Introduction

This paper investigates the differential effects of changes in the interest rate on economic activity across the Canadian provinces. The results reveal that provinces experience changes in economic activity of vastly different magnitude. The information gleaned from the results of this paper are valuable for central banks setting monetary policy as well as the development of better macroeconomic theory. By modeling regional interest rate sensitivities, inferences can be made about monetary policy transmission channels. At the end of this paper it should be evident that using regional macroeconomics adds to the understanding of how the Canadian macro-economy really functions.

By using a monthly structural vector auto-regression (SVAR), it is possible to isolate interest rate, commodity price, and output shocks. Impulse response functions can then be used to map out shocks on the economic activity of the Canadian provinces. Interest rate changes elicit no change in the economic activity of some provinces, this result would have been missed if the provincial economies were not modelled. [1]

To address the regional effects of monetary policy, this paper examines provinces individually. The provincial approach is in contrast with earlier studies in this field, which group states or provinces into artificially constructed regions. Studies done in the United States usually group states into regional groups, while saying little about the fact that banking regulations may vary within these constructed regions. European studies examine the effect of European monetary policy union (EMU) on countries which, as the current debt crises has exposed, are able to set their own national fiscal policy.

The central banks of most monetary unions do not explicitly use regional data when setting the interest rate. Canada is no different; the Bank of Canada is committed to setting an

[1] The provinces that have a muted response to monetary policy tend to be quite sensitive to commodity price shocks.

interest rate that maintains national CORE inflation at 2%. To see why disregarding regional information might be a problem, consider the following example. Suppose that Canada has just two provinces: Manitoba and Alberta. The Bank of Canada is using the interest rate to maintain a CORE inflation rate of 2% and decides how to set the interest rate by looking at the national average inflation. Importantly, the two provinces have a different output response to a change in the interest rate. Alberta's output is insensitive to the interest rate while Manitoba's output is elastic. Suppose that because of a spike in the price of oil, inflation is now at 6% in Alberta and only at 2% in Manitoba. If the two populations are equal then the national inflation is 4% which is above the Bank of Canada's target. To decrease national inflation to the 2% target, the Bank of Canada will need to raise the interest rate to disinflate the economy. Alberta's inflation is insensitive to the interest rate, which means that Manitoba's inflation will need to be brought down to -2% in order for the Bank of Canada to achieve its target. Manitoba's output and employment will suffer as a result of deflation while Alberta will continue to have a 6% rate of inflation. The monetary policy decision has a different effect on the two provinces. While this example may be stylized, it shows the conditions under which a national monetary decision would have divergent regional consequences (Krugman, 2011).

In the previous example, if inflation is pushed close to zero the outcome may be even worse. The problem is the possibility of a non-linear aggregate supply curve. As central banks try to push inflation close to zero, they must sacrifice an increasing amount of output (Akerlof, Dickens & Perry, 1996). By acting on national data, a central bank may continue to raise interest rates further, while some regions have their economic activity severely curtailed. In practice, a central bank setting a target national inflation rate in the face of a non-linear aggregate supply curve would incur high cost to output and employment. A central bank considering regional

heterogeneity would set a higher target inflation rate in order to lessen the disparate regional impacts of monetary policy.

Having knowledge about regional interest rate sensitivity is an asset to central bank decision making. If the central bank is to act credibly, it is important to commit to a policy rule or monetary policy reaction function (MPRF). The Bank of Canada uses a Terms of Trade Economic Model (Murchison & Rennison, 2006) to set monetary policy. This projection model is much more complicated than a simple Taylor rule, but it does not include regional information. Indicators such as regional employment and output, and more stable factors like interest rate sensitivities, are not used in the interest rate decision. The Bank of Canada may use regional information informally, but the bank is still constrained by a commitment to national rather than regional inflation rates. While firm monetary policy commitments serve to mitigate social loss, the previous example shows the perils of low inflation targets using only national data. The usefulness of regional information has been explored by Angelini, et al (2008). They found that by augmenting a simple MPRF with regional information, social loss was decreased by 30%. These gains diminish as the Taylor-rule becomes more forward looking, but the authors admit that this mechanism is not well understood (2008). Further support for using regional information comes from the dynamic stochastic general equilibrium model developed by Benigno (2004). The two region model reveals that the most efficient monetary policy would target the average price level but weight the average by relative price stickiness rather than the populations. This theoretical work suggests that there may well be a role for regional information in making monetary policy more efficient.

The next sections of this paper are the following: Section I, using a literature review, highlights the different identification techniques that have been brought to bear on the regional

response problem. Section II describes the data, their source and forms some expectation of the results. Section III briefly explains the econometric model used. Section IV presents the results of this paper; employment responses to both interest rate and commodity shocks are examined. Section V shows some of the robustness testing that was done. Section IV discusses the implications of the results and concludes the research.

I. Literature review

Given the problems arising from differential regional interest rate sensitivity, the structural causes of the difference will be explored by this paper. The most common theory about regional interest rate sensitivity is the credit view, which effects economic activity through the broad and narrow channels. Generally, the credit view refers to the central bank changing the interest rate, which affects the assets and liabilities on a bank's balance sheet (Bernanke & Blinder, 1992). A change in the interest rate will influence the ability of a bank to make new loans because banks borrow short and lend long. The demand for loans by firms is not uniform. The firms that depend most on bank loans will have production costs increase if the interest rate rises. There are two theoretical consequences stemming from the credit view. The broad credit view states that small firms are affected by an interest rate change more than large firms. Small firms deal with banks directly and have little direct access to financial markets. Large firms may use financial markets to raise low cost capital when the bank lending rate is high (Gertler & Gilchrist, 1991). Alternatively, the narrow credit view states that the manufacturing industry is more sensitive to interest rates than other industries. Manufacturing firms tend to have large fixed capital expenditure, which needs to be financed through banks. Additionally, manufacturing firms face interest rate sensitive demand unlike for example, the food processing industry. A rise in interest rates will have a large effect on the cost of production of loan laden

manufacturing firms (Bernanke & Blinder, 1992). Taken together, the broad and narrow credit view suggest that the output of regions with a relatively large manufacturing sector and a high proportion of small firms will be most sensitive to an interest rate change by the central bank.[2]

The bank lending channel is a third view of monetary transmission. In a monetary union without homogeneous banking regulation, some regions will have banks that are more or less able to alter their balance sheets (Kashyup & Stein, 1994). For example, in the United States, reserve requirements differ across state lines. Empirical work often use the percentage of a state's total loans made by banks below the 90^{th} percentile in national bank capitalization as a proxy for the bank lending channel. Carlino and Defina (1998) found that the bank lending channel was a significant indicator of interest rate sensitivity. The bank lending channel is not applicable to Canada since banking regulation is nationally mandated. This makes the magnitude of Canadian results of this paper interesting to compare with the results found in United States papers, because even without the bank lending channel, we still find sizable differences across regions.

The first relevant article to address regional responses to national monetary policy was a Canadian paper written by John Beare in 1976. He was participating in the monetarist critique of that period, which is apparent in his model specification. Beare was trying to make a case for money supply being important at the provincial level; Beare ran a regression of autonomous expenditure and national money supply on regional expenditure, across the Prairie provinces. The results suggest that national money supply does have a significant effect on the expenditure of the Prairie provinces. The problem with these results is that the reduced form approach

[2] It should be noted that the broad and narrow credit views may be somewhat contradictory. Firms with large fixed capital expenditure that are thought to be sensitive to interest rate changes are also often large firms. Since large firms have better access to financial markets that make them less sensitive to interest rates, the effects of these theoretical propositions may be ambiguous.

employed suffers from bias as well as unaddressed autocorrelation which serves to generate huge t-statistics (Mathur & Stein, 1980). So, while Beare's assertion about the effect of the money supply is questionable, the results do show differences in the response between provinces. This paper builds on this observation of regional difference and use contemporary econometrics to improve the accuracy of the results.

The next important paper in this literature was Chang and Garrison (1979). Much like Beare's paper, this paper is also a production of the monetarist critique. In contrast to the specification of Beare, Garrison and Chang adopted a more neutral identification which included fiscal policy as an explanatory variable of output. Their results suggest that United States fiscal policy does have a role in determining output, and that changes in the money supply are slower to affect manufacturing sector than fiscal policy. More importantly, they found large regional differences in response to changes in the money supply and fiscal policy. A striking example is the Rocky mountain region, where output was entirely insensitive to the money supply. Similar to Beare's paper, the findings begged the question; what is giving rise to differences in the output sensitivity of regions?

After the pioneering work of Sims' 1980 paper, regional macroeconomists had the econometric techniques to confront regional issues directly. Several articles have come out of the United States that utilized the structural vector auto-regression method. Two papers were written by Carlino and Defina (1998, 1999) were published out of the Philadelphia Federal Reserve branch. The first paper used regional aggregates to examine the interest rate sensitivity across the country. They found that both the broad and narrow credit channel made regions were the most interest rate sensitive. Together these theories predict that regions with a high portion of small firms and a high portion of output from manufacturing will be sensitive to changes in

the interest rate. The first of these two studies had a methodological issue pertaining to the aggregation of states into regions. Although the 1998 article refers to the bank lending channel as a source of heterogeneity at the state level, this information is not incorporated into their specification. Essentially, states are grouped together which the bank lending channel would predict should act differently to a given interest rate shock. By aggregating states into regions, the effect of different bank regulations across states is concealed and it is possible that within regions there are offsetting differential responses.

The second paper by Carlino and Defina addresses interest rate sensitivity at the state level. They find that there is variation among states within the regions they had constructed. With the bank lending channel no longer confounding their results, Carlino and Defina maintain that both the broad and narrow credit channel predict the interest rate sensitivity of a state. However, both papers are compromised in their use of quarterly data. This necessitates long sample periods which cross several different monetary policy regimes. Carlino and Defina conclusion about monetary policy channels are difficult to accept when the stability of interest rate sensitivity over 34 years is doubtful.

A more recent paper out of the St. Louis Federal Reserve branch by Owyang and Wall (2006) addresses the concern about such a long sample period. They do this by separating the long sample of previous papers into samples over different monetary regimes. Interestingly, Owyang and Wall find that only the narrow credit channel affects regional heterogeneity in the low inflation Volker-Greenspan era. They also find that the bank lending channel, in this paper defined as the portion of loans coming from banks in the lower 90^{th} percentile, does not predict regional interest rate sensitivity. Unfortunately, in this paper the authors state explicitly that using state level data was too computationally expensive. Once again the bank lending channel

is confounding the results; states with different responses are grouped together even though the bank lending channel theory predicts these states should be separated. This raises the possibility that the bank lending channel is indeed important in the United States at the state level.

The methodological problems faced by papers on this topic from the United States, serve to motivate this type of research in Canada. The bank lending channel suggests that differences in regional banking constraints, such as reserve requirements, will cause a given interest rate shock to have varied impacts on regional economic activity. Devoid of regional banking regulation, Canada effectively has no bank lending channel. Therefore theory predicts that only the broad and narrow credit channel cause differences in the way that regional economic activity responds to monetary policy. Comparing this paper with regional aggregate studies done in the United States, one can be convinced that the broad and narrow credit channels are, in part, responsible for this regional heterogeneity. It is also possible to get an idea of the effect that the bank lending channel has in the United States by studying the counter-factual in Canada.

With the creation of a unified European currency zone in 1999, studies into regional response to monetary policy gained importance. Critics of the euro zone can use the same regional method as this paper to suggest that the European Union is not an optimal currency area (Martin, 2001). These types of studies fall victim to some of the same issues as US studies. The current financial crisis in Europe shows that member nations are following vastly different fiscal policy regimes. While it is possible that a Canadian province could use fiscal policy to systematically counter Bank of Canada policy, provinces would have a difficult time funding such a venture because of strong solvency constraints. Moreover, the provinces that have an incentive to move against Bank of Canada policy are the ones most sensitive to monetary policy; making adversarial fiscal policy prohibitively costly. In Europe the same might not be true,

solvency constraints are not as important for EU countries which are sovereign nations that have the ability to issue debt. Most of the nations that make up the union are all large enough to undertake significant fiscal stimulus. Knowing this casts doubt as to whether or not structural vector auto-regressions done in Europe are capturing the true differential effects of ECB policy.

II. Data section

The data used in this model was obtained from the CANSIM database. Provincially disaggregated data was retrieved for the employment level. National data was retrieved for employment, CORE price index, the one month Treasury bill rate, and consistent with the SVAR literature; a national commodity price index. The twelfth difference was taken for all variables except the interest rate so that the model is expressed entirely in rates of change.

Monthly data extends as far back as January 1981 but we use a sample from January 1991 to March 2011. This is a much smaller sample than is used in the other regional literature. We are concerned about the stability of the regional interest rate sensitivities as the monetary regimes changed. The small sample is meant to avoid a unit-root arising from Canada's move towards inflation targeting in the early 1990's. This decision was made easier given that Statistics Canada provides monthly data, as opposed to quarterly and yearly data which is used in other related studies. The high frequency data allows for a relatively small sample period to be examined without losing explanatory power because we are interested in the dynamics as opposed to the long-run effects.

Another consideration that arose from the change in monetary policy regimes relates to the model specification. A linear and quadratic trend variable were generated and added exogenously to the model. By doing this we attempt to control for the Bank of Canada's

systematic efforts to bring down inflation to their target rate. So, while restricting the sample size allows conclusions to be valid for the current monetary policy period. The trend is an acknowledgment that in the 1990's Canada was transferring into a period of low and stable inflation (Murchison & Rennison, 2006, P.17).

In line with the literature estimating the regional effects of monetary policy, this paper uses employment as a proxy for economic activity. There may be some reasons that output would be a better measure of economic activity. Firstly, regional employment is related to the policy decisions of provincial regulators which we do not model. This suggests that there is a systematic relationship between provincial employment policy and Bank of Canada monetary policy. If this were true, specifying the model using output rather than employment would not be a solution because if a province has full control over employment, then this implies major control over output. If provincial governments are able to use policy to control the provincial economy then the Bank of Canada should have little role in Canada, but this is not the case (Fortin, 1996). Secondly, much of macroeconomics focuses on output as it relates it relates to inflation and the interest rate. Here it is possible to appeal to empirical regularities such as Okun's law. Adanu (2005) shows that, although not uniform, a statistical relationship exists between output and unemployment across provinces. Even if there was no empirical relation between output and employment, this would not diminish the fact that employment is a valid measure of economic welfare.

Another specification decision made about this model was to use the one month Treasury bill yield for the interest rate. This bond yield is not control directly by the Bank of Canada in the way the overnight bank lending rate is. Although the bank rate, by virtue of direct control by the Bank of Canada is more exogenous, we use the one month yield because it embodies more

information about the macro economy. Financial theory tells us that a bond price will hold information about the expected future inflation, interest, and output growth. In this sense, the Bank of Canada uses the overnight rate to move short term interest rates and would take the information conveyed by the yield curve into account when setting interest rates (Murchison & Rennison, 2006, p.28).

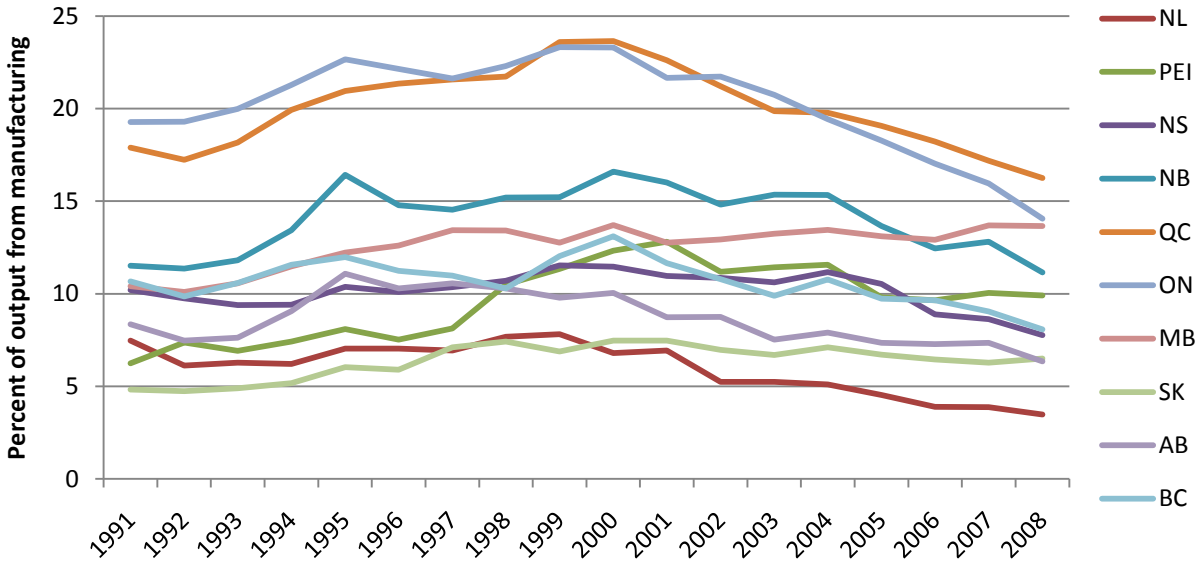
In order to form a causal story about the findings of this paper, we will develop some expectations about the results based on theory. In Canada, the monetary policy transmission theory states that there are two channels of monetary transmission operating. Taken together the broad and narrow credit channel view holds that provinces with a high number of small firms and intensive manufacturing will be most sensitive to interest rate changes. There exists some (limited) data on industry mix and firm size. We use this data to form some expectations about the results of this paper's model.

Figure 1: Average percent of output from manufacturing from 1991-2008

Province	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario
Average	10.66	8.66	6.37	12.58	20.22
Rank	5	8	9	4	1

Province	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland
Average	20.01	14.03	10.15	9.57	5.99
Rank	2	3	6	7	10

Figure 2: Provincial Manufactuing Intensity



Recall that the narrow credit channel predicts that regions with a large share of manufacturing will be more sensitive to the interest rate. Figure 1 shows the percent of output from manufacturing firms in each province. Generally, manufacturing is done in the central provinces of Quebec and Ontario. The percent of output from the manufacturing sector then declines to the east and west. A notable exception to this trend is British Columbia, which has a relatively high portion of manufacturing compared to the other western provinces. The time series graph (Figure 2) reveals that the manufacturing output of the provinces is not particularly volatile. This means that the relative position of each provide does not change very much over the course of the sample. Stable data makes the problem of taking averages much less worrisome and addresses the caveat referred to previously. From the averages and rankings of the provinces, narrow credit channel theory suggests that the central provinces, with high rankings, will have a large response to an interest rate change.

One possible confounding factor in this interpretation was brought up by Garrison and Chang (1979). When they found that the Rocky Mountain region was almost completely insensitive to the interest rate, they also observed that the region was not devoid of a manufacturing sector. Garrison and Chang suggest that the manufacturing in this region may serve the interest rate insensitive mining and agricultural sectors. This means that manufacturing in this region was sheltered from interest rate shocks by virtue of their local demand (1979). In this respect we would like to know whether or not a region's manufacturing sector is supplying interest rate insensitive industries. Since such data is not readily available, we must make some assumptions. The problem of demand insensitivity should not be important for manufacturing intensive provinces such as Ontario because it is doubtful that the region is itself consuming a 20% manufacturing output share. Provinces with low manufacturing could be using most of that sectors output for interest rate insensitive activities. However, theory says that these low levels of manufacturing will not explain much of the provincial differences.

Figure 3: Ratio of small to large firms (2000-2011)

Province	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario
Average	0.842	0.727	0.690	0.555	0.576
Rank	1	4	5	10	9

Province	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland
Average	0.751	0.644	0.588	0.732	0.627
Rank	2	6	8	3	7

Figure 4: Ratio of Small Firms to Large Firms

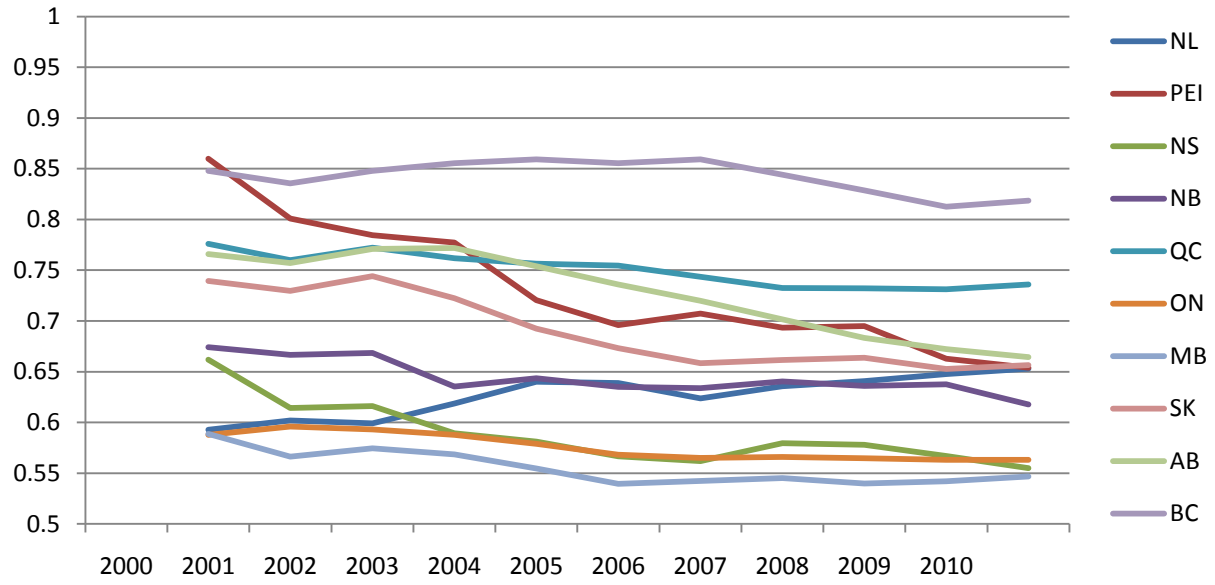


Figure 3 displays the ratio of small firms (of less than 100 employees) to large firms across provinces. The interpretation of these numbers is that large numbers signify a province that has a high ratio of small firms. The broad credit channel theory suggests that provinces with high ratios of small firms will be more sensitive to monetary shocks. The data shows that British Columbia has the highest ratio of small firms in the country. Ontario has quite a low number of small firms which could be interpreted as being due to the large portion of large manufacturing in the province. This does not seem to be a consistent interpretation because Quebec has quite a large number of small firms. Again the time series graph (Figure 4) shows that these rankings have been relatively stable over the last decade, apart from P.E.I which has seen a persistent move towards employment in large firms.

III. Model

$$A_0 y_t = A_1 y_{t-1} + A_2 y_{t-2} + A_3 y_{t-3} + u_t$$

$$y_t = (\Delta_{12} Commodity\ price_t, i_t, \Delta_{12} CORE_t, \Delta_{12} GDP_t, \Delta_{12} emp_t, \Delta_{12} Prov\_emp_t^i)'$$
$$\Delta_{12} Prov\_emp_t^i \quad for\ each\ i\ province$$

$$A_0 = \begin{bmatrix} 1 & . & . & . & . & 0 \\ a_{21}^0 & 1 & & & & . \\ a_{31}^0 & a_{32}^0 & 1 & & & . \\ a_{41}^0 & a_{42}^0 & a_{43}^0 & 1 & & . \\ a_{51}^0 & a_{52}^0 & a_{53}^0 & a_{54}^0 & 1 & . \\ a_{61}^0 & a_{62}^0 & a_{63}^0 & a_{64}^0 & a_{65}^0 & 1 \end{bmatrix}$$

$E(u_t u_t') =$ D diagonal matrix

$E(u_t u_s) = 0 \quad \forall \quad s \neq t$

Figure 5: Model specification

The equations and matrix specified in figure 5 represent the SVAR model that is estimated in this paper. The vector y_t includes all of the endogenous variables used in the provincial models. When y_t is post-multiplied the recursive structure of the A_0 matrix, the product specifies exact-identification of the endogenous variables. This means that the y_t vector elements are ordered from most exogenous to least exogenous. For example, commodity price does not depend contemporaneously on any other variables and so, it is explained by the lag of the other variables[3] and the lag of commodity prices. The following variable, interest rate, does depend contemporaneously on commodity prices but no other variables. These model restrictions allow for orthogonal shocks but because they are imposed prior to estimation the restrictions are not testable.

[3] It should be noted that the lag length is the same for all variables, consistent with Sims (1980). See the Robustness section for a discussion of how the lag length was chosen.

IV. Results

Before delving into the results related to provincial employment it is first necessary to examine whether the response to monetary policy is broadly consistent with expectations. This is an important step in any related SVAR because it is this shock that is used to examine the response of provincial employment. To convey proper identification the national model is used and the resulting impulse response functions are shown in figure 6.

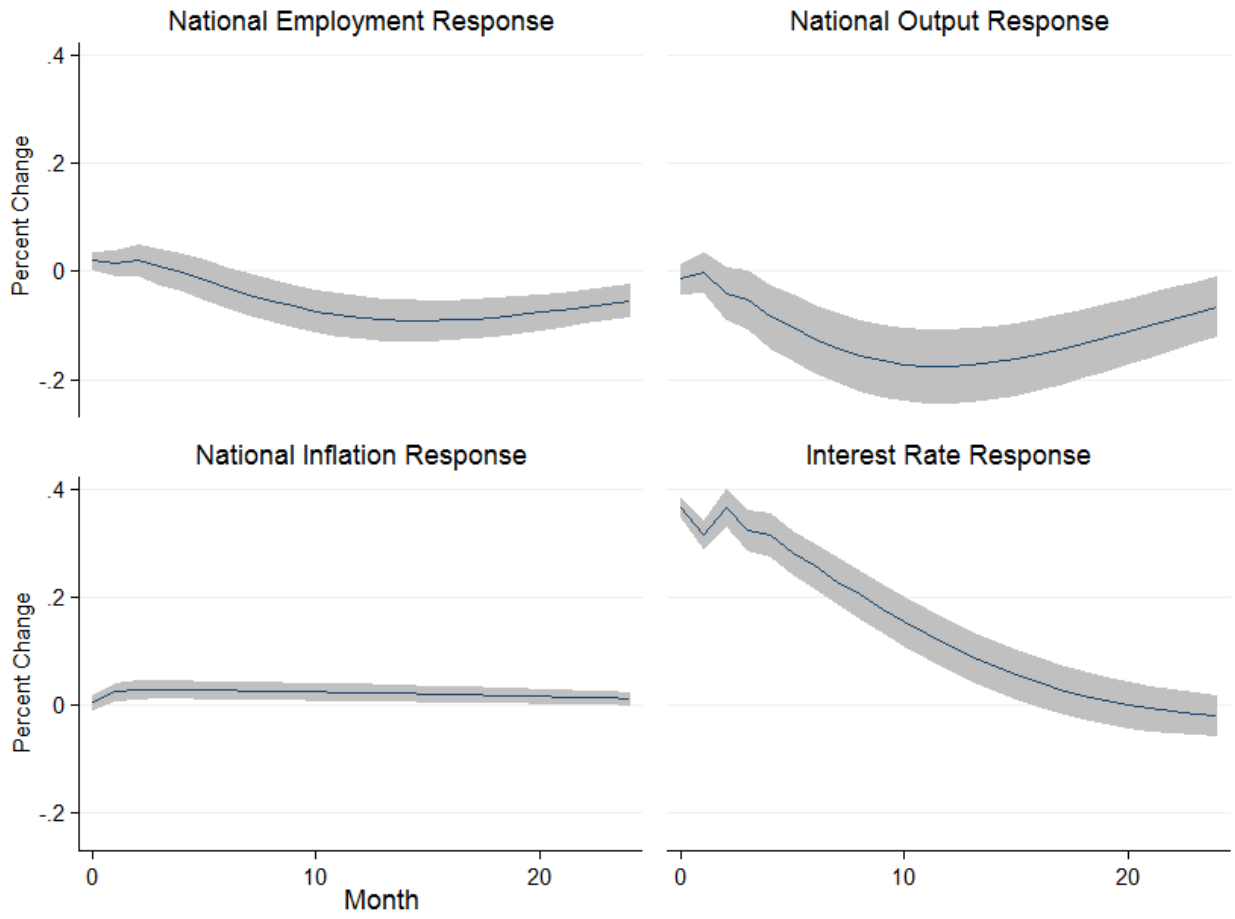


Figure 6: Shows the percentage change in various national variables to a positive one standard deviation shock in the rate of interest The confidence intervals in this, and all the following impulse response functions, are set at 66 per cent which is roughly one standard deviation. The SVAR approach does not allow for statistically insignificant lag variables to be removed without some theoretical explanation. As a consequence, an SVAR will carry a large number of irrelevant regessors. This in turn increases the variance of the OLS estimates. Although, such a low confidence level is not standard for other types of estimation, the nature of the SVAR suggests that smaller confidence intervals may be used.

First it is important to recognize that the monetary policy shock is an unanticipated exogenous change in the interest rate. That means that this shock is different from changes to the interest rate made by the central bank acting on endogenous information about the economy. One way to think about these exogenous shocks is with an example. Suppose, there is an analyst whose job is to forecast what interest rate will be set by the Bank of Canada. By using information on inflation, output, employment, and commodity prices, the analyst could suggest what the average interest rate will be in a given period. The monetary policy shocks are deviations from what the analyst forecasts. Such deviations could arise if the Bank of Canada is using additional information about the macro-economy that the analyst does not use, in fact this is one explanation for some anomalies in the following results.[4]

Figure 6 shows the response of four national economic variables to a 36 basis point increase in the one-month Treasury bill rate by the Bank of Canada. The first thing to notice about figure 6 is that all the variables are moving in the expected direction following the interest rate increase. National employment decreases due to the interest rate increase, reaching a maximum decrease in the growth rate of employment of 0.07%, ten months after the initial shock. After the maximum decrease, national employment begins a modest recovery. National output has a more significant decrease than is seen from employment. Output reaches a maximum decrease in the growth rate of 0.13%, nine months after the monetary shock, and only a month before the maximum response of employment. The response of national CORE inflation is far more muted. We observe that initially inflation is increasing until five months after the shock when it begins to fall. This result is the opposite of what theory predicts as a

[4] The full model also provides some indication that endogenous monetary policy is being modelled correctly. Due to Canada's resources production an increase in commodity prices should act as an aggregate demand shock. When a positive commodity price shock hits the Canadian economy, output and employment both increase, as does inflation. Endogenous interest rates rise in response to this shock in order to ward off inflation. All of these values are moving in the expected direction. See Appendix for the full table of national impulse responses.

positive interest rate shock should decrease inflation. This observation of contradictory inflation is known as the price puzzle and is a common result in the SVAR literature.

One possible explanation for the price puzzle is that the central bank has better information about a coming increase in inflation than the information carried by the variables in this model (Sims, 1992). Although the commodity price index is in the model and represents an important indicator, the Bank of Canada has access to a large number of leading indicators. Furthermore, the complicated nature of ToTEM indicates that multifaceted analysis is being carried out and is not captured by this relatively simple SVAR model. The outcome of a central bank having better information is that they can act to dampen future inflation before it arrives. In the context of an SVAR model, prices will still rise but less than they would have if the central bank had not shocked interest rates (1992).

The explanation that Sims uses for the price puzzle makes sense when inflation has a large increase due to an interest rate shock as observed in his data. The results of this paper show that inflation has an extremely muted increase following a monetary policy shock. It seems that in Canada, inflation expectations have been well anchored to the Bank of Canada's target rate. This means that when a monetary policy shock occurs, the increase in nominal interest rates should move through to real interest rates, unmitigated by changes in inflation. Since changes to the real interest rate are very important in determining output and employment, the results of figure 6 conform to this explanation. Said another way, if inflation is well anchored, monetary policy shocks will have little impact on inflation but should change output and employment.

Given the alternative explanation, these results are what we expect to see from this sample which is characterized by the Bank of Canada commitment to low and stable inflation.

The effectiveness of Bank of Canada policy is made even more evident by the graph of the interest rate response to the interest rate shock. This graph shows that once the Bank of Canada has imposed an interest rate shock, the percent change in rates are then returned to its previous level within 15 months. If the Bank of Canada is not able to use monetary policy to control inflation effectively, we would see interest rates held at high levels long after the initial shock had occurred.

One general observation coming out of these results (Figure 6) is that a given monetary policy shock does not have a large magnitude impact on output and employment. There are two reasons for this, and they serve to further motivate correct identification. Firstly, the one standard deviation shock of 36 basis points is quite small. The Bank of Canada generally moves interest rates in 25 basis point increments and has a minimum of 8 fixed dates to change the rate.

Related to this point is the fact that a central bank would only use the interest rate to control inflation if the social cost was relatively low. Observing that a small increase in the interest rate has only a small effect on output and employment, and controls inflation is evidence of the efficacy of Bank of Canada monetary policy. One other source of information that can be used to show identification of a monetary policy shock is the forecast error variance decomposition (FEVD) of the national model.

Figure 7: Forecast Error Variance Decomposition of the National model

Shock	Forecast (months)	Proportion of FEV for variable				
		Commodity prices	Interest Rate	Inflation	Output	Employment
Commodity price	1	1	0.041	0.001	0.041	0.014
	6	0.946	0.165	0.020	0.165	0.100
	12	0.789	0.184	0.018	0.184	0.154
	24	0.615	0.185	0.029	0.185	0.131
Interest rate	1	0	0.997	0.001	0	0.001
	6	0.001	0.928	0.066	0.011	0.006
	12	0.002	0.753	0.074	0.039	0.030
	24	0.010	0.428	0.082	0.062	0.068
Inflation	1	0	0	0.998	0.001	0.001
	6	0.023	0.002	0.868	0.017	0.009
	12	0.053	0.004	0.753	0.027	0.026
	24	0.090	0.035	0.702	0.026	0.102
Output	1	0	0	0	0.958	0.101
	6	0.001	0.050	0.023	0.778	0.373
	12	0.030	0.175	0.055	0.660	0.504
	24	0.106	0.368	0.056	0.553	0.455
Employment	1	0	0	0	0	0.883
	6	0.030	0.017	0.024	0.030	0.512
	12	0.126	0.066	0.099	0.090	0.287
	24	0.179	0.165	0.131	0.173	0.245

The FEVD (Figure 7) shows the relative amount of variation that a given shock contributes to the variance of an endogenous variable. By using this measure it is possible to infer the relative importance of different shocks in determining the variance of variables used in this model. From figure 7 it is apparent that the interest rate shock is not particularity important in explaining output or national employment. This is consistent with the impulse response functions found in figure 6. Another aspect of the interest rate shock that is worth noting is inflation. While national employment and output variation is not coming from interest rates

shocks to a large degree, inflation variation is relatively more influenced by interest rate shocks, this is consistent with other SVAR literature (Sims, 1980).

Figure 7 is consistent with other papers in the SVAR literature in that inflation and interest rate shocks are the main determinates of interest rate variance. Given the widely held belief that the Bank of Canada has direct control over the one month T-bill rate (Murchison & Rennison, 2006, p.28), the lack of response from other variables to an interest rate shock suggest that a monetary shock has been identified (Sims, 1992).

One final observation to make about the national FEVD table (figure 7) is that commodity price shocks are quite important in determining the variance of national output and employment. In fact, commodity prices are relatively more important than the interest rate. Since the province have different levels of natural resources based industry and given the importance of commodity price shocks, there may be some possible insulation from interest rates for commodity producing provinces.

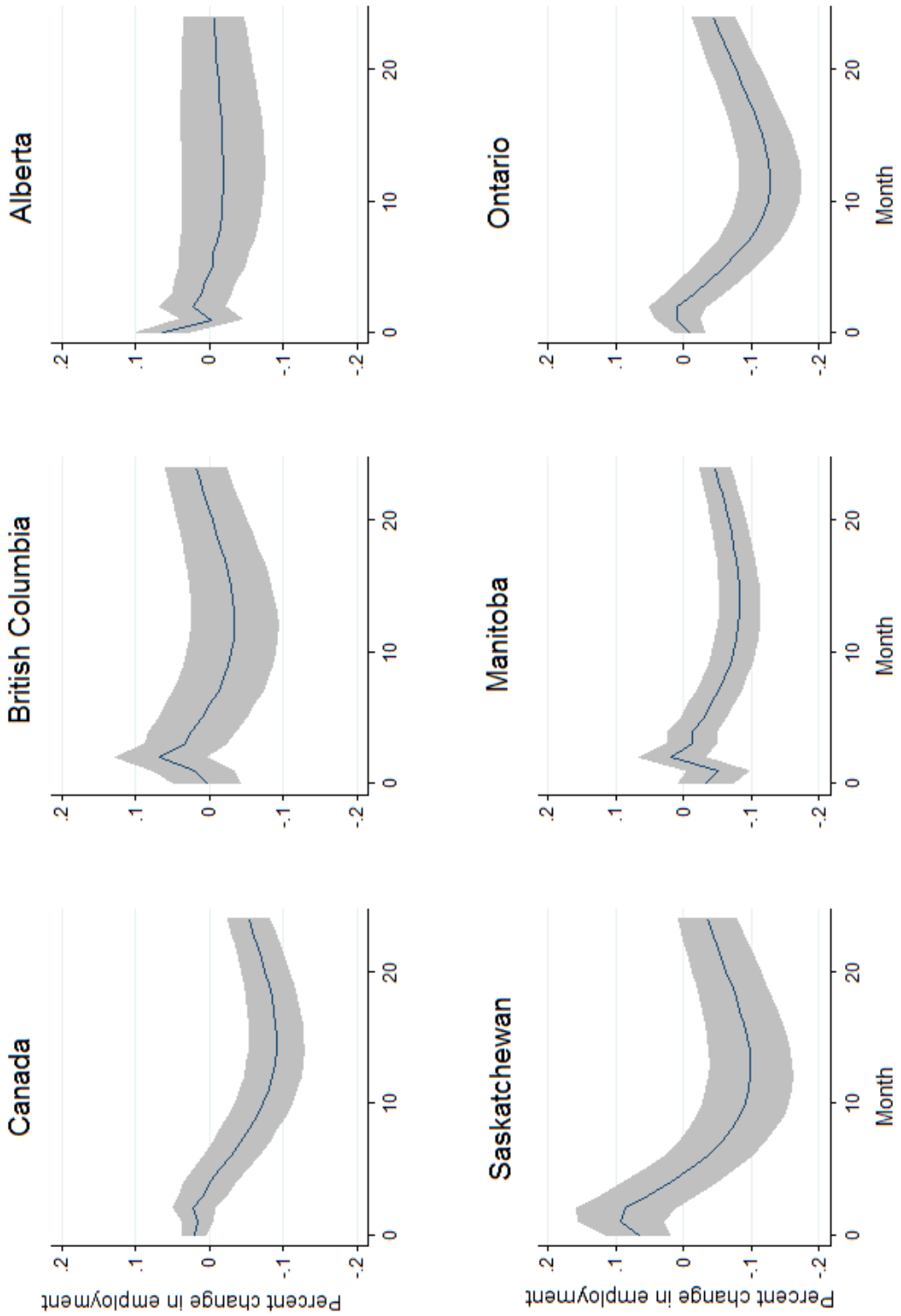


Figure 8: These are the impulse response functions for Canada and the western provinces. Each graph shows the percent change in employment growth following a one standard deviation interest rate shock Standard error bands are calculated at a 66% confidence level.

Figure 8 shows the employment responses of the five western provinces to a one standard deviation increase in the interest rate over 24 months. It is immediately apparent that employment is responding differently across provinces to monetary policy. An example of the varied response is Alberta and British Columbia, the employment growth of either province does not differ significantly from zero after the initial shock. In contrast, Ontario sees Canada's largest decrease in employment growth, a 0.13% decrease at twelve months after the monetary policy intervention. Saskatchewan and Manitoba also show sizable decrease in employment growth as a result of the interest rate change over time. It is also worth comparing the provincial results to the effect of the shock on national employment. While national employment growth decreases by less than 0.1%, with British and Alberta having a negligible response, a response greater than the national average must come from the other provinces.

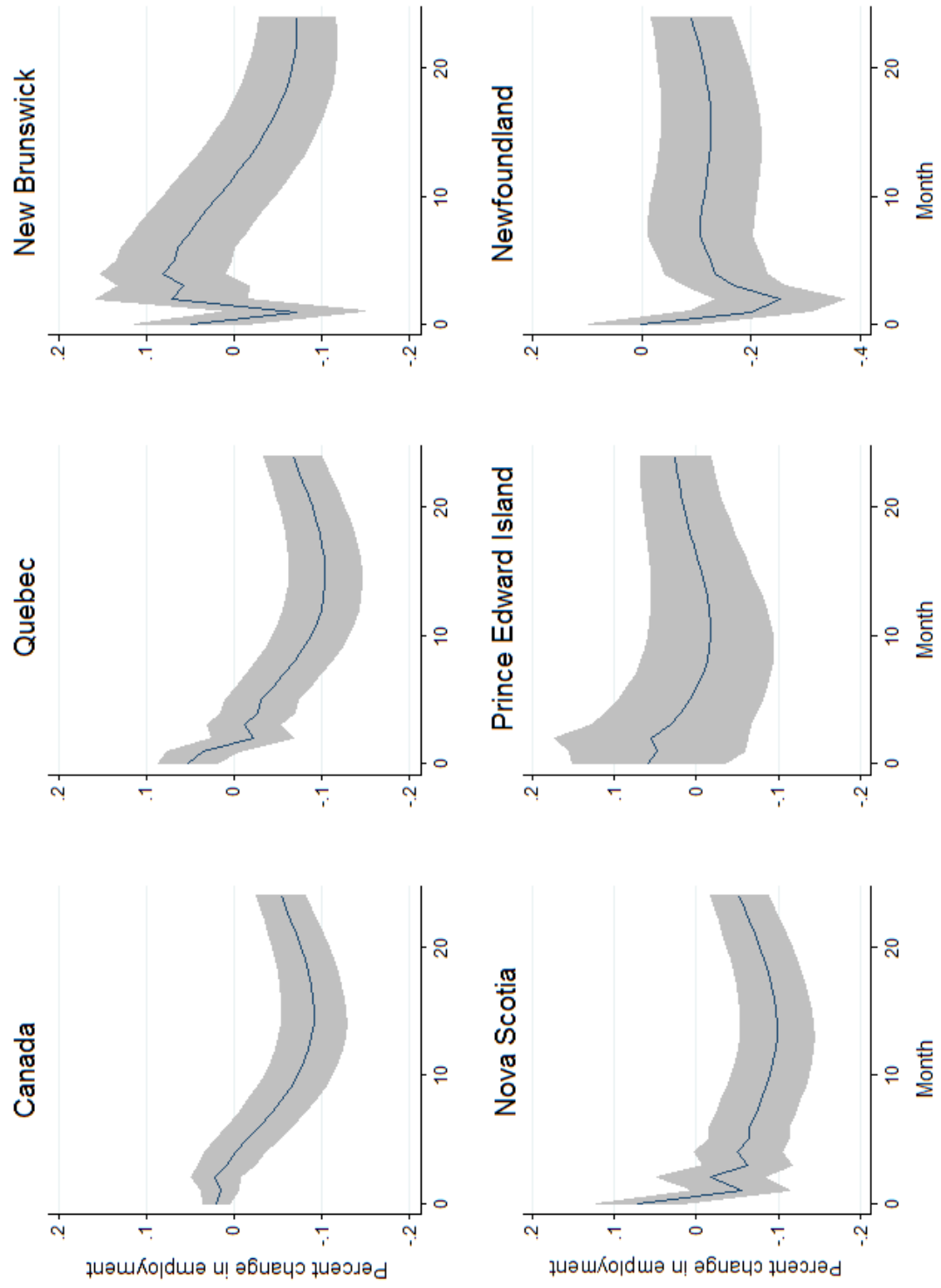


Figure 9: These are the impulse response functions for Canada and the eastern provinces. Each graph shows the percent change in employment growth following a one standard deviation interest rate shock. Standard error bands are calculated at a 66% confidence level.

Figure 9 shows the employment response of the remaining five eastern provinces. Again there are sizable differences in the employment responses of these provinces. Quebec sees a -0.1% change in employment 15 months after the monetary policy shock where as Prince Edward Island's response is not significantly different from zero. Nova Scotia has an average response to Bank of Canada policy with a decrease in employment of -0.1%. The second largest response of any of the provinces belongs to Newfoundland where employment decreases by 0.13%. New Brunswick displays a response that is inconsistent with the fundamental expectation of macroeconomics. An increase in the rate of interest actually increases employment growth for twelve months before employment begins to decrease. The same pattern is evident, though to a lesser extent, in Saskatchewan. It is somewhat reassuring in both cases that the change in employment does go below zero at twelve months for New Brunswick and only five months after for Saskatchewan.

Figure 10: Provincial employment responses to an interest rate shock

Provinces	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario
Maximum response	-0.03	-0.02	-0.10	-0.08	-0.13
Max month	12	12	13	14	12

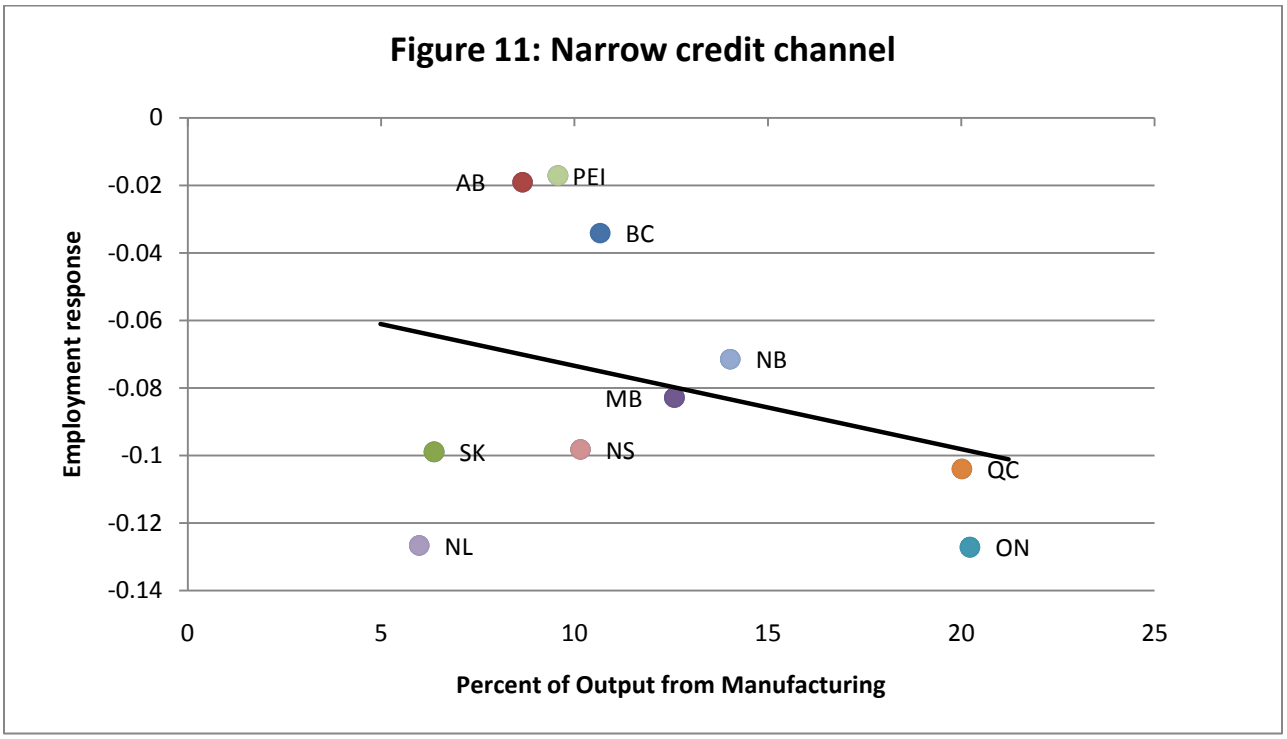
Provinces	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland
Maximum response	-0.10	-0.07	-0.10	-0.02	-0.13
Max month	15	24	14	10	15

The maximum employment responses to the interest rate shock are tabulated in figure 10. Here a general pattern emerges which shows that the maximum employment response of each province occurs 12-15 months after the monetary shock. This result is consistent with the widely held belief that there is a lag in the effect of monetary policy, and the national and provincial

results bear this out. Again the time of maximum employment response shows that New Brunswick is an outlier at twenty-four months to maximum response.

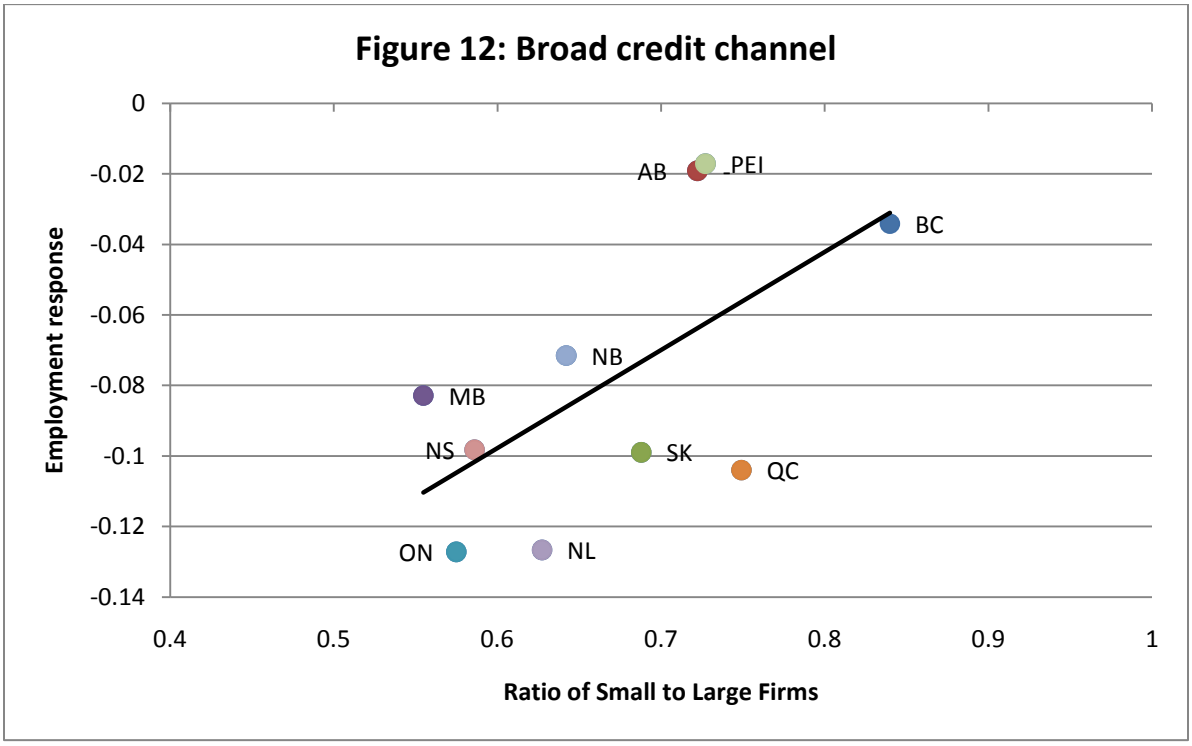
The tabulated maximum responses show that major decrease in employment come from the central provinces of Ontario and Quebec. Newfoundland has the second largest provincial response while the decrease of employment in Nova Scotia, Saskatchewan, and Manitoba are somewhat milder. The employment response in British Columbia, Alberta, and P.E.I. is muted and not significantly different from zero. This leads to the conclusion that there are indeed differential effects of a given interest rate change across provinces.

Given the maximum decreases in provincial employment as a result of the interest rate shock (tabulated in Figure 10, it is possible to explore the predictive value of the broad and narrow credit channels.



The narrow credit channel predicts that provinces with a large portion of their output coming from manufacturing will be more sensitive to changes in the interest rate. Figure 11 shows a

trend line with a negative slope which is consistent with the narrow credit channel theory. Provinces with a manufacturing intensive economy tend to also be sensitive to interest rate changes. Recognising that we only have 10 observations, this scatter plot shows that this relationship is quite loose, with Newfoundland and Saskatchewan having a large response but little manufacturing output.[5]



The narrow credit channel theory predicts that provinces with a large portion of small firms will be the most sensitive to a change in the interest rates. Figure 12 suggests that the broad credit channel does not predict provincial interest rate sensitivity. This means that provinces with small firms do not tend to be more sensitive to interest rate changes than provinces with large

[5] Since the narrow credit channel can predict the relative interest rate sensitivity of provinces, future work should try to find out whether it is capital intensity or interest rate sensitive demand that is behind this relationship. With only ten observations this was not feasible in this paper.

firms. These results are consistent with Owyang and Wall (2006) who found that only the narrow credit channel was relevant in explaining interest rate sensitivity in the low inflation Volker-Greenspan years. Furthermore, they suggested that the bank lending channel was not important in determining interest rate sensitivity[6]. The bank lending channel cannot be active in Canada either, because banking regulations are the same across provinces and there are no formal reserve requirements. This means that bank balance sheets are not constrained differently across provinces.

Commodity price shocks

The specification of the provincial SVAR equations allows for across province comparison of employment sensitivity to commodity shocks. The Bank of Canada is forward-looking in setting interest rates. Although the Bank of Canada is only mandated to target CORE inflation[7] , commodity prices are an important component of the leading indicator index used to forecast economic activity. The results of this paper suggest that commodity price shocks are quite important to the real economy. The employment effect of a positive one standard deviation commodity price shock is, in many provinces, much larger than an equivalent monetary policy shock. And a persistent change in commodity prices may feed into inflation. For example, a rise in the price of oil will put upward pressure on prices in provinces that are major producers of oil.

[6] Recall that the bank lending channel predicts that regions with a high portion of small banks will be sensitive to interest rate changes. This monetary transmission mechanism could be expected to generate regional differences if banks are constrained differently across regions. An example of this would be some states having different reserve requirements in the United States.

[7] CORE inflation is the CPI less commodity prices

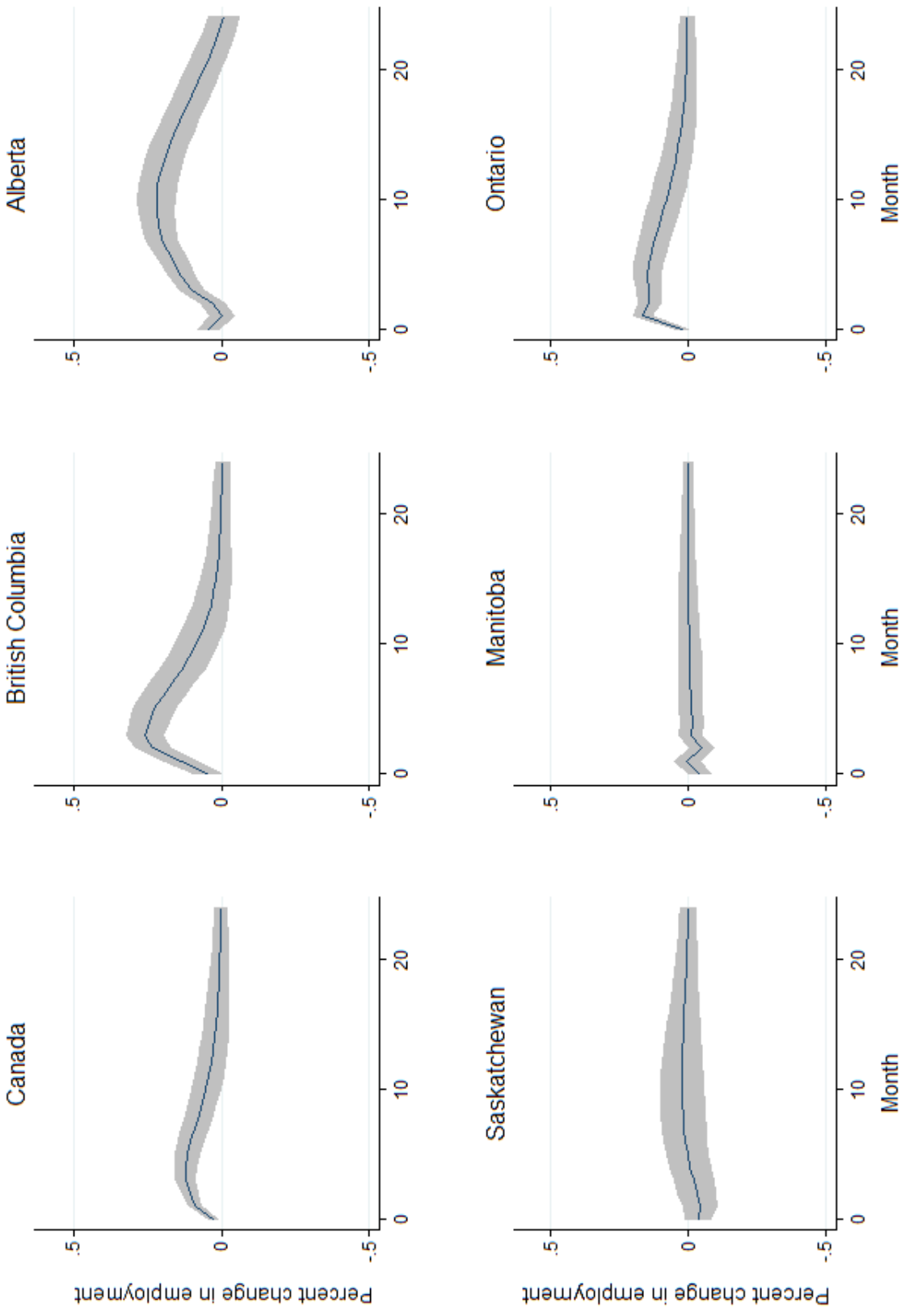


Figure 13: Canada and the western provinces' employment response to a positive one standard deviation commodity price shock.

Figure 14: Canada and the eastern provinces' employment response to a positive one standard deviation commodity price shock.

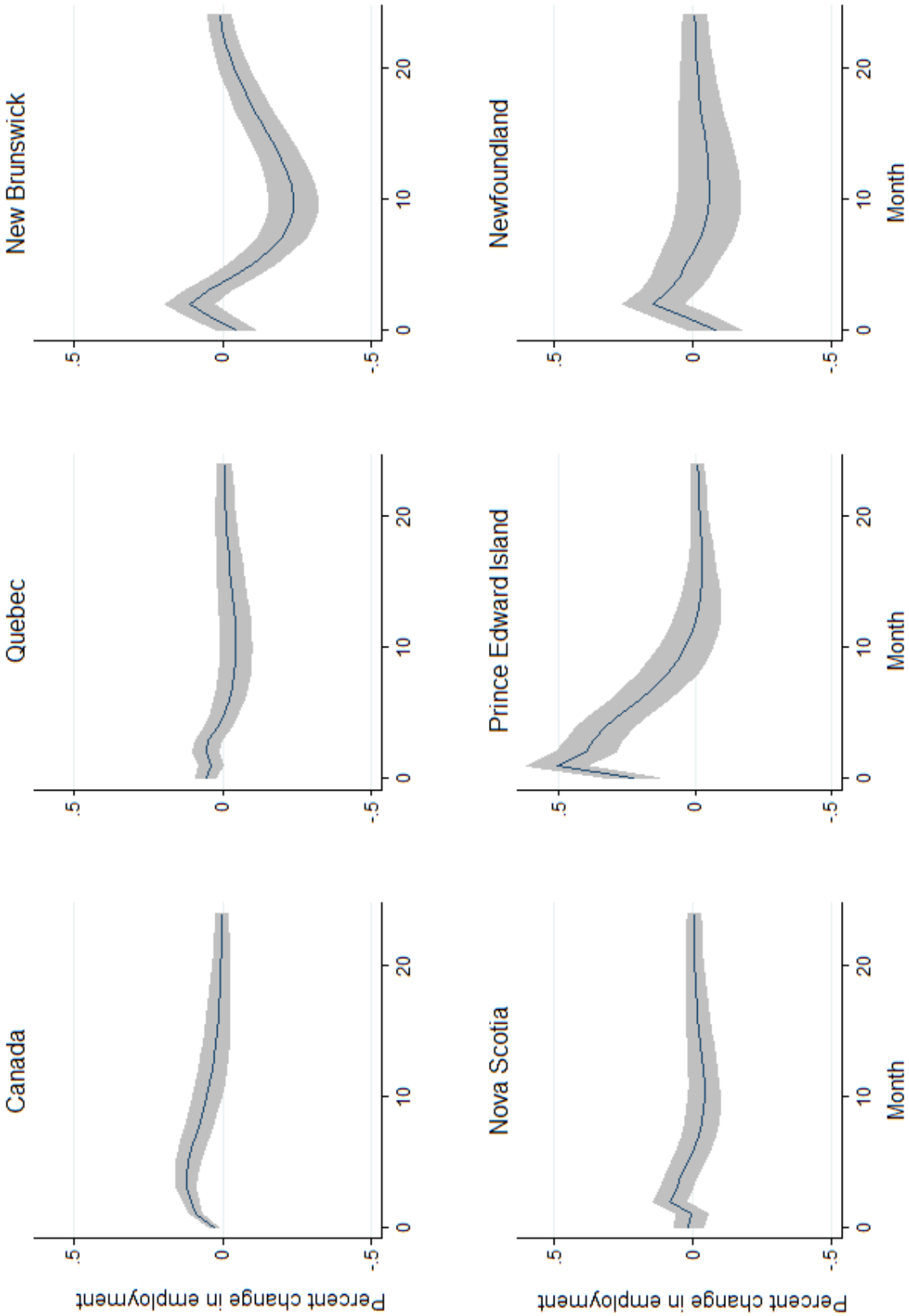


Figure (13 & 14) show the impulse response function of various provincial employment

reactions to a commodity price shock. Canada sees a modest national increase in employment as a result of an increase in commodity prices. This is consistent with the relatively high resource production of Canada. The same approximate response occurs in Ontario, however it should be noted that these modest responses approach the magnitude of the largest magnitude responses that resulted from the monetary policy shock. The commodity price shock is similar to the monetary policy shock in its differential provincial impacts. While Canada as a whole and Ontario, have modest employment responses the following provinces have employment insensitive to commodity price changes: Quebec, Saskatchewan, New Brunswick, Nova Scotia, and Newfoundland. In contrast, British Columbia and P.E.I both see a large magnitude, if short lived, employment increase as a result of the rise in commodity prices. Alberta also sees a large increase which is more sustained and is consistent with the provinces heavy resource production. Finally, New Brunswick is peculiar, as it was in the interest rate shock, in that a commodity price increase serves to decrease employment substantially which is not characteristic of any other province. These results suggest that commodity price shocks have a major affect on provincial employments and that these affects are not homogeneous. Because commodity prices are used as a leading indicator and source of information in Bank of Canada decisions, provincial differences should be considered. For example, since an increase in commodity prices have a stimulatory effect on the nation, the Bank of Canada may need to increase interest rates to ward off inflation. However, in many provinces the commodity price increase has no significant effect. By raising interest rates some of the commodity price insensitive provinces will see large decrease in employment due to monetary policy.

V. Robustness

One aspect of the provincial model specification that may be problematic is the use of national and provincial employment in a single specification. For instance, Newfoundland employment in a model that has national employment which includes Newfoundland employment. Since Newfoundland employment is a part of the national employment, the two variables have some multicollinearity. For most provinces this issue is not particularly troubling because small provinces make up a small portion of national employment. For large provinces such as Ontario and Quebec, this multicollinearity is more important. One possible solution would be to remove the provincial component from national employment in each specification. For example, in estimating the SVAR for Newfoundland, the national employment variable would have had Newfoundland employment subtracted from it. The problem with this approach is that the shocks that come out of each provincial speciation would differ considerably. In fact even in the model used in this paper the shocks do not have identical magnitudes across provinces because of different provincial employment variables used in each. Ideally, this paper would utilize block exogeniety in order to have uniform shocks and a separation of national and provincial employment. Unfortunately, this technique was not feasible. Since block exogeniety could not be used, this paper simply leaves the provincial component in the national employment variable. This specification format keeps the shocks as uniform as possible which allows comparison across provinces. If this paper examined only one province then the national employment variable would have been appropriately modified but the comparative goal of this paper suggests the approach used.

Figure 15: Normality of the disturbance terms

		Jarque-Bera test		Skewness test		
Variables	df	$\chi2$ value	Prob>$\chi2$	Skewness	$\chi2$ value	Prob> $\chi2$
Commodity prices	2	18.763	0.00008	0.14228	0.82	0.36523
Interest rate	2	4836.756	0	2.6651	287.66	0
Inflation	2	12.975	0.00152	0.21259	1.83	0.17609
Output	2	2.863	0.23899	0.13819	0.773	0.37916
Employment	2	0.58	0.74838	-0.06842	0.19	0.66324
Joint test	10	4871.936	0		291.273	0

Variables	df	Kurtosis	$\chi2$ value	Prob> $\chi2$
Commodity prices	2	4.3312	17.943	0.00002
Interest rate	2	24.197	4549.096	0
Inflation	2	4.0491	11.145	0.00084
Output	2	3.4543	2.089	0.14834
Employment	2	2.8037	0.39	0.53225
Joint test	10		4580.663	0

The Jarque-Bera test was used to evaluate the disturbance terms of the national model. Figure 15 shows that only national output and employment fail to reject the null hypothesis of normally distributed disturbances. This test is not constructive in that it does not suggest possible remedies for the non-normal distribution of the commodity price, interest rate, and inflation shocks (Vogelvang, p.115). The test results also show both skewness and kurtosis tests. The skewness test shows that only the interest rate shock is skewed significantly from a normal distribution. The table of the kurtosis test suggests that inflation and commodity shocks are being rejected by the Jarque-Bera test due to kurtosis rather than skewness. The consequence of this robustness test is that the one standard deviation shock size used for the interest rate and commodity price shock is not normal. This means that of 'n' number of shocks we cannot say that 66% of them will be within one standard deviation. Furthermore, this result means that the

inference testing becomes somewhat problematic. Given that the SVAR is lightly restricted, lag variables are not being thrown out on the basis of inference testing. What will be affected are the confidence interval bands that are calculated in the impulse response graphs.

Figure 16: Lag length selection

Lag length	Log likelihood	Likelihood ratio	df	p-value	FPE	AIC	HQIC	SBIC
0	-2242.48				80.6998	18.5801	18.667	18.7957
1	-1060.22	2364.5	25	0	0.005893	9.05528	9.28688	**9.63027***
2	-1009.33	101.76	25	0	**.004764***	8.84226	**9.21861***	9.77662
3	-991.661	35.347	25	0.082	0.005065	8.90256	9.42366	10.1963
4	-972.839	37.644	25	0.05	0.005337	8.95341	9.61926	10.6065
5	-950.604	44.47	25	0.01	0.005472	8.97616	9.78677	10.9886
6	-934.264	32.68	25	0.139	0.005896	9.04744	10.0028	11.4193
7	-917.754	33.02	25	0.131	0.006351	9.11732	10.2174	11.8485
8	-892.049	51.41	25	0.001	0.006352	9.11151	10.3564	12.2021
9	-870.849	42.401	25	0.016	0.006603	9.14279	10.5324	12.5927
10	-855.832	30.034	25	0.223	0.007235	9.22495	10.7593	13.0343
11	-845.053	21.557	25	0.661	0.008226	9.342	11.0211	13.5107
12	-814.668	60.771	25	0	0.007977	9.29768	11.1215	13.8257
13	-731.605	166.13	25	0	0.005027	**8.8198***	10.7884	13.7072
14	-707.663	**47.885***	25	0.004	0.005168	8.8285	10.9419	14.0753
15	-689.444	36.438	25	0.065	0.005586	8.88431	11.1424	14.4905

An important aspect of SVAR model specification is choosing an appropriate lag length. Figure 16 shows the results of five different post-estimation lag length tests on the national model. The first test is the Likelihood Ratio test (LR). For each lag length p, the LR test compares the computed value of a model of lag length p with a regression using p-1 lags. Minimum value resulting from this test suggests that 14 lag terms should be included in the model.

The next test employed is the Final Prediction Error test (FPE). This test examines which lag length minimizes the predicted error while weighting different models by their degrees of freedom. The results of this test suggest that a lag length of 3 should be used (Stata, 2011).

The final three tests are the Akaike, Hannan-Quinn, and Schwarz/Bayesian information criterions. Generally, these tests evaluate the models of different lag lengths for their goodness – of-fit while penalizing over-parameterized models. The optimal model is the one with a lag length minimizing the value of these information criterions. The Akaike information criterion (AIC) suggests that 13 lag terms should be included. One concern with this recommendation is that AIC is only asymptotically valid and in a relatively small sample, such as in this model, will tend to overestimate the optimal number of lag terms. Consistent estimates of the lag order come from the Hannan-Quinn and Swarz information criterions which recommend 2 and 1 lag terms respectively (Mathworks, 2011).

Given the results of these tests a lag length of 3 was chosen. Since the results of the tests were split between having approximately one year or a one quarter lag length, the shorter lag was chosen for its greater computational efficiency.

VI. Implications

The results of this paper consider how the Canadian macroeconomy responds to shocks and the mechanism that transmits shocks differentially across region. From these results three policy implications arise. There is the suggestion that transfer payments are important in addressing provincial disparity under low labour mobility. And optimal monetary policy should include regional data and target a higher inflation rate.

The first policy implication that comes from finding that a monetary policy shock has a different effect across provinces and the observation that Canadian labour mobility is low relative to the United States (Obstfeld & Peri, 1998). In a frictionless labour market, a province with employment growth hurt by an interest rate shock should see an exodus of workers to an interest rate insensitive province. Since labour is not entirely mobile there are barriers to lessening the differences across provinces. Furthermore, this papers finding that the narrow credit channel is important in Canada suggests that difference in provincial interest rate sensitivity comes partly from a specific industry; manufacturing. Given that workers cannot costlessly switch industries it is necessary to redistribute across provinces. By using transfer payments the federal government can offset some of the welfare losses that accrue to interest rate sensitive regions following monetary policy shocks.

Another policy implication that comes out of the empirical findings of this paper is that optimal monetary policy may be augmented with regional information. This paper's finding that there are large differences in employment response to monetary policy shocks, suggests that it is possible that social loss could be avoided by using a Taylor-rule weighted by regional employment sensitivity. This recommendation is consistent with the dynamic stochastic general equilibrium model of Benigno (2003). It should be acknowledged that monetary policy conducted by a central bank is necessarily national. Said another way, setting short term interest rates and other monetary policy instruments affect an entire monetary policy union even though the outcomes may be differential. Using a provincially weighted monetary policy rule benefits the decision making process of a central bank and does not require that monetary policy is carried out in a novel way. Consider an example where three Canadian province s are generating sufficiently high inflation that the Bank of Canada, after looking at a national forecast, increases

interest rates. Given the lags in monetary policy shown by this paper of 12-15 months, the Bank of Canada might do better to use the provincial information to make province specific forecasts. If each of the three provinces, with overheated economies, is headed towards a recession, perhaps as the result of a decline in commodity prices, the Bank of Canada may do best to avoid intervention entirely.

The final policy implication that comes out of this paper's results is that the Bank of Canada should consider a higher inflation target. The provincial differences in response to an interest rate shock suggest that some provinces bear a greater burden in maintain low nation inflation. These costs are greater if the aggregate supply (AS) curve is non-linear so that as inflation gets close to zero, increasingly large reductions in output and employment are required to decrease inflation any further. Another reason that a higher inflation target may be beneficial is that a central bank using provincial information in its Taylor-rule needs more flexibility when making monetary policy decisions. If the Bank of Canada sees that the economy of one or two overheated provinces will soften then the bank should refrain from acting even if inflation increases a modest amount. Even without a provincially weighted Taylor-rule or a non-linear AS curve it may still be worthwhile to raise the inflation target. If inflation is being driven by provinces that are largely insensitive to the interest rate and inflation is high enough to warrant a large increase in interest rates then some interest rate sensitive provinces may be pushed into deflation. Since deflation causes severe decrease in output and employment and may lead to a reinforcing loop of provincial recessions, a higher inflation target is preferable since the marginal cost of additional inflation is so low (Krugman, 2000).

Conclusion

The results of this paper address two related areas. Firstly, the results of the SVAR model provide some information about how provinces respond to exogenous monetary policy shocks. The maximum response of provincial employment to a one standard deviation increase in the rate of interest varies widely across provinces. Although the magnitude is different, the maximum effects occur about a year after the shock is imposed. This result suggests that the provinces differ in their employment sensitivity to interest rate shocks. A similar story can be told about commodity price shocks. The Canadian economy sees an increase in the growth of employment due to a positive increase in commodity prices. However, the national increase is not shared equally between provinces, with some seeing large spikes in employment growth while other provinces are commodity price insensitive.

The other contribution of this paper is in the area of monetary transmission in Canada. By using data on relative firm size and manufacturing across provinces, the predictive power of the broad and narrow credit channel could be assessed. The resulting scatter plots showed that only the narrow credit channel was an accurate predictor for this sample. Said another way, the manufacturing intensity of a provinces economy suggests how sensitive it will be to an interest rate shock. In contrast, the broad credit channel theory, which is associated with firm size, does not fit the observation from this sample. Finding that the narrow credit channel but not the broad credit channel is working in Canada is consistent with similar work done in the United States by Owyang and Wall (2006).

Further research in this area should use data on demand sensitivity and capital intensity in order to understand why the manufacturing sector is particularly sensitive to the interest rate. This type of analysis would require provincial interest rate sensitivities to be calculated over

several periods. Another area to explore would be whether the differential interest rate sensitivities observed in this paper are stable over time. These two areas of further research are well motivated by the desire to better understand the transmission of monetary policy.

Appendix

National model impulse responses

Shock	Month	Commodity prices	Interest Rate	Inflation	Output	Employment
Commodity prices	0	6.092	0.019	0.009	0.063	0.026
	6	4.849	0.045	0.012	0.212	0.103
	12	0.778	0.031	0.009	0.073	0.034
	24	-0.078	0.018	0.002	-0.006	0.001
Interest rate	0	0.000	0.366	0.005	-0.014	0.020
	6	0.259	0.259	0.028	-0.125	-0.029
	12	0.172	0.111	0.024	-0.176	-0.085
	24	0.234	-0.019	0.013	-0.065	-0.054
Inflation	0	0.000	0.000	0.211	-0.010	0.018
	6	-1.466	-0.026	0.076	-0.093	0.024
	12	-0.984	-0.027	0.034	-0.099	0.012
	24	-0.434	-0.042	0.009	-0.062	-0.012
Output	0	0.000	0.000	0.000	0.454	0.095
	6	2.019	0.129	-0.016	0.368	0.222
	12	0.302	0.142	-0.010	0.126	0.111
	24	-0.225	0.045	0.002	-0.068	-0.025
Employment	0	0.000	0.000	0.000	0.000	0.230
	6	-0.053	-0.007	0.013	-0.055	0.103
	12	-1.095	-0.044	0.010	-0.130	-0.003
	24	-0.371	-0.057	0.004	-0.051	-0.018

References

Adanu, K. (2005). A cross-province comparison of Okun's coefficient for Canada, *Applied Economics*, 37(5), 561-570.

Akerlof, G., Dickens, W., & Perry, G. (1996). The macroeconomics of low inflation. *Brookings Papers on Economic Activity, 1996*(1), 1-76.

Angelini, P., Giovane, P., Siviero, S., & Terlizzese, D. (2008). Monetary policy in a monetary union: What role for regional information?. *International Journal of Central Banking, 1-28.*

Beare, J. (1976). A Monetarist model of regional business cycles. *Journal of Regional Science*, 16(1), 57-64

Benigno, G. (2004). Real exchange rate persistence and monetary policy rules. *Journal of Monetary Economics*, 51, 473-502.

Bernanke, B., & Blinder, A. (1992). The federal funds rate and the channels of monetary transmission. *The American Economic Review*, 82(4), 901-921.

Bernanke, B. & Gertler, M. (1995). Inside the black box: The credit channel of monetary transmission. *Journal of Economic Perspectives*, 9(4), 27-48.

Carlino, G., & Defina, R. (1998). The differential regional effects of monetary policy. *The Review of Economics and Statistics*, 80(4), 572-587.

Carlino, G., & Defina, R. (1999). Do states respond differently to changes in monetary policy. *Business review*, 2, 17-27.

Chang, H. & Garrison, C. (1979). The effect of monetary and fiscal policies on regional business cycles. *International Regional Science Review*, 4(2), 167-180.

Fortin, P. (1996). The great Canadian slump. *The Canadian Journal of Economics*, 29(4), 761-787

Gertler, M. & Gilchrist, S. (1991). Monetary policy, business cycles and the begavior of small manufacturing firms. *The Quarterly Journal of Economics*, 109(2), 309-340.

Kashyap, A., & Stein, J. (1994). Monetary policy and bank lending. In N. Mankiw (Ed.), *Monetary Policy* (pp. 221-261). Chicago: the University of Chicago Press.

Krugman, P. (2000). Thinking about the liquidity trap. *Journal of the Japanese and International Economies*, 17, 221-237.

Krugman, P. (2011, November 1). European inflation targets. *The New York Times*

Mathur, V. & Stein, S. (1980). The regional impact of monetary and fiscal policy: An investigation into the reduced form approach. *Journal of Regional Science*, 20(3).

Mathworks (2010). Matlab manual. 7(12). http://www.mathworks.com/help/toolbox/ident/ug/bq5z7kv.html

Martin, R. (2001). *EMU versus the regions? Regional convergence and divergence in the Euroland*. Journal of Economic Geography, 1, 51-80

Mishkin, F. & Serletis, A. 2011. *The Economics of money, banking, and financial markets* (4ed). Toronto, ON: Pearson Canada.

Murchison, S., & Rennison, A. Bank of Canada, (2006). *ToTEM: The bank of Canada's new quarterly projection model*. Ottawa

Owyang, M. & Wall, T. (2006). Regional SVARs and the channels of monetary policy. *Federal Reserve Bank of St. Louis*. January, 2006.

Sims, C. (1980). Macroeconomics and reality. *Econometrica*, 48(1), 1-48

Sims, C. (1992). Interpreting the macroeconomic time series facts. *European Economic Review*, 36, 975-1011.

Stata quick reference and index, (12) 2011, Stata Press: College Station, TX

Vogelvang, B. (2005). *Econometrics: Theory and applications*. Harrow, England: Prentice Hall