The Macroeconomic Effects of Uncertainty on the Canadian Economy

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Abstract

The 2007-2008 global financial crisis caused severe economic damage and the subsequent recovery has been slow and stagnant. Immediately following these events, a great deal of literature focusing on the effects of uncertainty emerged. Much of the research has demonstrated that uncertainty shocks negatively impact economies. Moreover, research shows that elevated uncertainty has hindered the recovery. Despite this, very little work about uncertainty has been advanced for Canada. In turn, this paper uses a Structural Vector Autoregressive (SVAR) model to estimate the impact of Canadian and United States (US) uncertainty shocks on the economy. The results indicate that Canadian uncertainty shocks, after taking into account US uncertainty, have minimal effects on the economy. Gross Domestic Product (GDP) and the Bank Rate (BR) are the two variables that are negatively affected in a statistically significant manner. Unsurprisingly, the impact of US uncertainty shocks produce negative economic fluctuations on all Canadian variables and thus, the economy. The conclusion drawn from this paper is that Canadian and US uncertainty have a negative impact on the Canadian economy but the impact of US uncertainty is far greater.

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Section 1

1.1 Introduction

Since the Great Recession in 2008, uncertainty has become a popular topic among academics and a serious concern for policy makers. The global financial crisis that occurred seven years ago was arguably the worst since the Great Depression. As a results, severe economic damage transpired and people along with the economics world were left baffled. Few if any, including experts, really knew what the future had in store. The combination of events left us in somewhat unchartered territory; we came out of the recession with more public debt than we started; governments were bailing out major companies much to the chagrin of taxpayers; credit markets were completely frozen; there was mass coordination of federal stimulus across the G8; and of course, the near-zero lower bound interest rates that remain today. Policy makers were quick to respond but unsure how future events would unfold. The heightened sense of uncertainty gave everyone much to think about. Nevertheless, the recession along with the pain eventually subsided and GDP growth slowly and stagnantly resumed.

In the years that followed these exceptional events, there was a dark cloud of seemingly ubiquitous uncertainty. Ambiguity permeated the world and expectations were crucially altered. In other words, people no longer held firm beliefs about future outcomes. All previously formed expectations were recalibrated to include a much wider and more cautious set of possibilities. Even our top economic leaders stressed the importance of uncertainty. In 2009, at the House of Commons Standing Committee on Finance, Bank of Canada governor Mark Carney said in his opening statement "… the speed and synchronized nature of the recent global downturn has resulted in a heightened degree of uncertainty…" and "Indeed, it is safe to say that the degree of uncertainty – the range of possible outcomes – is greater than the range of point forecasts."[1] One year later, in 2010, US Federal Reserve Chairman Ben Bernanke testified before the Senate Banking Committee and perhaps said it best: "the economic outcome remains unusually uncertain."[2] Our economic future was, without a doubt, uncertain at best.

Meanwhile, in academic research, a growing body of empirical literature, focused predominantly on the Great Recession, exposed the increasing importance of uncertainty as a source of negative economic fluctuation. The heightened uncertainty that followed the Great Recession has also been labeled as one of the key causes for the slow recovery. Likewise,

[1] http://www.bankofcanada.ca/wp-content/uploads/2010/03/state09-2.pdf
[2] http://www.cnbc.com/id/38347202#.

much of the recent research reveals that higher levels of uncertainty negatively affect consumption, investment, employment and thus GDP. Despite all this wealth of new information highlighting the negative impacts of uncertainty, the theoretical foundations supporting the empirical literature are not new. Bernanke (1983) was one of the first to indicate that an increase in uncertainty would lead to delayed investments causing short, sharp recessions. According to Dixit and Pindyck (1994), they "*provide the first detailed exposition of a new theoretical approach to the capital investment decisions of firms, stressing the irreversibility of most investment decisions, and the ongoing uncertainty of the economic environment in which these decisions are made. In so doing, they answer important questions about investment decisions and the behavior of investment spending*[3]."

Alternatively, some critics argue that recessions raise uncertainty and not the other way around. Besides, there is the question regarding the measurability of uncertainty. Uncertainty, in itself, is an abstract concept and therefore cannot be easily measured. In fact, any quantifiable form of uncertainty becomes subjective. Bloom (2012) adequately and succinctly states that "unfortunately, no working uncertainty barometer exists." Regardless, many different ways have been devised to measure different types of uncertainty. Such measures include forecaster dispersion, policy uncertainty, tax uncertainty, stock market volatility, monetary policy uncertainty and so on. The seminal paper of Bloom (2009), using stock market volatility as a measure of uncertainty, has been paramount in the revival of uncertainty measures and indexes.

Ever since, many uncertainty indicators have appeared in the literature but two, in particular, repeatedly re-emerge: the Economic Policy Uncertainty (EPU) and Implied Volatility Index (VIX). The EPU was developed and used by Baker et al. (2013) and is a weighted combination of quantified newspaper articles, expiring tax codes and forecaster disagreement. It serves to capture uncertainty regarding economic policy. The newer version of this index, the news-based-policy-uncertainty index, is based solely on newspaper articles. The Canadian version of this index, the Canadian News-based Policy Uncertainty (CNPU) index, will serve as the main uncertainty indicator for this paper. On the other hand, the Chicago Board Options Exchange (CBOE) created the VIX index, formerly VXO, which is a popular implied volatility stock market index in the US. It aims to capture the market's expectations of future volatility based on options prices. It serves as an uncertainty index for finance but is also considered a good proxy for general uncertainty. Baker et al. (2013) note that although the VIX is more

[3] Dixit, A., Pindyck, R. (1994): *Investment Under Uncertainty*. Princeton University Press, pp 1.

sensitive to financial crisis and the EPU to major political events, they share a correlation of 0.578. The Canadian version of the VIX, VIXC was created in the early 2000's and research by Biktimirov and Wang (2010) shows that the VIXC and VIX provide the most accurate forecast regarding next day volatility, from an investor stand point.

There has been a lot of research done on the subject of the effects of uncertainty on the macro economy in the US, United Kingdom (UK) and the Euro area; however, little work has been advanced for Canada. In this paper, my goal is to investigate whether Canadian and US uncertainty produce similar economic effects in Canada as those demonstrated in other countries. In other words, I evaluate the effect of Canadian and US policy uncertainty on macroeconomic variables and analyze the overall impact on the Canadian economy. The goal of adding US uncertainty indexes is to provide insight as to whether US uncertainty strongly influences the Canadian economy. Given the strong interconnectedness between Canada and the US, it will be interesting to see if US indicators have a similar or stronger impact on the Canadian economy.

The overall results from this paper will have important implications for Canada in several different ways. This paper aims to investigate, first, the effect of policy uncertainty shocks on Canada and whether they produce similar effects to those estimated in the US and European countries. In addition, these estimations will provide some insight to the extent of which US and Canadian policy uncertainty affect the Canadian economy. Given the large open US economy, one would assume that US uncertainty would have a large impact on the Canadian economy, possibly even greater than Canadian uncertainty. The estimations will help confirm this.

The main analysis of this paper focuses on the effect of Canadian and US uncertainty shocks on the economy. To achieve this, I use a SVAR model with Cholesky orderings. My primary measure of uncertainty is the CNPU index for Canadian shocks and the USNPU for US shocks. For my sensitivity analysis I use different lags, change the ordering of the price and quantity variables, reverse the ordering of all variables and use alternate uncertainty indexes such as the Canadian and US EPU, VIX and VIXC. This serves to add further robustness to the outcomes and ensure the quantitative results are sound. The setup allows for a strong and robust analysis of the contemporaneous relationship among the variables.

Exploring the effects of uncertainty shocks is not novel, yet little work has been advanced for Canada. Benati (2014), to the best of my knowledge, is the only other author who has explored the effects of Canadian uncertainty shocks on the economy. This is also done

within the context of the Great Recession. Using two identification strategies, namely inertial and sign restriction, and that of Uhlig (2003, 2004) combined with counterfactual exercises, Benati's conclusions point out that for the former strategy, uncertainty played a marginal role, and with the latter strategy, the results are non-negligible. That being said, his Impulse Response Functions (IRFs) do not show any particular patterns during the Great Recession, compared to previous years. My paper sets out to evaluate whether Canadian uncertainty shocks have a negative effect on the economy, in general. The focus of my paper is not specifically set on the Great Recession. As such, my results will provide new information as to whether Canadian Uncertainty affects the economy in general. My data set is also slightly different from that of Benati's as it includes one additional year of data, is quarterly and contains different variables. On another note, I also evaluate US shocks to help determine whether US uncertainty plays a greater role in the Canadian economy than Canadian uncertainty. This is also new as Benati focuses mainly on the effects of domestic uncertainty with regards to the domestic economy. Benati does not focus on international spillovers whereas I evaluate US uncertainty shocks on the Canadian economy. This adds another dimension that has not been previously explored.

Colombo (2013) has an interesting empirical paper, which looks at the effects of international spillovers of uncertainty shocks. Her findings show that a US uncertainty shock has a greater effect on the Euro area than a Euro based uncertainty shock. My paper evaluates the same idea; Do US uncertainty shocks affect the Canadian economy at all, the same or more than Canadian shocks? As far as I know, this has yet to be done for Canada. This empirical analysis will be a valuable exercise as it will help establish whether US uncertainty shocks are more important for the Canadian economy than Canadian uncertainty shocks. Therefore, my paper adds to the literature by exploring whether US uncertainty affects the Canadian economy.

The rest of the paper is divided into the following segments. Section 2 delves through the relevant literature to establish precedents and lay the guiding framework with regards to the theory, model and empirical analysis. Section 3 explains the methodology. More precisely, there is a description of the SVAR model along with the Cholesky ordering and the implementation of the model. I go through the data's constraints and transformations, and justify choice variables. Section 4 provides a discussion of the results. I provide analysis and statistical significance of the Impulse Response Functions (IRFs). Section 5 covers the extensive sensitivity analysis. Finally, Section 6 concludes and provides final remarks.

Section 2 Related Literature

Studying the effect of policy uncertainty on the economy is important for policy makers. The Great Recession has led to a great deal of academic and policy insight with regards to heightened levels of uncertainty and its potential effect on the economy. Therefore, going over the literature will help provide a more comprehensive understanding of previous works and lay the foundations for this paper. The theory and empirical results are essential factors in the construction and organization of my work. As such, I go over the many studies, both theoretical and empirical, with regards to the impact of uncertainty on economic fluctuations during the Great Recession. Given the broad range of uncertainty measures and different macroeconomic variables available for study, I focus not only on policy uncertainty but include a variety of alternative uncertainty measures. This will help deliver profound insights on the matter while providing a general understanding of the topic. It will also allow for the comparison of a wide range of results. In turn, the intricate details acquired will help in the construct of the framework for the analysis.

2.1 The Role of Uncertainty in Economic Theory

As mentioned in the introduction, the theoretical concepts surrounding the impacts of uncertainty on the economy are not novel. Bernanke (1983) notes that agents must often make timing decisions between early commitments of irreversible investment versus the benefits of waiting and acquiring more information. If the trade-off of waiting yields greater benefits in the long run, given an uncertain environment which is subject to random change, then uncertainty directly impacts investment cycles. In turn, short sharp recessions can ensue. Dixit and Pindyck (1994) elaborate on the theoretical approach of capital investments by firms. They stress the importance of irreversible decisions in an uncertain environment and the option value that stands to be gained by waiting for more information. They conclude that firms have a beneficial interest of waiting during uncertain times as this leads to optimal outcomes in the long run. Although they do not elaborate extensively on the economic impacts of such decisions, the insight gained from the decision making process of firms is invaluable.

Building on previous works, Knotek and Khan (2011) provide an updated theoretical framework for uncertainty shocks. Elaborating on the theory, they explain what to expect from

theoretical models regarding economic activity. One important feature, uncommon to the previous literature, is the inclusion of households/consumers. Their main premise is that increased uncertainty causes agents (both consumers and firms) to decrease spending as they enter "wait-and-see" mode. This is typical of expensive and irreversible purchases as they are costly to undo. However, when uncertainty decreases, economic activity tends to rebound sharply.

For households/consumers they explain that uncertainty shocks can take many forms and affect total wealth. For example, a negative drop in the stock market can significantly impact the paper value of assets. On the other hand, policy decisions made by government is often an essential factor in the determination of job opportunities. When uncertainty is high, the prospect of these unexpected outcomes is greater and thus consumers are less likely to make large purchases. The latter are often associated with durable goods like houses, cars and home appliances as they are costly to undo should anything happen. The same line of logic applies to firms. Businesses often need to make large capital purchases which are specific to their industry. They may also need to hire highly skilled workers to operate this capital/machinery. These purchases are often very expensive, cannot be undone or would be very costly to reverse. The point is that firms would lose a large amount of money should they need to reverse their decision. Therefore, when uncertainty is high and the economic outlook is unsure, they have an incentive to wait for more information (more certainty). In short, greater uncertainty lends to the probability of more extreme outcomes, therefore investment and consumption[4] are reduced. Firms wait to hire and invest, and households hold back on major purchases. As a corollary, economic activity is dampened.

2.2 Empirical Results: Policy Uncertainty and Stock Market Volatility

Although the majority of the empirical literature focuses on the Great Recession and successive events, empirical studies with regards to previous events tend to validate the economic theory even outside of the Great Recession. The seminal paper of Bloom (2009) was the first recent empirical paper providing strong evidence that uncertainty has a negative impact on output, employment and productivity. Bloom achieves this by building "*a model with a time-*

[4] Although consumption refers to both durable and non-durable goods, for the remainder of this paper, I will use the word consumption to represent that of durable goods purchases only, unless noted otherwise.

varying second moment, which is numerically solved and estimated using firm-level data. The parameterized model is then used to simulate a macro uncertainty shock, which produces a rapid drop and rebound in aggregate output and employment.[5]" The result is a drop in aggregate output and employment followed by a fast rebound causing an overshoot and drop in productivity. Bloom then estimates a number of VARs using monthly data and the stock market volatility as a measure of uncertainty. He identifies his SVAR model using ordering restrictions; more specifically he orders his variables as S&P500, uncertainty indicator, Federal Funds Rate (FFR), average hourly earnings, Consumer Price Index (CPI), employment and Industrial Production (IP) under the assumption that stock markets are affected instantaneously followed by prices and quantities. In other words, the ordering is such that; any stock market related uncertainty will be captured by the S&P500 therefore excluding it from policy uncertainty, the FFR serves to capture any monetary policy shocks and the prices are placed before quantities as they are assumed to adjust faster. Replicating this work, Carreiro et al. (2013) show that by using proxy SVAR models they can attenuate the effect of measurement error via Mont Carlo experiments. In other words, in the original SVAR, they capture the volatility shock and use it as an instrument in the second and thus proxy SVAR. By using this as an exogenous variable, they suggest that the effects of uncertainty shocks might be much larger in magnitude than previously believed.

Creating their own measure of uncertainty, namely the EPU, Baker et al. (2013) use a VAR model with monthly data and six lags to estimate the effects of uncertainty. Using a Cholesky decomposition, their variable ordering is uncertainty index, S&P500, FFR, employment and real industrial production. The results show that uncertainty causes a fall in production and employment, with the lowest points occurring after 14 and 18 months, respectively. For their sensitivity analysis, they try with three and nine month lags and reverse the Cholesky ordering, among others. The results remain very similar. Using quarterly data, they find peak declines in GDP of 2.3% after four quarters with peak declines in private investment of 14% after three quarters. Consumption also shows similar results to GDP with durable goods showing a greater drop and sharper rebound than non-durable goods. The results are statistically significant and imply that policy uncertainty is either forward looking and foreshadows recessions or is a cause for recessions. A study by Baker and Bloom (2013) using first and second moment shocks, designed to specifically address the issue of causality, produces similar results and confirms that uncertainty drives recessions.

[5] Bloom, N. (2009): *The Impact of Uncertainty Shocks*. Econometrica Vol. 77, No. 3 pp. 1.

This is an important point as other authors such as Bachman et al. (2010) come to the conclusion that uncertainty has a limited negative impact on economic activity. Using a SVAR model with high frequency data, they perceive no “wait-and-see” effect. Rather they associate business uncertainty innovations to those of business confidence. Thus they argue recessions are the cause of high uncertainty as the latter is a mere by-product of bad economic times. Despite this, the general consensus is that the direction of causality runs from uncertainty to the business cycle and not the other way around. As I delve further into the literature, I will present papers supporting both sides of the argument. For this reason, I put particular emphasis on highlighting the models used, the variable ordering and the number of lags.

In light of the controversy, many empirical tests with either VARs, SVARs or a form of time-varying VARs have been attempted in recent years and have yielded positive results. In other words, many studies imply, with statistical significance, that uncertainty shocks have negative economic impacts. Alexopoulos and Cohen (2009) use data from 1968 to 2008 and estimate a number of VARs with different orderings using stock market volatility and a news-based uncertainty index. They find that both measures of uncertainty can result in short, sharp recessions. Industrial production, employment, consumption, productivity, investment and unemployment are all negatively affected. Leduc and Liu (2014) use a VAR model and estimate the effects of uncertainty using survey data from the US and U.K. They present empirical evidence that uncertainty shocks lower inflation and raise unemployment acting as negative demand shocks. Arpaia and Turrini (2013) find that changes in policy uncertainty makes the unemployment rate more responsive to changes in output as uncertainty causes employers to enter “wait and see” mode. Dennis and Kannan (2013) study the impact of uncertainty shocks in the U.K. during the Great Recession. Using monthly data, they implement a VAR model with recursive orderings but also change the ordering of the variables for robustness. Their original ordering is uncertainty, unemployment and an economic variable. Using implied volatility of the stock market and the dispersion of GDP forecast as their measures of uncertainty, their results show that unemployment is less affected but uncertainty significantly impacts GDP and industrial production. The latter impacts are similar to those in the US. The peak impacts are not felt immediately but rather six to twelve months later.

Benati (2014) uses Bayesian time-varying parameters on SVARs with stochastic volatility to explore the role played by policy uncertainty during the Great Recession for the US, Euro area, U.K. and Canada. His Canadian data spans the entire possible timeframe given the

availability of the uncertainty indicators: 1990-2013. I point this out because I will be using data from 1990-2014. Although my paper is not as extensive as his, our data span is almost identical. I use quarterly data, where he uses monthly data. Therefore, it will be interesting to see if our results are similar. The peculiar feature of Benati's paper is that it permits for time variation in both the coefficients and the covariance matrix. This allows him to identify the role played by uncertainty during the Great Recession in comparison to previous years. His results demonstrate that uncertainty shocks only have marginal effects on industrial production and employment. With a second identification strategy, that of Uhlig (2003, 2004) he finds that in the US as well as Canada, policy uncertainty did not play an overly important role during the Great Recession in comparison to previous years. Benati does not however, look into the effects of US uncertainty unto the Canadian economy. Moreover, his IRFs for policy uncertainty shocks have exhibited, over the sample period, a statistically significant but negligible time variation. Given this negligible time-variation, my time-invariant VAR should suffice to adequately describe the data.

Alternatively, Enders and Jones (2014) emphasize that the effects of uncertainty shocks are highly dependent on the state of the economy. They "*estimate a number of macroeconomic variables as logistic smooth transition autoregressive (LSTAR) processes with uncertainty as the transition variables*[6]" and find that, contrary to Benati, uncertainty shocks are worse during times of crisis. Therefore, during critical times such as the financial crisis, uncertainty shocks tend to be underestimated. They also note that positive uncertainty shocks have a greater effect than negative shocks. This follows from Mishkin (2011) who argues that agents tend to overstate crisis scenarios and thus become more risk-averse during bad times. In turn, Mishkin suggests that the effect of uncertainty on the economy is not likely to be linear. Uncertainty shocks are therefore not symmetric. Although interesting, to include this within the study, one would require two sets of regressions or specific parameters to take into account these features. Moreover, different regressions from uncertainty shocks during crisis and non-crisis times would be required for comparison. This study does not include such regressions.

Another interesting strand is the focus of US uncertainty shocks on other economies. In other words, how do US economic policy uncertainty shocks affect other countries? Given that the recent global financial crisis originated from the US, it is a valuable experiment to see how US shocks affect other countries. Colombo (2013) investigates the effects of US economic

[6] Enders, W., Jones, P. (2014): *The Asymmetric Effects of Uncertainty on the Macroeconomic Activity*. University of Alabama, Department of Economics, Finance, and Legal Studies Tuscaloosa, pp. 1.

policy uncertainty on macroeconomic aggregates from the Euro area using a SVAR model and finds significant declines in industrial production and prices. Her variable ordering is done in two blocks. The first is a set of US variables ordered as CPI, IPI, IR and the USNPU index. The second block is a set of Euro variables ordered immediately after the first block as HCPI, IPI, IR, and the Euro-NPU index. The ordering follows Giavazzi and Favero (2008) with the idea of putting the uncertainty indicator last to purge the policy uncertainty shock from all the contemporaneous movements of the US indicator. The results show that US economic policy uncertainty shocks have a quantitatively larger effect on Euro aggregates than a shock stemming from the Euro area. These results are interesting because Canada and the US share an intricate relationship that is most likely stronger than that of the US and EURO area. No quantitative research, to the best of my knowledge, has been done on the effects US uncertainty shocks on the Canadian economy.

In a paper by Klosner and Sekkel (2014), it is shown that the effects of policy uncertainty shocks are not limited to domestic economies but have international spillovers. In fact, these authors calculate a spillover indicator using a six country (Canada, US, UK, Italy, France and Germany) data sample in order to see who are net importers and exporters of policy uncertainty. Not surprisingly, their results show that the US is the greatest net exporter and Canada, after Germany, the largest net importer of policy uncertainty. The results indicate that roughly 33% of Canada's policy uncertainty variance is a result of exterior policy uncertainty or international spillovers. For the purpose of their study, these spillovers are limited to the five other countries mentioned above. Nevertheless and unsurprisingly so, Canada's open economy leaves it susceptible to outside influence.

Adding to this idea of international spillovers, from the monetary policy perspective, is Knut et al. (2013). They use a SVAR model to establish whether heightened uncertainty affects the monetary policy transmission channel. They claim that higher financial uncertainty reduces monetary policy influence not only domestically (US), but in Canada too. Therefore, heightened uncertainty weakens the macroeconomic influence of monetary policy and central banks must act accordingly. In addition, they show that US uncertainty also affects Canadian investments. Although both effects are not quantitatively large, they are significant. Bloom (2013) believes that much of Canada's current economic policy uncertainty is due to US contagion. Seeing as Canada has suffered relatively less damage than the US throughout the financial crisis and has had stable monetary and fiscal policy, Canadian uncertainty is lower. Bloom claims that the elevated policy uncertainty in Canada is due to US policies which have a large economic impact

on Canada. The aggregation of these studies generate strong expectations for my results. Given that the Canadian and US' uncertainty indexes are already correlated at a medium to high level, Appendix B Table 1, I am expecting similar outcomes. Should the effects be greater using uncertainty measures from the US over Canada, then this would support the claims mentioned above, which is a very likely scenario.

Using forecast dispersion as a measure of uncertainty in her VAR model with a variety of orderings, Guglielminetti (2014) evaluates the impact of uncertainty on the US economy. Her results show that even with her three different orderings (two recursive and one long run restrictions) uncertainty significantly affects different measures of economic activity. In her tri-variate VAR model she orders the variables as follows: GDP, uncertainty and what she calls "a measure of economic activity", which can be Industrial Production, Consumption, Investment, Vacancies, Labor Market Tightness, Unemployment or The Job Finding Rate. She uses these measures in each of her tri-variate VAR models. As a result, the economic variables are all negatively affected in each scenario and tend to overshoot when they rebound. In her second ordering, she places uncertainty last, switching it with the economic variable and the results are slightly less significant but largely unchanged. In her multivariate VAR the ordering is: GDP, uncertainty, an economic variable, CPI and the FFR. The interest rate serves to disentangle the monetary shock from the policy shock. She uses different uncertainty indicators such as Total Factor Productivity (TFP), EPU and VIX. Other than the labour market, the results are statistically and economically significant. More succinctly, uncertainty depresses economic activity. Her last ordering in the multivariate SVAR shows the uncertainty index placed last. This stems from the assumption that uncertainty is contemporaneously affected by the state of the economy. As such, the policy uncertainty shock excludes all other structural shocks contemporaneously affecting the economic variables. All the results are significant and remain so when using stock market and TFP growth rate volatility.

2.3 Empirical Results: General Economic Uncertainty

Although much of the literature focuses on policy uncertainty and stock market volatility, there are also many papers that use different measures of uncertainty. Looking at these other measures of uncertainty will provide powerful insight as to the effects of uncertainty as a whole on economic activity. This will offer additional support to the already extensive list of papers mentioned above.

Johannsen (2014) uses “a new-Keynesian model with endogenous capital accumulation”, to “show that uncertainty about fiscal policy can cause large declines in consumption, investment, and output when the zero lower bound (ZLB) binds, but has modest effects when the monetary authority is not constrained by the ZLB.” However, he does not use a common measure of policy uncertainty. Rather, his proxy for a fundamental shock is the marginal efficiency of investments. This is driven by the disturbances in the financial markets during the start of the Great Recession. Nevertheless, the common theme that emerges with different types of uncertainty shocks, including heightened policy uncertainty, is that they negatively affect economic activity. Flores et al. (2013) assess the impact of uncertainty on consumption and investment in the Euro area using business and consumer surveys. They establish that it has a significant negative impact on economic activity and that it has become worse since the crisis. This is an interesting finding given that previous results using stock market volatility have shown minor improvements in economic activity as uncertainty has decreased. Kose and Terrone (2012) use four different measures of uncertainty in their analysis and show that they have detrimental effects on economic activity. Moreover, they elaborate on the fact that elevated uncertainty since the Great Recession (more than five standard deviations higher) has considerably slowed down the recovery. Haddow and Hare (2013) for example, explain that many different measures for the U.K. are showing that households and companies have not been spending since the recent crisis due to elevated widespread uncertainty. Using a VAR model, they estimate the difference between the impact of uncertainty shocks and prolonged elevated uncertainty. As imagined, uncertainty shocks produce short-lived downturns while persistent high uncertainty seems to show weakened spending.

Leduc and Liu (2012) use a VAR model and an uncertainty measure from consumer and firm survey data in the US and U.K. which asks specifically how uncertainty affects their durable goods consumption and capital expenditures. The results show a negative impact on unemployment, credit spreads, investment, inflation and short-term interest rates. Using the VIX and EPU for sensitivity analysis, they achieve similar results. Moreover, they implement the same exercise but this time using a DSGE model. Again they find similar negative impacts on the economy. Murray (2014) uses an autoregressive distributed lag model to determine the effect of fiscal uncertainty on real GDP, consumption, investment and unemployment. However, he looks at fiscal uncertainty from four policy variables, namely government expenditures, taxes, transfers and government debt. He computes a coincident indicator from these four variables which he uses as a common component. In other words, he creates a weighted average of these indicators to create an index. His results show that the build-up of fiscal uncertainty

occurring in the years leading up to the Great Recession and the magnitude of the impact on real GDP is sizable enough to help explain the severity of the Great Recession and subsequent events. Once again, there is a trend where economic uncertainty, no matter how it is measured has a statistically significant impact on economic activity. The magnitude of these impacts does vary however, from study to study.

Conversely, some authors have found that that the impact of uncertainty shocks on economic activity are either insignificant or negligible. Born et al. (2014) tested six different proxies of uncertainty to see if amplified levels of intensity during the Great Recession had any effect on the US recovery. By identifying first moment shocks through a VAR model with monthly data, they are able to use the results in a VAR model with quarterly data and identify the impact of the shocks. Their results are similar to those in Bloom's seminal paper; however, once they analyze the variance decomposition, they are able to show that uncertainty explains a near-negligible amount of the variance; less than one percentage point of the nine percent drop. Moreover, they find that economic policy uncertainty effects are small especially when compared to macroeconomic uncertainty.

Knotek and Khan (2011) from the Kansas City Federal Reserve study the varying effects of uncertainty over time, focusing on household responses. They use uncertainty measures such as news-based and stock market volatility. Using a bivariate VAR model, their results show, alongside theory, that household spending decreases when an uncertainty shock occurs. However, once more variables are added to produce an augmented VAR, the results tend to disappear. They also decompose household spending into durable and non-durable expenditures coming to the conclusion that durable-goods expenditures diminish much more than non-durable goods. However, once they begin to add more economic variables, the consumption variables generally tend to stay below trend but become statistically insignificant. When using the stock market index in the multivariate model, durable and non-durable consumption goods actually increase before leveling off. Their conclusion is that uncertainty shocks affect household spending only moderately and account for a small fraction of the variance in household expenditures. Conducting larger uncertainty shocks, where the series is not de-trended, similar in magnitude as those found in Bloom, they find similar results.

On their part, Cesa-Bianchi, Pesaran and Rebucci (2014) demonstrate that volatility measures do not impact the business cycle. In fact, using a Global VAR (GVAR) model they claim that uncertainty is a symptom rather than the cause of recessions. Chugh (2011) comes to the conclusion that firm-level productivity risk shocks in the US manufacturing sector fail to have

a significant impact on GDP fluctuations. Bachmann and Bayer (2009) use German firm-level data to estimate time-varying risk shocks. They also conclude that risk shocks alone do not have a large effect on business cycles.

In retrospect, the majority of these studies tend to focus on the implications that uncertainty shocks have on the economy. Given that the 2007-2008 global crisis was financial and originated in the US, the majority of the studies tend to focus on specific uncertainty indicators such as stock market volatility and policy related issues, and on data from the US or how US data affects other countries. As such, much of the studies indicate that uncertainty shocks do in fact have a negative impact on economic activity. Although some studies show the opposite, an overwhelming amount support the idea that uncertainty shocks significantly impact the economy in a negative manner. My aim is to conduct a similar undertaking by evaluating Canadian and US uncertainty shocks on the Canadian economy.

Section 3: Methodology

3.1 VAR Methodologies and Identification via SVAR

VAR (p)-models, originating from Sims (1980), are the standard choice to empirically investigate macroeconomic uncertainty shocks. They also enjoy popularity in the examination of monetary policy as well as studies about macroeconomic uncertainty.

VAR-methodologies estimate an autoregressive system (of order p) of equations of the type

$$Y_t = b_0 + B_1 Y_{t-1} + B_2 Y_{t-2} + \cdots + B_q Y_{t-q} + u_t = b_o + \sum_{j=1}^{p} B_{t-j} Y_{t-j} + u_t$$

This is the "reduced form" of the model with:

$Y_t = \begin{pmatrix} y_t^1 \\ \dots \\ y_t^k \end{pmatrix}$ a vector of endogenous k endogenous variables used in the VAR-estimation

$b_O = \begin{pmatrix} b_0^1 \\ \dots \\ b_t^k \end{pmatrix}$ a vector of k constants

Each $k - by - k$-Matrix *B* ($B_1, B_2, \dots, B_q$) takes the form:

$B = \begin{pmatrix} b^{1;1} & \dots & b^{k;1} \\ \dots & \dots & \dots \\ b^{1;k} & \dots & b^{k;k} \end{pmatrix}$ where each $b^{i;j}$ represents the coefficient of the $i - th$ endogenous variable on the $j - th$ endogenous variable.

$u_t = \begin{pmatrix} u_t^1 \\ \dots. \\ u_t^k \end{pmatrix}$ a k-dimensional vector of innovations with $E(u_t u'_{t-j}) = 0$ for $j \neq 0$ and $E(u_t u'_t) = \Omega$

That is, each variable used has an own autoregressive equation and also depends on all the other variables in the system of equations. It is crucial that there is no structural break during the time period from which the sample is drawn. Inspecting B one can see that variables are allowed to affect each other, thus allowing explicitly for endogenous reactions between them.

This is the strength as well as the difficulty of VAR-approaches: the covariances between the innovations in vector u_t capture the endogeneity between all the variables used. Most often the contemporaneous effect of variable i onto variable j is of interest and for this purpose the "structural form" ("SVAR") of the model needs to be obtained. This is done by defining:

$$C'C \equiv \Omega$$

This allows us to rewrite the reduced form VAR to

$$Y_t = b_0 + B_1 Y_{t-1} + B_2 Y_{t-2} + \cdots + B_q Y_{t-q} + C\varepsilon_t$$

where $\varepsilon_t \sim N(0, I)$, a vector of shocks associated with the "structural model", which are assumed to be uncorrelated with each other. Since $E(\varepsilon_t \varepsilon_t') = I$ we can write $E(C\varepsilon_t \varepsilon_t' C') = C[E(\varepsilon_t \varepsilon_t')]C' = \Omega$

Now one can multiply C^{-1} onto the "reduced form VAR" from the left to obtain

$$C^{-1}Y_t = C^{-1}b_0 + C^{-1}BY_{t-1} + C^{-1}BY_{t-2} + \cdots + C^{-1}BY_{t-q} + C^{-1}C\varepsilon_t$$

Defining $C^{-1}B_t \equiv A_t$(the "structural parameters") we can write the above equation as

$$A_0 Y_t = a + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_2 Y_{t-q} + \varepsilon_t$$

The information about the contemporaneous relationships between the endogenous variables will then be available in MatrixA_0. The essential problem is to make a choice between the numerous matrices C that satisfy $C'C = \Omega$.

I decided to use the most common approach: ordering restrictions and subsequent Cholesky-decomposition, according to which any positive definite Matrix (such as Ω since it is a covariance matrix) can be uniquely decomposed into a lower triangular matrix and a conjugate transpose. Thus, I identify the SVAR model that I use for my analysis by setting: $C = chol(\Omega)$.

Using this approach, the order of the variables is crucial due to the lower-triangular structure of the matrix C - each possible ordering will provide a unique matrix A_0 that captures the contemporaneous relationships between the endogenous variables. That is, the variable which is ordered first is considered (at time t) unaffected by the others at first but the first variable is permitted to influence the ones ordered below. The first variable remains affected by its own lags and the lags of the other variables. The ordering of the endogenous variables can be justified by economic theory or implied by the research question of interest.

3.2 Data

In order to examine the effect of economic uncertainty in Canada on aggregate economic activity, I choose the CNPU, the only index which spans the entire period of examination (1990Q1 to 2014Q4). In the robustness analysis, I will also use alternative indexes such as the CEPU and VIXC; however, these indexes unfortunately are not available for the whole period of investigation.

The three Canadian indicators used in this study are the CNPU, the CEPU and the VIXC. The CNPU is an index constructed from news-based articles regarding policy uncertainty. The index is comprised of quarterly data and has been transformed into logs. The CEPU is a previous version of the CNPU and additionally contains forecaster dispersion. However, in 2014 forecaster dispersion data was no longer collected, thus the CEPU data set only spans from 1990Q1 to 2014Q1. Given that both indicators (CEPU and CNPU) are/were highly correlated, this was not seen as having a major impact to Canadian data. Both data sets have been retrieved from the Economic Policy Uncertainty website[7] which also provides a more in-depth description of their construction. The VIXC is the Canadian version of the VIX-index, capturing the implied volatility on the aggregate Canadian stock market – Toronto Stock Exchange (TSX). It is completely analogous to the VIX and the US stock market. Daily open and close data for the VIXC are available but only the monthly averages of the close was used in this study, which were then aggregated to quarterly data to provide consistency with the other variables used. Moreover, the only available data set for the VIXC was from 2005Q2 to 2014Q4. Given that the latter index does not include enough data points to provide reliable results, the VIXC is only used as an addendum to see a "what if" scenario. Regarding US uncertainty shocks, I make use of three US-based uncertainty indexes, namely the USNPU, USEPU and the VIX. Each US index is the counterpart to the individual Canadian indexes mentioned above. The only difference, naturally, is that they are constructed using US data. The US uncertainty indicators span the whole sample period: 1990Q1 to 2014Q4. The USNPU is used in the baseline scenario alongside the CNPU in order to provide more accurate results when both Canadian and US uncertainty shocks are studied. A graph of each uncertainty index, displayed in log differences, can be found in Figure 1 of Appendix A. Table 1, Appendix B, shows the correlation

[7] http://www.policyuncertainty.com/

among all possible indexes and proxies while Table 4, Appendix B, provides a description of all the uncertainty indexes.

The macroeconomic variables chosen for the exercise are CPI, GCFC, DGC, GDP, EMP and BR, (see Table 3, Appendix B, for more details about these variables and their sources). The Consumer Price Index (CPI) is a price variable and captures the movement of consumer prices. Gross Fixed Capital Formation (GFCF) is a component of GDP and highlights the new value added in the economy that is invested rather than consumed. While it speaks of investments, Durable Goods Consumption (DGC) indicates households' consumption of typically larger, more expensive and longer lasting goods. Gross Domestic Product (GDP) is indicative of overall economic health and is widely used by most countries to gauge economic performance. Employment (EMP) is also an indicator of economic health but from the prospective of the labour market. The Bank Rate (BR), the overnight rate from the Bank of Canada, is said to be an endogenous variable as it responds/the Bank of Canada adjusts it based primarily on inflation and also economic activity. The motivation for choosing these variables was quite clear; they are the ones that reoccur most often in the literature and are generally all sensitive to aggregate economic uncertainty. All of the data for the macro-economic variables has been retrieved from Statistics Canada[8] and is in the form of quarterly or monthly data. The monthly data was transformed into quarterly data by taking a three month average. Subsequently, the log of each variable, save for the BR as it is already in percentages, was taken with excel to achieve first differences. Then, a stationary test was conducted for each variable to ensure model stability. A graph of the macro variables can be found in Figure 2 of Appendix A.

3.3 Specification and Implementation

The main focus of my paper is to investigate the extent to which a Canadian and/or US uncertainty shock affects the Canadian economy. The baseline analysis is comprised of three different exercises. The first scenario studies the impact of a CNPU shock on USNPU, CPI, GFCF, DGC, GDP, EMP and the BR, in that specific order. The vector of endogenous variables can be found in Model (1).The idea is to capture the effects of a Canadian uncertainty shock on the Canadian economy without taking into account any US uncertainty. Model (2) is the exact

[8] http://www.statscan.gc.ca

same as Model (1) but the USNPU and CNPU are flipped. In other words, the USNPU is placed first while the CNPU is second. Two exercises are performed with the model described by Model (2). In the first one, I study the impact of a CNPU shock. By placing CNPU second and the USNPU first, the ordering allows for the Canadian uncertainty shock to be separate from US uncertainty. Said differently, USNPU catches all the US uncertainty and thus the CNPU shock is strictly the result of the Canadian uncertainty that is orthogonal to the uncertainty "imported" from the US. In this way, I will be able to disentangle the impact of Canadian uncertainty on the Canadian economy from the impact of US uncertainty. In the second exercise, I focus on the impact of a USNPU shock in Model (2). This will help explain whether US uncertainty has a significant impact on the Canadian economy. In short, the baseline analysis will help infer whether Canadian and/or US uncertainty affects the Canadian economy.

$$Yt = (CNPU, USNPU, CPI, GFCF, DGC, GDP, EMP, BR) \quad (1)$$

$$Yt = (USNPU, CNPU, CPI, GFCF, DGC, GDP, EMP, BR) \quad (2)$$

Given that the sense of causality remains uncertain (do recessions cause uncertainty or does uncertainty cause recessions?), the placement of the uncertainty indicator as the first variable in the SVAR model could be subject to some questioning. In Models (1) and (2), I follow in the footsteps of the previous literature, in particular Alexopoulos (2009) and Leduc and Liu (2014). By placing uncertainty index first, one assumes that uncertainty affects all the other variables after it. In consequence, there is a contemporaneous effect on all other variables with no mitigating factors. For Model (2), I place the CNPU second to let the USNPU "purge" any US uncertainty. Bloom (2009) and Baker et al. (2013) let a stock market variable precede the uncertainty index under the rationale that the former is more forward looking, and for this reason reacts to the structural shocks before all the other variables. Guglielminetti (2013) also places her measure of uncertainty second after total factor productivity shocks, but does so in order to disentangle the two. In some instances, the uncertainty index is placed last. This follows from the idea that uncertainty does not affect the economy but rather the other way around. Precisely, it is believed, in such a case, that a weakened economy causes uncertainty to rise. As for the ordering of the other variables, there are two main strands. Alexopoulos (2009) keeps with Christiano et al. (1997), putting quantities first followed by prices under the assumption that prices can react contemporaneously to quantities, while quantities adjust slowly and will affect prices only with a one lag delay. Conversely, Bloom (2009) and Baker et al. (2013) place prices

first followed by quantities claiming that “stock markets are affected instantaneously followed by prices and quantities.” I follow the latter ordering under the assumption that prices are affected immediately followed by production. Thus, I order the remaining variables as CPI, GFCF, DGC, GDP, EMP and BR. Although BR is a price variable, it is not a typical price variable. Rather, it is the price of money and the Bank of Canada adjusts the BR in response to inflation and economic health. Keeping this in mind, I follow Primiceri (2005), place the BR last and assume that the monetary policy variable reacts contemporaneously to the other variables in the VAR model, but affects them with a lag.

For the selection of the number of lags to be included in the specification of the VAR model, I considered the recommendations of several alternative measures. The results are reported in Table 2, Annex B. The Schwartz (SC), and Hannan-Quinn (HQ) criteria find one lag to be optimal. The Sequential Modified LR Test Statistic (LR) and Final Prediction Error (FPE) chose 2 lags to be optimal and finally the Akaike (AIC) criterion finds eight lags to be optimal. Based on these results, one lag is used for the baseline scenario, while alternative specifications with two and eight lags are studied in the sensitivity analysis.

To ensure that the variables and thus the model are stable, stationary tests are done for all variables, individually. Using the Augmented Dickey-Fuller test with Eviews 9 Software Package for each variable, I find t-stats that are smaller than the critical values and p-values that are 0.00. In other words, for each individual variable, I can reject the null hypothesis that it has a unit root with 99% confidence. As such, all the variables used in the estimation of the VAR models of interest are stationary

The estimation is performed using Eviews 9 Software package. The IRFs displayed, which represent the effects of a one Standard Deviation (SD) uncertainty shock on the macro variables, are analyzed for ten periods or in this case, ten quarters. The error bands are calculated by a two Standard Error (SE) width and are indicative of the uncertainty of the results. The central line from the IRFs represents the mean tendency.

Section 4: Results

As previously discussed, in the baseline analysis, I study the impact of a Cholesky one standard deviation innovation of the CNPU in Model (1), and of the CNPU and USNPU in Model (2). The first exercise evaluates the effects of a CNPU shock disregarding US uncertainty. The second exercise focuses again on a CNPU shock, but explicitly accounts for the fact that part of the variation in the Canadian index might actually be due to US uncertainty. The third exercise studies the impact of a USNPU shock, and seeks to evaluate the effect of US uncertainty on the Canadian economy. For each of these shocks, the responses of CPI, GFCF, DGC, GDP, EMP and BR are reported for a period of ten quarters following the shocks.

Figure 3 shows that the responses of all variables to a CNPU shock obtained from Model (1) are in the expected direction, and all results are significant for at least one period, except for CPI. The CPI decreases by 0.125 percentage points followed by a sharp rebound, returning to trend in the third quarter. Despite this, the error bands, other than a small portion of the first quarter, never move outside zero rendering the results statistically insignificant. As for GFCF, there is an immediate decrease, which hits a low of -0.7 percentage points in the second quarter. Quarter three shows a sharp rebound and GFCF returns to trend at the fifth quarter. The results are significant for the first two quarters. DGC sees an immediate drop of 0.7 percentage points from trend but rebounds sharply and returns to zero by the fourth quarter. This time, the results are only significant for the first quarter. Looking at GDP, it drops 0.1 percentage point after the first quarter and hits a low of 0.2 percentage points below trend in the second quarter. It rebounds less sharply and returns to trend by the sixth quarter. The results are only statistically significant for the first three quarters. As for EMP, it drops by 0.04 percentage points from trend in the first quarter to a low of 0.13 percentage points in the second quarter. It then rebounds and returns to trend by the sixth quarter. The results are statistically significant for the second, third and fourth quarters. A common theme is quickly emerging from the literature and this is the short drops followed by sharp rebounds and concave returns to trend displaying a checkmark pattern. Finally, the BR declines for five quarters before hitting a

low of 0.25 percentage points below trend. It slowly increases up to 0.2 percentage points below trend by the tenth quarter. The results are statistically significant from the third quarter onward.

The results of a Canadian uncertainty shock without any regard for US uncertainty show negative fluctuations on the Canadian economy. Although the CPI results are not very significant, all other variables display a certain significance and magnitude. GFCF shows a decrease from trend followed by a sharp rebound. GDP and EMP also fall abruptly from trend but are slower to return. DGC starts at a low but rebounds immediately, while the BR shows a sustained decrease. The results show that Canadian uncertainty does negatively affect the Canadian economy; however, these results do not take into account that a fraction of this Canadian uncertainty might in fact be due to uncertainty that originates in the US.

In the second exercise, I study again the impact of a shock to the CNPU, but this time the US uncertainty index, the USNPU, is ordered first in the SVAR model. This allows for US uncertainty to be captured and thus excluded from Canadian uncertainty. Looking at the results, it becomes clear that the impact of Canada-specific uncertainty is quite different if the effects of US uncertainty are excluded. The economic variables in Figure 4 display similar patterns to those from Figure 3 but with less magnitude and much less statistical significance. The CPI drops 0.5 percentage points below trend before overshooting and coming back to trend, yet the results are never statistically significant. GFCF shows the same general checkmark pattern, hitting a low of 0.5 percentage points below trend in the second quarter. The results are also only statistically significant in the second quarter. DGC hits a low of 0.35 percentage points below trend before returning in the fourth quarter yet the results are never significant. GPD also displays the checkmark pattern hitting a low of 0.13 percentage points below trend by the second quarter before returning several quarters later. The results are statistically significant for the first two to three quarters. EMP also shows a similar pattern but stays flat for an extra quarter upon reaching its low, but the error bands show that the response for this variable is almost never statistically different from zero. As for the BR, it again stays below trend hitting a low of 0.2 percentage points by the fourth quarter before reverting back towards zero. The results are statistically significant from the fourth quarter onward. In short, all economic variables display similar patterns, smaller magnitudes and less significance. Therefore, we can say that, in general, Canadian uncertainty by itself has smaller effects on the Canadian economy, although GDP and the BR exhibit a sizable and significant impact for several periods.

Finally, I study the impact of a shock to the USNPU from Model (2); the purpose of this exercise is to evaluate the effects of uncertainty originating from the US. CPI drops 0.12

percentage points below trend before slightly overshooting in the third quarter. The results are only significant for a portion of the first quarter and are therefore negligible. GFCF shows the usual checkmark pattern; a drop to 0.25 percentage points below trend followed by a low of 0.5 percentage points in the second quarter and sharp rebound back to trend by the fourth quarter. Yet, the results are only significant for the second and third quarters. DGC shows an immediate decline to 0.7 percentage points below trend. There is then a sharp rebound and subsequent return to trend a few quarters after. The results are significant for one quarter. GDP shows an extended checkmark pattern hitting a low of 0.13 percentage points below trend followed by a return to trend in the sixth quarter. Despite this, the error bands are large, initially, making the results significant for the second and third quarters only. EMP shows a similar pattern hitting a low of 0.12 percentage points by quarter two followed by a slow return to trend. The BR displays a similar pattern to previous simulations. It drops to 0.18 percentage points below trend in the third quarter hitting a low of 0.2 percentage points below trend in the fifth quarter, only to slowly reverse course. The results for the BR are statistically significant from the third quarter onward. In short, the results of a USNPU shock bear more magnitude and significance than a CNPU shock as defined by Model (2). That being said, the results for GDP and the BR, perhaps the two most important variables, are strikingly similar to those originating from the second exercise.

The baseline analysis has demonstrated that a Canadian uncertainty shock as defined by Model (1), i.e. including US uncertainty, imply strong negative impacts on the Canadian economy. The results change significantly when US uncertainty is accounted for. In the latter situation, a Canadian uncertainty shock bears far less importance to the economy. However, although most of the economic variables are not effected as strongly and are much less significant, GDP and the BR due show substantial movement. Finally, a USNPU shock identified from Model (2) has a greater impact on the Canadian macro economy than a Canadian uncertainty shock identified from the same Model.

Section 5: Sensitivity Analysis

5.1 Sensitivity Analysis: Alternative Model Specifications

In order to ensure that the results are robust, a variety of sensitivity checks are conducted. In all of them, I will still implement the same three exercises that I perform in the baseline framework. The first robustness test is to estimate Models (1) and (2) using the FPE and LR suggested lag length of two periods. The results are shown in Figures 6, 7 and 8. On the other hand, Figures 9, 10 and 11 report the results for the same models estimated using the 8 lags suggested by the AIC criterion.

The next exercise follows Alexopoulos (2009). In this exercise, I keep all the original variables, but I reverse the ordering of the price and quantity variables. More specifically, the models that I estimate are (3) and (4) below:

$$Yt = (CNPU, USNPU, EMP, GDP, DGC, GFCF, CPI, BR) \quad (3)$$

$$Yt = (USNPU, CNPU, EMP, GDP, DGC, GFCF, CPI, BR) \quad (4)$$

The purpose of this exercise is to study whether the impact on prices or quantities makes a significant difference in the final outcome. Models (3) and (4) are estimated with one lag and the results can be found in Figures 12, 13 and 14.

To address the causation debate, I study the robustness of the results to a different ordering of the policy uncertainty variables. In Models (5) and (6), the US and Canadian uncertainty indexes are included as the last variables in the SVAR, using the same ordering of the CNPU and USNPU as in Models (1) and (2). In these models, the uncertainty indexes are allowed to respond contemporaneously to all other variables, thus reflecting a framework where economic conditions affect uncertainty first, while policy uncertainty shocks have an impact on the economy only with a one lag delay. The results of this exercise can be found in Figures 15,

16 and 17 from Appendix A. The lag length selected is again, one quarter.

$$Yt = (CPI, GFCF, DGC, GDP, EMP, BR, CNPU, USNPU) \quad (5)$$

$$Yt = (CPI, GFCF, DGC, GDP, EMP, BR, USNPU, CNPU) \quad (6)$$

In addition, to validate the robustness of the results to the choice of the uncertainty indexes, I run the baseline analysis but change the CNPU with the CEPU and the USNPU with USEPU. Figures 18, 19 and 20 report the results for the same models depicted in Figures 3, 4 and 5, except that the CNPU is replaced by the CEPU and the USNPU is replaced by the USEPU, as detailed in Models (7) and (8) below. The only caveat is that the CEPU's data only goes up to 2014Q1 rather than Q4. Therefore the estimations contain three less data points for all variables.

$$Yt = (CEPU, USEPU, CPI, GFCF, DGC, GDP, EMP, BR) \quad (7)$$

$$Yt = (USEPU, CEPU, CPI, GFCF, DGC, GDP, EMP, BR) \quad (8)$$

Figures 21, 22 and 23 make use of the popular VIX index but maintain the original CNPU index for Canada. The specific vectors of the VAR endogenous variables used in this exercise can be found in Models (9) and (10) below. This robustness test is important because the VIX is one of the popular alternatives to the economic/policy uncertainty indexes. Being an uncertainty index that stems directly from the financial markets it will provide similar information but from a different angle.

$$Yt = (CNPU, VIX, CPI, GFCF, DGC, GDP, EMP, BR) \quad (9)$$

$$Yt = (VIX, CNPU, CPI, GFCF, DGC, GDP, EMP, BR) \quad (10)$$

Finally, Figures 24, 25 and 26 are simply addendum "what if" scenarios. They replicate the baseline analysis but make use of the VIXC and VIX indexes. Therefore, uncertainty stems solely from financial markets. The only limitation, as mentioned earlier, is the VIXC only has data from 2005Q2 to 2014Q4. Naturally, the results cannot be relied upon given the lack of data

points; however, the VIXC is very strongly correlated with the VIX but poorly correlated with the other Canadian indexes. If the results are significant, this may provide additional information regarding the impact of financial market uncertainty shocks on the Canadian economy.

5.2 Sensitivity Analysis: Results

As discussed in the previous Section, in the first robustness exercise I change the number of lags used in the estimation of Models (1) and (2). More specifically, given that the optimal number of lags is two according to the sequential modified LR test statistic (LR) and the Final Prediction Error (FPE), and eight according to the Akaike Information Criterion (AIC), I re-run the estimations of the models using these two different specifications for the number of lags.

Figures 6, 7 and 8 report the results for the Models estimated using two lags. Looking at the results from Figure 6, all variables show the same general patterns although slightly more varied than those from the CNPU shock from the original estimation. However, the results are not the same. For all practical purposes, CPI, DGC and the BR are all statistically insignificant. GFCF and EMP display a similar but more elastic checkmark pattern. They are also significant for two and one quarters, respectively. GDP hits a similar low but in the third quarter rather than the second, before slowly returning to trend. Although the results are alike, there magnitudes are slightly smaller and significance levels much smaller.

Figure 7 replicates the impact of a CNPU shock from Model (2) estimated with 2 lags. This time, the typical patterns, including the checkmark, are more stretched out and are basically insignificant for all variables. Figure 8 reports the response to a USNPU shock identified from Model (2). The results, this time, are very similar in direction and magnitude as those from the original estimation, but are insignificant for half the cases. GFCF, DGC, GDP and EMP all have significance for roughly one quarter each.

Figures 9, 10 and 11 again replicate Figures 3, 4 and 5, but this time the models are estimated using eight lags. For Figures 9 and 10, the results are rather dull. Although they are correct, directionally speaking, their patterns tend to oscillate about trend. Moreover, the magnitudes remain similar, but again, in almost all cases for all quarters, the results are statistically insignificant. The BR however, is significant from the fifth to the seventh quarter showing a slow convex decline rather than the usual quicker concave decline. The magnitude demonstrated is also much greater hitting a low of 0.5 percentage points. Figure 10 displays

similar oscillating trends for all the variables. Nevertheless, almost all variables are insignificant. Figure 11 shows similar results as those from Figure 9, but with greater magnitudes. All variables are insignificant, save for the BR. It hits a low of 0.7 percentage points below trend and is significant from the fifth to the eight quarter.

Next, I follow Alexopolous (2009) and reverse the ordering of the price and quantity variables, as described in Models (3) and (4). Figures 12, 13 and 14 report the results of this exercise. Figure 12 shows the responses to a CNPU shock identified from Model (3). The results are strikingly familiar. All the directions, magnitudes and statistical significances are practically the same as those from the original estimation. When looking at Figure 13 though, the results are slightly less significant. For DGC and CPI they are completely insignificant. Despite this, they show the same general patterns. Figure 14 displays the same characteristics as Figure 5. All variables show some significance and bear similar patterns and magnitudes.

To address the causation debate, I reverse the ordering of the variables and include the uncertainty indexes after all the other variables, as described in Models (5) and (6). This robustness exercise attempts to address the causation debate: do recessions elevate uncertainty or does uncertainty drive recessions? By placing uncertainty last, this variable is allowed to respond contemporaneously to the developments of the economy, and the uncertainty shocks identified from Models (5) and (6) are assumed to be orthogonal to all other structural shocks that affect the variables of interest. Figures 15, 16 and 17 show the results of this reversed ordering. Figure 15 shows the responses to a CNPU shock identified from Model (5). The results show that almost all the variables display different and varying patterns that are insignificant. The BR is slightly significant for several quarters but the drop from trend is only of 0.10 percentage points. Next, Figure 16 shows the responses to a CNPU shock identified from Model (6). Since in this case the CNPU is placed before the USNPU, CNPU shocks are assumed to be orthogonal to uncertainty shocks affecting the US uncertainty index. In this case, the responses of the variables are different and slightly more significant. The BR is significant for all periods. EMP shows that usual checkmark pattern and is significant for the first quarter. The same analysis applies for GDP yet both magnitudes are very small compared to previous results. DGC and CPI are completely insignificant. GFCF does drop to a low of 0.5 percentage points and is significant for the first three quarters. Finally, Figure 17 shows that the responses of all variables to a USNPU shock identified from Model (6) fluctuate about trend but are insignificant in all cases and all periods. Overall, Figures 15, 16, and 17 highlight the fact that the baseline results rely, at least to some extent, to the assumption that the Canadian economic

variables of interest are affected by Canadian and US policy uncertainty contemporaneously, and not the other way around.

In the final three exercises, I repeat the baseline estimations using alternative uncertainty indexes. First, I replace the USNPU and CNPU with the USEPU and CEPU using one lag. Because of the availability of the CEPU data, my sample in this case goes from 1990Q1 to 2014Q1 only. Second, I replace the USEPU with the VIX index while keeping the original CNPU. Finally, although there is a severe lack of data, the last three figures make use of the VIXC and VIX uncertainty indexes. The data set spans 2005Q2 to 2014Q4 or 42 periods. Although the limited number of observations makes the results of this analysis far from reliable, they might still be indicative of the potential effects of the uncertainty arising from the Canadian stock markets.

Figure 18, 19 and 20 report the results of the Models that include the CEPU and USEPU. All three figures serve to replicate the estimations from the baseline analysis with the exception that CNPU is replaced by CEPU and USNPU with USEPU. Figure 18 shows, once again, very similar results to the baseline analysis. All variables bear some significance. GFCF, GDP and EMP display the checkmark pattern with similar magnitudes, CPI and DGC show instant drops followed by immediate rebounds and the BR shows the same decline and prolonged stagnation. Figure 19 reports the responses to a CEPU shock identified from Model (8). The patterns are somewhat similar to the original ones, the directions are correct, but the error bands are much wider and thus the results are statistically insignificant in all cases. Figure 20 shows the responses to a USNPU shock, and the results are again similar to the baseline analysis. All the directions and magnitudes are roughly the same. The statistical significance for each variable is also quite similar. These strings of results build mounting evidence that US shocks prove to cause greater negative economic harm than Canadian shocks.

Figures 21, 22 and 23 report the results for the Models estimated using the CNPU and VIX index. Although the original CNPU index is included, the VIX, a financial markets uncertainty index, brings a new dynamic and attests to the strength of the model. Figure 21 reports the responses to a CNPU shock identified from Model (9). The results are nearly identical, in all aspects, to those from the original estimation. Figure 22 shows the impact of a shock to the CNPU as identified from Model (10), and provides a very different picture compared to the baseline scenario. The economic variables are much more volatile and much less significant. In fact, the magnitudes are much smaller than in the original estimation and practically all variables are insignificant for almost all quarters. Looking into Figure 23, depicting

the responses to a shock to the VIX, the results are similar to the third estimation from the baseline analysis, save for a few differences. The patterns and magnitudes are comparable but the error bands are much tighter for all variables except for the BR where the error bands are much wider. Given that this scenario is the result of a US uncertainty shock from the stock market, it would appear as though the response of the BR to this type of shock is less defined than the response to the more general US policy uncertainty shock.

In addendum, I investigate the impact of Canadian and US uncertainty as measured by the VIXC and the VIX. Given that the data set for the VIXC is only available for roughly 40 quarters, which is likely not enough to obtain accurate estimates, I use these estimates only to obtain some additional, suggestive insights. The results, not surprisingly, are relatively similar to the baseline analysis and can be found in Figures 24, 25 and 26. In Figure 24, all variables display the same general patterns and are actually statistically significant for many periods in each graph. Figure 25, shows similar patterns as Figure 4, but all the variables are statistically insignificant. Finally, Figure 26 displays a shock to the VIX and all the results are significant for minimum one quarter. The magnitudes are also stronger and the error bands tighter. Although these estimations cannot be relied upon due to a lack of data, they are in line with most other results displayed above.

Overall, the results from the sensitivity analysis go a long way to justify the baseline scenario. The majority of the additional estimations clearly attest to the robustness of the model and the original results.

Section 6: Conclusion

6.1 Interpreting the Results

There has been much literature in the past few years about the effects of uncertainty on national economies. Much of this literature has focused on the US or Euro area. The goal of this paper was to evaluate uncertainty and its effects on the Canadian economy. As in previous contributions, I used a SVAR model to evaluate the effect of uncertainty on the consumer price index, investment, consumption, gross domestic product, employment and the bank rate.

At first glance, it would seem as though Canadian uncertainty significantly impacts the Canadian economy. This is in fact the case when US uncertainty is not excluded from the equation. Rather, the results of the IRFs from the main analysis, as well as the sensitivity analysis, indicate that Canadian uncertainty has minor negative effects on the Canadian macro-economy when US uncertainty is included. Actually, in most cases the results are not very strong nor very significant. Despite this, they are measurable and worth mentioning for two variables. GDP and the BR are the most affected in terms of magnitude and significance indicating that Canadian uncertainty does play a small role on the two most important indicators. The robustness of the model tends to also attest to these adverse effects.

Finally, the responses of the variables of interest to US policy uncertainty shocks show that the impact of US uncertainty on the Canadian economy is important, and larger than the impact of Canada-specific uncertainty. This result can be explained by the openness of the Canadian economy, and the strong Economic connections of this country with the US.

6.2 Contributions and final remarks

The results of my analysis provide some interesting insight for the Canadian economy. The fact that Canadian uncertainty does have a small negative effect on the economy means that we should be cautious of future elevated uncertainty. Although the magnitude of the results are not drastically elevated by any means, during times of crisis, uncertainty rises rapidly and the effects are most likely compounded through contagion. Therefore, it is in the best interest for policy makers to keep a watchful eye on the amount or level of uncertainty present in the economy. Indicators such as the CNPU or VIXC provide a good measuring stick.

That being said, an equal or greater amount of caution should be held in regards to US uncertainty. Indeed, based on my results, when US uncertainty strikes, the Canadian economy responds. As a matter of fact, I find that US uncertainty affects the Canadian economy even more than Canadian uncertainty. Therefore, my results imply that Canadian policy makers should give a high importance to the US uncertainty indexes, and closely monitor their developments over time.

It has been shown through other studies such as Knut. et al. (2013) and Johannsen (2014) that elevated uncertainty plays a role in attenuating the effects of monetary policy on the economy. Further research on the combination of government and monetary policy could shed some light on how to handle high and persistent uncertainty. Naturally, there are many other factors at play; however, as demonstrated after the recent financial crisis, uncertainty played a key role in slowing monetary policy and the recovery altogether. Even with drastic government and monetary policy action during and after the recent Great Recession, uncertainty persisted for years. Therefore, our government, along with but not limited to, the US, face an exceptional challenge in mitigating uncertainty ahead of and during future recessions and crisis.

This also opens the door for further research on the effects of US uncertainty on the Canadian economy. Many American policies have a vital impact on the Canadian economy and uncertainty most likely plays an equally important role. Studying the effects of US uncertainty on the Canadian economy would further extend our understanding of its internal as well as external effects. A more in depth analysis regarding this issue could shed some light on the situation as not all aspects were explored in this paper. For example, other variables such as the Federal Funds Rate could be included. Canada is highly dependent on imports and exports therefore factors such as oil prices and commodities index could prove useful in bringing more information to the table regarding uncertainty and Canada.

Appendix A List of Figures

Graphs of Data

Figure 1 Canadian and US Uncertainty Indicators in Log Differences

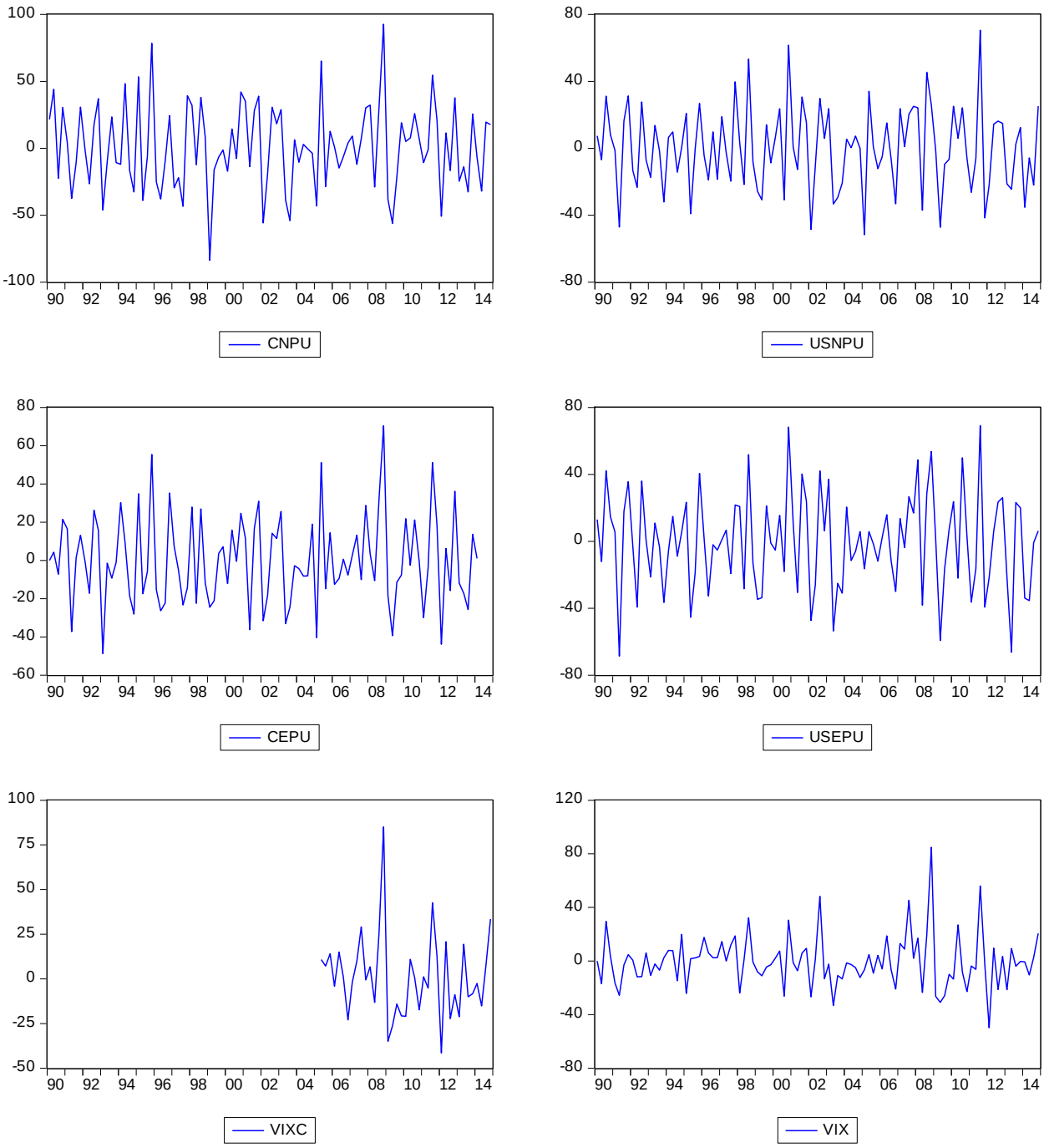
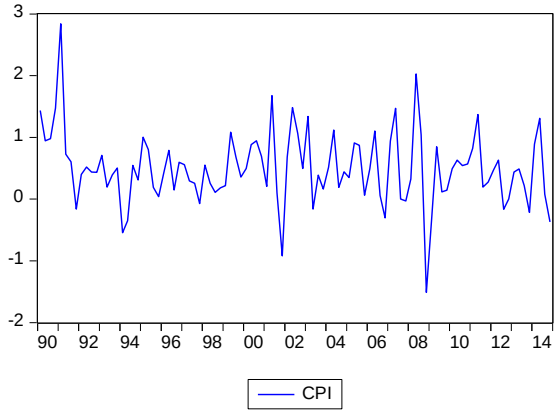
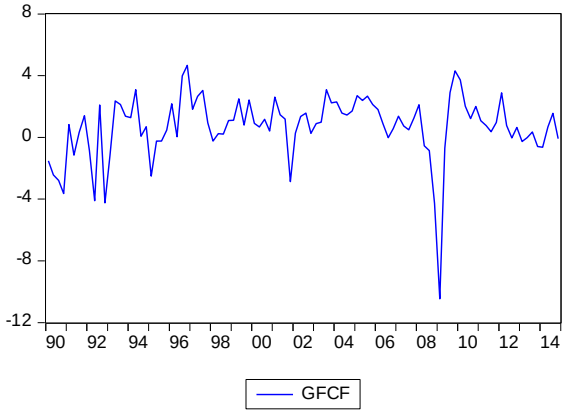
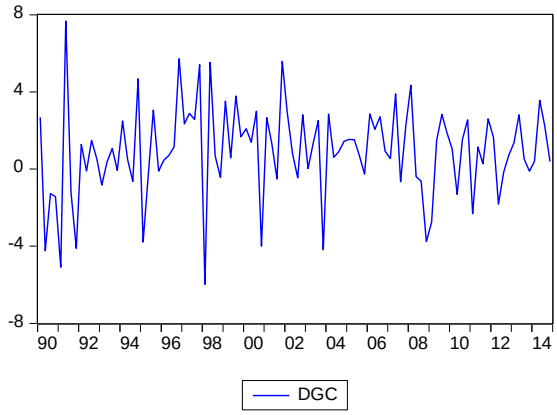
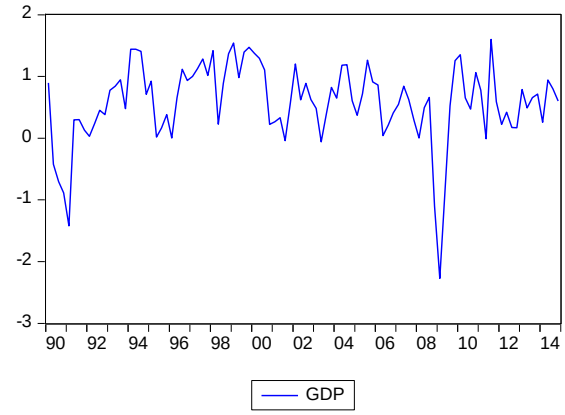


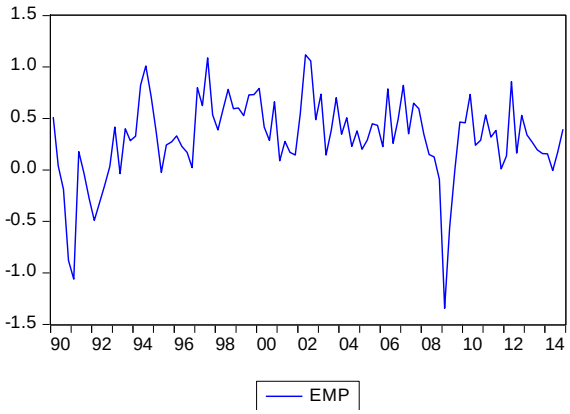
Figure 2 Canadian Macro-Economic Variables in Log Differences

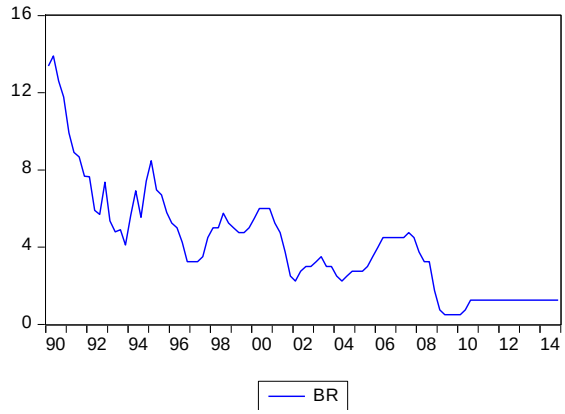












Impulse Response Functions

Baseline Analysis

Figure 3 Canadian News-Based Policy Uncertainty (CNPU) Shock (1 lag) – CNPU ordered first

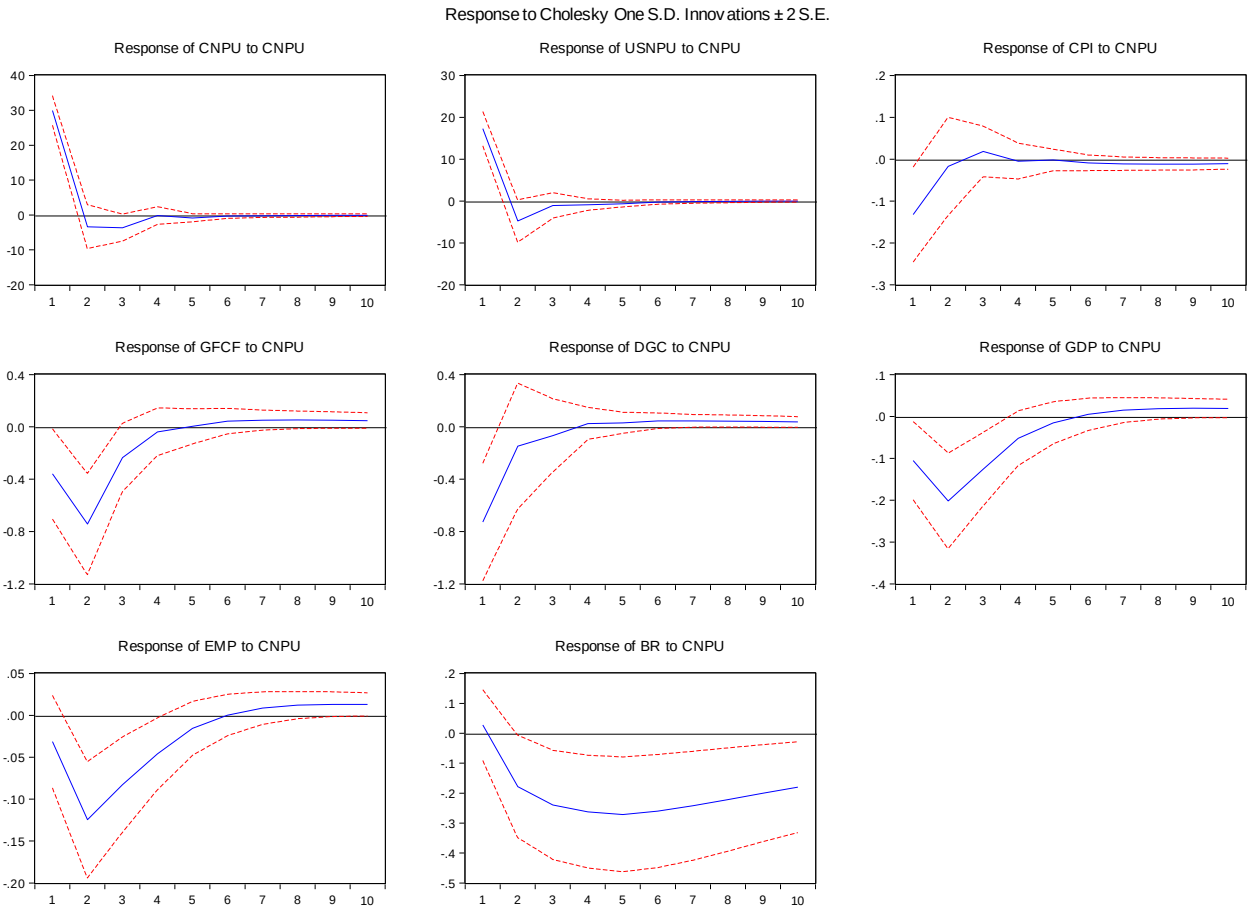


Figure 4 Canadian News-Based Policy Uncertainty (CNPU) Shock (1 lag) – CNPU ordered second

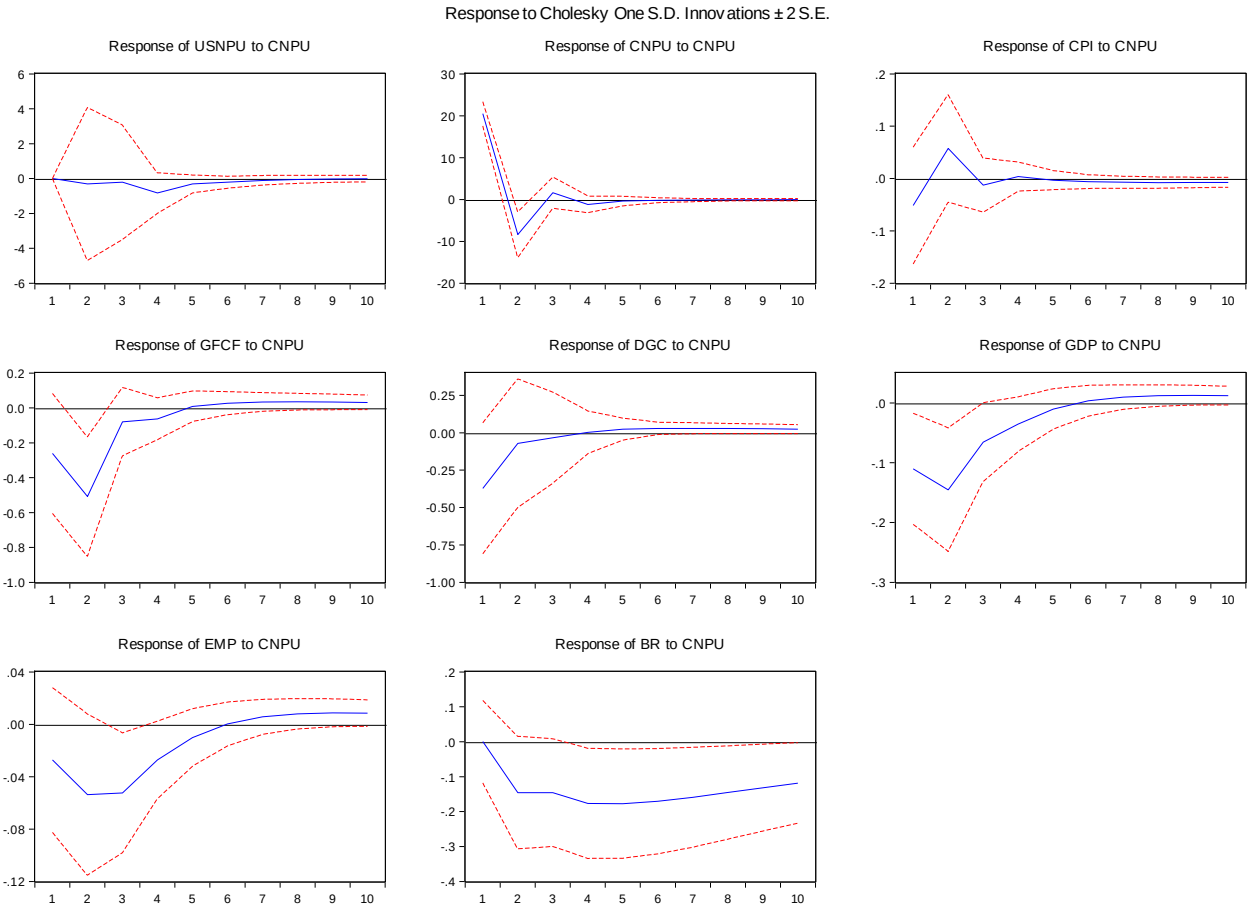
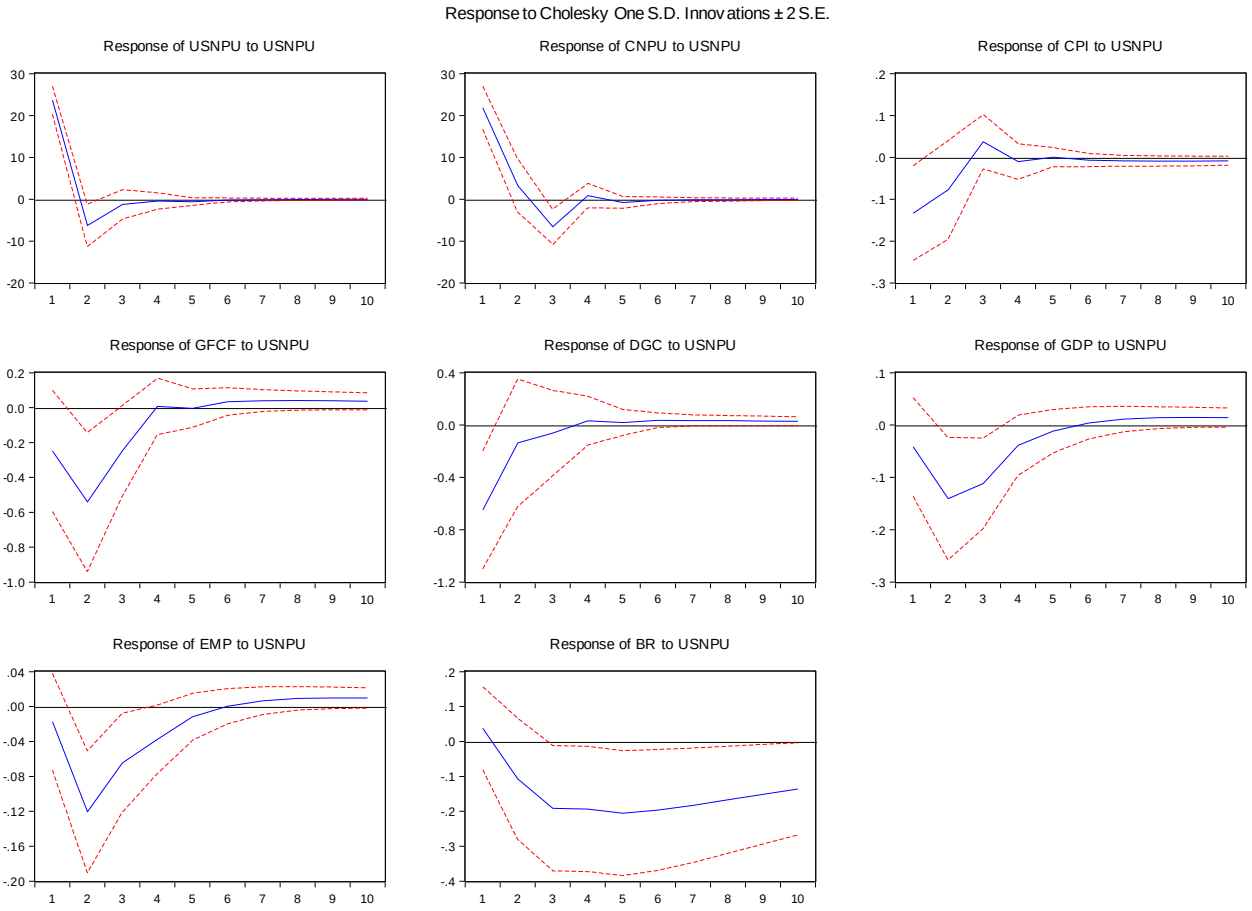


Figure 5 US News-Based Policy Uncertainty (USNPU) Shock (1 lag) – CNPU ordered second



Sensitivity Analysis

Figure 6 Canadian News-Based Policy Uncertainty (CNPU) Shock (2 lags) – CNPU ordered first

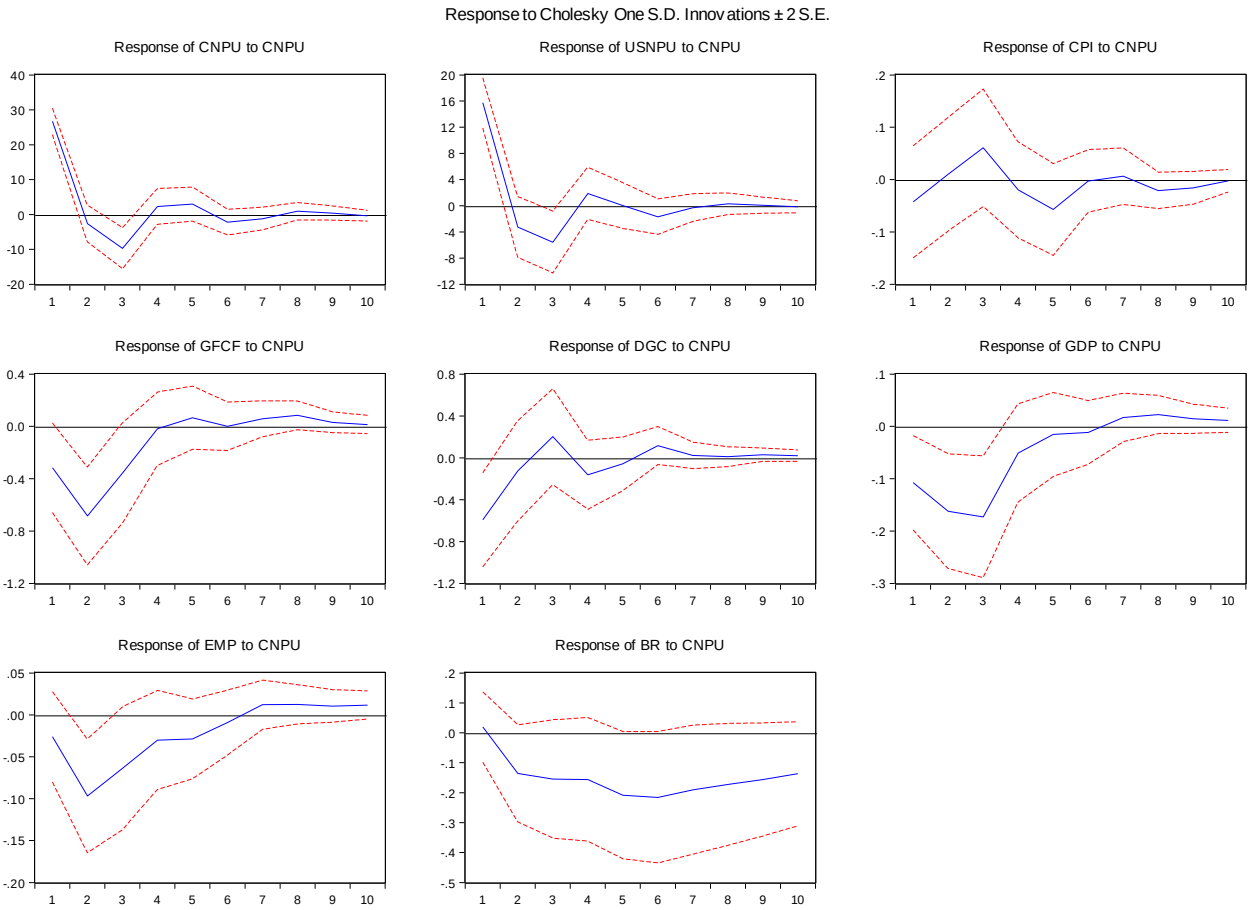


Figure 7 Canadian News-Based Policy Uncertainty (CNPU) Shock (2 lags) – CNPU ordered second

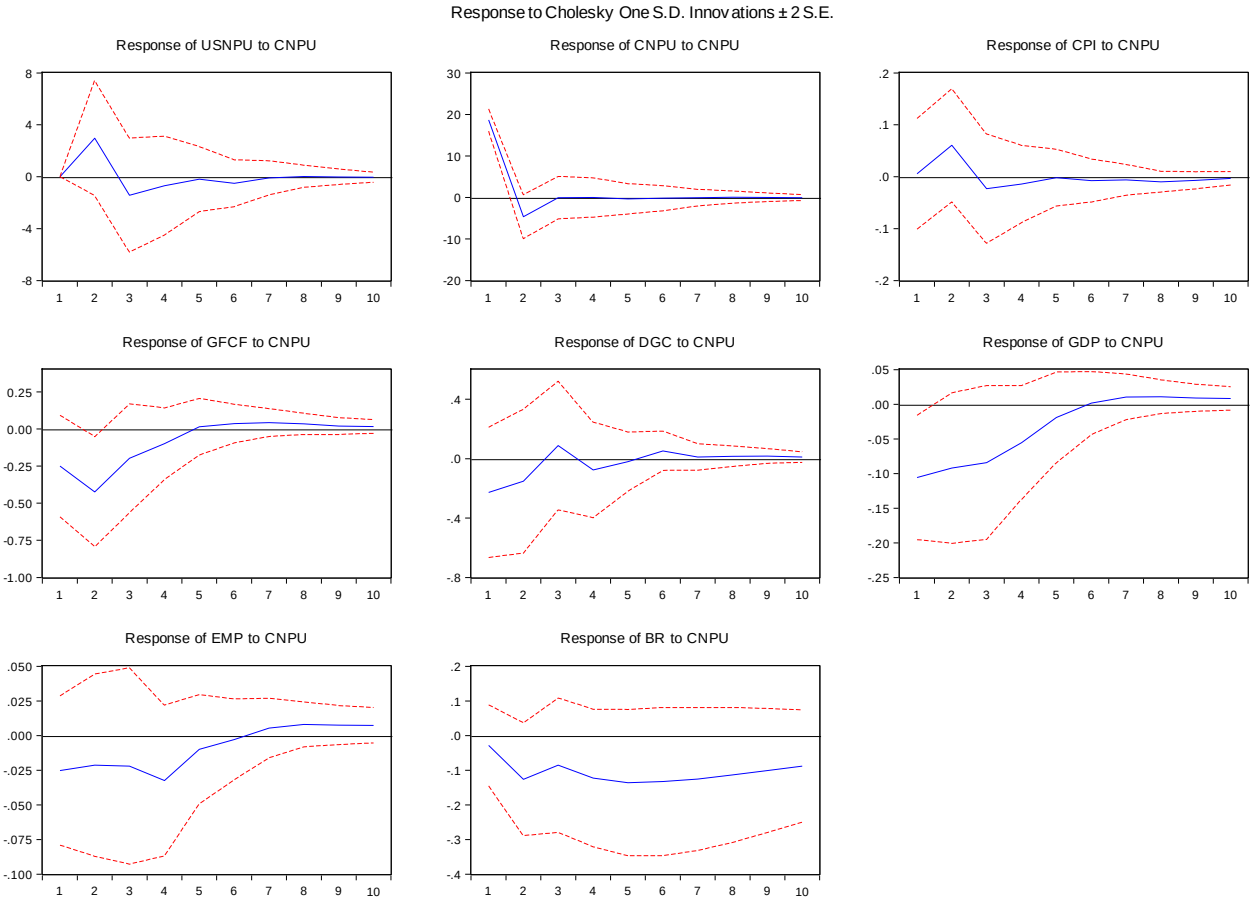


Figure 8 US News-Based Policy Uncertainty (USNPU) Shock (2 lags) – CNPU ordered second

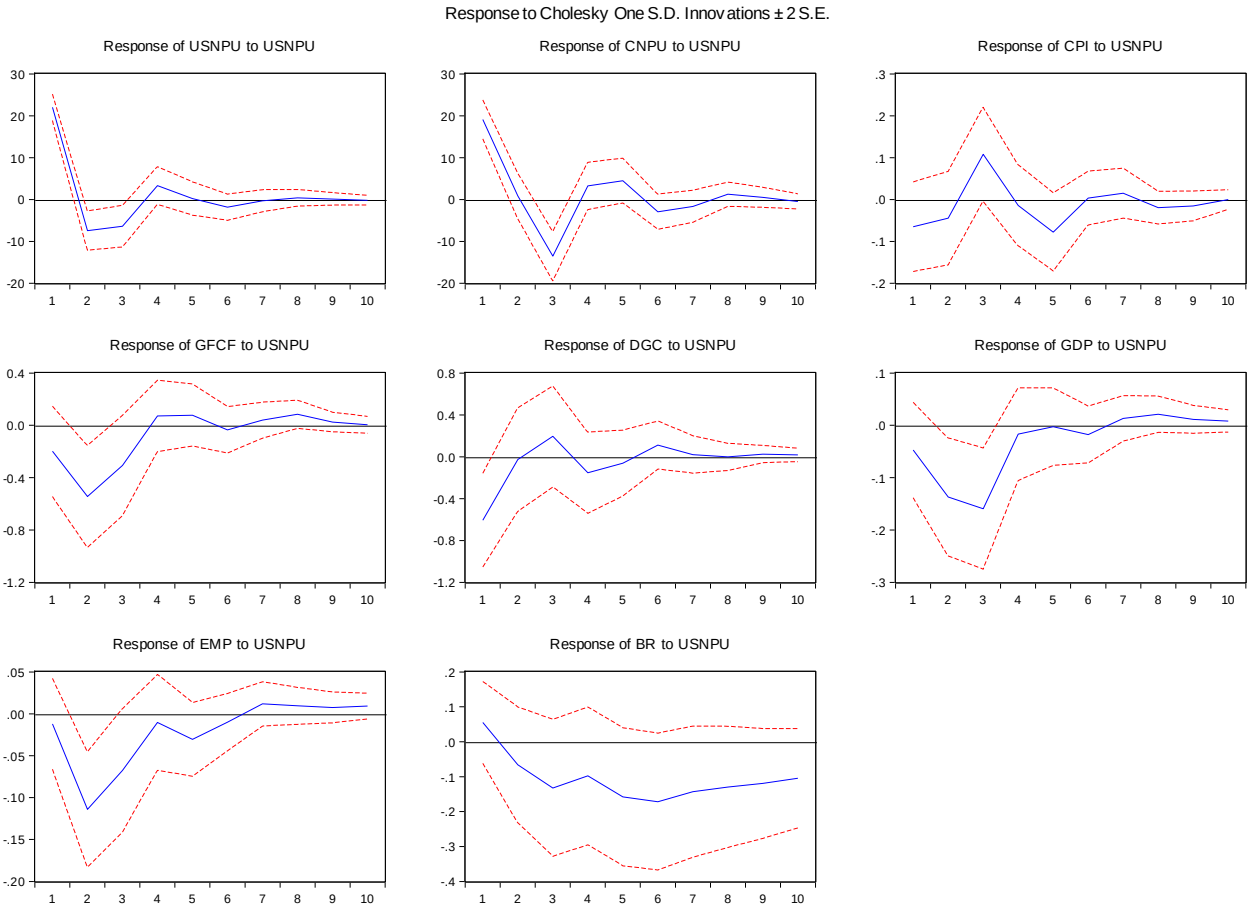


Figure 9 Canadian News-Based Policy Uncertainty (CNPU) Shock (8 lags) – CNPU ordered first

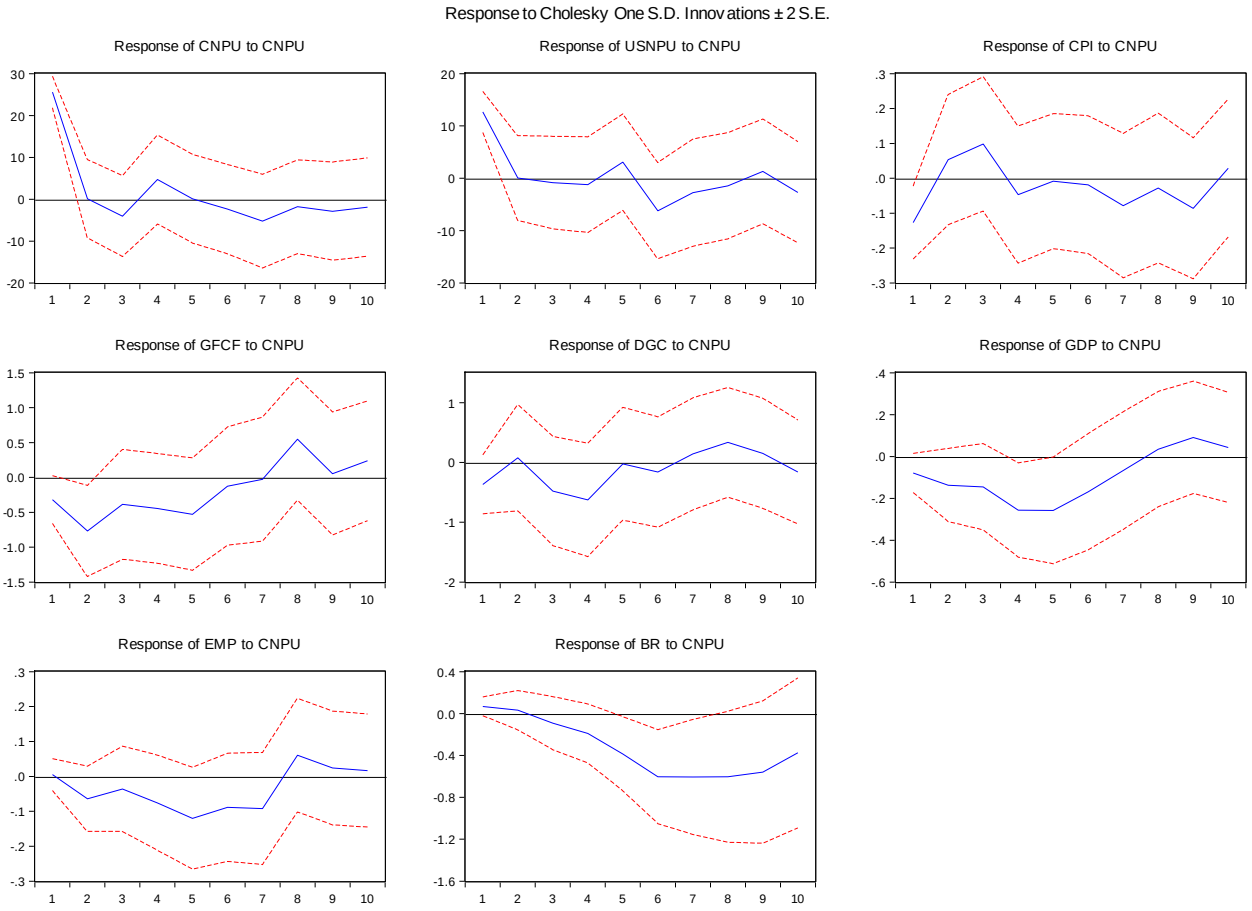


Figure 10 Canadian News-Based Policy Uncertainty (CNPU) Shock (8 lags) – CNPU ordered second

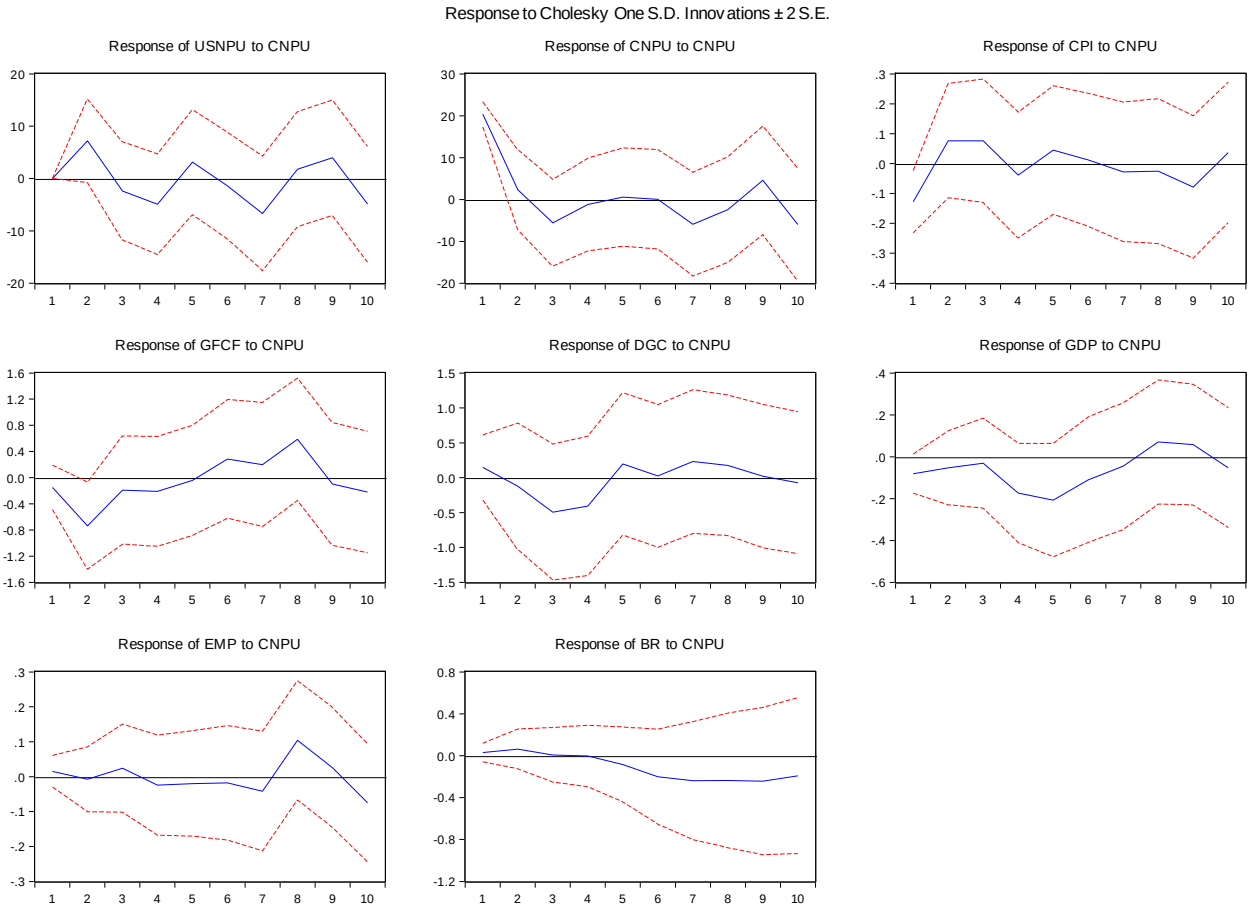


Figure 11 US News-Based Policy Uncertainty (USNPU) Shock (8 lags) – CNPU ordered second

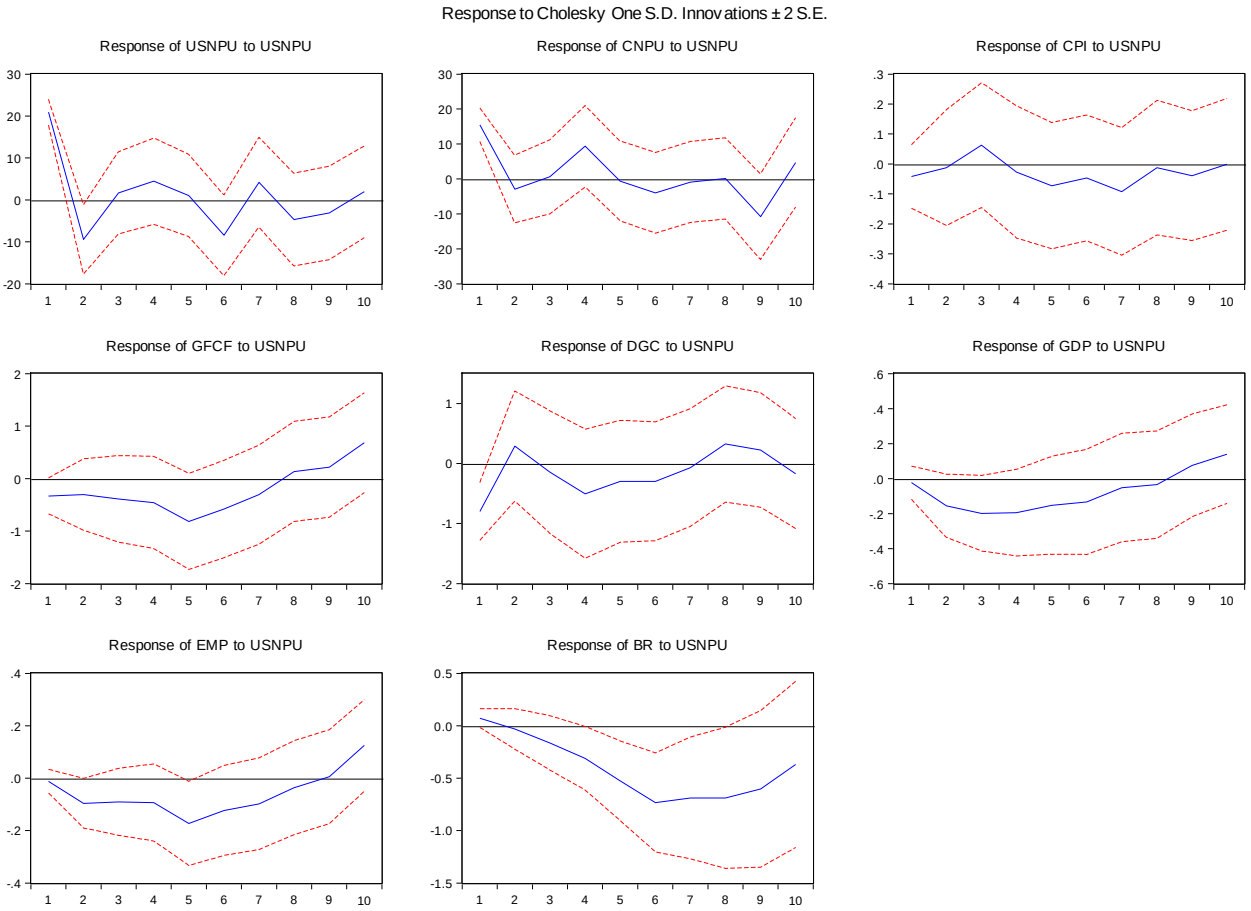


Figure 12 Reversed Q's and P's Canadian News-Based Policy Uncertainty (CNPU) Shock (1 lag) – CNPU ordered first

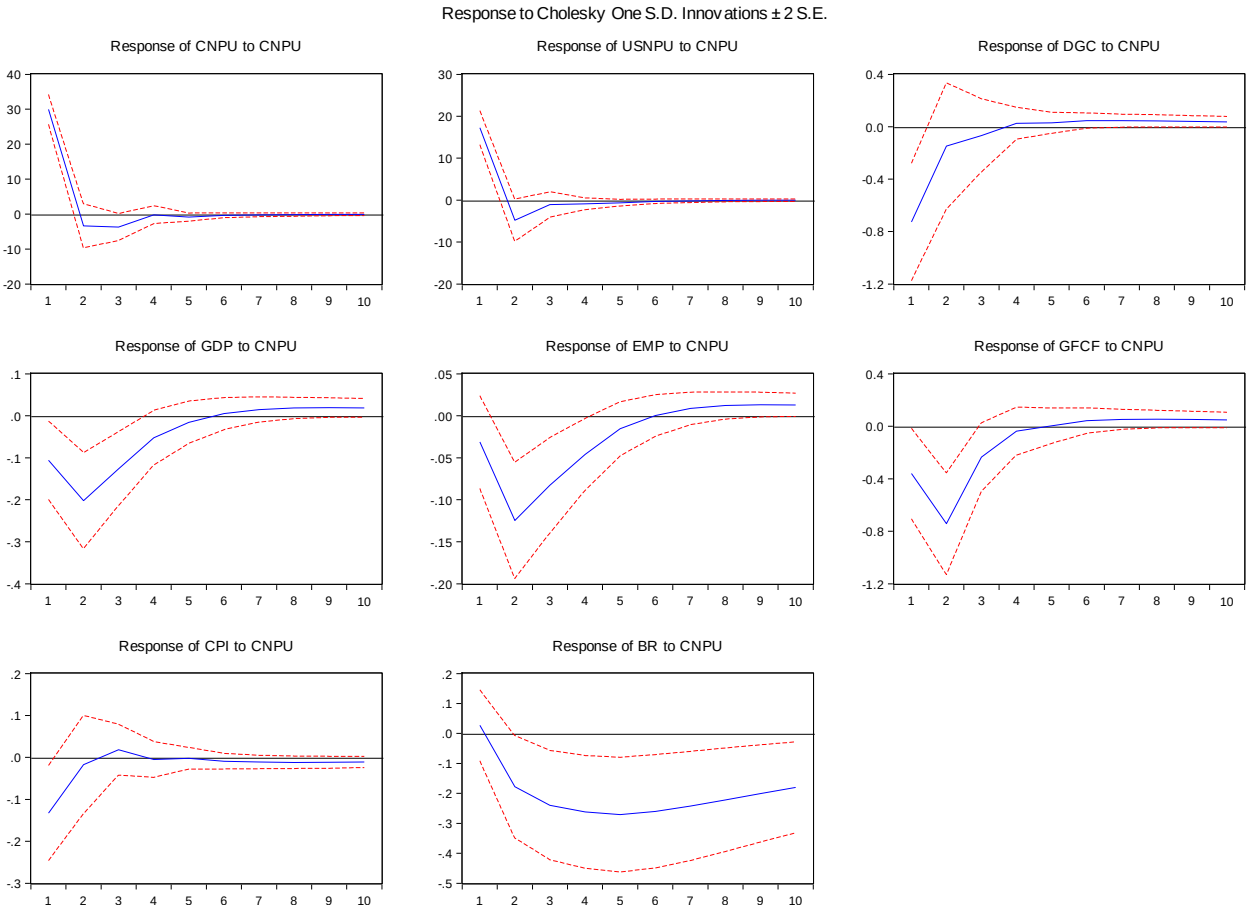


Figure 13 Reversed Q's and P's Canadian News-Based Policy Uncertainty (CNPU) Shock (1 lag) – CNPU ordered second

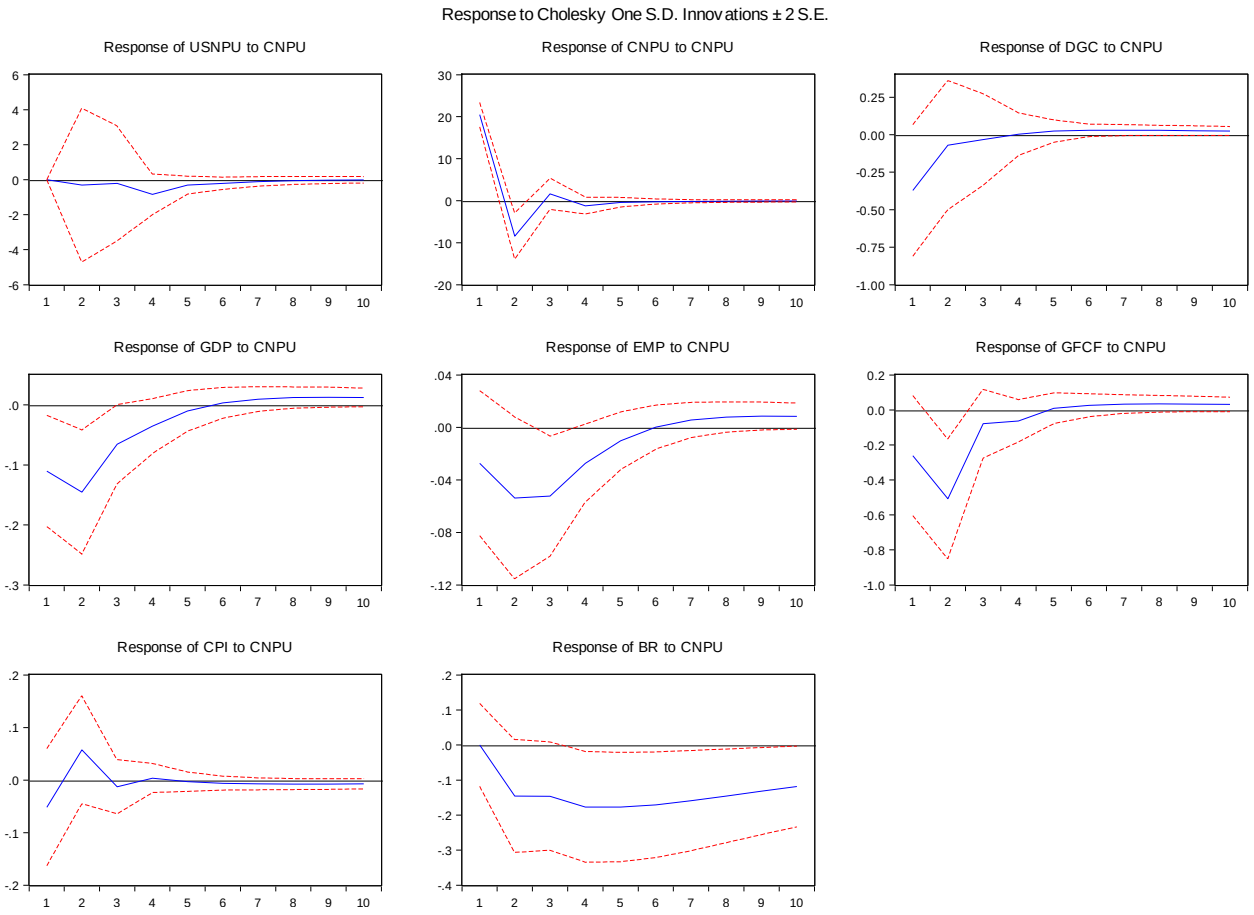


Figure 14 Reversed Q's and P's US News-Based Policy Uncertainty (USNPU) Shock (1 lag) – CNPU ordered second

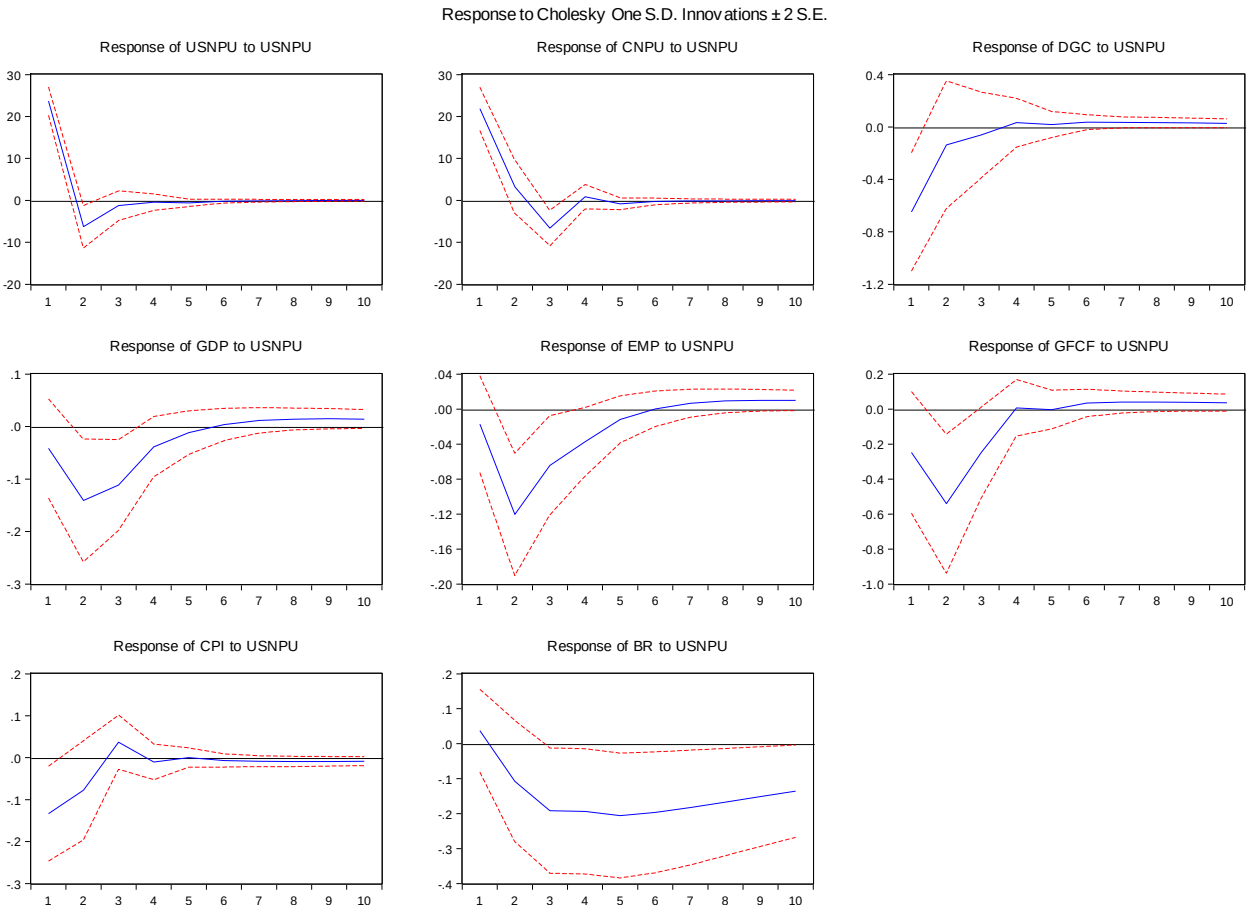


Figure 15 Reverse Ordering Canadian News-Based Policy Uncertainty (CNPU) Shock (1 lag) – CNPU ordered last

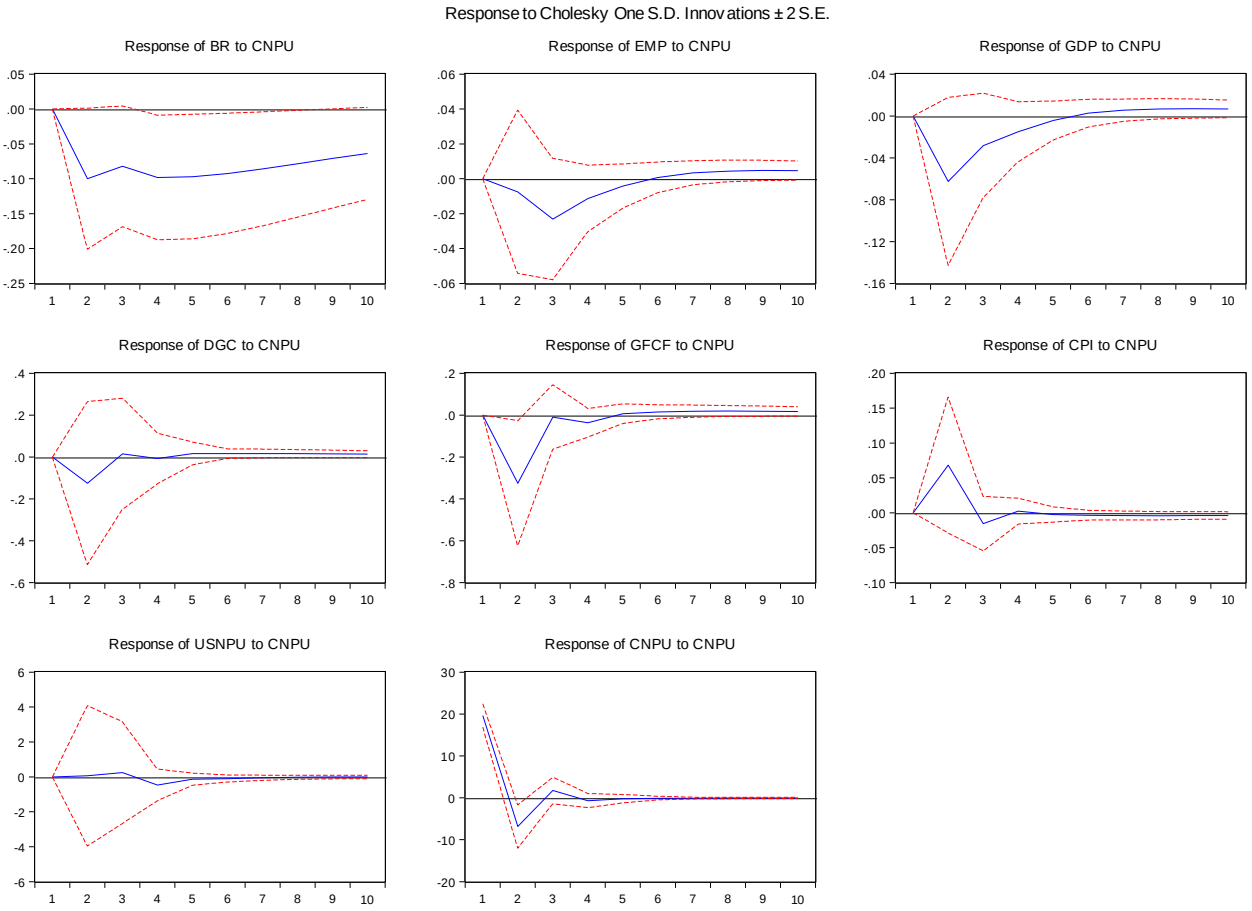


Figure 16 Reverse Ordering Canadian News-Based Policy Uncertainty (CNPU) Shock (1 lag) – CNPU ordered next to last

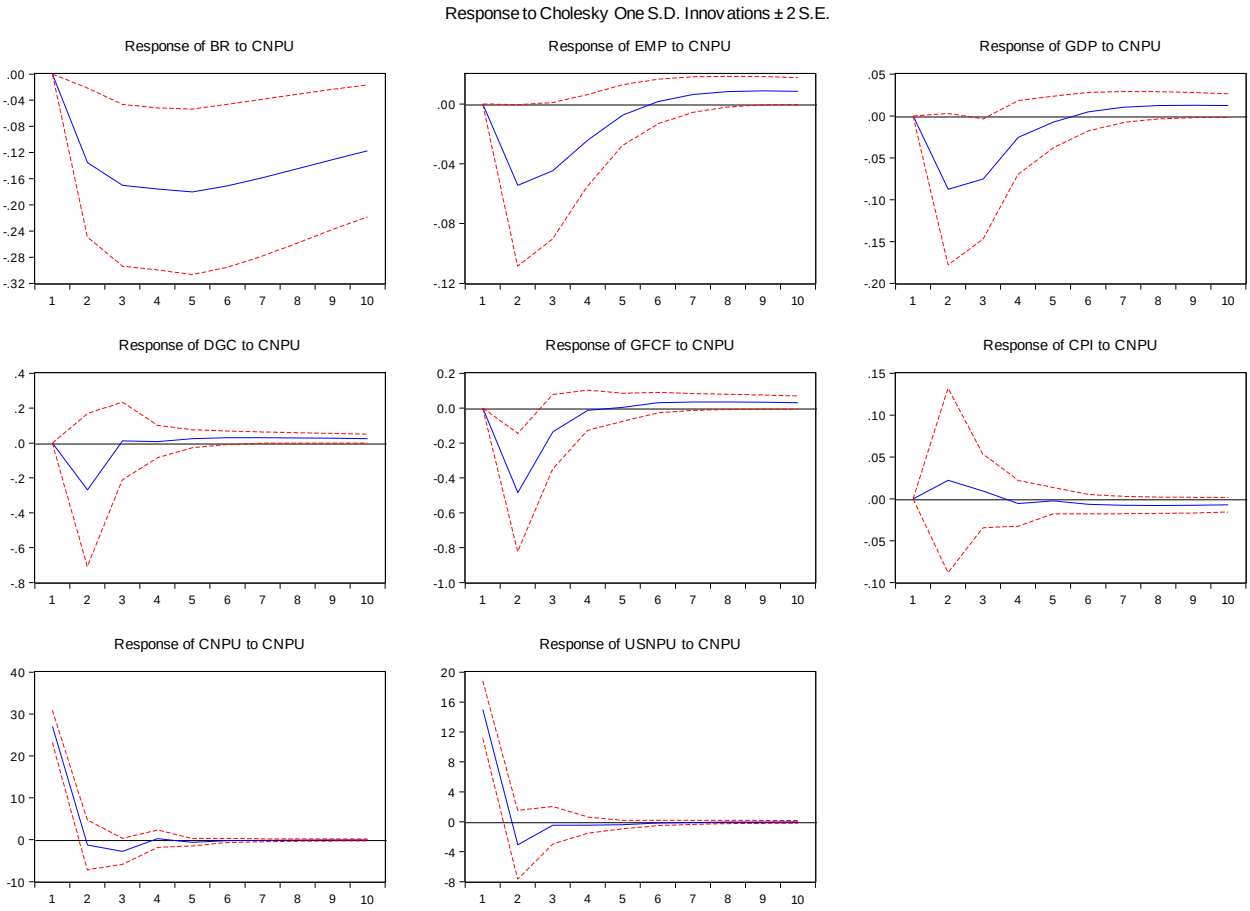
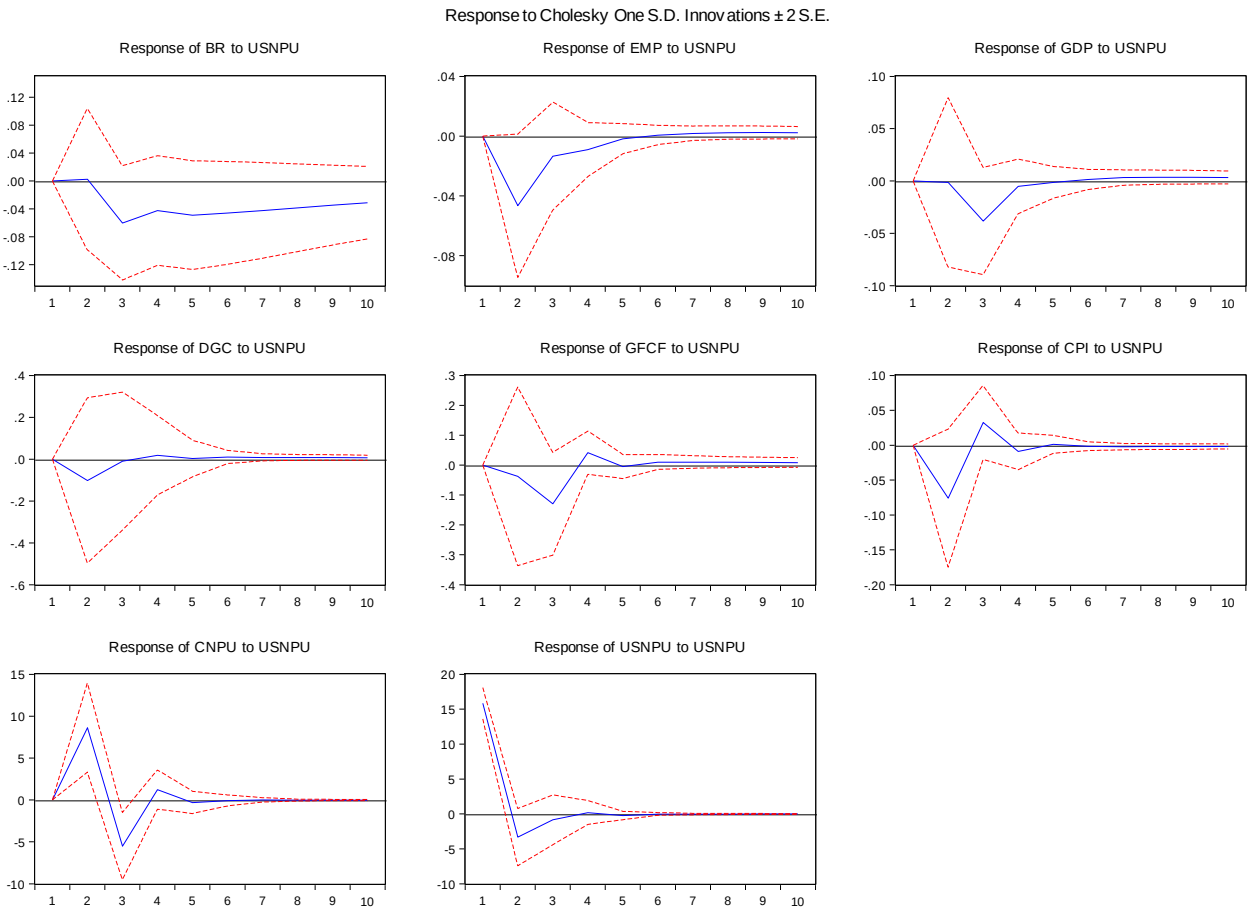


Figure 17 Reverse Ordering US News-Based Policy Uncertainty (USNPU) Shock (1 lag) – CNPU ordered next to last



Alternate Uncertainty Indexes

Figure 18 Old Canadian Economic Policy Uncertainty (CEPU) Shock (1 lag) using US Economic Policy Uncertainty (USEPU) index (1990Q1 to 2014Q1) – CEPU ordered first

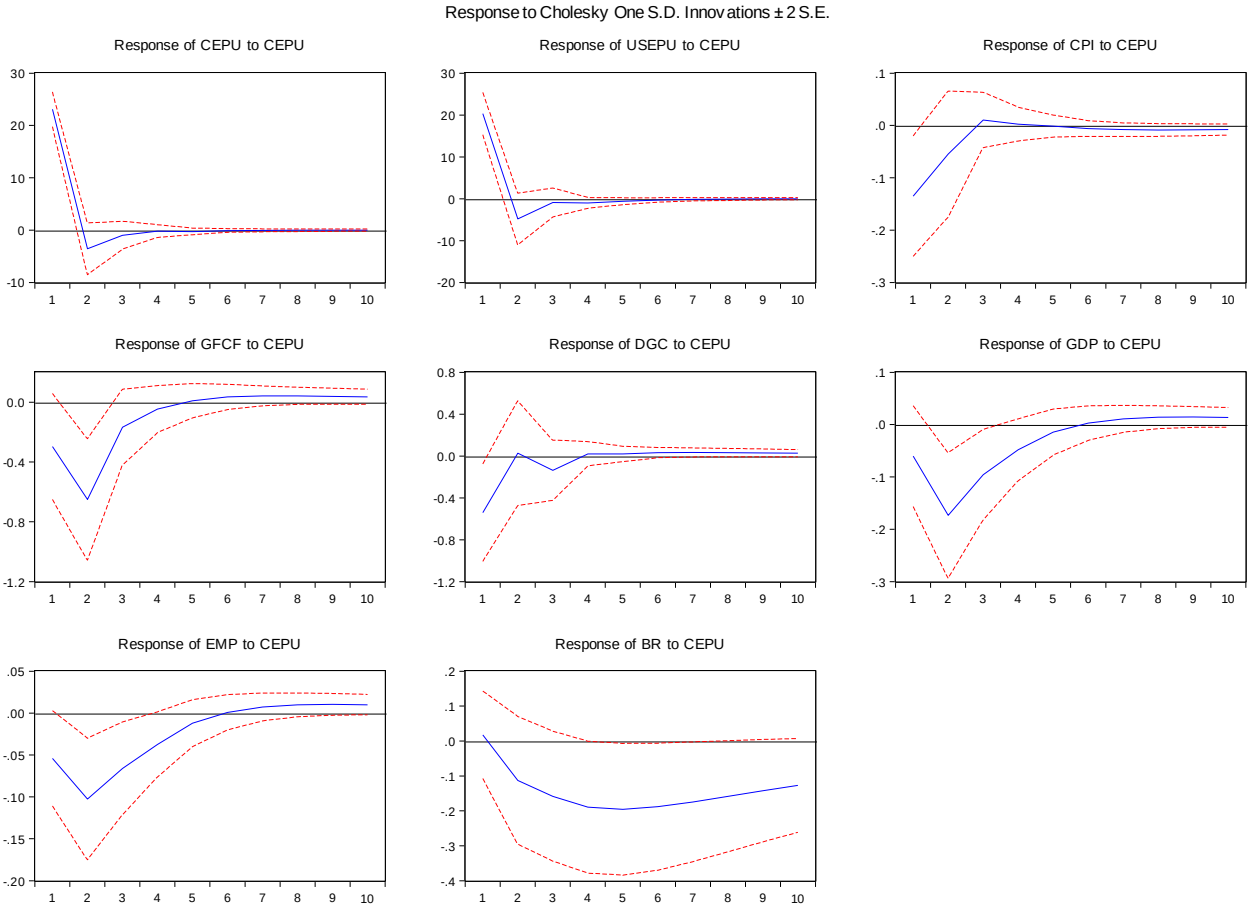


Figure 19 Old Canadian Economic Policy Uncertainty (CEPU) Shock (1 lag) using US Economic Policy Uncertainty (USEPU) index (1990Q1 to 2014Q1) – CEPU ordered second

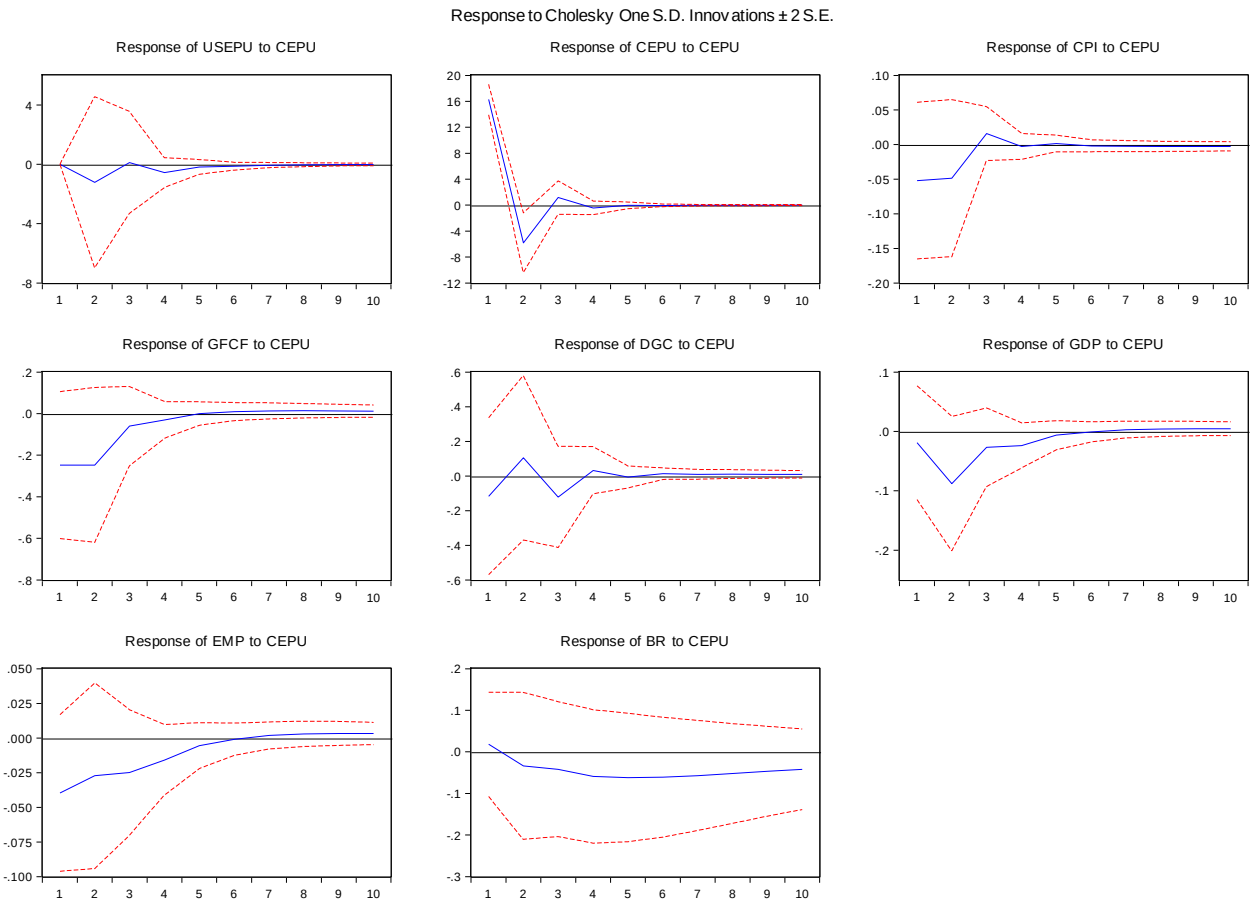


Figure 20 US Economic Policy Uncertainty (USEPU) shock (1 lag) using Old Canadian Economic Policy Uncertainty (CEPU) Index (1990Q1 to 2014Q1) – CEPU ordered second

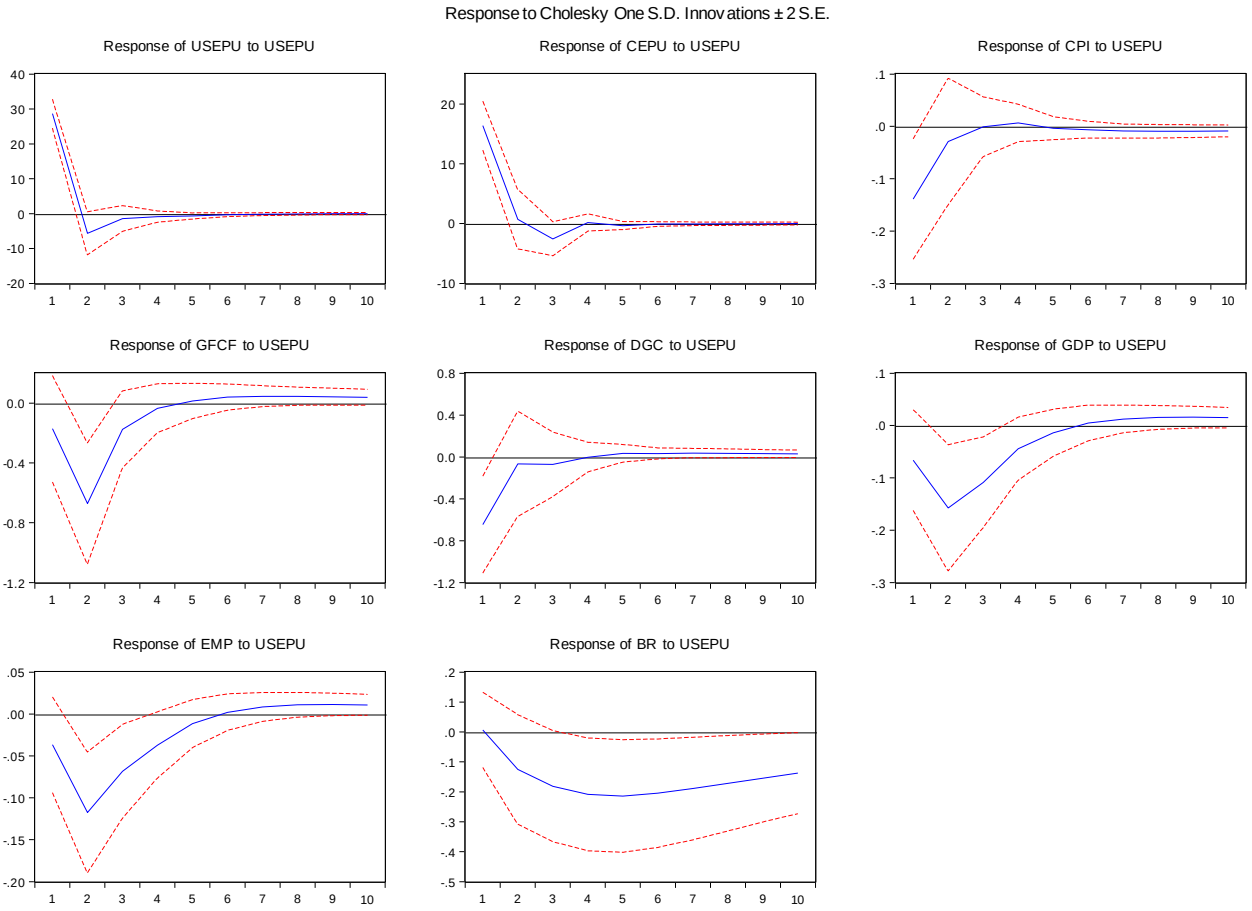


Figure 21 Canadian News-Based Policy Uncertainty (CNPU) Shock (1 lag) using US Implied Volatility Index (VIX) – CNPU ordered first

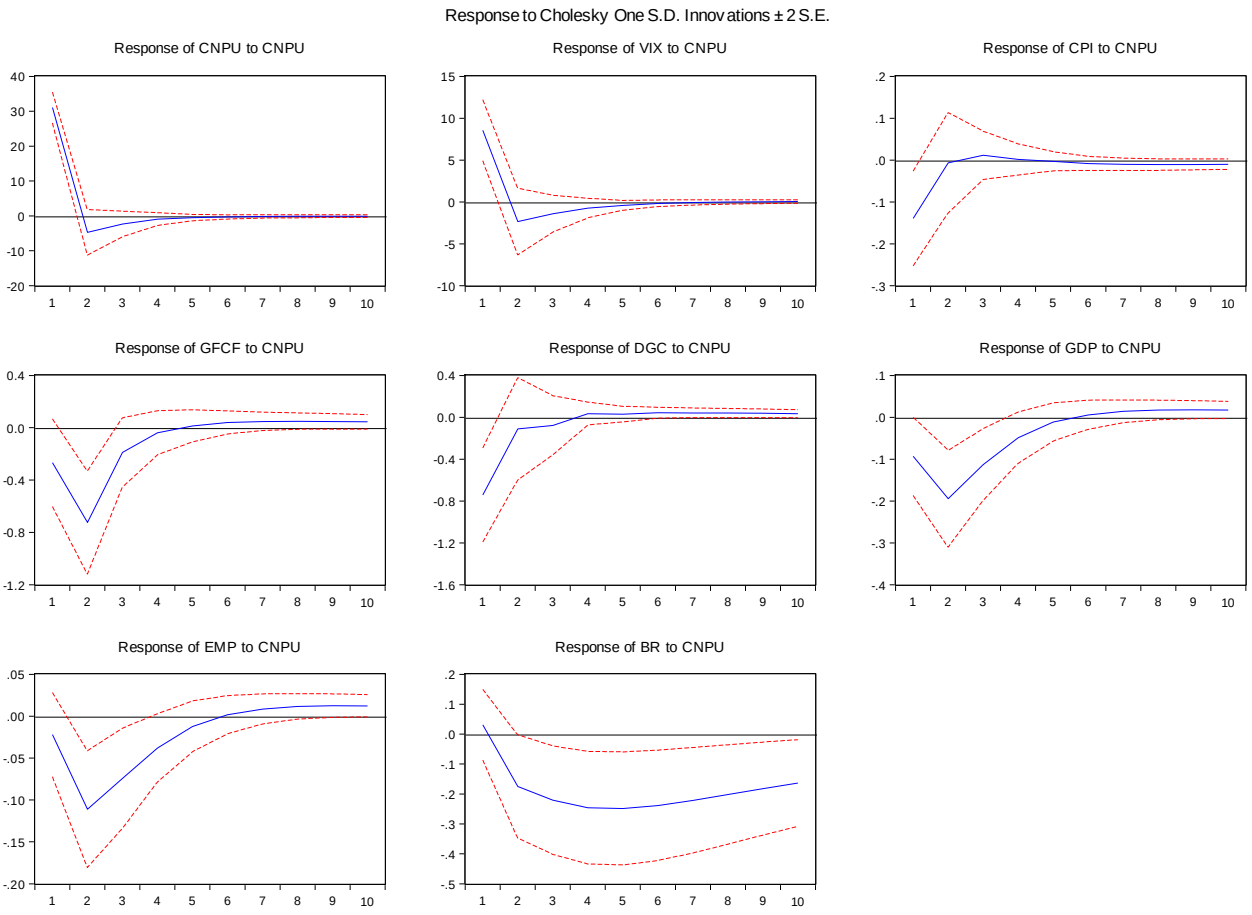


Figure 22 Canadian News-Based Policy Uncertainty (CNPU) Shock (1 lag) using US Implied Volatility Index (VIX) – CNPU ordered second

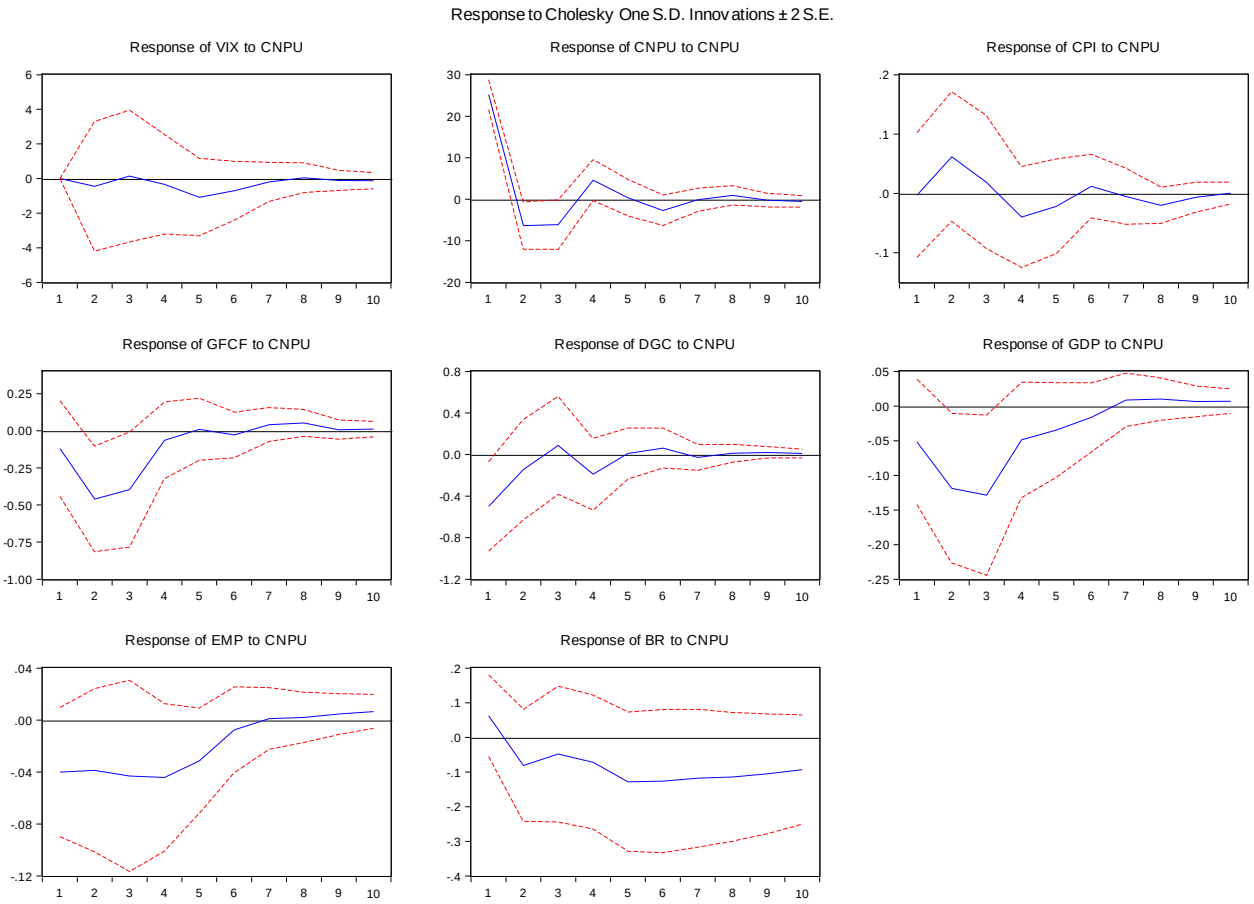


Figure 23 Implied Volatility Index (VIX) shock (1 lag) using Canadian News-Based Policy Uncertainty (CNPU) Index – CNPU ordered second

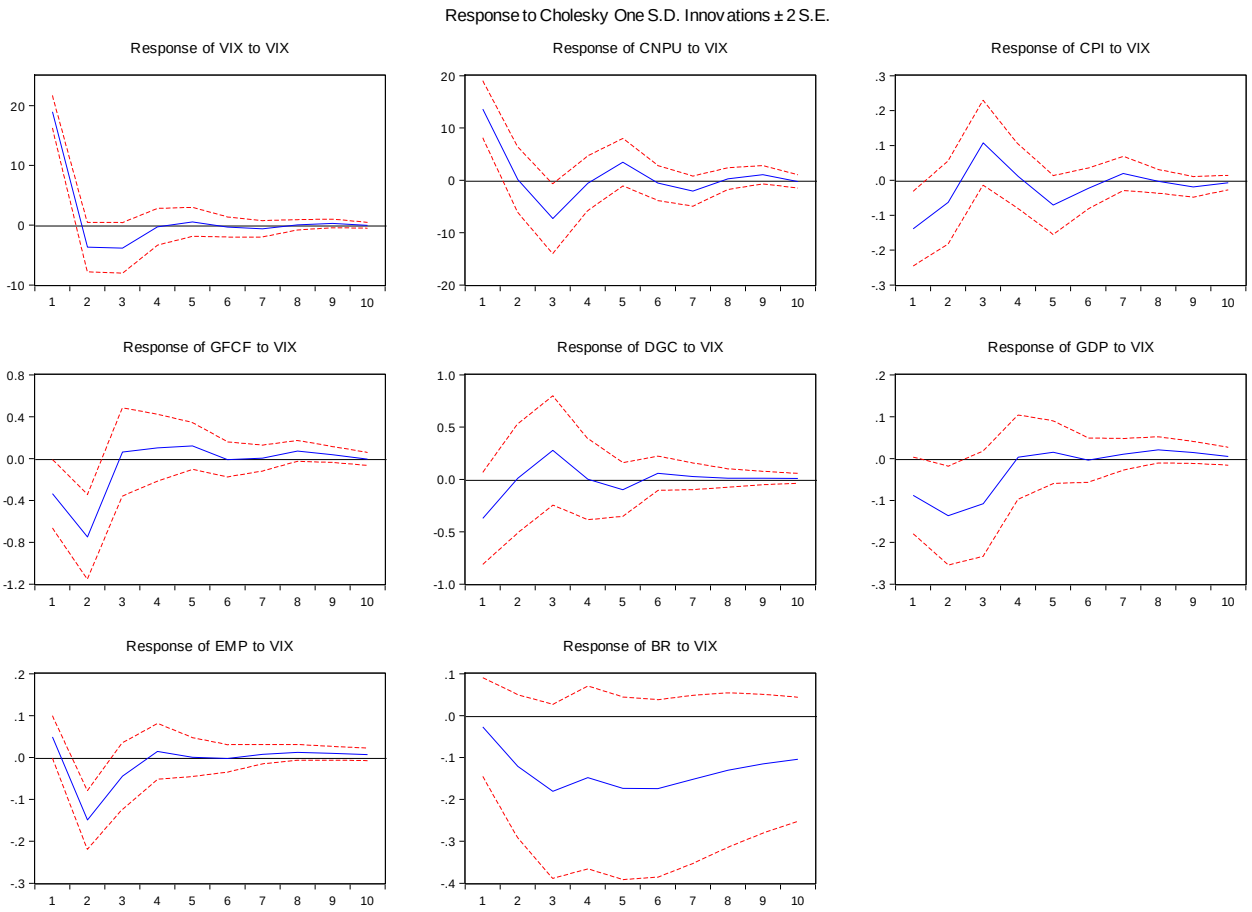


Figure 24 Canadian Implied Volatility Index (VIXC) shock (1 lag) using US Implied Volatility Index (VIX) (2005Q2 to 2014Q4) – VIXC ordered first

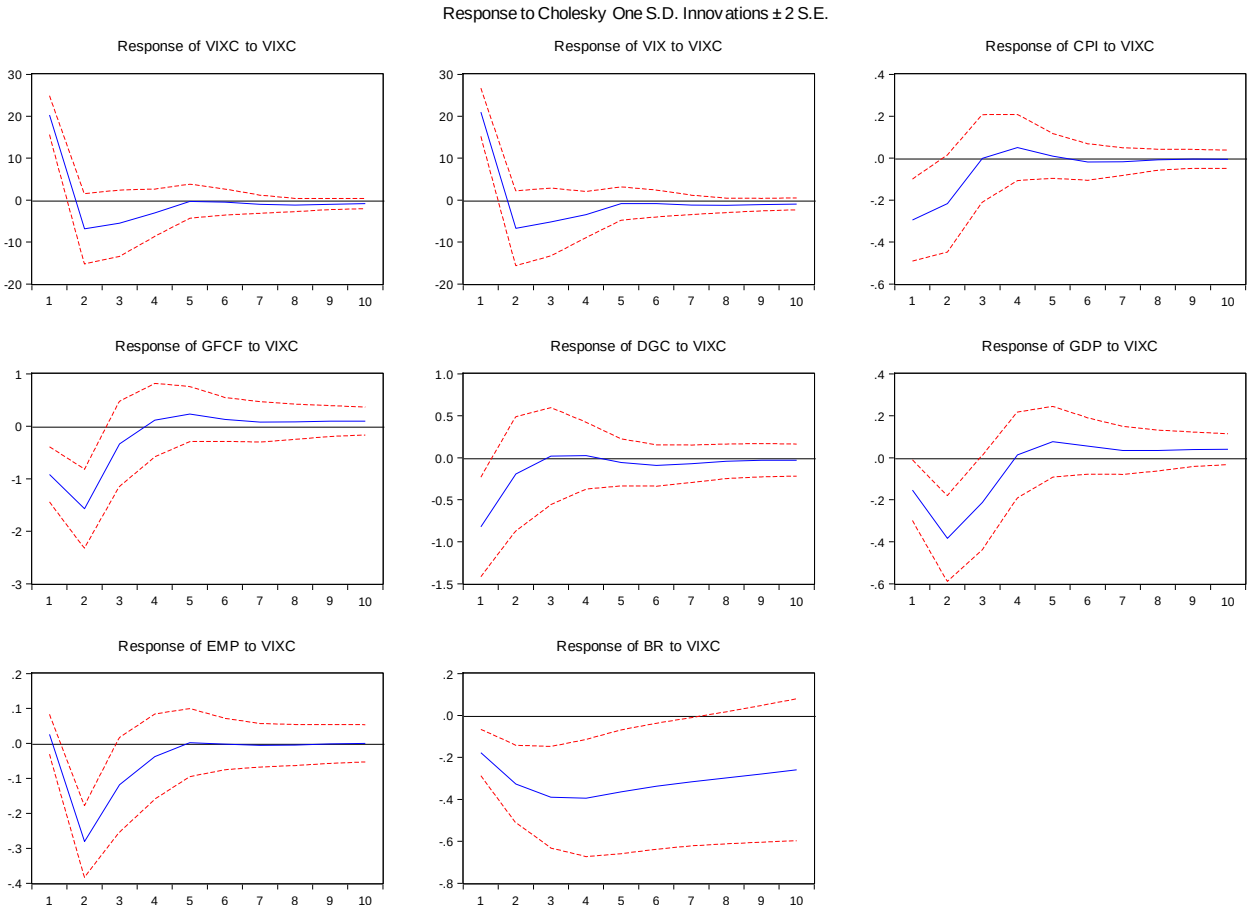


Figure 25 Canadian Implied Volatility Index (VIXC) shock (1 lag) using US Implied Volatility Index (VIX) (2005Q2 to 2014Q4) – VIXC ordered second

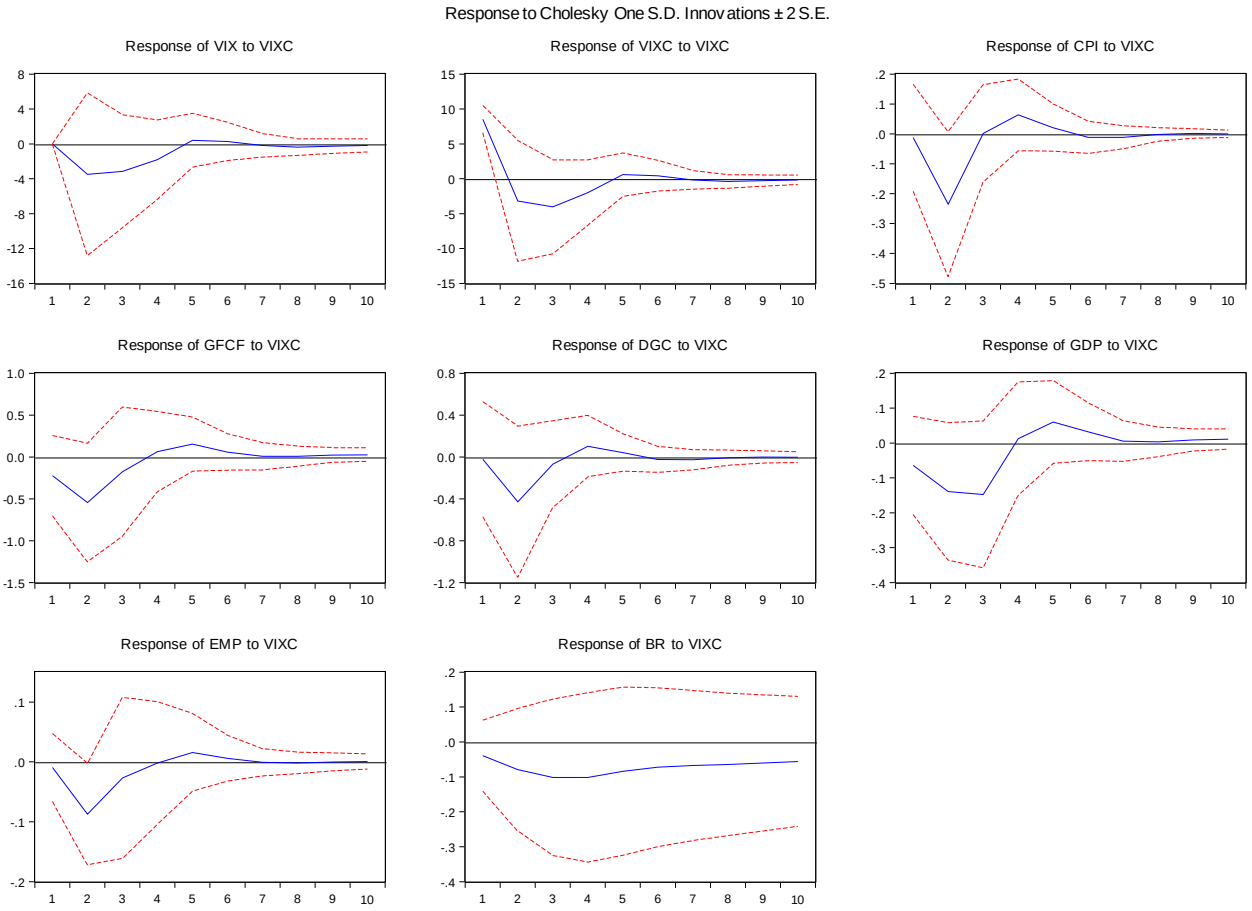
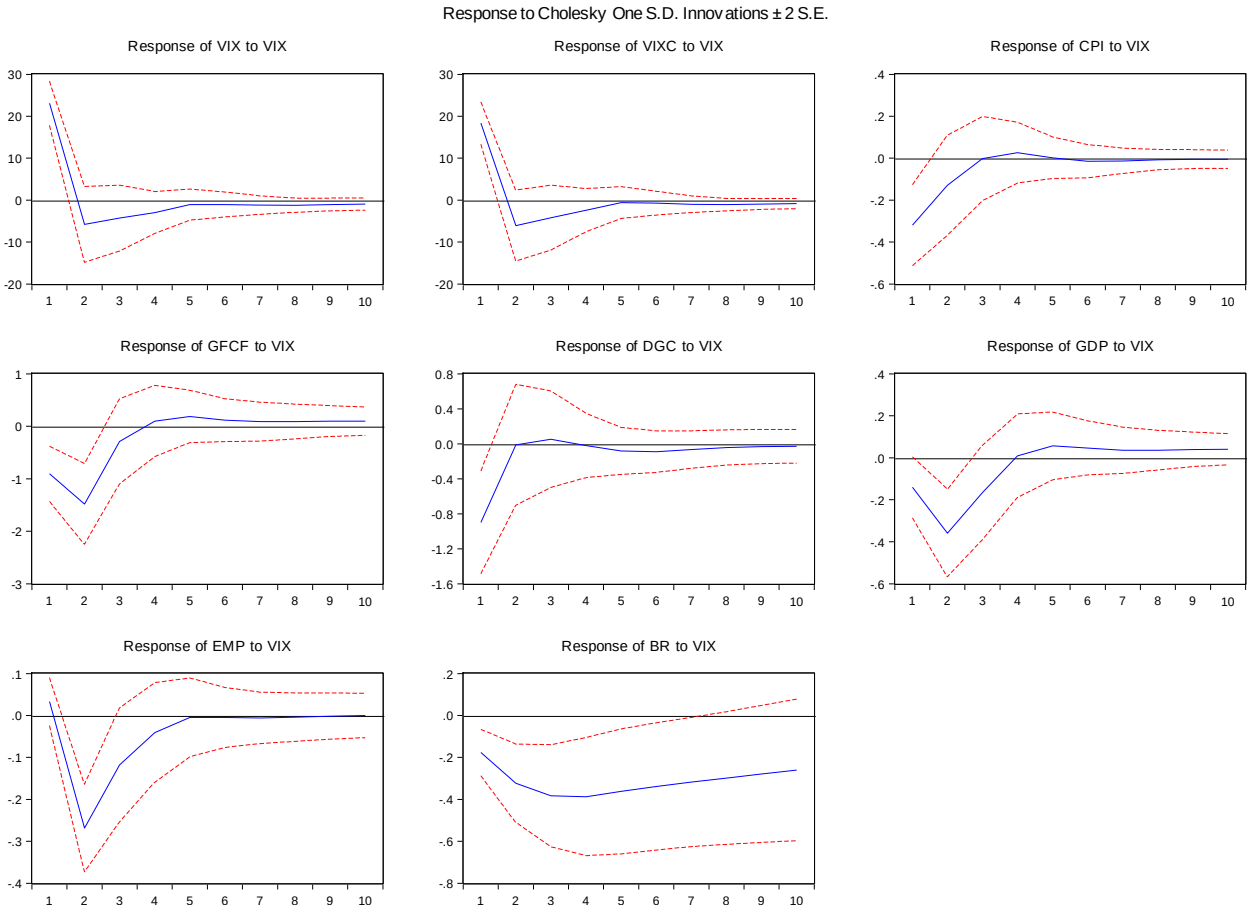


Figure 26 US Implied Volatility Index (VIX) shock (1 lag) using Canadian Implied Volatility Index (VIXC) (2005Q2 to 2014Q4) – VIXC ordered second



Appendix B List of Tables

Table 1 Correlation Coefficient of Uncertainty Indicators (1990Q1 to 2014Q4)

Correlation Coefficient 1990-2014		US EPU	US BOI	US USNPU	US VIX	Can CNPU	Can CEPU*	Can VIXC**
US	EPU	1.000	0.832	0.893	0.450	0.666	0.738	0.570
US	BOI	0.864	1.000	0.904	0.463	0.733	0.668	0.499
US	USNPU	0.946	0.906	1.000	0.560	0.714	0.647	0.509
US	VIX	0.562	0.484	0.576	1.000	0.301	0.359	0.968
Can	CNPU	0.738	0.750	0.726	0.309	1.000	0.869	0.459
Can	CEPU*	0.736	0.691	0.675	0.438	0.914	1.000	0.604
Can	VIXC**	0.314	0.616	0.340	0.901	0.323	0.372	1.000

*The data for CEPU spans from 1990Q1 to 2014Q1
**The data for VIXC spans from 2005Q2 to 2014Q4

Table 2 Lag Length Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: USNPU CNPU CPI GFCF DGC GDP EMP BR
Exogenous variables: C
Sample: 1990Q1 2014Q4

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1560.444	NA	88751.65	34.09661	34.31589	34.18511
1	-1350.166	379.4149	3709.501	30.91665	32.89022*	31.71320*
2	-1281.561	111.8550*	3456.083*	30.81655	34.54441	32.32115
3	-1244.435	54.07554	6699.352	31.40076	36.88291	33.61340
4	-1193.932	64.77570	10490.58	31.69417	38.93061	34.61486
5	-1129.969	70.91515	13762.70	31.69498	40.68571	35.32371
6	-1059.967	65.43701	18773.78	31.56449	42.30951	35.90127
7	-955.0139	79.85538	15474.40	30.67422	43.17352	35.71904
8	-849.7212	61.80226	19004.96	29.77655*	44.03014	35.52942

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 3 Variable Descriptions

Abbreviation	Variable	Description	Source
BR	Bank Rate	Financial Market Statistics, Bank of Canada, Bank Rate, monthly	Statistics Canada. *Table 176-0043*
CPI	Consumer Price Index	Consumer Price Index (index, 2002=100), Bank of Canada, monthly (seasonally adjusted)	Statistics Canada. *Table 176-0003*
DGC	Durable Goods Consumption	Durable goods in chained 2007 dollars, expenditure-based, quarterly (dollars x 1,000,000) (Seasonally adjusted)	Statistics Canada. *Table 380-0064*
EMP	Employment	Labour Force Survey Estimates (LFS), Employment, Population (x 1,000), Both sexes, 15 years and over, quarterly (Seasonally adjusted)	Statistics Canada. *Table 282-0087*
GDP	Gross Domestic Product	Gross Domestic Product in chained 2007 dollars, expenditure-based, quarterly (dollars x 1,000,000), (Seasonally adjusted)	Statistics Canada. *Table 380-0064*
GFCF	Gross Fixed Capital Formation	Gross fixed capital formation in chained 2007 dollars, expenditure-based, quarterly (dollars x 1,000,000) (Seasonally adjusted)	Statistics Canada. *Table 380-0064*

Table 4 Uncertainty Index Descriptions

Abbreviation	Index	Description	Source
CNPU	Canadian News-based Policy Uncertainty Index	Canadian News-based Policy Uncertainty Index, Monthly	Economic Policy Uncertainty
CEPU	Old Canadian Economic Policy Uncertainty Index	Old Canadian Economic Policy Uncertainty Index, Monthly	Economic Policy Uncertainty
VIXC	Canadian Implied Volatility Index	S&P/TSX 60 VIX, Daily	S&P Dow Jones Indices
USNPU	US News-based Policy Uncertainty Index	US News-based Policy Uncertainty Index, Monthly	Economic Policy Uncertainty
USEPU	US Economic Policy Uncertainty Index	Economic Policy Uncertainty Index, Monthly	Economic Policy Uncertainty
VIX	Implied Volatility Index	CBOE, VIX, Daily	Chicaco Board Options Exchange

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