Three Essays on News Shocks and Fiscal Multipliers

by

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Abstract

This thesis includes three essays on news shocks and fiscal multipliers. In the second chapter, I demonstrate that a fiscal news shock originated from an increased defence spending in the U.S. can directly transmit to Canada in the form of an induced defence spending. As a long-term ally of the U.S. in geo-political events, Canada had intervened in several wars and global conflicts along side with the U.S. in the last several decades. News about a large defence spending change in the U.S. can affect Canadian defence policy. Consequently, this change in defence spending may have a significant economic implication for Canada. This paper proposes a new channel of fiscal news shock transmission from the U.S. to Canada labelled as induced spending channel. My transmission model shows that a U.S. defence spending news shock has a positive impact on Canadian GDP. I coin a novel multiplier labelled as international defence multiplier which can estimate the magnitude of the induced defence spending change of a country in response to the defence spending change of another country.

In the third chapter, I explore whether the transfer payments to households boost private consumption spending across provinces in Canada. To estimate a causal relationship between transfer payments and consumption, I propose Universal Child Care Benefit payments across provinces in Canada as an instrument for transfer payments. Universal Child Care Benefit is a formula-based transfer where the total
allocation for a province depends on the total number of eligible children in that province. Therefore, Universal Child Care Benefit payments can explain exogenous variation in transfer payments as these payments vary across provinces due to the differences in demographic characteristics (distribution of particular age group) rather than their economic conditions. Using the Two Stage Least Square estimation method for the period 2006-2015, this paper finds the estimated local transfer multiplier of consumption in Canada to be 0.47. The findings of this paper suggest that direct transfer payments to the households can act as an effective policy instrument to boost the local consumption spending in Canada.

The last chapter assesses the role of commodity terms of trade news shocks in causing aggregate fluctuations in Canada. There have been large swings in commodity prices in last two decades. Movements in commodity terms of trade due to such sharp price movements can lead to aggregate fluctuations in commodity exporting countries such as Canada. Some recent empirical works have shown that unanticipated variations in commodity terms of trade alone cannot account for the movements in macroeconomic aggregates in small open economies. I demonstrate that it is important to consider the role of commodity terms of trade news shocks to explain the fluctuations in aggregate variables. This paper uses an alternative version of the maximum forecast error variance approach to identify a combination of both surprise and news shocks for Canada. My findings suggest that commodity terms of trade shocks can explain substantial variation in aggregate fluctuations in Canada.
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Chapter 1

Introduction

This thesis consists of three essays on news shocks and fiscal multipliers. During the last two decades, there has been a revival of the hypothesis that news about the future can cause aggregate fluctuations in an economy. Anticipated or news shocks are the shocks that are realized and observed before they materialize. As the economic agents are believed to be forward looking, they may adjust their expectations about the future state of the economy when they receive signals about future changes and consequently adjust current optimal decisions by internalizing the expected changes. Therefore, the anticipated future movements of some of the macroeconomic indicators may have important implications for the domestic economy. The news shocks originated in an economy can also have significant impact on neighbouring economies or trading partners as these shocks can transmit through various channels. It is important to identify the possible transmission channels of news shocks and assess their impacts on the economy for optimal decision making in both private and public sectors. The fiscal multipliers are useful tools in measuring these impacts of fiscal news shock or fiscal policy in general. The motivation of this dissertation stems from the importance of
identifying unexplored transmission channels of the news shocks and estimating their impact through fiscal multipliers. In the first essay (Chapter 2), I demonstrate that a defence spending news shock originated in the U.S. can transmit to Canada through the induced spending channel. I propose a new instrumental variable to estimate the local transfer multiplier of consumption in Canada in Chapter 3. In the Chapter 4, I assess the importance of commodity terms of trade news shock for aggregate fluctuations in Canada.

In Chapter 2, I propose a novel channel of fiscal news shock transmission from the U.S. to Canada. The U.S. and Canada have a long history of strong political and economic ties. This high degree of economic and political interdependence between Canada and the U.S. makes the Canadian economy sensitive to the policy changes in the U.S.. I demonstrate that a fiscal news shock originated from a significant increase in the U.S. defence spending, can directly transmit to Canada in the form of enhanced defence spending in Canada. I construct a transmission model containing defence spending news variable from Ben Zeev and Pappa (2017) and some Canadian domestic variables to assess the transmission fiscal news shock through this novel channel.

I find that a news about increase in the U.S. defence spending induces Canadian defence spending to rise. Consequently, this increased defence spending has a positive impact on the Canadian GDP. The estimated international fiscal multiplier for Canada is 0.11. I coin a novel fiscal multiplier labelled as international defence multiplier which quantifies the response of defence spending of a country due to a change in defence spending in another country.

In Chapter 3, I assess whether the direct transfer payments to households can boost private consumption spending across provinces in Canada. To estimate a causal relationship between transfer payments and consumption, I propose Universal Child
Care Benefit payments across provinces in Canada as an instrument for transfer payments. Universal Child Care Benefit is a formula-based transfer where the total allocation for a province depends on the total number of eligible children in that province. Therefore, Universal Child Care Benefit payments can explain exogenous variation in transfer payments as these payments vary across provinces due to the differences in demographic characteristics (distribution of particular age group) rather than their economic conditions.

Using the Two Stage Least Square estimation method for the period 2006-2015, this paper finds the estimated local transfer multiplier of consumption in Canada to be 0.47. I also demonstrate that there is a small positive spillover effect of transfer payments across the Canadian provinces. The findings of this paper suggest that direct transfer payments to the households can act as an effective policy instrument to boost the local consumption spending in Canada.

In Chapter 4, my objective is to explore the importance of commodity terms of trade news shocks for the aggregate fluctuations in Canada. I assess the hypothesis that many of the movements in the commodity terms of trade are anticipated and these anticipated changes in commodity terms of trade can have important implication for the Canadian economy. Some recent empirical works have shown that commodity terms of trade cannot account for the movements in macroeconomic aggregates in small open economies. This conclusion can be misleading if only unanticipated shocks are taken into consideration. Commodity terms of trade news shocks can trigger aggregate fluctuations in the economy because signals about future changes in commodity prices can change the expectations about the future state of the economy and consequently change the current optimal decisions on consumption and investment by economic agents.
I identify a combination of both surprise and news shocks for Canada using an alternative version of maximum forecast error variance approach proposed by Kurmann and Sims (2021) for the time period 2000Q1-2019Q4. My findings suggest that these combined commodity terms of trade shocks can explain substantial variations in aggregate fluctuations in Canada.
Chapter 2

International Transmission of Fiscal News Shock: Evidence from Defence Spending

2.1 Introduction

The U.S. and Canada have a long history of strong political and economic ties. From the political end, Canada has been a long-term ally of the U.S. in the geopolitical events and conflicts in last several decades. Economic ties are even stronger as the U.S. is the largest trading partner of Canada. This high degree of economic interdependence between Canada and the U.S. makes the Canadian economy sensitive to the economic fluctuations and policy changes in the U.S.. Indeed, several studies (see, for example, Burbidge and Harrison 1985; Ambler 1989; Johnson and Schembri 1990) have shown that transmission of U.S. macroeconomic shocks have important implications for a small open economy like Canada. A recent study by Levchenko and Pandalai-Nayar
(2020) demonstrate that the Canadian economy reacts much more strongly to non-technology (e.g. demand) shocks than technology (i.e. TFP) shocks.

By analyzing historical events such as the Korean War, Stairs (2000) point out that the most central determinant of the Canadian response to any significant global security confrontation is closely aligned with the response of the U.S.. He concludes that U.S. defence policy is an important determinant of the Canadian defence policy. The goal of this paper is to identify whether there is casual relationship between the defence policies of these two countries. I seek to explore whether a U.S. fiscal news shock that is generated by a large defence spending in the U.S. can directly transmit to Canada in the form of an induced defence spending in Canada. Can this novel transmission channel explain the spill over effect of fiscal shock from the U.S. to Canada?

Which type of defence spending shocks (anticipated or unanticipated) are more pertinent to fiscal policy? Anticipated shock or commonly known as news shock is the shock that is realised and observed before it is materialized. As there is a natural lag between decision making and implementation of any fiscal policy including defence spending, most of the fiscal policy changes are well anticipated. As a result, news shock has important implication for fiscal variables. Ramey (2011) demonstrates that a big increase in military spending is anticipated several quarters before it actually occurs in the U.S.. For example, the news of North Korea’s attack on South Korea on June 25, 1950 led to a dramatic increase in the estimates of the U.S. defense spending within two months of the attack. Ben Zeev and Pappa (2017) finds that defence spending news shock has significantly larger impact on the U.S. economy compared to the defence spending surprise shock.

What are the transmission channels that can explain the international spill over
of fiscal shocks? In previous studies on fiscal shock transmission, two main channels are identified to explain the cross border spill over effect: (1) international trade in goods and (2) financial channel which is driven by interest rate spread and equity price. Natoli and Metelli (2018) employ a global VAR framework to show that trade channel is more important than the financial channel in the propagation of a fiscal shock. They demonstrate that a positive fiscal shock in the U.S. increases its imports from the rest of the world, stimulated both by stronger U.S. demand and by real exchange rate depreciation vis-a-vis the U.S. dollar. Nicar (2015) uses sign restriction in a VAR framework to estimate the effect of the U.S. government spending and tax shocks on Canada, UK and Japan. He finds that the impact of a spending shock is larger than that of a tax shock and the spending shock has positive spill over effect on these countries. Arin and Koray (2006) use recursive ordering in a semi-structural VAR framework to analyse the transmission of government spending and tax shocks from the U.S. to Canada. In contrary to most the studies, their findings show that the U.S. government spending shock has an adverse effect on Canadian economy due to the deterioration of trade balance. However, the limitation of their study is that they use total government spending of the U.S. instead of the exogenous component of the spending. Most of the empirical studies on the transmission of government spending shock provide strong evidence in support of international trade as the main transmission channel for spill over effect.

Defence spending of a country can be influenced by internal (such as civil war) or external (such as geopolitical conflicts) threats or security concerns. Several papers in literature (see for example, Lai and Thyne 2007, Murdoch and Sandler 2002, Phillips 2015) look into the international spill over of civil war to other countries. Phillips (2015) demonstrates that civil war in a country leads to increased military spending
in her neighboring countries. The main focus of this paper is the international spill over effect of the anticipated large change in U.S. defence spending that results from mainly geopolitical and global conflicts.

This paper proposes a novel channel for the transmission of fiscal news shock that is originated from a change in defence spending in the U.S.. I demonstrate that U.S. defence spending news shock can directly transmit to Canada in the form of an induced defence spending in Canada. First, I construct a U.S. defence spending news variable using the news shock series from Ben Zeev and Pappa (2017). It is reasonable to assume that Canada takes the U.S. defence policy changes as exogenously given because these policy changes are mainly driven by geo-political events and global conflicts. Therefore, I order the U.S. defence news variable before the Canadian aggregates in VAR framework. Using the Cholesky decomposition in this VAR model, I assess the impact of anticipated changes in U.S. defence spending on the Canadian economy. I find that news about increase in the U.S. defence spending induces Canadian defence spending to rise for the sample period 1950Q1-2007Q4. Consequently, this increased defence spending has a positive impact on Canadian GDP. Net export of Canada declines after news shock indicating that the trade channel affects the Canadian GDP adversely. I demonstrate that it is important to take into account the induced spending channel in the transmission of defence spending news shock from the U.S. to Canada.

This paper has two main contributions. First, this paper contributes to the literature by identifying a novel transmission channel for defence policy change in the U.S. labelled as induced spending channel. Without accounting for such an induced spending channel and relying only on the conventional trade and financial channels for analyzing the transmission of defence spending shock can be misleading. Second, I coin a novel fiscal multiplier labelled as international defence multiplier which quantifies
the response of defence spending of a country due to a change in defence spending in another country. The estimated international defence multiplier for Canada is 0.011 which implies that a one billion dollar increase in the U.S. defence spending increases Canadian defence spending by 11 million dollars.

The rest of paper is organized as follows. Section 2.2 discusses the relationship between the Canadian and U.S. defence spending change. Section 2.3 presents the econometric strategy. Section 2.4 discusses the data used for this study. Section 2.5 discusses the key findings of the baseline model. Section 2.6 presents the results from the robustness check. Section 2.7 provides concluding remarks.

2.2 Relationship between Canadian and U.S. Defence Spending Change

In literature (see, for example, Ramey 2011 and Ben Zeev and Pappa 2017), it is widely accepted that defence spending (specially for the U.S.) is mainly driven by geo-political events and global conflict rather than the state of the economy. I plot the U.S. real defence spending per capita and the U.S. real GDP per capita from 1947Q1 to 2007Q4 to check whether the defence spending is correlated with economic condition of the country. Figure A1.1 illustrates that the U.S. defence spending tends to be uncorrelated with its output. Next, I plot Canadian real defence spending per capita and Canadian real GDP per capita for the same sample period (see Figure A1.2), and interestingly Canadian defence has a similar pattern as that of the U.S.. Both the U.S. and Canadian defence spendings tend to be uncorrelated with their GDP. To see how the defence spending of these two countries are correlated, I plot the real defence spending per capita of the U.S. and Canada from 1947Q1 to 2007Q4.
in Figure A1.3. The estimated unconditional correlation between these two series is 0.7 which reveals that they are highly positively correlated.

The vertical lines in Figure A1.3 indicates four major events in post WWII where the U.S. were directly involved. (i) 1950Q3 (Korean War began), (ii) 1965Q1 (U.S. directly intervened in Vietnam War on 1965Q1), (iii) 1980Q1 (Military build up by U.S. President Ronald Regan in response to Soviet Union’s invasion in Afghanistan), (iv) 2001Q4 (U.S. invaded Afghanistan in response of terrorist attack in September 11, 2001). Apart from Vietnam war, Canada was directly involved in these wars and military conflicts. The most striking feature is that the Canadian defence spending fluctuations have a similar pattern as that of the U.S. It is important to investigate whether there is any causal relationship between the defence spending of these two countries.

Canadian defence policy can potentially be influenced by the U.S. policy change as the U.S. is a long term ally and world superpower. Can we predict the Canadian defence spending from the spending change in the U.S.? To seek the answer for this question, I examine two hypotheses with Granger causality test to see whether an anticipated or unanticipated change$^1$ in the U.S. defence spending can predict the Canadian defence spending.

<table>
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<td>$H_0^1$: The U.S. defence spending news shock does not Granger cause Canadian defence spending</td>
<td>0.00</td>
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<tr>
<td>$H_0^2$: The U.S. defence spending surprise shock does not Granger cause Canadian defence spending</td>
<td>0.84</td>
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$^1$U.S. defence spending news and surprise shock series are taken from Ben Zeev and Pappa (2017).
I find that the U.S. defence spending news shock Granger causes Canadian defence spending (we reject $H^1_0$). This implies that the change in Canadian defence spending can be predicted from news about U.S. defence spending change. However, I do not find any evidence in support of predicting the Canadian defence spending from U.S. unanticipated policy change (we cannot reject $H^2_0$). This provides the motivation to investigate the transmission of the defence spending news shock, rather than the surprise shock from the U.S. to Canada.

2.3 Econometric Strategy

2.3.1 Extracting Defence Spending News Shocks of the U.S.

There are mainly two popular approaches in extracting defence spending news shock. One is the narrative approach proposed by Ramey (2011) and the other is the Maximum Forecast Error Variance (MFEV) approach proposed by Ben Zeev and Pappa (2017). Ramey (2011) constructs two measures of news about changes in U.S. defense spending. The first one is an estimate of the change in the expected present value of the U.S. government spending due to defence spending change based on information in the Business Week and other newspapers. The second one is constructed based on the Survey of Professional Forecasters. However, the news variable from narrative approach has very low predictive power if both WWII and Korean War are excluded (Ramey 2011). Following Barsky and Sims (2011) and Uhlig (2003), Ben Zeev and Pappa (2017) employ the MFEV methodology to extract the U.S. defence spending news shock as the shocks that best explain future movements in defence spending over a five years horizon and that are orthogonal to current defence spending. This method solely relies on actual data of defence spending and can extract news shocks that were
not reported in newspaper but existed in data. There are several advantages of MFEV approach over the narrative approach in extracting news shock.

- Narrative approach can be subjective and often requires judgement call whereas MFEV approach does not have this limitation because it extracts news shock directly from realized value of defence spending.

- Narrative approach is time consuming to implement and requires availability of detailed historical record.

- Ben Zeev and Pappa (2017) shows that news variable from MFEV method contains important information on future defence spending which narrative news variable is unable to capture. For example, the news shock identified by MFEV method significantly increases the excess returns of large defence contractors in the U.S. while the shocks from narrative approach does not.

Given the advantages of the MEFV approach over the alternative approach, I choose to construct a defence news variable using the identified U.S. defence spending news shock series in Ben Zeev and Pappa (2017). The MFEV methodology relies on medium run constraints and it extracts the news shock of a target variable (which is defence spending in this study) by maximizing the forecast error variance of that variable over some forecast horizon. The key identification restriction for identifying defence spending news shock is that defence spending is exogenous, i.e., it does not react to the economic condition of a country (Ben Zeev and Pappa 2017). This implies that defence spending is mainly driven by two shocks: surprise shock which affects defence spending on impact and news shock which affects defence spending with a lag.
So, the defence spending can be expressed as:

\[ D_t = \alpha D_{t-1} + \beta_1 \varepsilon^s_t + \beta_2 \varepsilon^n_{t-j} \]  

(2.1)

where \( \varepsilon^s_t \) is the defence spending surprise shock at period \( t \) and \( \varepsilon^n_{t-j} \) is the defence spending news shock that is realized \( j \) period ago. I cannot identify both shocks separately in a univariate framework. Since the rational agent reacts to an anticipated defence shock in order to maximize lifetime utility, some macroeconomic aggregates may respond instantaneously to the defence spending news shock. I can identify the news shock by using a multivariate VAR model with some forward-looking variables. The detailed methodology of MFEV to extract the U.S. defence news shock is presented in the appendix.

2.3.2 Transmission of Defence Spending News Shock

The fact that the U.S. defence spending news shock Granger causes Canadian defence does not establish a causal relationship between them. In order to check whether news about the U.S. defence spending change affects Canadian defence spending, I construct a VAR model that can capture the transmission of the news shock from the U.S. to Canada. I construct a U.S. defence spending news variable using the news shock series from Ben Zeev and Pappa (2017) and order it at the first position. It is reasonable to assume that Canada takes the U.S. defence policy changes as exogenously given because these policy changes are mainly driven by geo-political events and global conflicts. Therefore, I place the Canadian aggregates after the U.S. aggregates in the VAR framework and use the Cholesky decomposition to see the impact of anticipated changes in U.S. defence spending on the Canadian economy.
An alternative approach to assess the transmission of U.S. defence spending news shock is to augment the VAR model (with the same U.S. aggregates) used in Ben Zeev and Pappa (2017) by the Canadian variables and then extract the U.S. defence news shock from this augmented VAR model using MFEV approach. In that case the extracted news shock would be a linear combination of reduced-form residuals associated with all the U.S. and Canadian variables in the VAR, that explain the largest fraction of the forecast error variance of U.S. defence spending while being orthogonal to current U.S defence spending. Ben Zeev and Pappa (2017) extract the U.S. defence news shock from a large information set which includes twelve U.S. variables. They consider all relevant and important variables that can be included in the VAR model to extract U.S. defence spending news shock. They demonstrate that their identified shock contains more information of news about future defence spending than news shock series from other types of methodologies such as narrative approach of Ramey (2011). Therefore, augmenting VAR model with another four to five Canadian variables may not add too much additional information for the identification of the U.S. defence spending news shock. As a result, news shock identified from such an augmented Ben Zeev and Pappa (2017) VAR model with Canadian variable may not be too different than that of Ben Zeev and Pappa (2017). On the other hand, this alternative approach can lead to larger standard deviation of the estimates as the augmented VAR model would contain a large set of variables. Therefore, I opt to use the U.S. defence spending news shock series of Ben Zeev and Pappa (2017) directly in a small VAR model with Canadian aggregates to assess the transmission of the news shock from the U.S. to Canada.

In my VAR framework, I incorporate variables that originates the transmission (U.S. defence news variable and U.S. defence spending), variables that can explain
transmission mechanism (Canadian defence spending, bilateral real exchange rate and Canadian net export) and variable that show overall economic impact on Canada (Canadian GDP). The U.S variables are placed first as they are exogenous to the Canadian economy. As the shock is identified via a Cholesky scheme with the U.S. defence news variable and the U.S. defence spending being the first and second variables respectively in the VAR model, the rankings of the remaining Canadian variables are irrelevant. The sample period for this study is 1950Q1-2007Q4. The VAR framework is explained in details below.

Consider a structural VAR model

\[ A_0 Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t \]  

(2.2)

where \( Y_t \) is a vector of variables with the following order: U.S. defence spending news shock variable, U.S. defence spending, Canadian defence spending, bilateral real exchange rate between the U.S. and Canada, net export of Canada and Canadian GDP. \( \varepsilon_t \) is the structural shock.

So, the reduced form representation of VAR is

\[ Y_t = B_1 Y_{t-1} + B_2 Y_{t-2} + \cdots + B_p Y_{t-p} + u_t \]

(2.3)

Where \( B_i = A_0^{-1} A_i \) and \( u_t \) is the reduced form error which can be expressed as:

\[ u_t = A_0^{-1} \varepsilon_t = C \varepsilon_t \]

(2.4)
C denotes the impact matrix which needs to satisfy the following restriction:

$$ \sum = CC' $$

(2.5)

Suppose $\tilde{C}$ is the Cholesky decomposition of variance-covariance matrix $\sum$, i.e.,

$$ \tilde{C} = \text{chol}(\sum) $$

(2.6)

If Q is an orthonormal matrix that satisfies the restriction $QQ' = I$, then I can express:

$$ C = \tilde{C}Q $$

(2.7)

Using (2.4) and (2.7) we can write:

$$ u_t = \tilde{C} \tilde{\varepsilon}_t $$

(2.8)

$$
\begin{bmatrix}
  u_t^{\text{news(U.S.)}} \\
  u_t^{\text{DEF(U.S.)}} \\
  u_t^{\text{DEF(CAN)}} \\
  u_t^{\text{e(CAN)}} \\
  u_t^{\text{NX(CAN)}} \\
  u_t^{\text{GDP(CAN)}}
\end{bmatrix} =
\begin{bmatrix}
  C_{11} & 0 & 0 & 0 & 0 & 0 \\
  C_{21} & C_{22} & 0 & 0 & 0 & 0 \\
  C_{31} & C_{32} & C_{33} & 0 & 0 & 0 \\
  C_{41} & C_{42} & C_{43} & C_{44} & 0 & 0 \\
  C_{51} & C_{52} & C_{53} & C_{54} & C_{55} & 0 \\
  C_{61} & C_{62} & C_{63} & C_{64} & C_{65} & C_{66}
\end{bmatrix}
\begin{bmatrix}
  \tilde{\varepsilon}_t^{\text{news(U.S.)}} \\
  \tilde{\varepsilon}_t^{\text{DEF(U.S.)}} \\
  \tilde{\varepsilon}_t^{\text{DEF(CAN)}} \\
  \tilde{\varepsilon}_t^{\text{e(CAN)}} \\
  \tilde{\varepsilon}_t^{\text{NX(CAN)}} \\
  \tilde{\varepsilon}_t^{\text{GDP(CAN)}}
\end{bmatrix}
$$

(2.9)

Here $\tilde{C}$ is a lower triangular matrix. Equation 2.9 implies that each variable is affected by its own structural innovation ($C_{ii}$) and the structural innovations of other variables that are ordered before it.
2.3.3 Fiscal Multipliers

To quantify the impact of the U.S. defence spending on Canadian defence spending and GDP, I estimate two types of multipliers from impulse responses. The first one is the conventional international fiscal multiplier which shows how Canadian GDP responds to a change in the U.S. defence spending. I propose a novel multiplier labelled as international defence multiplier which helps to quantify the induced defence spending in Canada due to a change in the U.S. defence spending. In literature, there are two alternative methods to estimate the multiplier: (i) “max” multiplier (ii) “sum” multiplier (see Barnichon et al. 2022). I use the “max” multiplier approach as the benchmark to calculate the multipliers and check the robustness of my results using the “sum” multiplier approach.

**International Fiscal Multiplier:** Since the multiplier captures a ratio of changes in the levels of Canadian GDP and the U.S. defence spending change, while the impulse responses are estimated for variables in logs, I need to convert the estimated impulse responses into dollar units to estimate the fiscal multiplier (see Barnichon et al. 2022). The international fiscal multiplier is defined as the ratio of Canadian GDP response to the U.S. defence spending response at the quarter where the U.S. defence spending reaches its peak, multiplied by the ratio of average nominal Canadian GDP to average nominal U.S. defence spending over the sample period. More specifically the formula for estimating the international fiscal multiplier is:

\[
M_{fiscal} = \frac{\ln(GDP_{CAN})_i}{\ln(DEF_{U.S.})_i} \times \frac{GDP_{CAN}}{DEF_{U.S.}}
\]

**International Defence Multiplier:** International defence multiplier is defined as the ratio of Canadian defence spending response to the U.S. defence spending
response at the quarter where the U.S. defence spending reaches its peak, multiplied by the ratio of average nominal Canadian defence spending to average nominal U.S. defence spending over the sample period. More specifically the formula for estimating the international defence multiplier is:

\[ M_{DEF} = \frac{\ln(DEF_{CAN})_i}{\ln(DEF_{U.S.})_i} \frac{DEF_{CAN}}{DEF_{U.S.}} \]  

(2.11)

2.4 Data

This study uses quarterly data for the period 1950Q1 to 2007Q4 to assess the transmission of the U.S. defence news shock. U.S. defence spending is measured as national defense consumption expenditures and gross investment taken from the FRED. Canadian defence spending is measured as the total defence spending by the federal government of Canada. The real exchange rate is derived from the nominal exchange rate and GDP deflator of the U.S. and Canada, where an increase (decrease) indicates an appreciation (depreciation) of Canadian dollar. To make the real exchange rate stationary I use the first difference of it in the VAR model. Net export variable is defined as the net export of Canada with all other countries instead of bilateral net export with the U.S. because the quarterly data of bilateral trade is not available for the sample period of this study. However, this is a reasonable proxy for bilateral net export for Canada because the U.S. is the largest trading partner of Canada. Canadian output is measured as the Gross Domestic Product (GDP) of Canada. All the U.S. variables are from FRED and the Canadian aggregates are from Statistics Canada.
2.5 Results

In this section, I present the impulse responses of the U.S. defence spending and the Canadian aggregates to a U.S. defence news shock. Using the impulse responses, I estimate the international fiscal multipliers for the Canadian economy.

2.5.1 Responses of Canadian Macroeconomic Aggregate to News Shock

I estimate the baseline VAR model with 4 lags based on the Akaike Information Criteria (AIC). Figure 2.1 illustrates the impulse responses of the U.S. defence spending and the Canadian aggregates to a one standard deviation positive U.S. defence spending news shock.

Figure 2.1: Impulse Responses to the U.S. Defence Spending News Shock

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.
The impulse responses show that the U.S. defence spending news shocks do not affect the U.S. defence spending on impact, but it leads to a gradual increase in spending which reaches to its peak at 3rd quarter. The response of Canadian defence spending shows whether any potential transmission channel such as induced spending exists or not. In response to the U.S. defence news shock, the change in the Canadian defence spending on impact is not statistically significant. After one quarter there is a persistent rise in the Canadian defence spending. The important implication of this findings is that the news of an increased defence spending in the U.S. can transmit to Canada in the form of induced defence spending. The U.S. defence spending news shock explains 7 percent variation of Canadian defence spending over a twelve-quarter horizon. (see Table 2.2). This provides an evidence that the news on the U.S. defence spending change can influence the Canadian defence policy.

Table 2.2: Share of FEV Explained by the U.S. Defence Spending News Shock over a Twelve-Quarter Horizon

<table>
<thead>
<tr>
<th>U.S. Defence Spending</th>
<th>Canadian Defence Spending</th>
<th>Real Exchange Rate</th>
<th>Canadian Net Export</th>
<th>Canadian Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Model</td>
<td>45</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Notes: Shares are expressed in percent.

Next, I analyze the impact of defence spending news shock on other Canadian aggregates. Canadian real exchange rate appreciates in response to the news shock, however it quickly gets back to the steady state. The Canadian trade balance worsen due to the news shock. Despite the dampening effect of trade deficit on GDP, the U.S. defence spending news shock has a significant positive impact on Canadian GDP. The U.S. defence spending news shock explains 5 percent variation of Canadian GDP over
a twelve-quarter horizon. This rise in output cannot be directly contributed to the induced spending channel as it is confounded by the trade channel. Disentangling the impact of the two channels on output would require performing appropriate counterfactual experiments which is beyond the scope of the current study.

2.5.2 Estimating Multipliers

The impulse responses show that the U.S. defence spending reaches to its peak at the 3rd quarter in response to the U.S. defence spending news shock. Using the formula in 2.10, I find that the estimate of the international fiscal multiplier is 0.11. This implies that a one billion dollar increase in the U.S. defence spending leads to a 0.11 billion dollar increase in Canadian GDP.

Using the formula in 2.11, I find that the estimate of the international defence multiplier is 0.011 which implies that a one billion dollar increase in the U.S. defence spending increases Canadian defence spending by 11 million dollars.

As this study do not disentangle the impact of induced defence spending channel on the Canadian GDP from the trade channel, I am unable to estimate the fiscal multiplier of the Canadian defence spending.

2.6 Robustness Check

In this section, I check whether my results are robust across alternative model specifications and multiplier formulas.

Some studies in literature, such as Natoli and Metelli (2018) and Arin and Koray (2006), consider financial channel in the transmission of fiscal shocks. To check whether such a channel is important for the transmission of the U.S. defence spending news
shock, I augment the baseline model by incorporating interest rate spread between the U.S. and Canada. The interest rate spread is the short term real interest rate of Canada minus the short term real interest rate of the U.S. The short term nominal interest rates in the U.S. and Canada are measured as the 3-month treasury bill rates of the U.S. and Canada respectively. They are converted to real terms using their respective inflation rates. Interest spread is one of the key determinants of capital flow between two countries. If the defence spending news shock leads to a significant change in the interest rate spread, then this might affect the capital flow between the two countries and may have a sizeable impact on Canadian GDP.

Figure 2.2: Impulse Responses to the U.S. Defence Spending News Shock (Augmented Model)

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.
Figure 2.2 shows the impulse responses to the U.S. defence spending news shock for the augmented model. The responses of all the variables are very similar to that of the benchmark model even after incorporating interest spread. The interest spread decreases on impact, however it is not statistically significant. Incorporation of the financial channel in the transmission model does not change the relevance of the U.S. defence spending news shock in explaining aggregate fluctuations in Canada (see FEVD in Table 2.3). This provides an evidence that the financial channel is not an important transmission channel for U.S. defence spending news shock.

### Table 2.3: Share of FEV Explained by the U.S. Defence Spending News Shock (Augmented Model)

<table>
<thead>
<tr>
<th></th>
<th>U.S. Defence Spending</th>
<th>Canadian Defence Spending</th>
<th>Real Exchange Rate</th>
<th>Canadian Net Export</th>
<th>Canadian Output</th>
<th>Interest Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model with Interest Spread</td>
<td>45</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes: Shares are expressed in percent.

In the baseline model, I estimate the fiscal multipliers based on the formula of “max” multiplier approach. To check whether the estimated multipliers are sensitive to multiplier formula, I estimate the multipliers using the “sum” multiplier approach where international fiscal multiplier is defined as the ratio of the cumulative Canadian GDP response to the cumulative U.S. defence spending response at the 3rd quarter, multiplied by the ratio of average nominal Canadian GDP to average nominal U.S. defence spending over the sample period:

$$M_{fiscal} = \frac{\sum_{i=0}^{3} \ln(GDP_{CAN})_i \cdot \frac{GDP_{CAN}}{GDP_{U.S.}}}{\sum_{i=0}^{3} \ln(DEF_{U.S.})_i \cdot \frac{DEF_{U.S.}}{DEF_{U.S.}}}$$  \hspace{1cm} (2.12)

The international defence multiplier is defined as the ratio of cumulative Canadian GDP...
defence spending response to the cumulative U.S. defence spending response at the 3rd quarter, multiplied by the ratio of average nominal Canadian defence spending to average nominal U.S. defence spending over the sample period:

\[ M_{DEF} = \frac{\sum_{i=0}^{3} \ln(DEF_{CAN})_i}{\sum_{i=0}^{3} \ln(DEF_{U.S.})_i} \frac{DEF_{CAN}}{DEF_{U.S.}} \]  

(2.13)

The estimated values of the international fiscal multiplier and international defence multiplier are 0.14 and 0.012 respectively, which are larger compared to the benchmark multiplier values (see Table 2.4). Therefore, the estimates from the benchmark model are conservative estimates of the international fiscal multiplier for the Canadian economy.

Table 2.4: Multipliers Estimates under Alternative Formula

<table>
<thead>
<tr>
<th>Multiplier Method</th>
<th>International Fiscal Multiplier</th>
<th>International Defence Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>max multiplier approach</td>
<td>0.11</td>
<td>0.011</td>
</tr>
<tr>
<td>sum multiplier approach</td>
<td>0.14</td>
<td>0.012</td>
</tr>
</tbody>
</table>

2.7 Conclusion

There has been a renewed interest on better understanding the international spillover effect of macroeconomic shocks from the U.S. to the rest of the world. Such spillover effect can have important implication for Canada for having a close economic and political tie with the U.S.. In the literature, international trade is considered as the main transmission channel for the spillover effect of fiscal shock. This paper contributes to the literature by identifying a novel transmission channel for the international transmission of fiscal news shock. I demonstrate that news about defence spending change in the U.S. can transmit to Canada in the form of induced defence spending
and lead to an increase in Canadian output. Therefore, the induced defence spending channel is an important transmission channel of defence spending news shock.

This study provides empirical evidence of the economic implication of global geopolitical events and foreign policies in Canada. My findings suggest that the U.S. defence policy can have a significant impact on the Canadian economy. Therefore, it is important to take into account the economic implication of defence policy changes of allies on the domestic economy.
Appendix: Chapter 2

Extracting Defence Spending News Shocks of Canada

Ben Zeev and Pappa (2017) identify the U.S. defence spending news shock by employing the MFEV approach based on Barsky and Sims (2011). News shock is extracted from a multivariate VAR model containing U.S. defense spending, Ramey’s news shocks, output, consumption, investment, hours, the real wage, the Romer and Romer tax changes, the interest rate, inflation, TFP and defense contractors’ excess returns.

The reduced form VAR can be written as the following

\[ y_t = B_1 y_{t-1} + B_2 y_{t-2} + \cdots + B_p y_{t-p} + u_t \]  

(14)

where \( y_t \) is \( n \times 1 \) vector of variables observed at time \( t \), \( B_i \) are \( n \times n \) matrix of coefficient, \( p \) denotes the number of lags and \( u_t \) is a \( n \times 1 \) vector of reduced form error with variance covariance matrix \( \Sigma = E[u_t u'_t] \). We can write 14 more compactly as:

\[ B(L)y_t = u_t \]  

(15)

where \( B(L) = 1 - B_1 L - B_1 L^2 - \cdots - B_p L^p \). Here L denotes the lag operator and B(L) is the matrix of lag order polynomials. The vector moving average representation of this reduced form VAR is:

\[ y_t = C(L) u_t \]  

(16)

where \( [B(L)]^{-1} = C(L) = 1 + C_1 L + C_2 L^2 + \ldots \). To identify mutually orthogonal structural shocks, we assume that there is a linear relationship between reduced form
shocks $u_t$ and structural shocks $\varepsilon_t$ i.e.

$$u_t = A\varepsilon_t$$

(17)

where $A$ is the impact matrix. Therefore, the $j^{th}$ column of $A$ represents the immediate impact of the $j^{th}$ shock in $\varepsilon_t$ on all variables. The impact matrix $A$ must satisfy the following restriction:

$$\sum = E[u_t' u_t] = E[\varepsilon_t' e_t A'] = AE[\varepsilon_t' e_t] A' = AA'.$$

(18)

But this restriction is not sufficient to identify $A$ because $\sum = AA'$ gives us $n(n + 1)/2$ restriction where $\sum$ has $n \times n$ unknown. So, we will use Cholesky decomposition which is an arbitrary orthogonalization to satisfy this restriction. Suppose $\tilde{A}$ is Cholesky decomposition of $\sum$ such that $\sum = \tilde{A} \tilde{A}'$. Then there must be a $n \times n$ orthonormal matrix $Q$ satisfying $QQ' = I$ such that $A = \tilde{A} Q$ [QR decomposition]. $\tilde{A} Q$ gives us the entire space of permissible impact matrices which will help us to identify structural shocks. Now using (15) and (16) we can write:

$$y_t = C(L)A\varepsilon_t = C(L)\tilde{A} Q \varepsilon_t$$

(19)

Here $C(L)\tilde{A}$ shows impulse response, i.e., dynamic impact of $\varepsilon_t$ on all variables. Suppose $C_\tau$ is the matrix of reduced form moving average co-efficient at horizon $\tau$. The $h$ step ahead value of $Y_{t+h}$ is:

$$Y_{t+h} = \sum_{\tau=0}^{\infty} C_\tau \tilde{A} Q \varepsilon_{t+h-\tau}$$

(20)
\[ Y_{t+h} = \sum_{\tau=0}^{h-1} C_\tau \tilde{A} Q \xi_{t+h-\tau} + \sum_{\tau=h}^{\infty} C_\tau \tilde{A} Q \xi_{t+h-\tau} \] (21)

The 1st term captures the accumulative effect on \( Y_{t+h} \) of all the structural shocks that have yet to occur between \( t + 1 \) and \( t + h \) period. So the expected value of this term is zero as we have assumed \( \varepsilon \sim N(0, I) \). The 2nd term captures the accumulative effects on \( Y_{t+h} \) of all shocks that already occurred between \(-\infty\) and \( t \) period. This term is predetermined at \( t \). So the expected value of \( Y_{t+h} \) is:

\[ E_t Y_{t+h} = \sum_{\tau=h}^{\infty} C_\tau \tilde{A} Q \xi_{t+h-\tau} \] (22)

So the \( h \) step ahead forecast error of \( Y_{t+h} \) is:

\[ Y_{t+h} - E_t Y_{t+h} = \sum_{\tau=0}^{h-1} C_\tau \tilde{A} Q \xi_{t+h-\tau} \] (23)

Now the \( h \) step ahead forecast error of \( i^{th} \) variable in \( Y_{t+h} \) is:

\[ Y_{i,t+h} - E_t Y_{i,t+h} = e_i' \left[ \sum_{\tau=0}^{h-1} C_\tau \tilde{A} Q \xi_{t+h-\tau} \right] \] (24)

where \( e_i \) denotes selection vector with 1 on the \( i^{th} \) position and zeros elsewhere. So the forecast error variance of a particular variable \( i \) at horizon \( h \) is the sum of the contributions of the \( n \) structural shocks.

The contribution of the \( j^{th} \) shock to the forecast error variance of variable \( i \) at horizon \( h \) is:

\[ \Omega_{ij}(h) = E[(Y_{i,t+h} - E_t Y_{t+h})(Y_{i,t+h} - E_t Y_{t+h})'] = e_i' \left[ \sum_{\tau=0}^{h-1} C_\tau \tilde{A} q q' C_\tau' \right] e_i \] (25)
where \( q \) denotes the \( j \)th column of \( Q \) and \( \tilde{A}q \) is \( n \times 1 \) vector which represents the vector of the impact effects of shock \( j \).

Without loss of generality, we assume that the 1st structural shock is defence spending surprise shock and 2nd structural shock is the defence spending news shock. This implies that the second column of \( \tilde{A}Q \) is the impact vector of news shock. The assumption that only two shocks surprise and news effects defence spending imply that:

\[
\Omega_{1,1}(h) + \Omega_{1,2}(h) = 1 \quad \forall h
\] (26)

The restriction 26 is unlikely to hold at all horizon in a multivariate VAR model. So as proposed by Barsky and Sims (2011), we need to select the second column of the impact matrix \( \tilde{A}Q \) that comes as close as possible to making 26 hold over a finite subset of horizons. As surprise shock is identified as the innovation in defence spending, \( \Omega_{1,1}(h) \) will be invariant at all horizon \( h \). So, we are going to choose the second column of \( Q \) i.e. \( q \) such that this second shock maximizes the forecast error variance of defence spending variable over horizon \( H \) after accounting for the contribution of unanticipated defence shock.

I need to solve the following optimization problem to identify defence spending news shock over horizon \( h = [0, H] \):

\[
q^* = \arg\max \sum_{h=0}^{H} \Omega_{1,2}(h) \quad (27)
\]

\[
q^* = \arg\max e_i' \left[ \sum_{\tau=0}^{h} \sum_{\tau=0}^{h} C_\tau \tilde{A}qq' \tilde{A}' C'_\tau \right] e_i \quad (28)
\]

subject to

\[
q(1, 1) = 1 \quad (29)
\]
$q'q = 1$ \hspace*{1cm} (30)

Constraint 29 imposes the restriction that the news shock has no contemporaneous effect on defence spending. Constraint 30 ensures that $q$ is a column vector belonging to an orthonormal matrix.

Figures

Figure A1.1: Trend of U.S. Real Defence Spending and Real GDP Per Capita
Figure A1.2: Trend of Canadian Real Defence Spending and Real GDP Per Capita
Figure A1.3: Real Defence Spending Per Capita of the U.S. and Canada
Chapter 3

How Large is the Local Transfer Multiplier for Consumption:
Evidence from Canada

3.1 Introduction

There is an ongoing debate on the extent to which the government should intervene in the economy. Government spending can have differential impacts on the aggregate variables depending on the type of spending and the state of the economy. In particular during economic downturns when there is a sharp fall in private sector spending and investment, government spending can potentially stimulate the economy. There is a renewed interest on the response of the economy to an increase in government spending since the financial crisis. Most of the increase in government spending during economic downturns like the Great Recession consisted of government transfers to households, not government purchases (Giambattista and Pennings 2017). Many studies look into
the short-run macroeconomic effects of changes in government purchases and taxes, but a few focus on the impact of transfer payments on aggregate variables (Romer and Romer 2016). U.S. federal transfers to individuals were larger than government consumption during 2017 (Pennings 2021). Similar to the U.S., one of the largest expenses of the Canadian general government\footnote{Federal, provincial, territorial, local and other government entities combined.} is transfer payments to households. This paper seeks to estimate the impact of transfer payments to households on private consumption spending in the Canadian provinces using an instrumental variable approach.

In the literature, the response of aggregate variables like consumption due to government spending is measured using either aggregate multiplier or local multiplier (Dupor and Guerrero 2017). The studies that focus on aggregate multiplier to estimate the effectiveness of fiscal policy uses time series variation and employs narrative approach or VAR methods (e.g., Ramey 2011; Ben Zeev and Pappa 2017). A second set of studies use longitudinal variation across regions to estimate the multiplier, which is known as the local multiplier (Nakamura and Steinsson 2014). One of the advantages of local fiscal multiplier is that it takes the heterogeneous characteristics across regions into account. Therefore, it can be a good proxy of aggregate multiplier when a sufficiently long time series data is not available.

While much of the focus on the effectiveness of fiscal policies is at an aggregate level, the impact of fiscal stimulus at a disaggregate level (e.g., province or municipality level) is still relatively unexplored. Pennings (2021) investigates the size of the cross-region transfer multiplier in the U.S.. He finds that U.S. federal transfers to individuals are large, counter-cyclical and vary geographically. Auerbach et al. (2019) look into the impact of local government spending in the U.S. on output using defence contracts
as an instrument. They demonstrate that government spending has strong positive spill over effect within and across regions in the U.S.. Dupor et al. (2019) show that American Recovery and Reinvestment Act (2009-2012) had significant positive impact on regional consumption in the U.S.. Local government spending also has significant impact on developing countries like China (Guo et al. 2016). The impact of transfer payment on the regional consumption in Canada is still unexplored. This paper aims to fill this gap by estimating the local transfer multiplier of consumption for Canada.

The main challenge in estimating the local transfer multiplier of consumption is the endogeneity problem arising from omitted variable bias. If we use OLS to estimate the impact of transfer on consumption, then the estimated multiplier may have a downward bias as the transfer payments are usually inversely correlated to state of the economy. In the literature of fiscal multiplier, defence spending is widely used as an instrument to address this endogeneity problem of government spending (e.g., Ramey 2011; Ben Zeev and Pappa 2017). The rationale behind using defence spending as a valid instrument is that this spending is largely driven by geopolitical events rather than the economic condition of a country. Owyang et al. (2013) show that military spending has lower explanatory power and instrument relevance for Canadian government spending.

This paper proposes Universal Child Care Benefit (UCCB) payment as a novel instrument for estimating the local transfer multiplier in Canada. Most of the types of transfer payments to households in a province depends on the economic condition of that specific province. For example, if unemployment rate is higher in one province due to any province specific shock (e.g., oil shock) then the spending on Employment Insurance payments will be higher in that province. Unlike these types of transfer payments which are based on income and employment status of the households, UCCB
program provided $100 per month to every household with a child aged between 0 to 5 years regardless of their family income level. Therefore, the total UCCB payment varies across the provinces due to the differences in the distribution of children aged between 0 to 5 years rather than their economic conditions. Hence, I use UCCB payments to provinces as an instrument for the total transfer payments to households. I apply the Two Stage Least Square estimation method to estimate the local transfer multiplier of consumption in Canada.

The contribution of this paper is twofold. First, to the best of my knowledge, this is the first study that provides an estimate of local transfer multiplier of consumption for Canada. Second, I aim to resolve the endogeneity problem in estimating local transfer multiplier by proposing a novel instrument for the total transfer payments to households. My findings suggest that the estimated local transfer multiplier of consumption for Canada is 0.47. This implies that a one dollar increase in transfer payment to a province leads to 47 cents increase in consumption spending. The most important policy implication of this study is that transfer payments can have a significant impact on local consumption spending. My findings are consistent with previous works in literature. Romer and Romer (2016) finds an immediate and statistically significant response of consumption to permanent changes in transfers. They demonstrate that a permanent increase in Social Security benefits raises aggregate consumer spending almost one-for-one in the first month after the larger Social Security check arrives. Dupor et al. (2019) provides an estimate of 0.29 for the local fiscal multiplier of consumption for the U.S.. However, they look into a much broader class of government spending rather than only transfer payment.

The rest of the paper is structured as follows: Section 3.2 briefly discusses direct transfer payment programs to households and the details of UCCB program. Section
3.3 discusses the instrument validity of UCCB. Section 3.4 presents the econometric strategy. A discussion about data and variables is in section 3.5. Section 3.6 reports the results and section 3.7 presents robustness check. Concluding remarks are in Section 3.8.

3.2 Transfer Payments in Canada

3.2.1 Direct Transfer Payments to Households

The prime goal of the direct transfer payments to households from the federal government of Canada is to redistribute and stabilize income rather than to generate output. Therefore, these programs are targeted mainly towards the people who are in the middle or lower end of the income distribution. Some of the transfer programs like Employment Insurance program are automatic stabilizer implying that these types of transfer payments increase during economic downturns. Therefore, in general transfer payments and the state of the economy are negatively correlated.

There are eight broad categories of programs within the direct transfer payments to households in Canada (see Figure B2.1 in Appendix). The top three transfer programs in terms of total fund allocation during the period 2006-2016 in Canada were Employment Insurance (EI), Old Age Security (OAS) and Child Benefit. Figure 3.1 shows the distribution of transfer payments across different programs in Canada during 2015.
EI program \(^2\) in Canada provides temporary financial assistance to individuals who have lost their jobs. EI can also be extended to individuals who are unable to work because of illness or taking care of a newborn child or a seriously ill family member. OAS \(^3\) is a pension program dedicated to providing financial assistance to seniors aged 65 or above who meet the Canadian legal status and residence requirements. During the period 2006-2016, the child benefit program comprises two separate sub programs which were (i) Universal Child Care Benefit (UCCB) and (ii) Canada Child Tax Benefit (CCTB).

### 3.2.2 Universal Child Care Benefit

Universal Child Care Benefit (UCCB) was introduced in 2006 to make child care more affordable. It was one of the sub programs under the child benefit program during 2006-2016. Under this program, the federal government provided $100 per month to

\(^2\)Details on EI program are provided in the Appendix.
\(^3\)Details on OAS program are provided in the Appendix.
every family with a child aged between 0 to 5 years, regardless of income status of the household until 2015. During 2015 there was a significant policy change to extend the coverage of the program. Under the extended coverage, the monthly payments to family with a child aged below 6 years were increased to $160. In addition to that, every family with a child aged between 6 to 17 years started to get $60 per month. In 2015, the maximum UCCB was $1,920 per year for each child under 6 and $720 per year for each child aged between 6 to 17. The eligibility criteria for a parent or guardian to receive UCCB were the following:

- live with the child, and the child must be under the age of six (during 2015 age limit was increased to 17)

- be the person who is primarily responsible for the care and upbringing of the child

- be either a Canadian citizen or permanent resident, protected person, or temporary resident of Canada

UCCB aimed to provide financial support to all Canadian households with young children. The intended goal of the program was to assist parents to increase their spending on goods and services consumed by their children (Schirle 2015). At the household level, this transfer payment was exogenous as it did not depend on family income (Daley 2017). Therefore, at the aggregate level, the total UCCB allocation for the province was not affected by the income distribution of that province, rather it depended on the total number of eligible children. Koebel and Schirle (2016) argue that the UCCB payment was sizable as it represented 12-18% of the annual spending on children.
UCCB was terminated in June 2016 and a new program named Canada Child Benefit program (CCB) was introduced where the amount of benefit received by households were made contingent on the family income. As a result, under CCB program, the higher the household income the lower would be the child benefit.

3.3 Instrument Validity of UCCB

Estimating the impact of transfer payments on private consumption using a simple OLS regression may result in a biased estimate of the multiplier due to omitted variable bias. As some of the transfer programs are automatic stabilizers, the total spending on transfer payments is largely counter-cyclical. Therefore, the estimate of the multiplier may pick up a combination of the true multiplier effect and the counter-cyclicality of transfer system (Pennings 2021). This would cause a downward bias in the estimate of the multiplier. To resolve this endogeneity problem, I propose UCCB payments to provinces as an instrument for the total transfer payments to households across the Canadian provinces.

For UCCB to be a valid instrument, it must be uncorrelated with economic condition and any other confounding factors that may affect consumption. UCCB is a formula-based transfer from the federal government to households where the total allocation of UCCB payment for a province is proportionate to the total number of eligible children in that province. Therefore, the total UCCB payment to different provinces from the federal government depends on demographic characteristics (i.e., distribution of particular age group) rather than the economic condition of the provinces. More specifically, the total UCCB payments to a province is likely to be proportionate to the total number of children aged between 0-5 (until 2014) and
also the total number of children aged between 6 to 17 (during 2015-16). To verify this proposition, I plot the total UCCB payments to different provinces and their corresponding total number of children aged 0-4\(^4\) for every year between 2006-2016. Total UCCB payment to a province and total number of eligible children in that province tends to be highly correlated during 2006 to 2016 (Figure 3.2 shows the distribution for the year 2015). For example, during the year 2010\(^5\) Ontario received the largest UCCB payment from federal government as the number of eligible children was the highest in Ontario compared to other provinces. On the other hand, Yukon received the lowest UCCB payment as the number of eligible children in this province was the lowest.

Figure 3.2: Distribution of Total UCCB Allocation and Number of Children Aged 0-4 across Provinces during 2010

---

\(^4\)The total number of the children aged between 0-5 is not available in Statistics Canada.

\(^5\)Similar pattern is observed for other years within the sample period.
This high correlation is also evident when I control for the population size of provinces. Figure 3.3 shows the relationship between per capita UCCB payment and proportion (% of population) of eligible children across provinces during 2010.\textsuperscript{6}

Figure 3.3: Distribution of UCCB Per Capita and Proportion of Children Aged 0-4 Across Provinces during 2010

One of the conditions that UCCB needs to meet to be a valid instrument is that the allocation for UCCB for a province should be uncorrelated with the economic condition or performance of that province. The program design and the requirement for receiving the fund of UCCB at the household level do not have any clause that can translate in a direct linkage between the economic condition and disbursement of UCCB fund at provincial level.

\textsuperscript{6}Similar pattern is observed for other years within the sample period.
3.4 Econometric Strategy

I use Two Stage Least Square (2SLS) estimation strategy to identify how government transfer payments to households impact local private consumption. The total transfer payments in a province is instrumented using the UCCB payment to that province. The econometric specification of this study builds on the approach in Guo et al. (2016). I derive the local transfer multiplier of consumption by estimating the short run effects of local transfer payments on consumption spending at provincial level in Canada.

The benchmark specification of the first stage regression is

\[
\frac{T_{i,t} - T_{i,t-1}}{C_{i,t-1}} = \alpha \frac{UCCB_{i,t} - UCCB_{i,t-1}}{C_{i,t-1}} + \beta_1 \Delta U_{i,t} + \beta_2 \Delta Pop_{65}^{i,t} + \mu_i + \gamma_t + \epsilon_{i,t} \tag{3.1}
\]

where \(T_{i,t}\) is the real per capita transfer payments to households, \(C_{i,t}\) is the real per capita private consumption spending and \(UCCB_{i,t}\) is the real per capita UCCB payments in province \(i\) at time period \(t\). \(\Delta U_{i,t}\) denotes the change in unemployment rate in province \(i\) at time period \(t\). I include change in unemployment rate in the model to control for the variation in transfer payments due to the EI program within transfer payments. \(\Delta Pop_{65}^{i,t}\) denotes the change in the proportion of persons aged 65 or above in the total population. As the age of most of the OAS recipients is 65 or above, \(\Delta Pop_{65}^{i,t}\) variable is included to control for the variation in transfer payments due to the OAS program. \(\mu_i\) is the province fixed effect which takes the time invariant province specific characteristics (e.g., geography, local culture etc.) into account. The time fixed effect \(\gamma_t\) controls for the business cycle, monetary and fiscal policies that affect all provinces at a specific point in time. \(\epsilon_{i,t}\) is the error term.

The benchmark specification of the second stage regression is
\[
\frac{C_{i,t} - C_{i,t-1}}{C_{i,t-1}} = \delta \frac{T_{i,t} - T_{i,t-1}}{C_{i,t-1}} + \rho_1 \Delta U_{i,t} + \rho_2 \Delta Pop_{i,t}^{65} + \mu_i + \gamma_t + \epsilon_{i,t} \quad (3.2)
\]

The local transfer multiplier of consumption is the change in local consumption spending due to the exogenous change in local transfer payment. So, the coefficient \( \delta \) provides the estimate for the local transfer multiplier of consumption in the second stage regression.

Similar to the first stage regression, I use change in unemployment rate and change in the proportion of persons aged 65 or above as control variables in the second stage regression. If the unemployment rate is high then consumption is likely to be negatively impacted as unemployed people face larger income constraint. Even though older people typically spend less on food, clothing and personal care items, housing expenditures may be higher compared to other age group. The proportion of persons aged 65 or above is included to see the impact of demographic change on consumption.

### 3.5 Data

I use annual panel data of 13 provinces and territories of Canada over the period 2006-2015 for this study. I exclude the year 2016 from the sample period of this study because UCCB program was replaced by a new program known as Canada Child Benefit (CCB) program during July 2016. The amount of benefit received by households through this new program (CCB) depends on family income, i.e., the higher the family income, the lower would be the benefit received by the household with eligible children. Unlike UCCB, CCB cannot be used as an instrument since the total allocation for a province for this program depends on the state of the economy. Therefore, it is more appropriate to exclude the year 2016 from the analysis as it may
potentially pose bias in the multiplier estimate due to change in the child benefit program.

UCCB variable is measured as the total allocation in UCCB program for a province annually. Local private consumption is measured as the total household final consumption expenditure in each province. The total transfer payments to households are the sum of all types of direct transfer payments to households in provinces. Unemployment rate shows the annual average of unemployment rate in a province. UCCB, transfer payments and private consumption variables are measured in real per capita term. I use average annual consumer price index (base year 2002) to convert the nominal variables to real values. To derive the per capita values of the aggregate variables, I use the total annual population in provinces. The data source of this study is CANSIM database of Statistics Canada.

3.6 Results

In this section, I present both the OLS and IV estimates under the baseline specification. The descriptive statistics of the variables used in the model are shown in Table B1.1 of the Appendix.

3.6.1 Baseline Results

First, I run the OLS regression of private consumption on transfer payments for all the Canadian provinces and territories for the sample period 2006-15. Table 3.1 shows the OLS estimates for the benchmark specification. Column (1) shows the estimated results without the control variables. Column (2) and column (3) present the results by controlling unemployment rate and population age 65 and above respectively. Column
(4) shows the results from the full model. The estimated local transfer multiplier of consumption is 0.41 for the full model.

Table 3.1: Results of OLS Regression

<table>
<thead>
<tr>
<th>Dependent Variable: Change in Consumption (Relative to Consumption)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Changes in Transfer</td>
<td>0.31***</td>
<td>0.40***</td>
<td>0.32***</td>
<td>0.41***</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.07)</td>
<td>(0.08)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>Change in Unemployment Rate</td>
<td>-0.40</td>
<td>-0.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.28)</td>
<td>(0.29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Population Aged over 65</td>
<td></td>
<td>-0.10</td>
<td>-0.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.06)</td>
<td>(0.06)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.4***</td>
<td>1.43***</td>
<td>1.70***</td>
<td>1.72***</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.1)</td>
<td>(0.27)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>R-square</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Observations</td>
<td>117</td>
<td>117</td>
<td>117</td>
<td>117</td>
</tr>
</tbody>
</table>

Note: ***p<0.01, **p<0.05, *p<0.1

Next, I estimate the benchmark specification using 2SLS estimation method. Table 3.2 shows the results from the first stage regression.
Table 3.2: Results of First Stage Regression

<table>
<thead>
<tr>
<th>Dependent Variable: Change in Transfer (Relative to Consumption)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Changes in UCCB</td>
<td>0.10***</td>
<td>0.10***</td>
<td>0.10***</td>
<td>0.10***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Change in Unemployment Rate</td>
<td>0.29***</td>
<td></td>
<td>0.29***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.1)</td>
<td></td>
<td>(0.1)</td>
<td></td>
</tr>
<tr>
<td>Change in Population Aged over 65</td>
<td></td>
<td>0.28***</td>
<td></td>
<td>0.28***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.1)</td>
<td></td>
<td>(0.1)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.04</td>
<td>-0.08</td>
<td>-1.10***</td>
<td>-1.10***</td>
</tr>
<tr>
<td></td>
<td>(0.116)</td>
<td>(0.113)</td>
<td>(0.4)</td>
<td>(0.4)</td>
</tr>
<tr>
<td>Province Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>F Statistics Instrument</td>
<td>14</td>
<td>12</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>R-square</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Observations</td>
<td>117</td>
<td>117</td>
<td>117</td>
<td>117</td>
</tr>
</tbody>
</table>

Note: ***p<0.01, **p<0.05, *p<0.1

The first stage regression results of the baseline model show that the change in UCCB, the change in unemployment rate and the change in population aged over 65 have statistically significant positive impact on changes in transfer payments. The positive relation between change in unemployment rate and change in transfer payment is consistent with the fact that an increase in unemployment rate in any province...
increases the transfer payment through the increase in EI payments. Also, an increase in population aged 65 or over increases the transfer payment because of the rise in OAS payments. To check for instrument relevance, I follow the rule of thumb laid out by Stock et al. (2005). The standard rule of thumb is that the instrument(s) is weak if the F statistic for (joint) significance of instrument (s) in the first stage is below 10. My findings show that F statistics of UCCB from the first stage regression is above 10. Therefore, UCCB is not a weak instrument for transfer payments, and I can use this instrument to estimate the local transfer multiplier of consumption.

Table 3.3: Results of Second Stage Regression

<table>
<thead>
<tr>
<th>Dependent Variable: Change in Consumption (Relative to Consumption)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Changes in Transfer</td>
<td>0.57*</td>
<td>0.58*</td>
<td>0.46*</td>
<td>0.47*</td>
</tr>
<tr>
<td></td>
<td>(0.32)</td>
<td>(0.30)</td>
<td>(0.28)</td>
<td>(0.26)</td>
</tr>
<tr>
<td>Change in Unemployment Rate</td>
<td>-0.43***</td>
<td>-0.40***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td></td>
<td></td>
<td>(0.14)</td>
</tr>
<tr>
<td>Change in Population Aged over 65</td>
<td>0.21</td>
<td>0.21*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td></td>
<td></td>
<td>(0.13)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.35***</td>
<td>1.40***</td>
<td>2.10***</td>
<td>2.17***</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.12)</td>
<td>(0.48)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>Province Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-square</td>
<td>0.1</td>
<td>0.15</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>Observations</td>
<td>117</td>
<td>117</td>
<td>117</td>
<td>117</td>
</tr>
</tbody>
</table>

Note: ***p<0.01, **p<0.05, *p<0.1

The estimated value of local transfer multiplier for consumption is 0.47 in the
full model under 2SLS estimation, which implies that a one dollar increase in federal transfer payment to a province leads to a 47-cent increase in local private consumption. If we compare the OLS estimates with the 2SLS estimates, it is evident that the OLS estimates are lower than the IV estimates potentially reflecting the endogeneity of government transfer payments. The OLS estimates are likely to be capturing both the true multiplier effect and the countercyclicality of transfer system. As the OLS specification does not account for this countercyclicality, the omitted variable bias could potentially create a downward bias in the OLS estimate of the multiplier.

R square of the second stage regression is 0.2. Typically, the R square is low in panel data regression. Studies similar to this paper for example, Guo et al. (2016) also report low R square (0.2) for their 2SLS regression.

3.7 Robustness Check

The validity of UCCB as an instrument can be violated if there is a confounding factor that is correlated with UCCB and at the same time affects consumption. One potential candidate for such a confounding factor is birth rate. The total allocation of UCCB payment in a province depends on the number of eligible children in that province, which is in turn driven by a combination of changes in birth rates and changes in rates at which children “age out” of the program. So, if the birth rate is correlated with UCCB and also influences private consumption of a province, then UCCB may not be a valid instrument. To check this, first I calculate the unconditional correlation between UCCB per capita and birth rate across provinces over the sample period. The estimated unconditional correlation between UCCB per capita and birth rate is 0.55 which is a moderate correlation. Now to check whether birth rate has
statistically significant impact on private consumption of a province, I include change in birth rate as a control variable in the baseline model. Table 3.4 shows the estimates from the first (Column 1) and second (Column 2) stage regressions. My findings suggest that change in birth rate does not have a statistically significant impact on private consumption. Therefore, I do not find any evidence in favor of birth rate as a confounding factor that can violate the instrument validity of UCCB.

Table 3.4: Results of 1st and 2nd Stage Regression when Birth Rate is Controlled

<table>
<thead>
<tr>
<th></th>
<th>Relative Change in Transfer</th>
<th>Relative Change in Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Relative Changes in Transfer</td>
<td></td>
<td>0.47*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.26)</td>
</tr>
<tr>
<td>Relative Changes in UCCB</td>
<td>0.1***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0002)</td>
<td></td>
</tr>
<tr>
<td>Change in Unemployment Rate</td>
<td>0.27***</td>
<td>-0.40***</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>Change in Population Aged over 65</td>
<td>0.26***</td>
<td>-0.22***</td>
</tr>
<tr>
<td></td>
<td>(0.110)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>Change in Birth Rate</td>
<td>-3.67*</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>(2.1)</td>
<td>(2.6)</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.05***</td>
<td>2.20***</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.46)</td>
</tr>
<tr>
<td>Province Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-square</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Observations</td>
<td>117</td>
<td>117</td>
</tr>
</tbody>
</table>

Note: ***p<0.01, **p<0.05, *p<0.1

Public spending in a region may have a positive spillover to other regions through
increase in import demand. On the other hand, if government spending crowds out private demand for labor and leads to a relocation of factors (e.g. workers) to the region receiving the fiscal stimulus, then it may have a negative spillover effect. The local fiscal multiplier can underestimate the aggregate fiscal multiplier if there is a positive spillover and overestimate the aggregate fiscal multiplier if there is a negative spillover (Serrato and Wingender 2016). Local fiscal multipliers may be reliable indicators of the fiscal policy’s aggregate or nationwide effect if the spillover effect is insignificant (Serrato and Wingender 2016; Corbi et al. 2019; Dupor and Guerrero 2017).

To check the spillover effect of transfer payments and to assess whether my estimated local transfer multiplier can be a good proxy for the aggregate transfer multiplier, I extend the baseline model by incorporating the UCCB payments received by the largest trading partner of each province. Therefore, the second stage regression becomes:

\[
\frac{C_{i,t} - C_{i,t-1}}{C_{i,t-1}} = \delta \frac{T_{i,t} - T_{i,t-1}}{C_{i,t-1}} + \sigma \frac{UCCB_{i,t}^{TP} - UCCB_{i,t-1}^{TP}}{C_{i,t-1}} + \rho_1 \Delta U_{i,t} + \rho_2 \Delta P_{op_{i,t}^{65}} + \mu_i + \gamma_t + \varepsilon_{i,t}
\]

(3.3)

Here, \(UCCB_{i,t}^{TP}\) shows the per capita UCCB of the largest trading partner and the coefficient \(\sigma\) measures the spillover effect. Table 3.5 shows the results of 1st and 2nd stage regressions after I take the spillover effect into consideration. I find that transfer payments to households has a small but statistically significant positive spillover effect to other provinces.

\(^7\)Largest trading partner for each province is derived from Statistics Canada inter-provincial trade data.
Table 3.5: Results of 1st and 2nd Stage Regression with Spillover Effect

<table>
<thead>
<tr>
<th>Relative Change in Transfer</th>
<th>Relative Change in Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Relative Changes in Transfer</td>
<td>0.47*</td>
</tr>
<tr>
<td>Relative Changes in UCCB</td>
<td>0.1***</td>
</tr>
<tr>
<td>Change in Unemployment Rate</td>
<td>0.28***</td>
</tr>
<tr>
<td>Change in Population Aged over 65</td>
<td>0.25***</td>
</tr>
<tr>
<td>Relative Changes in UCCB of the Largest Trading Partner</td>
<td>0.002***</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.05***</td>
</tr>
<tr>
<td>Province Fixed Effect</td>
<td>Yes</td>
</tr>
<tr>
<td>Time Fixed Effect</td>
<td>Yes</td>
</tr>
<tr>
<td>R-square</td>
<td>0.20</td>
</tr>
<tr>
<td>Observations</td>
<td>117</td>
</tr>
</tbody>
</table>

Note: ***p<0.01, **p<0.05, *p<0.1

3.8 Conclusion

This study assesses the impact of transfer payments to households on private consumption at the provincial level in Canada. The main challenge in exploring such a causal relationship is to find a valid instrument for fiscal policy variables like transfer payments since they are often conditioned on pre-existing economic conditions. I address this challenge by using UCCB payments across provinces in Canada as an instrument for transfer payment and estimate the local transfer multiplier of consumption. Using the 2SLS estimation method for the period 2006-2015, this paper finds
that the estimated local transfer multiplier of consumption in Canada to be 0.47. The estimated local transfer multiplier of this study can also serve as a good proxy for aggregate transfer multiplier of consumption as the spillover effect of transfer payment is very small.

The findings of this study suggest that the government transfer programs in Canada have a positive and significant impact on the local consumption spending at the provincial level. Therefore, the transfer payments can be an effective tool in stimulating the local economy in the short run compared to the other types of government spending.
Appendix: Chapter 3

Figure B2.1: Breakdown of Direct Transfer Payments to Households in Canada

Description of EI Program:

Employment Insurance (EI) provides regular benefits to individuals who lose their jobs through no fault of their own (for example, due to shortage of work, or seasonal or mass lay-offs) and are available for and able to work, but can’t find a job. This program provides temporary income support to unemployed workers while they look for employment or to upgrade their skills. The EI program also provides special benefits to workers who take time off work due to specific life events:

- illness
• pregnancy

• caring for a newborn or newly adopted child

• caring for a critically ill or injured person

• caring for a family member who is seriously ill with a significant risk of death

Workers receive EI benefits only if they have paid premiums in the past year and meet qualifying and entitlement conditions. Self-employed workers may participate in EI and receive special benefits.

**Description of OAS Program:**

The OAS program provides a basic pension upon which individuals may add income from other sources, such as the Canada or Quebec Pension Plan (C/QPP), employer pension plans and personal savings. The OAS program includes the OAS pension, the GIS and the Allowances. The OAS pension is a basic pension to which most seniors aged 65 years and older are entitled. The OAS program provides additional support through the income-tested GIS to low-income seniors with little or no other income. In addition, the Allowance and the Allowance for the Survivor are paid to low-income individuals aged 60 to 64 who are the spouses or common-law partners of GIS recipients or who are widows or widowers. To qualify for OAS pension, a person living in Canada at the time of application must be 65 years or older and have resided in Canada for at least 10 years after age 18. The full basic OAS pension is payable to seniors who have resided in Canada for at least 40 years after age 18. A partial pension is paid to seniors who have lived in Canada for at least 10 years after age 18, and their benefits are prorated at the rate of one fortieth of the full pension for each complete year of residence. In order to be eligible for the GIS, a person must receive the OAS pension, be a legal resident of Canada and have income, or combined income
for couples, below the maximum annual thresholds. To qualify for the Allowances, a person must be 60 to 64 years old, be a legal resident of Canada and have resided in Canada for at least 10 years after the age of 18. In addition, a person must be a low-income widow or widower to qualify for the Allowance for the Survivor, or the spouse or common-law partner of a recipient of the GIS to qualify for the Allowance.

Table B1.1: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer Per Capita ($)</td>
<td>2222</td>
<td>582</td>
<td>1357</td>
<td>3522</td>
<td>117</td>
</tr>
<tr>
<td>UCCB Per Capita ($)</td>
<td>181</td>
<td>41</td>
<td>42</td>
<td>326</td>
<td>117</td>
</tr>
<tr>
<td>Consumption Per Capita ($)</td>
<td>23371</td>
<td>2847</td>
<td>16177</td>
<td>28569</td>
<td>117</td>
</tr>
<tr>
<td>Unemployment Rate (%)</td>
<td>8.1</td>
<td>3.1</td>
<td>3.5</td>
<td>17.1</td>
<td>117</td>
</tr>
<tr>
<td>Birth Rate (births per 1,000 population)</td>
<td>12</td>
<td>4</td>
<td>8</td>
<td>27</td>
<td>117</td>
</tr>
<tr>
<td>Proportion of Persons Aged Over 65 (%)</td>
<td>13.0</td>
<td>4.4</td>
<td>2.7</td>
<td>18.9</td>
<td>117</td>
</tr>
<tr>
<td>Proportion of Children Aged Between 0-4 (%)</td>
<td>6.1</td>
<td>1.9</td>
<td>4.4</td>
<td>12.3</td>
<td>117</td>
</tr>
</tbody>
</table>

Notes: Estimates are annual
Chapter 4

How Important are Commodity Terms of Trade News Shocks for Aggregate Fluctuations in Canada?

4.1 Introduction

There have been large swings in commodity prices\footnote{Figure C2.1 shows the trend of Bank of Canada commodity price index over the period 1980-2019.} globally over last two decades. Commodity prices started to rise sharply from early 2000s, interrupted only briefly by the global financial crisis and then there was a rapid decline from the middle of 2014 to early 2016. As Canada is a predominantly commodity exporting country, these fluctuations in commodity prices can lead to changes in commodity terms of trade (defined as the relative price of exportable goods in terms of importable goods) and consequently the trade balance. As the commodity prices are determined in the world market where Canada is relatively a small player, these changes in commodity terms
of trade can be treated as foreign shocks to Canada. These shocks to commodity terms of trade (henceforth, CTOT) due to commodity price movements can lead to aggregate fluctuations in commodity exporting countries like Canada.

CTOT shocks can be both anticipated or unanticipated. An unanticipated shock to the CTOT would cause a current movement in the CTOT. An example of such a shock is a natural disaster that lead to abrupt and unanticipated change in the global supply chain. This type of shock can lead to a change in contemporaneous CTOT and therefore it can be considered as an unanticipated CTOT shock. A typical anticipated CTOT shock affects the CTOT with a lag. For example, the news about a deal on climate change to reduce emission drastically in near future by big carbon polluters may not affect the current CTOT but can affect CTOT with a lag. This type of shock affect other macroeconomic variables such as investment in green energy contemporaneously as investment is a forward looking variable.

How important are commodity terms of trade shocks for aggregate fluctuations in a small open economy? A large number of studies (e.g. Mendoza 1995, Kose 2002, Shousha 2016) provide evidence in favor of terms of trade as an important determinant of business cycle in small open economies. However, a recent study by Schmitt-Grohé and Uribe (2018) have shown that unanticipated variations in terms of trade cannot account for the movements in macroeconomic aggregates in small open economies. Using the annual country-specific SVARs for 38 poor and emerging market economies they show that terms of trade shocks can explain on average 10% of movements in aggregate fluctuations. However, their study do not take into account the anticipated component of terms of trade shock commonly referred as terms of trade news shock. As some of the movements in CTOT may be anticipated, it is important to consider the role of CTOT news shocks to explain the fluctuations in
aggregate variables. Ben Zeev et al. (2017) demonstrate that the news component in the CTOT movement can explain significant variation in aggregate variables of five Latin American economies. They conclude that ignoring the impact of news shock can lead to misleading conclusion about the importance of CTOT as a key driver of business cycle in emerging small open economy.

How can CTOT news shocks trigger aggregate fluctuations in the economy? Once agents recognize signals about future changes in commodity prices, they adjust expectations about the future state of the economy and in turn, adjust current optimal decisions of consumption and investment (Farias and da Silva 2017). As a result, CTOT news shock can generate aggregate fluctuations in the economy. This paper assesses the role of combined (anticipated and unanticipated) CTOT shocks as an important driver of aggregate fluctuations for an advanced small open economy like Canada over the period 2000Q1-2019Q4.

By definition, news shock is a change in the expected value of a given exogenous variable at a future date, which is orthogonal to current shocks to that variable. News shocks may, for instance, correspond to (i) discoveries of new technologies or (ii) announcements about future changes in government spending, taxes, or the policy interest rate. In the former case, TFP news shocks do not affect current TFP because of the assumption that it takes some time for technological innovations to affect productivity. This assumption that news shock of a variable cannot affect that variable contemporaneously is known as zero impact restriction. Barsky and Sims (2011) employ the Maximum Forecast Error Variance (MFEV) approach to identify TFP news shock in the U.S. by imposing zero impact restriction. In the latter case, current values of the policy instruments remain constant by construction (reflecting the decision of policymakers to change them only at a future date). Commodity
prices are jump variables that react to geopolitical news contemporaneously and at subsequent horizons. As a result, it is difficult to find an example of pure news shock for CTOT as it is a forward-looking variable. Unlike the pure news shocks, an anticipated future change in the CTOT may cause a current movement in CTOT through movements in inventories (Pindyck 2001 and Roache and Erbil 2010). Due to the storability of commodity goods, the news in their prices can be hedged through movements in inventories, which can very often result to movements in commodity prices contemporaneously. Therefore, in order to properly capture the news component in the CTOT shock, it is more appropriate to identify CTOT news shock without imposing zero impact restriction.

Following Ben Zeev et al. (2017), I identify a combination of both news and surprise CTOT shocks of Canada from a VAR model containing foreign exogenous variable CTOT and five domestic endogenous variables by using an alternative version of MFEV identification approach. My identification strategy maximizes the forecast error variance share of the CTOT at a two-year horizon without imposing zero impact restriction. However, relaxing zero impact restriction in the MFEV approach only allow to identify a combination of both anticipated and unanticipated shocks (henceforth news augmented CTOT shocks) instead of pure news shocks. This implies that I allow potential correlation between surprise and news CTOT shocks. I find that the news augmented CTOT shocks can induce significant increases in output, consumption and investment in Canada. The trade balance increases with a delay and real exchange rate appreciates on impact. My findings suggest that news augmented CTOT shocks explain around 31% fluctuations of output as well as significant variations of other key macroeconomic indicators. I find that the contribution of CTOT in explaining the cyclical fluctuations in Canada becomes more than double when I account for
news component in CTOT. This provides an evidence that the news component of CTOT movements may be more important than surprise component for the Canadian economy.

A large number of papers in literature examine the role of terms of trade as an important driver of aggregate fluctuations. Using calibrated models, Mendoza (1995) and Kose (2002) find that terms of trade shocks are a major driver of short-run fluctuations. Fernández et al. (2018) argue that commodity prices have an important role in explaining business cycles in commodity-exporting countries since the mid-1990s. A similar study by Shousha (2016) shows that commodity price shocks are an important source of business cycle fluctuations for small open commodity exporters, with stronger effects on emerging economies relative to advanced economies. Fernández et al. (2018) find that commodity prices explain around one third of business cycle fluctuations in emerging economies. Kilian (2009) demonstrates that price shocks on commodities like oil can be very different depending on the origin of the shocks. For example, an oil price change driven by an unanticipated global aggregate demand shock will have a very different effect than an oil price change caused by an unanticipated increase in precautionary demand driven by fears about future oil supply shortfalls. Charnavoki and Dolado (2014) identify the main global shocks driving up the world commodity prices. Then they quantify the dynamic responses of a wide variety of Canadian variables to several global structural shocks that drive changes in real commodity prices.

The paper most closely related to mine is by Ben Zeev et al. (2017) who coin the concept of news augmented CTOT shocks. Using the data of five Latin American countries, Ben Zeev et al. (2017) find that news augmented CTOT shocks explain almost half of output variations in emerging economies. They show that accounting
for news almost doubles the contribution of CTOT in explaining cyclical fluctuations. This paper defers from previous studies in two aspects. First, I assess the importance of the effects of combined shocks (both anticipated and unanticipated) to CTOT for an advanced small open economy like Canada. Second, to the best of my knowledge, this is the first paper that examines the impact of CTOT news shock on the Canadian economy empirically. Even though a large body of literature examine the role of unanticipated terms of trade shocks as a major source of business cycles in emerging and poor countries, very few studies look into the impact of anticipated shocks. Specially, the role of anticipated CTOT shocks in generating aggregate fluctuations is still unexplored for advanced small open economies such as Canada.

The remainder of the paper is organized as follows. Section 4.2 describes the econometric strategy. Section 4.3 provides details of data. Section 4.4 presents the benchmark empirical results. Section 4.5 reports the results from robustness check. Section 4.6 concludes.

4.2 Econometric Strategy

To extract the news augmented CTOT shocks of Canada, I employ an alternative version of MFEV identification approach without zero impact restriction proposed by Kurmann and Sims (2021). This identification approach is based on the medium run restriction and builds on Francis et al. (2014), Uhlig (2003) and Faust (1998). In literature, typically news shocks are identified using zero impact restriction to ensure that news shock of a variable affects that variable with a delay. As news about future change in CTOT can potentially cause movement in current CTOT through inventory channel, I need to relax the zero impact or short run restriction in the identification
strategy. As a result, surprise and news CTOT shocks can potentially be correlated.

A key assumption to identify CTOT news shock is that Canada takes the commodity prices as exogenously given. It is widely accepted in both empirical and theoretical literature that terms of trade are exogenous for small open economy (Schmitt-Grohé and Uribe 2018). Canada is a small player in the world markets for the goods it exports and imports. In particular, Canada’s economy is not large enough to influence the price of exportable and importable goods in the global commodity market\(^2\). Therefore, it is reasonable to assume that the domestic aggregate variables of Canada do not have a direct or feedback effect on the CTOT. As a result, variations in the CTOT can be considered as an exogenous source of aggregate fluctuations in Canada.

Barsky and Sims (2011) find that TFP news shock can explain movements in technology over long horizons quite well, while the surprise technology shock accounts for almost all of the short run variation. Therefore, they suggest that news shocks do not explain significant short run fluctuations in technology. The max share identification of Kurmann and Sims (2021) is very similar to Barsky and Sims (2011), however, they do not impose the zero-impact restriction. In addition, unlike Barsky and Sims (2011), they maximize the sum of FEV shares of adjusted TFP at a long horizon H instead of from impact onward. This implies that their identification does not rely on short run fluctuations in productivity. As commodity prices are jump variables that react to geopolitical news contemporaneously and at subsequent horizons, it is ideal to consider the long run as well as the short fluctuations of CTOT while identifying news augmented CTOT shocks. Therefore, I identify the news augmented CTOT shock as the one with the largest contribution to the FEV of CTOT over horizons 0 to H similar to Barsky and Sims (2011) instead of at a given horizon H as Kurmann.

\(^2\)Canada’s export share is 2.28% and import share is 2.36% in the world during 2020. (source: UN Comtrade Database).
and Sims (2021).

My baseline VAR model includes six variables, namely, commodity terms of trade, trade balance, output, consumption, investment, and real exchange rate. The main identification assumption for news augmented CTOT shock is that CTOT evolves according to an exogenous process, which is independent to the Canadian aggregate variables. Therefore, I can use domestic macroeconomic variables to identify expected fluctuations in CTOT.

Consider a reduced form VAR as the following:

\[ y_t = B_1 y_{t-1} + B_2 y_{t-2} + \cdots + B_p y_{t-p} + u_t, \]  

(4.1)

where \( y_t \) is a vector of variables observed at time \( t \), \( B_i \) are matrices of coefficients, \( p \) denotes the number of lags, and \( u_t \) is a vector of reduced form error with variance-covariance matrix \( \Sigma = E[u_t u_t'] \).

We can write 4.1 more compactly as:

\[ B(L)y_t = u_t, \]  

(4.2)

where \( B(L) = 1 - B_1 L - B_2 L^2 - \cdots - B_p L^p \). Here \( L \) denotes the lag operator and \( B(L) \) is the matrix of lag order polynomials.

The vector moving average representation of this reduced form VAR is:

\[ y_t = C(L)u_t, \]  

(4.3)

Where \( [B(L)]^{-1} = C(L) = 1 + C_1 L + C_2 L^2 + \cdots \). To identify mutually orthogonal structural shocks, we assume that there is a linear relationship between reduced form
shocks \( u_t \) and structural shocks \( \varepsilon_t \), i.e.,

\[
    u_t = A\varepsilon_t,
\]

(4.4)

where \( A \) is the impact matrix. So, the \( j^{th} \) column of \( A \) represents the impact of the \( j^{th} \) shock in \( \varepsilon_t \) on all variables.

The impact matrix \( A \) must satisfy the following restriction:

\[
    \sum = E[u_t u'_t] = E[A\varepsilon_t \varepsilon'_t A'] = AE[\varepsilon_t \varepsilon'_t]A' = AA'
\]

(4.5)

But this restriction is not sufficient to identify \( A \) because \( \sum = AA' \) gives us \( n(n+1)/2 \) restriction where \( \sum \) has \( n \times n \) unknown. So, I use Cholesky decomposition which is an arbitrary orthogonalization to satisfy this restriction.

Suppose \( \tilde{A} \) is Cholesky decomposition of \( \sum \) such that \( \sum = \tilde{A}\tilde{A}' \). Then there must be a \( n \times n \) orthonormal matrix \( Q \) satisfying \( QQ' = I \) such that \( A = \tilde{A}Q \) (QR decomposition). \( \tilde{A}Q \) gives us the entire space of permissible impact matrices which will help us identify structural shocks.

Now using 4.2 and 4.3 we can write:

\[
    y_t = C(L)A\varepsilon_t = C(L)\tilde{A}Q\varepsilon_t.
\]

(4.6)

Here \( C(L)\tilde{A} \) shows impulse response, i.e., dynamic impact of \( \varepsilon_t \) on all variables.

Suppose \( C_\tau \) is the matrix of reduced form moving average coefficient at horizon \( \tau \). The \( h \)-step ahead value of \( Y_{t+h} \) is:

\[
    Y_{t+h} = \sum_{\tau=0}^{\infty} C_\tau \tilde{A}Q\varepsilon_{t+h-\tau},
\]

(4.7)
\[ Y_{t+h} = \sum_{\tau=0}^{h-1} C_{\tau} \tilde{A} Q \xi_{t+h-\tau} + \sum_{\tau=h}^{\infty} C_{\tau} \tilde{A} Q \xi_{t+h-\tau}, \] (4.8)

The first term captures the accumulative effect on \( Y_{t+h} \) of all the structural shocks that have yet to occur between \( t+1 \) and \( t+h \) period. So the expected value of this term is zero as I have assumed \( \xi \sim N(0, I) \). The second term captures the accumulative effects on \( Y_{t+h} \) of all shocks that already occurred between \(-\infty\) and \( t \) period. This term is predetermined at \( t \). So the expected value of \( Y_{t+h} \) is:

\[ E_t Y_{t+h} = \sum_{\tau=h}^{\infty} C_{\tau} \tilde{A} Q \xi_{t+h-\tau}. \] (4.9)

So the \( h \)-step ahead forecast error of \( Y_{t+h} \) is:

\[ Y_{t+h} - E_t Y_{t+h} = \sum_{\tau=0}^{h-1} C_{\tau} \tilde{A} Q \xi_{t+h-\tau}. \] (4.10)

Now the \( h \) step ahead forecast error of \( i^{th} \) variable in \( Y_{t+h} \) is:

\[ Y_{i,t+h} - E_t Y_{i,t+h} = e_i^t \left[ \sum_{\tau=0}^{h-1} C_{\tau} \tilde{A} Q \xi_{t+h-\tau} \right], \] (4.11)

where \( e_i \) denotes selection vector with 1 on the \( i^{th} \) position and zeros elsewhere. So the forecast error variance of a particular variable \( i \) at horizon \( h \) is the sum of the contributions of the \( n \) structural shocks.

The contribution of the \( j^{th} \) shock to the forecast error variance of variable \( i \) at horizon \( h \) is:

\[ \Omega_{ij}(h) = E[(Y_{i,t+h} - E_t Y_{i,t+h})(Y_{i,t+h} - E_t Y_{i,t+h})'] = e_i^t \left[ \sum_{\tau=0}^{h-1} C_{\tau} \tilde{A} q q' \tilde{A} \tilde{C}_{\tau}' \right] e_i, \] (4.12)
where \( q \) denotes the \( j^{th} \) column of \( Q \) and \( \tilde{A}q \) is \( n \times 1 \) vector which represents the vector of the impact effects of shock \( j \). Without loss of generality, I index the CTOT shocks as 1 in the vector of structural shocks.

Therefore, I need to solve the following optimization problem to identify CTOT news augmented shock over horizon \( h = [0, H] \):

\[
q^* = \arg\max H \sum_{h=0}^{H} \Omega_{1,1}(h) \tag{4.13}
\]

\[
q^* = \arg\max e_i' \left[ \sum_{\tau=0}^{H} \sum_{\tau=0}^{h} C_{\tau} \tilde{A}q \tilde{A}' C'_{\tau} \right] e_i \tag{4.14}
\]

subject to

\[
q' q = 1 \tag{4.15}
\]

Constraint 4.15 ensures that \( q \) is a column vector belonging to an orthonormal matrix. This normalization implies that the identified shocks have unit variance, but I do not restrict it to have a zero in its first entry, meaning that I allow the news-augmented CTOT shock to impact CTOT immediately. I estimate the VAR model using OLS estimation. I use the bootstrapping approach for inference. My benchmark choices for the number of lags and truncation horizon are \( P=4 \) and \( H=8 \) respectively.

### 4.3 Data

I use quarterly data from 2000Q1 to 2019Q4 to extract the news augmented CTOT shocks and CTOT surprise shocks of Canada. To measure commodity prices, I use Bank of Canada commodity price index (BCPI). The BCPI is a chain Fisher price index of the spot or transaction prices in U.S. dollars of 26 commodities produced in
Canada and sold in world markets. I construct CTOT of Canada by dividing BCPI by the U.S. import price of manufactured goods from industrialised countries. The trade balance to GDP is defined as the difference between exports and imports as a share of current GDP. Output is the expenditure-based GDP. Private consumption is measured as the household final consumption expenditure and investment is measured as gross fixed capital formation. Real exchange rate is expressed as the real broad effective exchange rate (REER) for Canada, where an increase (decrease) indicates an appreciation (depreciation). Stock price is the Standard and Poor’s/Toronto Stock Exchange Composite Index at closing. Nominal interest rate is measured as the Bank of Canada policy rate. The alternative measure of CTOT is constructed by taking ratio of merchandise export price over merchandise import price. All variables are taken from Statistics Canada except for REER, nominal interest rate and U.S. import price of manufactured goods from industrialised countries, which are extracted from FRED. Output, consumption, and investment are in real terms and in logarithm. I take first difference of REER to make it stationary.

4.4 Results

4.4.1 Impact of News Augmented CTOT shocks in the Canadian Economy

Following the identification strategy outline in Section 4.3, I identify the news augmented CTOT shock for the Canadian economy. I estimate the baseline VAR model with 4 lags based on the Akaike Information Criteria (AIC). Chinn and Coibion (2014) and Bowman and Husain (2004) suggest that the optimal horizon for predicting
commodity prices varies between one and two years. Therefore, I choose 8 quarters as the truncation horizon in the baseline specification\(^3\). Figure 4.1 shows the impulse responses of the aggregate variables for the benchmark specification to a one standard deviation news augmented CTOT shock in Canada. The impulse responses are interpreted as the responses of Canadian aggregates to the combination of anticipated and unanticipated CTOT shocks.

News-augmented CTOT shocks increase CTOT on impact and it reaches its peak in the fourth quarter. The CTOT shock induces an immediate increase in output, consumption and investment. Trade balance increases with a delay and reaches its peak in the fourth quarter. The real exchange rate appreciates on impact, however it returns to steady state relatively quickly compared to other variables.

These findings are similar to that of Ben Zeev et al. (2017) except for the response of trade balance. They find that trade balance improves in response to news augmented CTOT shocks whereas I find the opposite. As the news augmented shock is a combination of both of surprise and news shocks, the response of trade balance to these combined shocks depends on how it may react to surprise and news CTOT shocks. If the response of trade balance to surprise and news CTOT shocks are in opposite direction, then the direction of the combined (net) response depends on the magnitude of the impacts of these two shocks. After a CTOT surprise shock in an economy, substitution effect leads to an increase in demand for importable goods and a decrease in demand for exportable goods as exportable goods become relatively expensive. The increase in the price of exportable also causes a positive income effect that boosts the domestic demand for importable goods. These lead to an increase in import demand. On the other hand, an increase in the relative price of exportable

\(^3\)My findings are robust under alternative truncation horizons.
goods induces domestic firms to produce more exportable goods and less importable goods. As a result, export increases. Trade balance improves if export dominates import. A number of studies (e.g. Schmitt-Grohé and Uribe 2018, Ben Zeev et al. 2017, and Shousha 2016) find empirical evidence in favor of an improvement in trade balance due to a CTOT surprise shock.

The persistence and magnitude of the impulse responses of the Canadian aggregates to news augmented CTOT shock are lower compared that for emerging economies in Ben Zeev et al. (2017). This is consistent with the findings of Shousha (2016) who demonstrates that commodity price shocks are an important source of business cycle fluctuations for small open commodity exporters, with stronger effects on emerging economies relative to advanced economies.

To check how trade balance may react on impact to a CTOT news shock, it is important to understand how agents react by the release of the news before the shock materializes. Once agents recognize signals about future changes in commodity prices, they adjust expectations about the future of the economy and in turn, adjust current optimal decisions (Farias and da Silva 2017). As a result, the release of the news can result in an initial positive effect on consumption due to the income effect and consequently lead to a higher import demand. Therefore, the trade balance can deteriorate in response to a CTOT news shocks.
Figure 4.1: Impulse response to a one standard deviation news augmented CTOT shock.

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.

Next, I turn on to the FEVD \(^4\) presented in Table 4.1 which shows how much variation in aggregate fluctuations can be explained by the news augmented CTOT shocks. My findings show that the news augmented CTOT shocks can explain around

\(^4\)MFEV methodology identifies news augmented CTOT shock by maximizing the FEV of CTOT
31%, 35% and 64% variation in output, consumption and investment, respectively. Almost half of the variation in real exchange rate and one third of the variation in trade balance can be explained by CTOT shocks. This provides an evidence that news-augmented CTOT shocks can be considered as an important source of aggregate fluctuations for Canada.

Table 4.1: Share of FEV explained by news-augmented CTOT shocks

<table>
<thead>
<tr>
<th>Type of Shock</th>
<th>Terms of Trade</th>
<th>Trade Balance</th>
<th>Output</th>
<th>Consumption</th>
<th>Investment</th>
<th>Real Exchange Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>News Augmented CTOT Shock</td>
<td>80</td>
<td>34</td>
<td>31</td>
<td>35</td>
<td>64</td>
<td>52</td>
</tr>
</tbody>
</table>

Notes: Shares are expressed in percent.

4.4.2 Relative Importance of CTOT News Shock Compared to CTOT Surprise Shock

As the news augmented CTOT shock is a combination of both surprise shock and news shock, it does not provide the individual contribution of each of these shocks in explaining aggregate fluctuations. To check how the aggregate variables respond to a CTOT surprise shock and how much of the variation in aggregate variables it can explain, I identify the CTOT surprise shock using a Cholesky decomposition in SVAR model. I construct a SVAR model using the same aggregate variables as in the baseline model for extracting the news augmented CTOT shock (the detailed methodology is presented in the Appendix). As Canada is a small open economy, it takes the CTOT as exogenously given. Therefore, CTOT is ordered first in the SVAR model. The other variables are ordered as the following; trade balance, output, consumption, investment and real exchange rate.
Figure 4.2 displays the impulse responses of the aggregate variables to the surprise shock. The improvement in the terms of trade causes an expansion in aggregate activity. The CTOT surprise causes an improvement in the trade balance on impact. Output, consumption and investment also increase on impact. The real exchange rate increase on impact implying that there is an appreciation. The appreciation of real exchange rate is an indication that Canadian goods become more expensive vis-a-vis the goods from the rest of the world. These results are similar to the findings of Schmitt-Grohé and Uribe (2018) who has the same aggregate variables in their SVAR model.
Figure 4.2: Impulse response to a one standard deviation CTOT surprise shock.

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.

Table 4.2 presents the FEVD which shows estimated contribution of the surprise shocks in explaining variation in aggregate variables. The CTOT surprise shocks can
explain only 10%, 9% and 30% of fluctuations in output, consumption and investment respectively over a two-year horizons. It explains almost one third of the variation in real exchange rate and only 13% variation in trade balance. Comparing the FEVD in Table 4.1 with that of Table 4.2, I observe that accounting for news more than doubles the contribution of CTOT in explaining cyclical fluctuations in Canada. Therefore, the CTOT news shock may be relatively more important compared to the CTOT surprise shock for the aggregate fluctuations of the Canadian economy.

<table>
<thead>
<tr>
<th>Type of Shock</th>
<th>Terms of Trade</th>
<th>Trade Balance</th>
<th>Output</th>
<th>Consumption</th>
<th>Investment</th>
<th>Real Exchange Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTOT surprise Shock</td>
<td>36</td>
<td>13</td>
<td>10</td>
<td>9</td>
<td>30</td>
<td>33</td>
</tr>
</tbody>
</table>

Notes: Shares are expressed in percent.

4.5 Robustness Check

In this section, I consider several alternative VAR specifications to check the robustness of my baseline findings.

4.5.1 Alternative Truncation Horizon

In my baseline model, I extract news augmented CTOT shocks that account for the maximum FEV share of CTOT at truncation horizon of H=8 quarters. This choice of truncation horizon is based on the findings of Chinn and Coibion (2014) and Bowman and Husain (2004), who suggest that the optimal horizon for predicting commodity prices varies between one and two years. In this subsection, I change the
truncation horizon to 4 quarters and 12 quarters to check the robustness of the baseline findings. The impulse responses do not have any noticeable changes under alternative truncation horizons\(^5\). Comparing the FEVD under different truncation horizons in Table 4.3 (second and third rows), I find that the importance of the identified shocks in explaining the variation in aggregate variables does not change if truncation horizon is altered.

Table 4.3: Share of FEV Explained by News-Augmented CTOT Shocks for Alternative Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Terms of Trade</th>
<th>Trade Balance</th>
<th>Output</th>
<th>Consumption</th>
<th>Investment</th>
<th>Real Exchange Rate</th>
<th>Interest Rate</th>
<th>Stock Price Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline ((H = 8))</td>
<td>80</td>
<td>34</td>
<td>31</td>
<td>35</td>
<td>64</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Truncation ((H = 12))</td>
<td>79</td>
<td>33</td>
<td>30</td>
<td>31</td>
<td>64</td>
<td>51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Truncation ((H = 4))</td>
<td>79</td>
<td>32</td>
<td>29</td>
<td>33</td>
<td>63</td>
<td>53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Identification</td>
<td>81</td>
<td>37</td>
<td>30</td>
<td>36</td>
<td>60</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Measure of CTOT</td>
<td>75</td>
<td>38</td>
<td>29</td>
<td>37</td>
<td>59</td>
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<td>Response of Monetary Policy</td>
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Notes: Shares are expressed in percent.

4.5.2 Alternative Identification of News Augmented CTOT Shock

I identify news augmented CTOT shock by maximizing the sum of FEV shares from impact onward. Alternatively, I can use maximum FEV share of CTOT at a long

\(^5\)Impulse responses of news augmented CTOT shocks are provided in Figures C2.2\((H = 4)\) and C2.3 \((H = 12)\) of the Appendix.
horizon $H$ to identify the news augmented CTOT shock similar to Kurmann and Sims (2021). The impulse responses\textsuperscript{6} and FEVD (forth row of Table 4.3) of this news augmented CTOT shock under alternative identification strategy are very similar to that of the baseline model. Therefore, the relevance of news-augmented CTOT shocks in explaining aggregate fluctuations in Canada remains the same under alternative identification strategy.

4.5.3 Alternative Measure of CTOT

In the baseline specification, I use the Bank of Canada Commodity Price Index over import price of manufactured goods from industrialised countries as a measure of CTOT. In order to investigate whether the conclusions made in the baseline model are sensitive to the measure of CTOT, I re-estimate my benchmark model substituting BCPI based index of CTOT with an alternative measure of CTOT. I construct this alternative measure of CTOT by taking the ratio of merchandise export price over merchandise import price of Canada. The impulse responses\textsuperscript{7} and FEVD (fifth row of Table 4.3) using this measure of CTOT are very similar to that of the baseline model. The importance of news-augmented CTOT shocks in explaining cyclical fluctuations remains unchanged regardless of the measure of CTOT.

4.5.4 Response of Monetary Policy

My baseline findings suggest that a positive CTOT shock has an expansionary effect on the Canadian economy. The optimal policy response of the central bank after a rise

\textsuperscript{6}Figure C2.4 in the Appendix presents the impulse responses to news-augmented CTOT shock for the alternative identification of news augmented CTOT shock.

\textsuperscript{7}Figure C2.5 in the Appendix presents the impulse responses to news-augmented CTOT shock for the alternative CTOT measure.
in commodity prices is to undertake a contractionary monetary policy to tackle the inflationary pressure (Drechsel et al. 2019). To see the response of monetary policy to the news augmented CTOT shocks, I extend my baseline model by including nominal interest rate.\(^8\) The impulse responses in Figure 4.3 show that the nominal interest rate rises in response to the news augmented CTOT shock. This suggests that central bank reacts to offset the inflationary pressure by raising interest in response to a CTOT shock. The trade off of this policy response by Central Bank is that the expansion of the economy from the positive CTOT shocks can be dampen.

\(^8\)Nominal interest rate is measured by the Bank of Canada policy rate from FRED.
Figure 4.3: Impulse Responses to News-Augmented CTOT News Shock (including interest rate)

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.

4.5.5 Inclusion of Financial Variable

Beaudry and Portier (2006) demonstrate that financial variables such as stock price can be used to identify anticipated fluctuations in aggregate variables. They provide
evidence that TFP news shock can affect stock prices significantly. In this subsection, I extend my baseline specification to include the stock price index of Canada\textsuperscript{9} to see whether its inclusion changes my main conclusions. The impulse responses in Figure 4.4 show that stock price jumps up on impact due to news augmented CTOT shock similar to the findings of Beaudry and Portier (2006). Including stock price index does not change the relevance of news augmented CTOT shock in explaining aggregate fluctuations in Canada.

Figure 4.4: Impulse Responses to News-Augmented CTOT News Shock in the Extended Model with Stock Price.

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95\% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.

\textsuperscript{9}I use Standard and Poor’s/Toronto Stock Exchange Composite Index at closing as the measure of stock price.
4.6 Conclusion

There has been dramatic rise and fall of commodity prices during the last two decades globally. The CTOT can be an important source of macroeconomic fluctuations for commodity exporting countries like Canada which are sensitive to large commodity price shocks. This paper empirically assesses the importance of a combination of CTOT surprise and news shocks as an important driver of aggregate fluctuations.

Even though a large body of literature examine the role of unanticipated terms of trade shocks as a major source of business cycles in emerging and poor countries, very few studies look into the impact of CTOT anticipated shocks. Specially, the role of anticipated CTOT shocks in generating aggregate fluctuations in advanced small open economy like Canada is still unexplored. This paper tries to fill that gap by examining the impact of CTOT news shock on the Canadian economy.

The findings of this paper suggest that CTOT is an important source of cyclical fluctuations in Canada. Surprise CTOT shock alone cannot explain the aggregate fluctuations of the Canadian economy. However, accounting for news component of CTOT more than doubles the contribution of CTOT in explaining the cyclical fluctuations. This suggests that anticipated movement in CTOT may be relatively more important than the unanticipated movement in CTOT for the Canadian economy.
Econometric Strategy to Extract the CTOT Surprise

Consider a structural VAR model

\[ A_0 Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t \]  

where \( Y_t \) is a vector of variables with the following order: commodity terms of trade, trade balance to GDP ratio, GDP, private consumption, private investment, real effective exchange rate. \( \varepsilon_t \) is the structural shock.

\[ Y = [\text{CTOT}, \text{TB}, \text{GDP}, \text{C}, \text{I}, \text{REER}] \]  

So, the reduced form representation of VAR is

\[ Y_t = B_1 Y_{t-1} + B_2 Y_{t-2} + \cdots + B_p Y_{t-p} + u_t \]  

Where \( B_i = A_0^{-1} A_i \) and \( u_t \) is the reduced form error which can be expressed as:

\[ u_t = A_0^{-1} \varepsilon_t = C \varepsilon_t \]  

C denotes the impact matrix which needs to satisfy the following restriction:

\[ \sum = CC' \]
Suppose $\tilde{C}$ is the Cholesky decomposition of $\sum$, i.e.,

$$\tilde{C} = \text{chol}(\sum)$$ (21)

If $Q$ is an orthonormal matrix that satisfies the restriction $QQ' = I$, then we can express:

$$C = \tilde{C}Q$$ (22)

Using (19) and (22) we can write:

$$u_t = \tilde{C}\tilde{\epsilon}_t$$ (23)

$$\begin{bmatrix}
    u_t^{CTOT} \\
    u_t^{TB} \\
    u_t^{GDP} \\
    u_t^C \\
    u_t^I \\
    u_t^{REER}
\end{bmatrix} =
\begin{bmatrix}
    C_{11} & 0 & 0 & 0 & 0 & 0 \\
    C_{21} & C_{22} & 0 & 0 & 0 & 0 \\
    C_{31} & C_{32} & C_{33} & 0 & 0 & 0 \\
    C_{41} & C_{42} & C_{43} & C_{44} & 0 & 0 \\
    C_{51} & C_{52} & C_{53} & C_{54} & C_{55} & 0 \\
    C_{61} & C_{62} & C_{63} & C_{64} & C_{65} & C_{66}
\end{bmatrix}
\begin{bmatrix}
    \tilde{\epsilon}_t^{CTOT} \\
    \tilde{\epsilon}_t^{TB} \\
    \tilde{\epsilon}_t^{GDP} \\
    \tilde{\epsilon}_t^C \\
    \tilde{\epsilon}_t^I \\
    \tilde{\epsilon}_t^{REER}
\end{bmatrix}$$ (24)
Figures

Figure C2.1: Trend of commodity prices during the period 1980 to 2019
Figure C2.2: Impulse Responses to News-Augmented CTOT News Shock for Truncation horizon $H = 4$ quarters

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.
Figure C2.3: Impulse Responses to News-Augmented CTOT News Shock for Truncation horizon $H = 12$ quarters

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.
Figure C2.4: Impulse Responses to News-Augmented CTOT News Shock (alternative identification)

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.
Figure C2.5: Impulse Responses to News-Augmented CTOT News Shock (alternative CTOT measure)

Notes: Bootstrap methodology is used to estimate the error bands for the impulse responses. 95% confidence bands are depicted with dark-gray shaded area. These bands are based on 1000 repetitions.
Chapter 5

Conclusion

In this thesis, I assess the role of the anticipated shocks in aggregate fluctuations and explore new channels of international transmission of news shocks for the Canadian economy. In Chapter 2, I introduce a novel channel of international transmission of fiscal news shock from the U.S. to Canada. In Chapter 3, I estimate the impact of transfer payments to households on local consumption across the Canadian provinces. In Chapter 4, I assess the role of commodity terms of trade news shock in causing aggregate fluctuations in Canada.

Fiscal shocks from the U.S. can have important implications for a small open economy like Canada given its close economic and political ties with the U.S.. In the literature, international trade is considered as the main transmission channel for the spillover effect of fiscal shock. In chapter 2, I demonstrate that an induced spending channel can explain the transmission of defence spending news shock from the U.S. to the Canadian economy. I argue that this novel transmission channel needs to be taken into consideration in explaining the impact of the U.S. defence spending news shock on the Canadian output. This study provides an empirical evidence of the economic
implications of global geo-political events and foreign policies in Canada. My findings suggest that news about future change in U.S. defence spending can have a significant impact on the Canadian economy.

In chapter 3, I assess whether transfer payments to households can stimulate the local economy in Canada. To address the endogeneity problem between transfer payments and consumption, I use Universal Child Care Benefit as a novel instrument of transfer payments. Using the 2SLS estimation method for the period 2006-2015, this paper finds that the estimated local transfer multiplier of consumption in Canada to be 0.47. The estimated local transfer multiplier of this study can also serve as a good proxy for aggregate transfer multiplier of consumption as the spillover effect of transfer payment is very small. I argue that the transfer payments can be an effective tool in stimulating the local economy in the short run compared to the other types of government spending as its recipients are mainly from the middle and low income groups who have higher marginal propensity to consume.

The role of commodity prices in causing aggregate fluctuations may have increased in recent years due to the sharp swings in commodity prices. I assess whether the anticipated changes in commodity terms of trade are more important than the unanticipated changes in the context of Canadian economy in chapter 4. Commodity terms of trade news shocks can trigger aggregate fluctuations in the economy because signals about future changes in commodity prices can change the expectations about the future state of the economy and consequently change the current optimal decisions on consumption and investment by economic agents. Using the data for the time period 2000Q1-2019Q4, I evaluate the impact of both the anticipated and unanticipated commodity terms of trade shocks on the Canadian economy. Surprise CTOT shock alone cannot explain the aggregate fluctuations of the Canadian economy. However,
accounting for the news component of CTOT more than doubles the contribution of
CTOT in explaining the cyclical fluctuations. This suggests that CTOT news shock
has important implication for the Canadian economy.
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