indicates that monetary policy can slow the housing market through housing prices at a significant level. The problem is once again that slowing down the housing market comes at the expense of the real economy.

Table 4: SVAR LTV Coefficients (in percent)

	(1) Percent
LTV_1	0.583*
	(1.767)
LTV_2	-0.111
	(-1.143)
LTV_3	0.028
	(0.296)
LTV_4	-0.294***
	(-2.834)
Observations	362

t statistics in parentheses

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

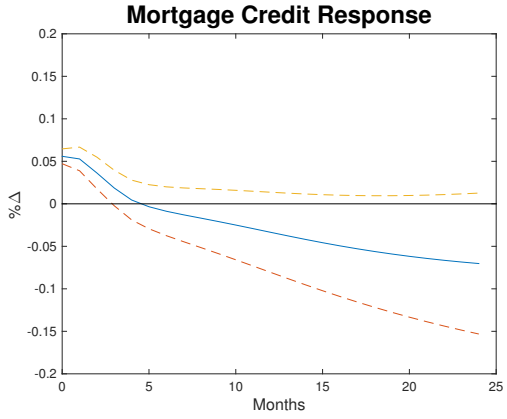

Figure 6: Mortgage Credit Reaction to Contractionary Monetary Policy Shock

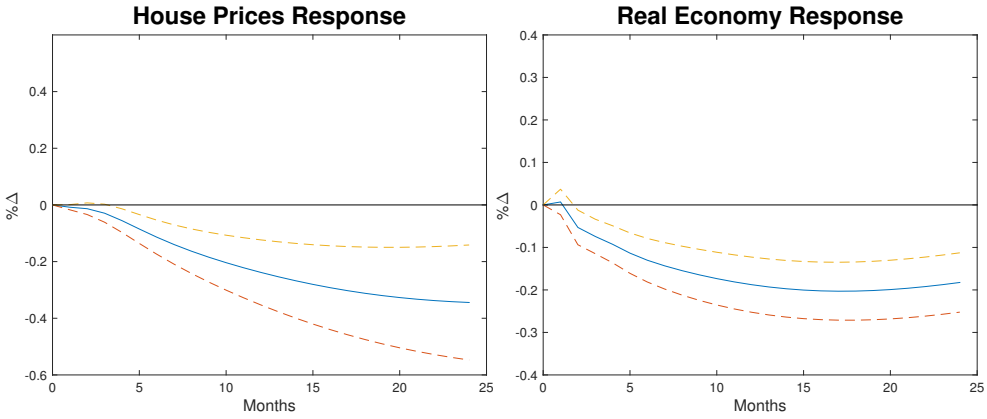

Figure 7: Housing Prices and Real Economy Reaction to Contractionary Monetary Policy Shock

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, GDP and prices should be included contemporaneously for the monetary policy equation.[17]

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{33} & a_{35} & a_{36} & a_{37} & a_{38} \\ a_{41} & a_{42} & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & a_{52} & 0 & 0 & 1 & 0 & 0 & 0 \\ a_{61} & a_{62} & 0 & 0 & a_{65} & 1 & 0 & a_{68} \\ 0 & a_{72} & 0 & a_{74} & a_{75} & a_{76} & 1 & 0 \\ a_{81} & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} u_t^{pc} \\ u_t^{y} \\ u_t^{xr} \\ u_t^{tc} \\ u_t^{hp} \\ u_t^{i} \\ u_t^{mc} \\ u_t^{ffr} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{88} \end{pmatrix} \begin{pmatrix} s_t^{pc} \\ s_t^{y} \\ s_t^{xr} \\ s_t^{tc} \\ s_t^{hp} \\ s_t^{i} \\ s_t^{mc} \\ s_t^{ffr} \end{pmatrix} \tag{12}$$

As Table 5 indicates, all LTV regulation changes are now insignificant in terms of their effect on mortgage credit. The significance of the 1982 tightening, despite being in the wrong direction, and the 2008 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. Figure 8 shows that monetary policy continues to give the desired slowing of mortgage credit growth, and this time with significance and no lag. Figure 9 indicates once again the ability of monetary policy to slow the housing market through housing prices. However, Figure 9 continues to indicate that slowing down the housing market comes at the expense of economic activity as a whole.

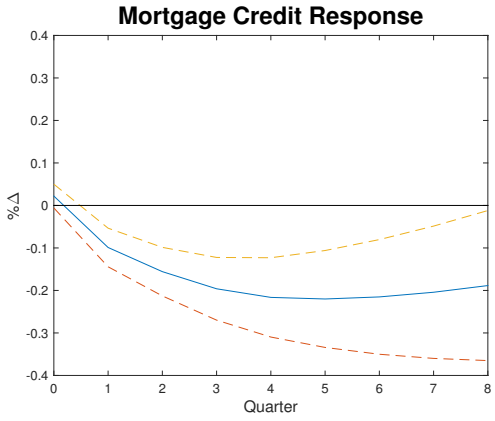

Figure 8: Mortgage Credit Reaction to Contractionary Monetary Policy Shock

[17] Jannsen and Klein (2011) also allow for domestic monetary policy to be affected by GDP and prices contemporaneously using their quarterly frequency data.

Table 5: SVAR LTV Coefficients (in percent)

	(1)
	Percent
LTV_1	1.709
	(1.064)
LTV_2	0.529
	(1.445)
LTV_3	0.489
	(1.460)
LTV_4	-0.728
	(-1.471)
Observations	123

t statistics in parentheses

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

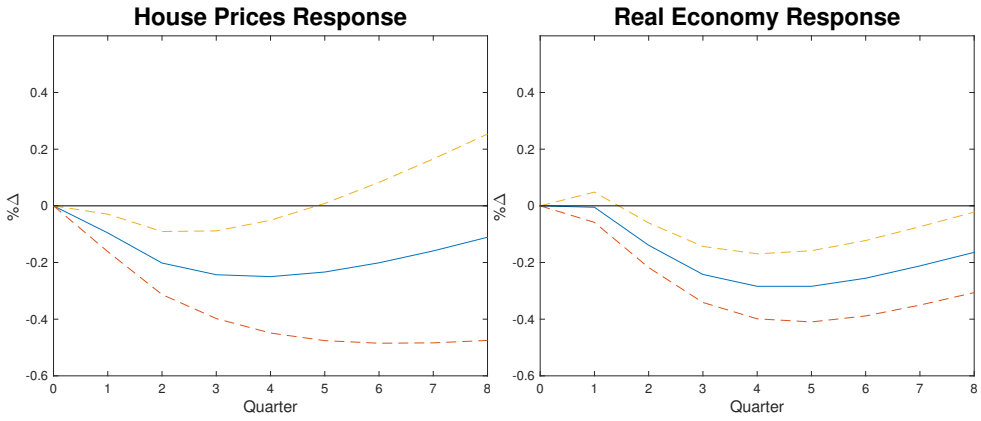

Figure 9: Housing Prices and Real Economy Reaction to Contractionary Monetary Policy Shock

5.3 Shorter Timeframe for LTV Effects on Mortgage Credit

The final robustness check 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. The problem is that the effect on mortgage credit during that period of time is then dominated not by the change itself but by the new level of mortgage credit that occurred because of this LTV adjustment. This effect would give off the appearance of insignificant LTV effects on mortgage credit. 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 the first three LTV changes are insignificant, while the 2008 tightening remains weakly significant. The implication again is that LTV regulation will mostly be ineffective.

The discussion on the insignificance being due to unaccounted for shocks would still apply to both the 1992 and 2006 regulation changes but would no longer be relevant for the 1982 tightening, as the introduction of mortgage-backed securities occurred after the two year window. The fact that the significant increase is lost at this shorter window shows the importance of unaccounted demand and supply-side shocks. However, the fact that LTV effects turn insignificant would lend credence to the notion that accounting for these types of shocks may still not produce the desired slowdown in mortgage credit using this form of macroprudential regulation. The earlier discussion on lenders compensating for tightenings by lowering rates at other downpayment levels would continue to explain this insignificance.

Evaluating the effects of monetary policy shocks as a replacement to LTV regulation changes is assessed in Figures 10 and 11. Figure 10 indicates no drop in mortgage credit from contractionary shocks, though housing prices are significantly lowered as shown in Figure 11. But as seen before, any effective slow down in the housing market comes at the expense of the real economy.

Table 6: SVAR LTV Coefficients (in percent)

	(1)
	Percent
LTV_1	0.018
	(0.126)
LTV_2	-0.020
	(-0.127)
LTV_3	0.119
	(1.164)
LTV_4	-0.165*
	(-1.721)
Observations	362

t statistics in parentheses

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

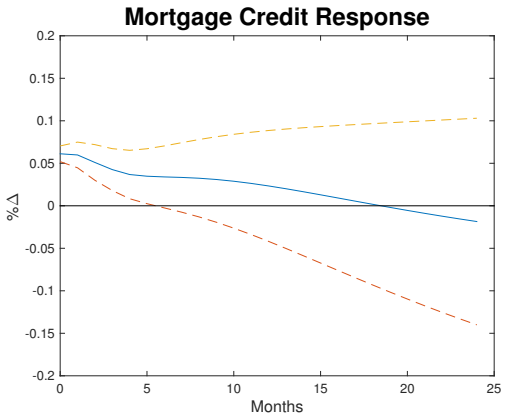

Figure 10: Mortgage Credit Reaction to Contractionary Monetary Policy Shock

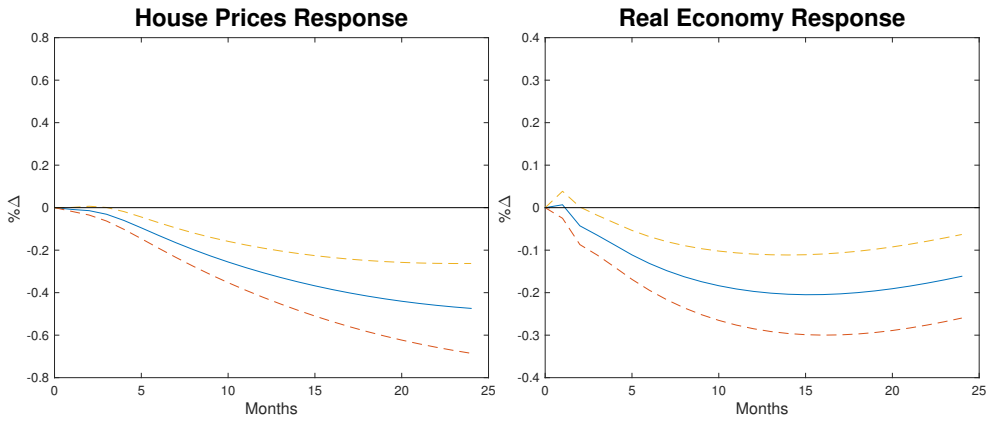

Figure 11: Housing Prices and Real Economy Reaction to Contractionary Monetary Policy Shock

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 LTV regulation changes that occurred 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 had either no significant effects on mortgage credit, or caused it to move contrary to expectations, in three of the four regulation changes: the 1982 tightening, 1992 loosening, and 2006 loosening. Only the 2008 tightening had significant effects on mortgage credit in the right direction; however, the significance was weak. The implication is that, whether the insignificance is due to unaccounted demand and supply shocks or adjustments by mortgage lenders to lending rates, it does not appear to be the case that LTV regulation will be effective in slowing down mortgage credit. Therefore, some other tool will have to be looked at in order to achieve this goal.

One potential option is monetary policy. Results indicate that monetary policy does cause the desired slowdown in mortgage credit, though the results are not always significant. Furthermore, 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. 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 and a panel analysis would provide a more robust analysis. Given the relevance of the housing market as a leading indicator of the health of the Canadian 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

	(1)
	Mortgage Credit Equation Coefficients
Mortgage Credit, real, log	
L.Oil	-0.00333**
	(-2.05)
L2.Oil	0.00792***
	(3.29)
L3.Oil	-0.00748***
	(-4.78)
L.GDP	0.00517
	(0.38)
L2.GDP	0.0181
	(1.05)
L3.GDP	-0.00820
	(-0.57)
L.XR	0.0137
	(1.59)
L2.XR	-0.00565
	(-0.46)
L3.XR	0.00456
	(0.55)
L.Total compensation	-0.0110
	(-0.86)
L2.Total compensation	0.00718
	(0.53)
L3.Total compensation	0.00451
	(0.38)
L.House Prices	0.0242
	(0.44)
L2.House Prices	0.0179
	(0.18)
L3.House Prices	-0.0323
	(-0.60)
L.Policy Rate	-0.0000117
	(-0.03)
L2.Policy Rate	-0.000599
	(-1.34)
L3.Policy Rate	0.000181
	(0.54)
L.Mortgage Credit	1.089***
	(23.37)
L2.Mortgage Credit	0.0468
	(0.65)
L3.Mortgage Credit	-0.146***
	(-2.90)
L.FFR	-0.000912**
	(-2.07)
L2.FFR	0.000414
	(0.71)
L3.FFR	0.000516
	(1.27)
L3.LTV_1	0.728***
	(5.08)
L3.LTV_2	0.677***
	(4.04)
L3.LTV_3	0.702***
	(3.77)
L3.LTV_4	0.401**
	(2.13)
Observations	362

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Coefficients in terms of percent change

B Coefficients and Standard Errors After Bootstrapping

Table 8: SVAR LTV Coefficients (in percent)

	(1)
	Percent
LTV_1	0.671**
	(0.283)
LTV_2	0.584*
	(0.306)
LTV_3	0.620*
	(0.320)
LTV_4	0.363
	(0.347)
Observations	362

Bootstrap standard errors in parentheses

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

C 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]

[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.

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 real, 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.

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.[20]

Monthly dummies are included to account for any variables that are not seasonally adjusted. A time trend variable is included as well.

[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).

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