How do different provinces and industries in Canada respond to commodity price shocks?

by

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Abstract

As a resource-endowed small open economy, Canada is susceptible to exogenous commodity price shocks. Given that the country's resources are dispersed unevenly amongst its provinces, we can expect heterogeneities in responses to any given commodity price shock at both the provincial and sectoral levels.

This study uses local projections to quantify the impact of such a shock. The model presented can accomodate a shock to any exogenous monthly commodity price, and is designed using those in the Bank of Canada's Commodity Price Index (BCPI). While the framework is flexible to a host of different commodity price shocks, in this study I choose to focus on results stemming from a shock to energy prices.

A positive shock to energy prices creates heterogeneous responses to employment in various provinces and industries. Some provincial industries — such as Alberta's oil and gas sector — see increases, while others — such as Québec's manufacturing sector — see lower levels of employment as a result of the shock. Canada's employment levels as a whole are lower as a result of the shock. As a net exporter of oil, this is an interesting yet counterintuitive result. Real wages, on the other hand, are higher all across the country as a result of the shock.

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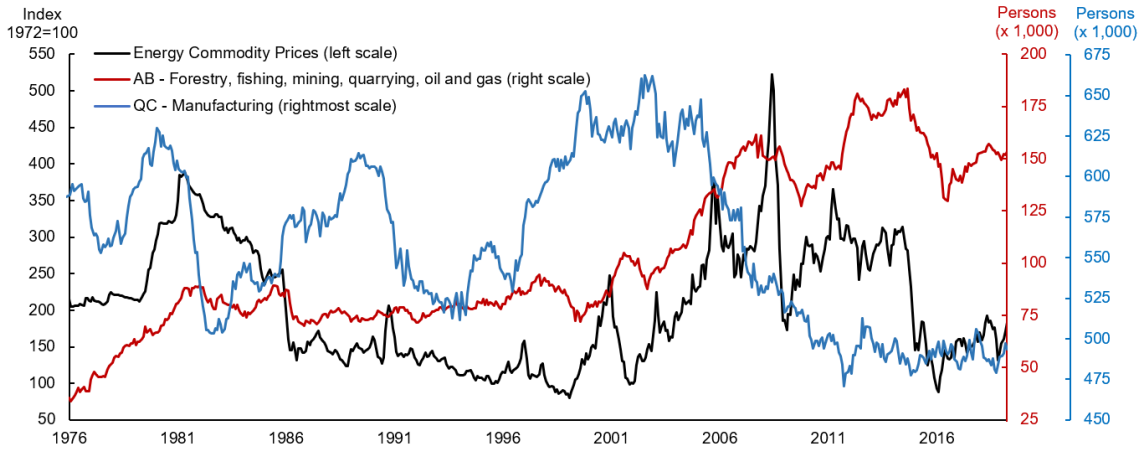
1 Introduction

Canada is a resource-endowed small open economy, making it particularly susceptible to exogenous commodity price shocks. As an oil-exporter, higher oil prices are widely considered to be unambiguously positive for Canada. However, the country is divided up into distinct provinces and territories (provinces henceforth for simplicity), across which natural resources are dispersed heterogeneously. Therefore, it is reasonable to expect that any two provinces — and the industries within those provinces — may respond differently to a given commodity price shock.

Chart 1 below illustrates this point. As we can see, in Alberta it seems that oil and gas employment (red line) broadly tracks the price index for energy commodities (black line). Meanwhile in Québec, where exporting to the United States is prominent, manufacturing employment (blue line) appears to move countercyclically with energy prices.

Chart 1: Alberta Oil/Gas Employment, Québec Manufacturing Employment and Energy Prices

Employment and Commodity Price Index, seasonally adjusted, monthly, Jan 1976 to present



Sources: Employment - Labour Force Survey; Commodity Price Index - Bank of Canada

Last observation: April 2019

There is a significant amount of research (see Sachs and Warner [2001], among others) which suggests that resource endowment is, counterintuitively, not always a net positive for the endowed country. For example, when oil prices are high the Canadian oil and gas sector will be booming. However, the manufacturing sector is now faced with higher input costs, and likely an appreciated national currency which could dampen exports. This concept is often referred to as the *Resource curse* and/or *Dutch disease*. Moreover, labour could reallocate from the manufacturing sector — often seen as a driver of long-term sustainable growth — in favour of the booming resource sector. The effect on real wages, therefore, will be a key indicator of the net impact of the commodity price shock. For example, if the labour mobility effect outweighs the Dutch disease effect, then real wages in both sectors could rise.

Empirical work looking at resource-endowed (and likewise, non-endowed) countries has proven challenging, largely due to differences between countries that are unrelated to the resource boom in question. These include differences in institutions, political structures, and monetary policies. Canada, on the other hand, has a number of diverse provinces that can be thought of as small oil-importing and oil-exporting "countries". These small "countries" would then all share similar institutions, political structures, monetary policies, and even a common currency. These characteristics make Canada an ideal testing ground for resource-curse effects, as nearly all issues that have plagued previous studies are controlled for organically.

This study uses local projections in order to construct impulse response functions for variables of interest as an alternative to the popular Vector Autoregression (VAR) method. VARs estimate a global approximation to the data generation process (DGP) by producing

optimal one-period ahead forecasts. Therefore estimates for $t+1$ are often reasonable, even if the model is misspecified. However at increasingly distant foreast horizons, these errors compound upon one another since forecasts for $t+1$ are used to predict values at $t+2$ and so forth. Local projections, on the other hand, are a collection of regressions specific (or "local") to each forecast horizon. Early forecast values are not included in the forecasts for increasingly distant horizons, and therefore errors do not compound upon one another. For this reason, Jordà (2005) claims that local projections are significantly more robust to misspecification of the DGP than their VAR counterparts.

Due to its relatively small size on the global scale, Canada is a price-taker on the world commodities market. Thus, commodity prices are generally exogenous to Canada. Yet, shocks to these prices can have profound impacts on the Canadian economy that can vary across both *provinces* and *industries*. This study will provide a framework to understand the effects of such shocks on *employment* and *wages* by using local projections and the impulse response functions that they produce.

Results show that for a positive shock to energy prices, total employment falls in Canada at nearly all forecast horizons. However, national real wages are higher as a result of the shock. There are distinct heterogeneities in employment responses across provinces and industries. For example, Alberta's oil and gas sector sees higher employment at all horizons, while Québec's manufacturing employment is lower at all horizons as a result of the shock. After five years, the shock results in higher real wages in almost every province-industry combination. This striking result for real wages suggests that, in the long run, the labour mobility effect appears to outweigh the Dutch disease effect.

2 Supply and Demand for Labour

Many of these effects can be thought of in a simple supply and demand framework for labour. Charts 2 and 3 show starting equilibria for both the oil-*exporting* Alberta and the oil-*importing* Nova Scotia.

Chart 2: Labour Supply, Demand - Alberta
Original equilibrium

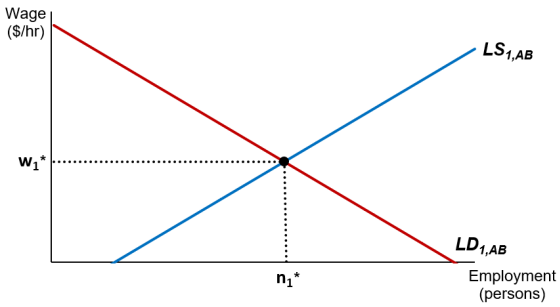
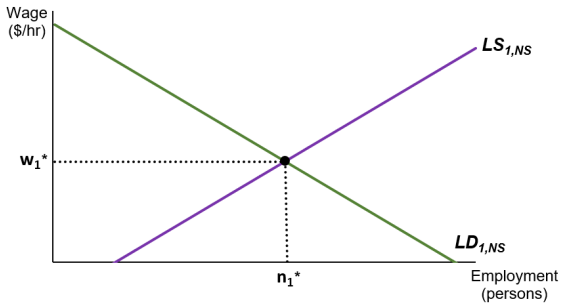
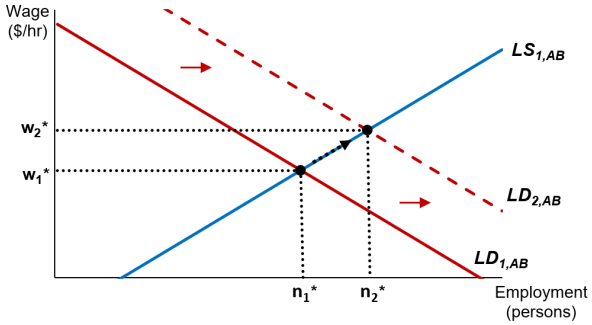


Chart 3: Labour Supply, Demand - Nova Scotia
Original equilibrium



When there is a positive oil price shock, firms who produce oil seek to expand production while their profit margins are elevated. Therefore we would expect labour demand in Alberta to shift outward, raising both wages and employment in the region as shown in Chart 4.

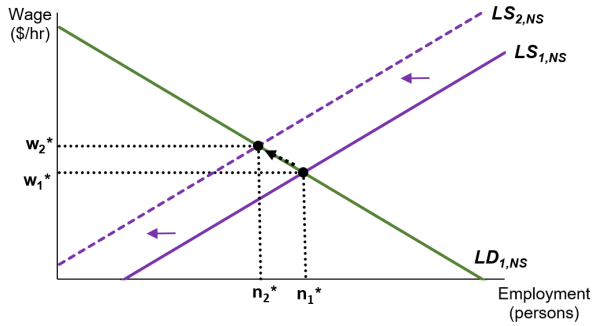
Chart 4: Labour Supply, Demand - Alberta
Following a positive oil price shock



The effect on an oil-importing province such as Nova Scotia involves a few moving parts. First, from a labour *supply* perspective, some of the labour force will observe the increased wages and job vacancies in Alberta and deem it worth their while to relocate. This causes

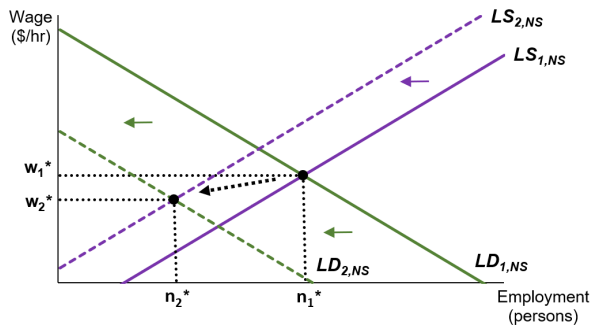
labour supply to shift inward, lowering employment and raising wages as shown in Chart 5a.

Chart 5a: Labour Supply, Demand - Nova Scotia
Following a positive oil price shock



Second is the effect from changes to labour *demand*. Firms in the oil-importing province have now seen their input costs rise in the wake of higher oil prices. In addtion to this, a positive oil price shock often causes the value of the Canadian dollar to rise, given that the country is an oil exporter. Naturally, this makes all of the country's exports more expensive to foreigners than they were prior to the shock. So, an oil-importing province faces higher input costs and less competitive exports. This concept is referred to as the *Dutch disease*, and is discussed in Section 3. If this effect is strong enough, labour demand could decrease to the point of something resembling Chart 5b, in which both employment *and* wages have decreased.

Chart 5b: Labour Supply, Demand - Nova Scotia
Following a positive oil price shock



However, under a smaller Dutch disease effect, the inward shift of the LD curve could

be less than in Chart 5b, leaving wages above their original equilibrium level. Basic theory would suggest that the LS and LD curves shifting should *both* result in a decrease in employment for the oil-importing province, however the two shifts would have *opposing* effects on wages. Therefore whether the impact on wages is positive or negative will largely depend on the size of the LS and LD shifts relative to one another, and will be a focus of the analysis.

Of course, this transmission doesn't happen overnight. It will therefore be important to look at multiple forecast horizons, taking into account the fact that regressors may require several lags in order to fully capture the effects from a shock.

3 Literature Review

3.1 Dutch Disease

Sachs and Warner (2001) empirically demonstrate what they refer to as the "Resource Curse", showing that resource-abundant countries see lower economic growth on average over time. They describe the adverse effects of a positive oil price shock on an oil-exporting country through two channels:

a) *Direct costs:* Oil-exporting countries tend to be high-price economies. As a result, these countries could potentially lose out on export growth.

b) *Crowding out:* A booming resource sector crowds out *industry x* which would otherwise drive long-term growth. The first suggested sector is manufacturing, which would be crowded out by labour reallocation and higher input costs. Other suggested sectors

are education and entrepreneurship, as people seek short-run profits by investing in — or devoting their labour to — the resource sector, instead of investing in other forms of longer-term, productivity-enhancing growth.

The model used is a simple OLS model, where economic growth is regressed on natural resource abundance, while controlling for variables such as rule of law, change in terms of trade, and past economic growth in an attempt to capture country-specific heterogeneities. They also regress against geographic and climate variables simply to control for criticisms of past studies.

Sachs and Warner's empirical demonstration of the 'Resource Curse' is the foundation for much of the literature, which largely extends their work by adding either a geographic or sectoral dimension to the analysis.

3.2 Sectoral Effects

Dissou (2010) argues that with respect to Dutch disease, non-booming sectors should be taken into stronger consideration. The paper mentions how the oil and gas industry accounts for approximately five percent of Canadian GDP, while energy-intensive industries — those who would be adversely affected by an oil price boom — make up a larger share. The paper employs a multi-sector general equilibrium model in order to gauge the impact on variables such as GDP, employment and investment for a number of different sectors in the short, medium and long-run.

The results of the paper show that a permanent increase in the oil price by 20 percent causes GDP, employment, and investment to increase in the oil and gas sector for nearly all time horizons. The manufacturing sector sees the opposite effect, as GDP, employment and investment all fall permanently. The author attributes these negative effects on manufacturing industries to the following:

i. Higher production costs through higher oil prices

ii. Appreciated national currency, dampening exports

iii. Labour reallocation to the booming sector at the expense of the manufacturing sector

The paper finds positive net effects for the Canadian economy at the aggregate level from an oil price boom. However, as illustrated above, there is also a significant reallocation of resources across industries, creating heterogeneity in effects across sectors.

Beine et al (2014) take a similar approach, using a general equilibrium model to determine the impact of an oil price shock on the booming (oil) sector, the tradeable (i.e. manufacturing) sector and the non-tradeable (i.e. services) sector. They draw the conclusion that spillover demand effects should provide a positive boost to all three industries, however the tradeable and non-tradeable sectors incur the adverse effect of increased supply-side costs. In addition to this, the increased resource price appreciates the national currency, further-dampening exports in the tradeable sector.

3.3 The Role of Factor Mobility

Raveh (2013) discusses how factor mobility can help mitigate Dutch disease symptoms. He argues that once factor mobility costs are low enough, an "Alberta Effect" is triggered which helps reduce and even reverse Dutch disease symptoms during a resource boom. The name stems from Canada's Alberta province, which is home to the majority of the country's oil and gas production, while the country also enjoys free movement of labour across its provinces. Hence during oil price shocks, labour can freely flow into and out of Alberta from other provinces, which helps to mitigate, and even reverse the now-familiar Dutch disease.

Beine et al (2014) also explores the role of factor mobility, by dividing provincial immigration into three groups: permanent international immigration, temporary international immigration, and interprovincial immigration. Similar to Raveh (2013), they find that interprovincial immigration can help mitigate Dutch disease symptoms by allowing labour supply to efficiently respond to changes in labour demand. They also find this to be true for temporary immigration, as immigrants with job offers from Canadian firms are often fast-tracked into the country. Permanent immigration, however, is not as responsive to changes in labour demand, and so does not help to mitigate Dutch disease.

3.4 Asymmetry of Shocks

Moshiri and Bakhshi (2018) use a Panel Vector Auto-Regression (PVAR) model to analyze the impact of oil price shocks on the economic growth of Canadian provinces. One of their key findings is that the impacts of positive and negative shocks to the oil price are not sym-

metric. Take an oil-importing province for example. When oil prices fall, the oil-importing province sees their direct production costs decrease, however this is offset by the indirect capital and labour reallocation costs. Meanwhile when prices rise, they see their production costs rise and they again incur reallocation costs. Hence when prices fall, there are positive and negative effects that offset to some extent, however when prices rise there are simply two negative effects. The result, therefore, is an asymmetry between the impacts of positive and negative shocks to the price of oil.

VAR methods like those in Moshiri and Bakhshi (2018) are appealing due to the impulse response functions that they provide. However, degrees of freedom can often be an issue, and errors from misspecification compound upon one another at longer forecast horizons. An alternate method is that of *local projections*, which is explored below in Section 4.

4 Comparing VARs and Local Projections

4.1 Vector Autoregression (VAR)

Vector autoregression has been a popular model choice in empirical macroeconomic research ever since the work of Sims (1980). The vector of endogenous variables Y_t is expressed as a function of its past values $Y_{t-1}, ..., Y_{t-p}$, a vector of exogenous variables X_t and an error term ϵ_t as follows:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + B_t X_t + \epsilon_t. \tag{1}$$

VARs are often used to compute impulse response functions (IRFs) and forecast-error decompositions, despite the VAR itself sometimes not being of particular interest. Furthermore, as Jordà (2005) points out, there is often no specific reason to expect that the data are generated by a VAR. For a shock a_i, the impulse response function of the VAR is defined as:

$$IRF(t, h, a_i) = \mathbb{E}[Y_{t+h}|\epsilon_t = a_i] - \mathbb{E}[Y_{t+h}|\epsilon_t = 0]. \tag{2}$$

VARs estimate a global approximation of the DGP by producing optimal one-period ahead forecasts. Therefore estimates for $t+1$ are often reasonable, even if the model is misspecified. As we can see in (1), Y_t is expressed as a function of all past values back until Y_{t-p}, and the exogenous X_t. Therefore as we forecast into the future, the estimates will become functions of forecasted values, for example:

$$\hat{Y}_{t+3} = \hat{A}_1\hat{Y}_{t+2} + \hat{A}_2\hat{Y}_{t+1} + ... + \hat{A}_pY_{t+3-p} + \hat{B}_{t+3}\hat{X}_{t+3}. \tag{3}$$

Thus it is easy to see how forecast errors will compound upon each other at increasingly distant horizons, potentially resulting in large inaccuracies.

4.2 Local Projections

Jordà (2005) suggests that more accurate forecasts can instead be obtained by using a collection of regressions local to each forecast horizon, called local projections. These are

sequential regressions of the endogenous variable for each forecast horizon. Specifically,

$$y_{t+h} = \alpha_0^h y_t + \alpha_1^h y_{t-1} + ... + \alpha_p^h y_{t-p} + \beta^h x_t + \gamma^h z_t + \epsilon_{t+h} \tag{4}$$

such that:

$$\begin{cases} y_{t+1} & = \alpha_0^1 y_t + \alpha_1^1 y_{t-1} + ... + \alpha_p^1 y_{t-p} + \beta^1 x_t + \gamma^1 z_t + \epsilon_{t+1} \\ y_{t+2} & = \alpha_0^2 y_t + \alpha_1^2 y_{t-1} + ... + \alpha_p^2 y_{t-p} + \beta^2 x_t + \gamma^2 z_t + \epsilon_{t+2} \\ & \vdots \\ y_{t+H} & = \alpha_0^H y_t + \alpha_1^H y_{t-1} + ... + \alpha_p^H y_{t-p} + \beta^H x_t + \gamma^H z_t + \epsilon_{t+H} \end{cases}$$

where ϵ_{t+h} is a $(h-1)^{th}$-order moving average. Here, y_t is our endogenous variable of interest, y_{t+h} is this variable at horizon h, and y_{t-p} is the same endogenous variable lagged by p periods. x_t is the exogenous variable for which we are interested in a shock, and z_t is the set of any additional exogenous control variables thought to have predictive power over the endogenous y_{t+h}. The exogeneity of regressors x_t and z_t ensures that there is no reverse causality bias in the model.

In equation (4), α_p^h is the reaction of y_{t+h} to a one-unit change in y_{t-p}. In other words, it is the coefficient on the endogenous variable lagged p periods, for forecast horizon h. Likewise, β^2 is the coefficient β on the exogenous x_t at forecast horizon $h = 2$. It is not to be interpreted as beta-squared. Note that the maximum lag p can be selected by information criteria (IC), and need not be fixed for all H projections. That is, the maximum lag p can be optimized at each forecast horizon.

Local Projections are more robust to misspecification of the DGP, as forecast errors do not compound at increasingly distant horizons. Another advantage is the ability to be estimated univariately using ordinary least squares. While local projections consume degrees of freedom with both their lead h and lag p, their univariate equation-by-equation nature consumes less degrees of freedom than a multivariate VAR.

The impulse response function, similar to that of the VAR, is defined as the difference in conditional forecasts at time t for horizon h from the exogenous shock a_i:

$$IRF(t, h, a_i) = \mathbb{E}[y_{t+h}|x_t = a_i] - \mathbb{E}[y_{t+h}|x_t = 0] \tag{5}$$

which, by plugging in $x_t = a_i$ and $x_t = 0$ respectively into (4), simplifies to:

$$IRF(t, h, a_i) = \hat{\beta}^h a_i. \tag{6}$$

The forecast error, by definition, is:

$$y_{t+h} - \mathbb{E}(y_{t+h}|x_t) = u^h_{t+h}. \tag{7}$$

Giving the unnormalized mean squared error (MSE):

$$MSE_u(\mathbb{E}(y_{t+h}|x_t)) = \mathbb{E}(u^h_{t+h} u^h_{t+h}{}') \tag{8}$$

By comparison, the unnormalized MSE for a traditional VAR is:

$$MSE_u(\mathbb{E}(y_{t+h}|x_t)) = \mathbb{E}(u_t^0 u_t^{0\prime}) + \psi_1 \mathbb{E}(u_t^0 u_t^{0\prime})\psi_1{}' + \ldots + \psi_h \mathbb{E}(u_t^0 u_t^{0\prime})\psi_h{}' \tag{9}$$

where the ψ_i and $\mathbb{E}(u_t^0 u_t^{0\prime})$ terms depend on the moving average representation and residual variance-covariance matrix of the VAR [see Jordà (2005), p 6]. Here, the quality of the variance decompositions will depend on how well ψ_i is estimated by the VAR. I estimate the sample version of these local projection impulse response functions below for both wages and employment.

5 Data

5.1 Labour Force Survey (LFS)

The dataset contains variables from multiple sources. Wage and employment data come from Statistics Canada's *Labour Force Survey (LFS)*, which is a monthly survey of approximately 56,000 Canadian households. The data are available provincially and by industry at a monthly frequency from January 1976 onward for employment, and beginning in 1997 for wages. For the sake of comparability, I only use employment data from 1997 onward.

The other popular option for these data would be the *Survey of Employment, Payroll and Hours (SEPH)*, which is Canada's main business employment survey. The LFS is slightly more volatile than the SEPH, but it contains less data supression, particularly in smaller provinces and industries. The LFS also covers the Agriculture sector while the

SEPH does not. LFS estimates for employment are higher than those of SEPH due to their respective methods and classifications of employment, but this is simply a level shift and does not impact the analysis.

5.2 BoC Commodity Price Index (BCPI)

The exogenous commodity price data come from the Bank of Canada's Commodity Price Index, the BCPI. The BCPI contains an aggregate commodity price index as well as sub-aggregates for both Energy and Non-Energy, the latter of which further disaggregates into Metals/Minerals, Forestry, Agriculture, and Fish. The price indices are measured in US dollars, and are available at a monthly frequency going back to January 1972.

5.3 Data Transformations

Employment data are measured in thousands of persons, adjusted for seasonality. I simply take the natural log of the variable.

Wage data are measured in current dollars, and are unadjusted for seasonality. Each province's wage data are thus deflated by their respective provincial CPI in order to obtain the series in real terms. Provincial CPIs are obtained from Statistics Canada. The wage data are then seasonally adjusted using an X11 transformation, performed in the software *R*. The end result is a seasonally adjusted real wage series, of which the natural log is then taken.

Commodity price indices are measured in current U.S. dollars, and indexed to 1972. I deflate the indices by the U.S. CPI to obtain them in real terms. The natural log is then taken of each index.

Specifically, the data will be transformed as follows: w_t, the natural log of the real wage; n_t, the natural log of employment; x_t, the natural log of the real energy price index; z_t, the natural log of any additional real commodity price indices being used as control variables, all of which are adjusted for seasonality where necessary.

Alquist et al (2012) suggest that real commodity prices such as oil are optimally forecasted by a random walk model at medium-term horizons or greater. That is, the best forecast for x_t is simply x_{t-1}. If this is indeed the case, then a shock to our model is the unanticipated change to the real commodity price, Δx_t. The reaction of either wages or employment to a one-unit change in (shock to) this variable is conveniently captured by the regression coefficient of the commodity price, $\hat{\beta}^h$.

6 Example

Take a simple example involving two endogenous variables, wage (w_t), and employment (n_t), for two provinces, Alberta (AB) and Nova Scotia (NS). There is also the exogenous world price of oil x_t. We will also let the optimal lag p be equal to one for simplicity. We can apply the equation to any forecast horizon h. Constant terms are included but not shown for ease of reading.

Therefore, the local projections for wage and employment, respectively, in Nova Scotia are:

$$w_{t+h,NS} = \alpha^h_{0,NS} w_{t,NS} + \alpha^h_{1,NS} w_{t-1,NS} + \beta^h_{NS} x_t + \epsilon_{t+h,NS} \tag{10}$$

$$n_{t+h,NS} = \rho^h_{0,NS} n_{t,NS} + \rho^h_{1,NS} n_{t-1,NS} + \theta^h_{NS} x_t + \epsilon_{t+h,NS}. \tag{11}$$

Likewise, the local projections for Alberta are:

$$w_{t+h,AB} = \alpha^h_{0,AB} w_{t,AB} + \alpha^h_{1,AB} w_{t-1,AB} + \beta^h_{AB} x_t + \epsilon_{t+h,AB} \tag{12}$$

$$n_{t+h,AB} = \rho^h_{0,AB} n_{t,AB} + \rho^h_{1,AB} n_{t-1,AB} + \theta^h_{AB} x_t + \epsilon_{t+h,AB}. \tag{13}$$

For clarity, α^h_{AB} in equation (12) would be the reaction of wages in Alberta at forecast horizion h to a one-unit change in wages. Likewise, β^h_{AB} is the effect on wages in Alberta resulting from a one-unit (percent) shock to the exogenous oil price, x_t. While this coefficient isn't necessarily the main interest of our study, it serves as a useful check as basic theory suggests that β^h_{AB} should be positive (wages should rise in Alberta following a positive oil/gas shock).

A central focus is the sign and magnitude of β^h_{NS}, which is the effect on wages in the oil-importing Nova Scotia resulting from a one-unit (percent) shock to the exogenous oil price, x_t. As noted earlier in Chart 5b, a positive effect implies that the mobility of labour leads wages to rise in Nova Scotia, while a negative effect implies that that effect is outweighed by the Dutch disease effect (via input costs and the exchange rate). The impulse

response function for wages in Nova Scotia resulting from the shock could be plotted as $\beta^1_{NS}, \beta^2_{NS}, \ldots, \beta^H_{NS}$ for forecast horizons $h = 1, 2, \ldots, H$.

Recall from Section 4.2, that the h-step ahead forecast error (ϵ_{t+h}) in the local projection follows an $(h-1)^{th}$-order moving average. Therefore all standard errors are constructed as Newey-West heteroskedasticity and autocorrelation consistent (HAC) standard errors with lag length $h-1$. These HAC standard errors are then used to construct the confidence bands for the impulse response functions.

7 Model Details

Now that the general framework for the model is established, there are two important decisions to be made. The first concerns how many lags of the endogenous variable to use in the model, and the second is a matter of which exogenous variables (in this case, which price indices) to include. Lastly, I address concerns regarding the stationarity of the model.

7.1 Lag Selection

The model is largely unaffected by different lag length selections of the endogenous variable. Standard errors in some instances fall marginally once more than ten lags are included. However in other cases, including this many lags introduces additional volatility of the confidence bands at longer forecast horizons. While local projections offer the ability to re-optimize lag length at each forecast horizon, this can be computationally expensive. The

computational cost is exacerbated in a study like this, where I am interested in long forecast horizons for 16 industries (as well as the goods, services, and total aggregates) in each of the ten provinces. Attempting to strike the right balance, and since results are largely unaffected by the lag length selection, I choose to fix the number of lags to $p = 3$ for all forecasts.

7.2 Exogenous Regressors

The BCPI sub-aggregates — namely Energy and Non-Energy, the latter of which further disaggregates into Metals/Minerals, Forestry, Agriculture, and Fish — are conveniently exogenous variables that may help predict employment and wages in Canada. The question that remains, however, is which indices to include as controls when shocking a given price index.

The model is robust to specification, often seeing only minor changes in forecasts and confidence bands as various regressors are swapped in and out of the model. That being said, I believe it is important to take into account the movements of all commodity prices when analyzing a shock, as opposed to looking at one price index in a vacuum. That is, the impact on, say, Ontario's mining industry from an increase in energy prices should also take the price of metals into account. For this reason, I choose to include all commodity price indices as controls.

Whether to use the non-energy aggregate, or the disaggregated fish, forestry, agriculture and metals/minerals indices appears trivial, yet there are marginal differences since we are working with the natural log of variables. In other words, the sum of logs does not

equal the log of sums. The actual forecasts of the model are largely unaffected by which specification I employ, however confidence bands narrow slightly when using the aggregated non-energy price index. Therefore I use the aggregated index, as it provides more precision.

7.3 Stationarity

Given that employment and real wages have generally trended upward over time, one might be concerned about a lack of stationarity in the model. The work of Sims, Stock and Watson (1990), however, shows that for most classical regressions the distribution of the statistics of interest are unaffected by non-stationarity. They find that even if variables are non-stationary, meaningful regressions can still be performed as long as combinations of the variables exhibit stationarity. That is, hypotheses can still be tested without transforming the data into stationary regressors. Therefore, deferring to the secondary literature, variables will enter the model as originally laid out in Section 5.3.

8 Results

The final models for any provincial industry's wage and employment, respectively, at a given horizon h are therefore:

$$w_{t+h} = \alpha_0^h w_t + \alpha_1^h w_{t-1} + \alpha_2^h w_{t-2} + \beta^h x_t + \gamma^h z_t + \epsilon_{t+h} \tag{14}$$

$$n_{t+h} = \rho_0^h n_t + \rho_1^h n_{t-1} + \rho_2^h n_{t-2} + \theta^h x_t + \lambda^h z_t + \epsilon_{t+h} \tag{15}$$

where x_t is the commodity price of interest, and z_t is the set of controls. In this case, x_t is energy commodity prices and z_t is non-energy commodity prices. As outlined in Section 4, the impulse responses for real wages and employment from a shock to x_t are captured by the $\hat{\beta}$ and $\hat{\theta}$ coefficients, respectively, at each forecast horizon. Examples of some notable impulse responses are shown below, starting with Alberta's oil and gas sector.

Chart 6: Impulse Response - Oil and Gas Employment, Alberta

Percent change in employment resulting from a one percent increase in energy prices

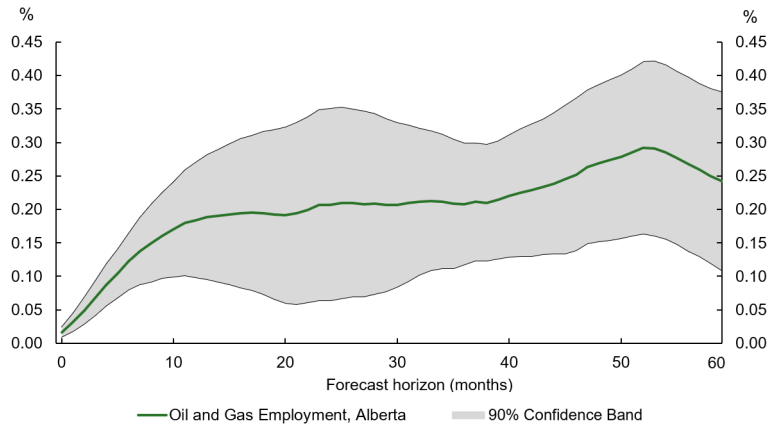
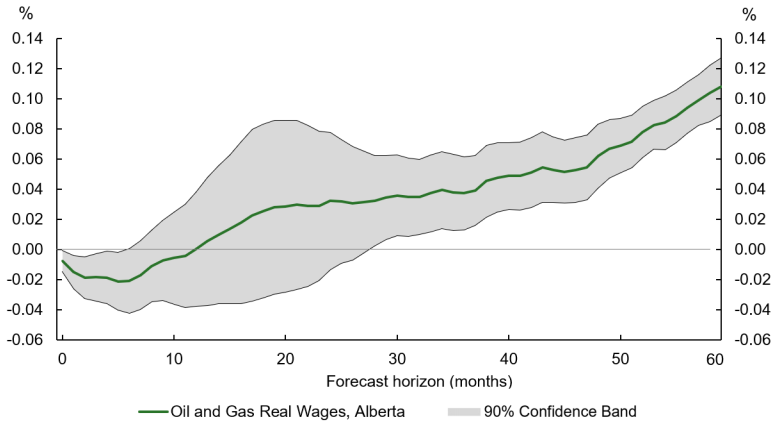


Chart 7: Impulse Response - Oil and Gas Real Wages, Alberta

Percent change in real wages resulting from a one percent increase in energy prices



Above we see the responses of employment and real wages in Alberta's oil and gas industry from a positive (one percent) shock to energy prices. Employment in the sector sees a statistically significant increase at all forecast horizons. Real wages in the sector do not rise immediately, however gains are statistically significant at horizons of two and half

years and longer.

Next, we look at a sector that would be a candidate for Dutch disease in Québec's manufacturing sector.

Chart 8: Impulse Response - Manufacturing Employment, Québec

Percent change in employment resulting from a one percent increase in energy prices

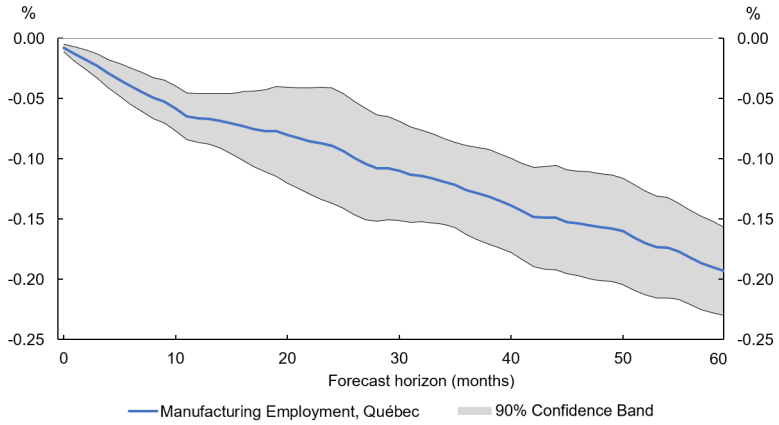
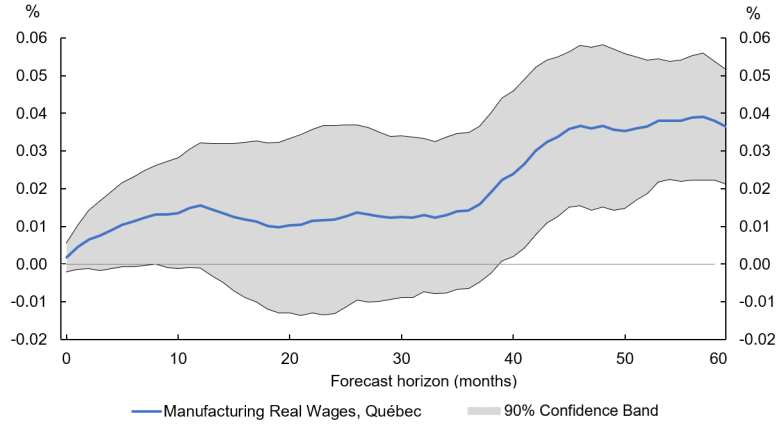


Chart 9: Impulse Response - Manufacturing Real Wages, Québec

Percent change in real wages resulting from a one percent increase in energy prices



The model predicts that employment in Québec's manufacturing sector will experience a statistically significant decline at all forecast horizons. Real wages, however, do not decline. Increases are forecasted throughout all forecast horizons, and gain statistical significance at horizons of approximately three and a half years and longer. This result would suggest that, in the long run, the labour mobility effect may outweigh the Dutch disease effect.

Lastly, we look at how the country as a whole responds to the shock.

Chart 10: Impulse Response - Total Employment, Canada

Percent change in employment resulting from a one percent increase in energy prices

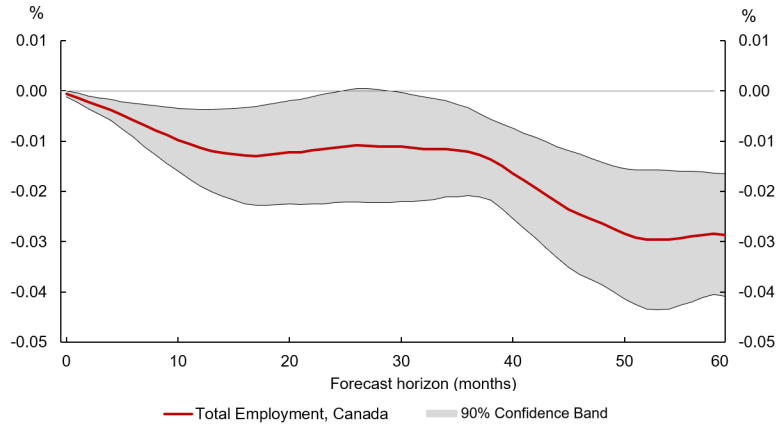
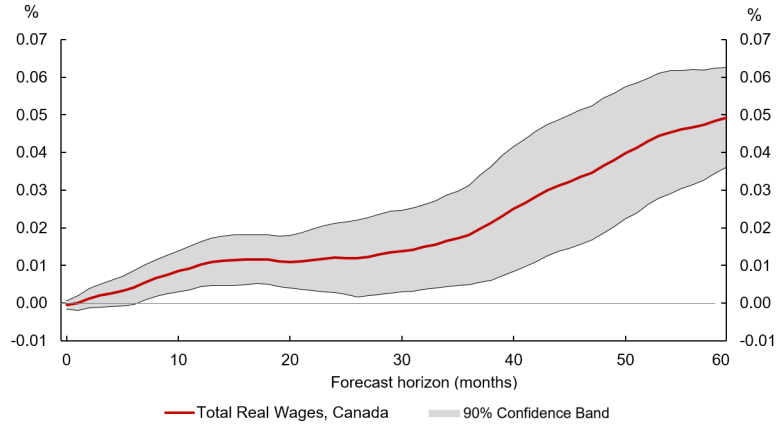


Chart 11: Impulse Response - Total Real Wages, Canada

Percent change in real wages resulting from a one percent increase in energy prices



National employment sees a statistically significant decline at nearly all forecast horizons in the wake of the shock. Given that Canada is a net exporter of oil, this result is somewhat counterintuitive. Real wages, however, are higher as a result of the shock, with statistical significance at nearly all forecast horizons. While the employment results would begin to suggest a resource curse effect taking place, real wages are higher than they would have been had energy prices remained the same. A critique of local projections is that they lack precision in their estimates, often resulting in statistical insignificance. However in the

impulse response charts shown, we can clearly see that our model does have precision, and statistically significant outcomes.

Given the possible combinations of different horizons h, commodity prices x_t, and wage/employment, it is not feasible to report each finding. Therefore I focus on three distinct horizons — one, two and five years — for an energy price shock to both wages and employment in each province-industry combination. This results in six tables which, along with descriptions of the results, can be found below.

Each table is organized with rows for every sector, and a column for each province, as well as the national aggregate. Tables are described below, and collected at the end of the paper. Numbers in the table represent the percent change in employment (or real wages) in a sector resulting from a one percent increase in energy prices. For example, a 0.18 in the table would indicate a 0.18 percent response, not 18 percent. One star (*) represents statistical signifcance at the 68 percent confidence level; two stars (**) represents statistical significance at the 90 percent confidence level, and three stars (***) means statistical significance at the 95 percent confidence level. Statistically significant increases and decreases are coloured green and red, respectively. Numbers that are not statistically signifcant at any of the aforementioned thresholds are shown in standard black font, and will have no stars. An employment "increase" refers to employment being higher than it would be had there been no shock. Likewise, a "decrease" is not necessarily a level decrease, but rather a lower level than there would have been with no shock. For ease of viewing, the "Total" sector is bolded, and the "Goods" and "Services" sectors are bolded and italicized. All other sub-aggregates are shown in standard font.

8.1 Employment at a One-Year Horizon

Table 1 shows the response of employment to an energy price shock at a one-year forecast horizon. At the national level, total employment sees a statistically significant decline after just one year. Employment increases — largely concentrated in the "forestry, fishing, mining, quarrying, oil and gas" sector (oil and gas sector henceforth) — are not enough to offset declines in sectors such as manufacturing and transportation/warehousing.

At the provincial level, Alberta is the only province to experience a statistically significant increase for total employment, driven by a large increase in its oil and gas sector. Provinces with statistically significant declines include Ontario and Québec, and to a slightly lesser extent Manitoba and P.E.I., all of which see declines in their manufacturing sectors.

At the sectoral level, there are large and statistically significant increases to employment in the oil and gas sectors for Alberta, Saskatchewan and Newfoundland. Declines in provincial employment are frequently observed in the agriculture and manufacturing sectors, and also in other services.

8.2 Employment at a Two-Year Horizon

Table 2 shows the response of employment to an energy price shock after two years. At the two-year forecast horizon for Canada, we once again see a statistically significant decrease in national total employment. Decreases in the manufacturing and transportation/warehousing sectors are large enough to outweigh gains in the oil and gas, utilities,

and construction sectors, among others.

Provincially, Manitoba no longer sees a statistically significant decrease in total employment, leaving only Ontario, and to a lesser extent Québec and P.E.I. as the provinces seeing net employment decreases. Alberta, Saskatchewan and Newfoundland see the largest positive responses to total employment, followed by Nova Scotia and New Brunswick.

Oil and gas is the sector that sees the largest increase in employment, driven mostly by Alberta, Saskatchewan and Newfoundland. A trend has also emerged in sectors that see employment decreases, as manufacturing and transportation/warehousing have declined in the majority of provinces. It is worth noting that manufacturing declines are observed in all provinces except for Alberta, Saskatchewan and Newfoundland; the country's main energy-producing provinces.

8.3 Employment at a Five-Year Horizon

Table 3 shows the response of employment to an energy price shock after five years. The five-year forecast horizon is intended to offer a glimpse into the long-run effects of the shock. For the national aggregate, we see that total employment has declined by more than it had after one and two years. Some of the largest increases — namely in oil/gas and construction — are not enough to offset declines in manufacturing, transportation/warehousing, and building services.

Provincially, we now see total employment increases in five out of ten provinces. However, declines in Ontario and Québec — Canada's two largest provinces — are enough to bring down the national aggregate. It is worth noting that the two negatively-affected provinces are the country's two largest exporters. Although I have not studied the real exchange rate in this study, this may be indirect evidence of a Dutch disease effect.

At the sectoral level, a now-familiar dynamic continues to emerge. The manufacturing sector sees significant decreases in employment in nearly all provinces. The oil and gas sector continues to experience the largest employment increases, followed by construction, which sees employment gains in all but two provinces.

8.4 Real Wages at a One-Year Horizon

Table 4 shows the response of real wages to an energy price shock at a one-year forecast horizon. Nationally, the positive energy shock leads to higher real wages after just one year. Increases are fairly miniscule, and are not concentrated in any one sector. There are no sectors that see real wages decrease (lower than they would have been in the event of no shock) at the national aggregate.

All provinces see higher real wages as a result of the shock, led by P.E.I., Newfoundland, Alberta and Saskatchewan. Real wage increases are, interestingly, not concentrated in the oil and gas sector. Health care and social assistance is the only sector with increases in every province. On the other end of the spectrum, the only sector to experience lower real wages in more than one province is the agriculture sector.

8.5 Real Wages at a Two-Year Horizon

Table 5 shows the response of real wages to an energy price shock at a two-year forecast horizon. Notice that Table 5 contains mostly green numbers (representing a statistically significant increase), and notably more so than in Table 4. After two years, real wages in Canada are higher on average as a result of the shock. Gains at the national level are spread across several sectors, including (with high levels of significance) in health care, education and construction. The only sector with lower real wages — professional, scientific and technical services — is only significant at the 68 percent confidence level, with no significant decreases in the sector at the provincial level.

Provincially, Newfoundland sees the largest increase in total real wages, followed by Alberta, Saskatchewan, P.E.I. and Manitoba. Nova Scotia and New Brunswick no longer see statistically significant increases to total real wages. Four of the five largest responses in the table are all observed in Newfoundland, in the agriculture, information/culture/recreation, accomodation and food services, and other services sectors.

Health care and social assistance is once again the only sector that sees higher real wages in every province, however educational services are a close second. Information, culture and recreation is the only sector with lower real wages in more than one province, despite having one of the more significant increases at the national level.

8.6 Real Wages at a Five-Year Horizon

Table 6 shows the response of real wages to an energy price shock at a five-year forecast horizon. Five years after the shock, real wages have increased in nearly every province-industry combination: Table 6 is almost all green. All headline aggregates — whether it be national aggregates for each sector, or the total category for each province — have increased with statistical significance. Alberta, Saskatchewan, Newfoundland and New Brunswick see the largest increases amongst the provinces. At the sectoral level, the real wage gains are the largest in the oil and gas sector, followed by the agriculture sector. Oil and gas increases are driven by the usual suspects — Alberta, Saskatchewan and Newfoundland — as well as Manitoba.

Due to the high proportion of statistically significant increases at this horizon, one might suspect that the forecast is simply picking up a general upward productivity trend over time. That is, a spurious correlation could arise if both real wages and energy prices are non-stationary. However, this is not the case, for two reasons. First, we have included lagged values of real wages as well as an intercept in the regression. Therefore if real wages are rising due to overall productivity growth, then these regressors will control for that. Second, we know that real commodity prices both rise and fall over the sample, as seen in Chart 1 for example. So, the statistically significant positive coefficients in the table imply that the effects on real wages from commodity price movements were negative at certain times as well.

9 Future Work

Future avenues of research could explore different ways to "scale up" shocks. In the framework presented, a 20 percent change in a commodity price would simply result in 20 times the impact of a one percent shock. However, if we believe that there would be little response to a small shock, and more pronounced responses to larger shocks, one could investigate the possibility of incorporating non-linearities into the model.

One could also look into variable selection methods. While additional regressors in the local projection should remain exogenous to avoid biasing the coefficients, the question of which regressors to include remains. It could be worthwhile and interesting to explore some of the machine learning literature for model selection, namely *Best Subset Selection*. The concept is to take every possible one-variable model and select the one with the lowest out-of-sample forecast MSE. Then, take every possible combination of two-variable models and perform the same exercise. This can be performed for each possible subset of variables until one obtains the optimal one-variable model, two-variable model, three-variable model, and so on. The shortlist of "optimal" models can then be compared to see which is the best amongst them. While this approach makes few decisions using economic theory, it is a purely objective method of variable selection that could be explored.

10 Summary

Canada is a small open economy with natural resource endowments, particularly in oil and gas. Due to its relatively small size on the global scale, however, the country is a price-taker on the world commodities market. This makes the country susceptible to exogenous movements in the prices of the commodities that it produces.

The country's endowments are dispersed unevenly across its provinces and territories, creating hetereogeneities in both their underlying economic fundamentals, as well as their responses to price shocks. This study therefore draws on the local projections literature in an attempt to quantify the impact of commodity price shocks on different Canadian provinces and industries. I study monthly data since 1997 for all provinces, 16 industries (as well as the goods, services, and total aggregates), and multiple horizons.

While the framework can address a number of commodity price shocks to a host of different provincial industries, I have chosen to present results stemming from a shock to energy prices. Results show that employment responses vary widely across provinces and industries at all horizons. Notable trends are employment increases in sectors such as oil/gas and construction, and lower employment levels in sectors such as manufacturing and transportation/warehousing. Provinces such as Alberta, Saskatchewan and Newfoundland often see higher employment levels as a result of the shock, particularly in the goods-producing sector. Ontario and Québec, however, often see lower levels of employment as a result of the shock.

Real wages do not always rise immediately after the shock. But, by the five-year forecast horizon they are higher in nearly every province-industry combination. This dramatic finding from Tables 4 through 6 shows that, in the long run, the labour mobility effect appears to outweigh the Dutch disease effect. Recall Charts 5a and 5b in Section 2, which showed why real wages in oil-importing provinces are a key focus of this study. Further, this area has not been explored in detail in previous research. Therefore, Table 6 — which shows real wage increases in nearly all province-industry combinations, both energy and non-energy intensive — presents the most striking result of this essay.

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Table 1: Impact on Employment from a Positive Shock to Energy Prices - 1 Year Horizon

Percentage change in employment after one year, resulting from a one percent increase in the BoC's Energy Price Index

Shock: Energy Prices (1%)	**CAN**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**NB**	**NS**	**PEI**	**NFLD**
Total employees, all industries	**-0.01** ***	**-0.01** *	**0.01** *	**0.00**	**-0.01** *	**-0.02** ***	**-0.01** ***	**0.00**	**0.00**	**-0.01** *	**0.01**
Goods-producing sector	***-0.01*** *	***0.00***	***0.05*** ***	***0.03*** **	***-0.04*** ***	***-0.04*** ***	***-0.04*** ***	***-0.01***	***-0.03*** **	***0.02***	***0.04*** *
Agriculture	-0.04 *	-0.03	-0.08 *	-0.06 *	-0.05 **	-0.04	-0.05 *	-0.06	-0.02	-0.07 *	0.15
Forestry, fishing, mining, quarrying, oil and gas	0.07 ***	-0.15 ***	0.18 ***	0.21 ***	0.00	-0.02	-0.12 ***	-0.07 *	-0.02	-0.07 *	0.11 ***
Utilities	0.03 *	-0.08 *	0.06	0.08 *	-0.08 *	0.07 ***	0.1 ***	-0.05	-0.05	-0.12	-0.04
Construction	0.01 *	0.05 *	0.02	0.08 ***	-0.03 *	0.00	0.01	0.05 *	0.03	0.19 ***	0.02
Manufacturing	-0.06 ***	-0.03 *	0.05 *	0.02 *	-0.03 *	-0.09 ***	-0.06 ***	-0.03	-0.08 ***	-0.07 ***	-0.04
Services-producing sector	***-0.005*** *	***-0.01*** **	***0.00***	***-0.01*** *	***0.00***	***-0.01*** *	***0.00***	***0.00***	***0.00***	***-0.01*** *	***0.00***
Wholesale and retail trade	0.00	0.01	0.00	-0.03 *	0.03 ***	0.01 *	0.01	0.01	0.00	-0.01	0.03 *
Transportation and warehousing	-0.03 ***	-0.03	-0.01	-0.04 *	0.00	-0.03 *	-0.02	0.03 *	-0.01	-0.02	0.12 ***
Finance, insurance, real estate, rental and leasing	0.02 **	0.00	0.03 *	0.03	0.00	0.02 ***	0.05 ***	0.04	-0.05 ***	-0.03	-0.09 **
Professional, scientific and technical services	-0.03 ***	-0.04 *	-0.01	0.00	-0.07 **	-0.04 ***	-0.02	0.12 ***	-0.01	0.06	-0.07 *
Business, building and other support services	-0.02 *	0.01	-0.03	0.01	0.02	-0.01	-0.02	0.26 ***	0.15 **	0.2 ***	0.19 ***
Educational services	0.00	-0.01	0.03	0.00	0.02 *	0.00	0.01	0.04 **	0.01	0.04	0.03 *
Health care and social assistance	0.01 *	0.02 *	0.01 *	0.01	0.03 **	0.00	0.01	-0.02	0.03 *	-0.03 *	0.00
Information, culture and recreation	0.01 *	-0.01	0.02	-0.02	0.08 ***	0.06 ***	0.03	-0.05 *	0.11 ***	0.11 **	0.27 ***
Accommodation and food services	0.00	0.01	0.03 *	0.01	0.03	-0.02 *	0.03 *	0.06 ***	0.06 ***	0.06	-0.01
Other services (except public administration)	-0.01	-0.04 *	0.06 ***	-0.02	-0.01	0.01	-0.03 **	-0.06 **	-0.08 ***	-0.17 ***	-0.05 *
Public administration	0.01 *	0.02	0.08 ***	0.05 ***	0.06 ***	0.00	0.01	-0.03	0.07 ***	0.08 ***	0.00

Note: For each region, the "**Total**" aggregate is shown in bold font, and the "***Goods***" and "***Services***" sectors are bolded and italicized. All remaining sub-aggregates are shown in standard font. Statistically significant increases and decreases are coloured green and red, respectively. Increases and decreases are relative to a forecast with no shock. One star (*) represents statistical signifcance at the 68 percent confidence level; two stars (**) represents statistical significance at the 90 percent confidence level, and three stars (***) represents statistical significance at the 95 percent confidence level.

Table 2: Impact on Employment from a Positive Shock to Energy Prices - 2 Year Horizon

Percentage change in employment after two years, resulting from a one percent increase in the BoC's Energy Price Index

Shock: Energy Prices (1%)	**CAN**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**NB**	**NS**	**PEI**	**NFLD**
Total employees, all industries	**-0.01 ****	**-0.01**	**0.02 ***	**0.03 *****	**0.00**	**-0.03 *****	**-0.01 ***	**0.01 ***	**0.01 ***	**-0.01 ***	**0.03 *****
Goods-producing sector	***0.01 ****	***0.04***	***0.08 ******	***0.07 ******	***-0.02 ****	***-0.05 ******	***-0.02 ****	***-0.01***	***-0.02***	***0.00***	***0.06 ******
Agriculture	0.00	0.06 *	-0.11 *	-0.02	-0.02	-0.02	0.00	0.00	-0.09 *	-0.16 ***	0.39 ***
Forestry, fishing, mining, quarrying, oil and gas	0.11 ***	-0.13 ***	0.21 ***	0.23 ***	-0.08 *	0.06 **	-0.08 ***	-0.05	0.02	0.01	0.12 ***
Utilities	0.09 ***	-0.02	0.1	0.09	-0.07 *	0.11 ***	0.16 ***	0.04	-0.08	0.05	-0.06
Construction	0.04 ***	0.13 **	0.06 *	0.15 ***	0.02	-0.01 *	0.05 **	0.15 ***	0.04 *	0.11 *	0.07 *
Manufacturing	-0.09 ***	-0.05 *	0.02	0.04 *	-0.04 *	-0.12 ***	-0.09 ***	-0.1 ***	-0.1 **	-0.08 *	-0.04
Services-producing sector	***-0.01***	***-0.02 *****	***0.01***	***0.00***	***0.00***	***-0.01 ****	***0.00***	***0.01 ****	***0.01 ****	***0.00***	***0.02 ******
Wholesale and retail trade	-0.01 *	0.03	-0.01	0.00	0.04 ***	-0.02 *	0.02 *	0.03 ***	0.03	-0.02	0.04 **
Transportation and warehousing	-0.06 ***	-0.04 ***	-0.06 ***	-0.05 **	-0.03 *	-0.06 ***	-0.05 *	0.03	-0.02	-0.04	-0.01
Finance, insurance, real estate, rental and leasing	0.03 **	0.03	0.05 *	0.05 *	0.00	0.04 ***	0.07 *	0.09 *	0.02	0.07	0.01
Professional, scientific and technical services	-0.04 ***	-0.04 *	-0.03	0.03	0.00	-0.06 ***	0.03	0.19 ***	0.00	0.05	0.01
Business, building and other support services	0.01	0.05 *	0.08 *	0.05	0.16 ***	-0.01	0.04	0.26 ***	0.08	0.39 ***	0.31 ***
Educational services	0.01	-0.01	0.03	0.03 *	0.02 *	0.03 *	0.03	0.06 *	0.00	0.1 *	0.03 *
Health care and social assistance	0.02 ***	0.04 ***	0.06 ***	0.04 ***	0.02 *	0.02 *	0.00	-0.02	0.07 ***	-0.02	0.05 ***
Information, culture and recreation	0.00	-0.02	0.09 ***	0.04 *	0.08 **	0.04 *	0.00	0.02	0.13 ***	0.05	0.14 ***
Accommodation and food services	0.01 *	-0.01	0.02	0.00	0.01	0.02	0.07 ***	0.03	0.06 *	0.11 **	0.04 *
Other services (except public administration)	0.02	-0.08 ***	0.08 ***	0.03	0.06 *	0.05 **	0.03 *	0.02	-0.07 *	-0.01	-0.07 *
Public administration	0.03 *	0.05 *	0.13 ***	0.03	0.06 ***	0.04 *	-0.01	-0.01	0.06 *	0.13 ***	0.02

Note: For each region, the "**Total**" aggregate is shown in bold font, and the "***Goods***" and "***Services***" sectors are bolded and italicized. All remaining sub-aggregates are shown in standard font. Statistically significant increases and decreases are coloured green and red, respectively. Increases and decreases are relative to a forecast with no shock. One star (*) represents statistical signifcance at the 68 percent confidence level; two stars (**) represents statistical significance at the 90 percent confidence level, and three stars (***) represents statistical significance at the 95 percent confidence level.

Table 3: Impact on Employment from a Positive Shock to Energy Prices - 5 Year Horizon

Percentage change in employment after five years, resulting from a one percent increase in the BoC's Energy Price Index (M.ENER)

Shock: Energy Prices (1%)	**CAN**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**NB**	**NS**	**PEI**	**NFLD**
Total employees, all industries	-0.03 ***	-0.02	0.01	0.07 ***	0.00	-0.05 ***	-0.01 ***	0.01 **	0.02 ***	0.01 *	0.08 ***
Goods-producing sector	***0.00***	***0.13 ******	***0.08 ****	***0.19 ******	***0.04 ******	***-0.11 ******	***-0.05 ******	***-0.01***	***-0.05 ******	***0.03***	***0.17 ******
Agriculture	0.00	-0.12 ***	-0.03	-0.03 *	-0.09 ***	0.08 ***	0.01	0.00	-0.06	0.02	0.09 ***
Forestry, fishing, mining, quarrying, oil and gas	0.18 ***	0.05 *	0.24 ***	0.29 ***	0.11 ***	0.1 ***	-0.08 *	0.03	-0.02	-0.05 *	0.13 ***
Utilities	0.03	0.12 ***	-0.02	0.13 *	-0.05 *	0.00	0.04	0.01	0.32 ***	0.75 ***	0.03
Construction	0.09 ***	0.38 ***	0.05	0.46 ***	0.33 ***	-0.03	0.23 ***	0.33 ***	0.14 ***	0.16 ***	0.45 ***
Manufacturing	-0.21 ***	-0.22 ***	-0.05 *	0.07 ***	-0.06 ***	-0.27 ***	-0.19 ***	-0.25 ***	-0.24 ***	-0.02	-0.24 ***
Services-producing sector	***-0.01 ******	***0.00***	***0.00***	***0.00***	***0.01 ****	***-0.02 ******	***0.00***	***0.02 ******	***0.02 ******	***0.04 ******	***0.05 ******
Wholesale and retail trade	-0.01 *	0.09 ***	0.07 ***	0.00	0.04 **	-0.02 *	0.01	0.05 ***	0.02	0.03 *	-0.02
Transportation and warehousing	-0.06 ***	0.09 **	-0.06 *	0.14 ***	-0.01	-0.03 *	0.03	-0.04 ***	-0.04 **	-0.03	0.03
Finance, insurance, real estate, rental and leasing	0.04 ***	0.08 ***	0.15 ***	0.04 *	0.16 ***	0.01	0.14 ***	-0.03 *	-0.03 **	0.14 ***	0.03
Professional, scientific and technical services	0.01	0.03	0.05 *	0.11 ***	0.00	-0.03	0.13 ***	-0.01	0.14 ***	0.06 ***	0.08
Business, building and other support services	-0.03 **	0.12 ***	0.03 *	0.02	-0.01	0.00	0.02	-0.04 *	-0.03	0.13 ***	-0.19 ***
Educational services	0.02	0.01	0.06 *	0.03	0.00	0.08 ***	0.05 ***	0.15 ***	-0.03	0.18 ***	0.02
Health care and social assistance	0.02	0.07 ***	0.07 ***	0.03 **	0.05 *	0.01	0.00	0.05 *	0.14 ***	0.1 ***	0.17 ***
Information, culture and recreation	0.01	0.06 **	0.01	-0.03	0.01	0.02	0.03 *	0.00	0.12 ***	0.01	0.01
Accommodation and food services	0.01	0.05 ***	0.02	-0.03 *	0.14 ***	0.01	0.12 ***	-0.02	0.02	0.05 *	0.08 ***
Other services (except public administration)	0.08 ***	0.05 ***	0.12 ***	0.05 ***	0.04 **	0.1 ***	0.06 ***	0.00	-0.08 ***	0.03 *	0.01
Public administration	0.08 ***	0.07 ***	0.15 ***	0.12 ***	0.00	0.1 ***	0.04 **	0.16 ***	0.07 ***	0.1 *	0.06 *

Note: For each region, the "**Total**" aggregate is shown in bold font, and the "***Goods***" and "***Services***" sectors are bolded and italicized. All remaining sub-aggregates are shown in standard font. Statistically significant increases and decreases are coloured green and red, respectively. Increases and decreases are relative to a forecast with no shock. One star (*) represents statistical signifcance at the 68 percent confidence level; two stars (**) represents statistical significance at the 90 percent confidence level, and three stars (***) represents statistical significance at the 95 percent confidence level.

Table 4: Impact on Real Wages from a Positive Shock to Energy Prices - 1 Year Horizon

Percentage change in real wages after one year, resulting from a one percent increase in the BoC's Energy Price Index

Shock: Energy Prices (1%)	**CAN**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**NB**	**NS**	**PEI**	**NFLD**
Total employees, all industries	**0.01** ***	**0.01** *	**0.02** ***	**0.02** ***	**0.01** *	**0.01** *	**0.01** ***	**0.01** **	**0.01** *	**0.03** ***	**0.03** ***
Goods-producing sector	***0.01*** ***	***0.00***	***0.02*** *	***0.02*** **	***0.01***	***0.02*** ***	***0.01*** *	***0.00***	***0.02*** *	***0.03*** **	***0.02***
Agriculture	0.01	-0.06 *	0.08 **	0.03	0.01	0.01	-0.04 *	-0.01	0.00	0.00	-0.03
Forestry, fishing, mining, quarrying, oil and gas	0.01	-0.01	0.00	0.01	-0.05 ***	-0.01	0.01	0.00	0.01	0.04	0.01
Utilities	0.01	0.01	0.03	0.06 ***	0.02	0.02	0.00	0.02	0.00	0.13 **	0.01
Construction	0.02 ***	0.01	0.03 ***	0.03 *	-0.01	0.01 *	0.01	0.02	0.02	0.01	0.02
Manufacturing	0.01 ***	0.00	-0.01	0.00	0.01	0.03 ***	0.01 *	-0.02 *	0.01	0.04 ***	0.02
Services-producing sector	***0.01*** ***	***0.01***	***0.01*** **	***0.02*** ***	***0.01*** *	***0.01*** *	***0.01*** **	***0.02*** ***	***0.01*** *	***0.03*** ***	***0.03*** ***
Wholesale and retail trade	0.01 *	0.01	0.01 *	0.01 *	0.02 *	0.00	0.01	0.01	0.02 **	0.04 ***	0.02
Transportation and warehousing	0.00	-0.01	0.01	-0.01	0.00	0.01	0.00	0.02	-0.03 ***	-0.01	0.05 ***
Finance, insurance, real estate, rental and leasing	0.00	-0.01	0.02	0.02	0.01	0.00	0.01 *	-0.01	0.04 ***	0.02	-0.01
Professional, scientific and technical services	0.00	0.01	-0.02 *	-0.02	0.02	-0.01	0.04 **	0.03 *	0.02	0.07 *	0.08 *
Business, building and other support services	0.02 ***	0.05 *	0.01	-0.01	0.03 *	0.02 *	0.03 *	0.01	0.02	0.05 ***	-0.03
Educational services	0.02 ***	-0.01	0.03 ***	0.02	0.01 *	0.02 **	0.00	0.01	0.00	0.04 ***	0.04 ***
Health care and social assistance	0.02 ***	0.03 ***	0.02 **	0.04 ***	0.02 *	0.01 *	0.02 **	0.04 **	0.02 *	0.02 *	0.04 ***
Information, culture and recreation	0.00	0.00	0.00	0.05 ***	0.04 **	-0.01	-0.02 *	0.01	0.01	0.00	0.09 ***
Accommodation and food services	0.01	-0.02 *	0.00	0.03 ***	0.03 **	0.01	0.02 *	0.04 ***	0.03 *	0.01	0.05 ***
Other services (except public administration)	0.01	0.01	0.03 **	0.02 *	0.03 **	-0.01	0.01	0.03 *	0.01	0.06 ***	0.02
Public administration	0.01 *	0.03 ***	0.02 *	0.01	-0.02 *	0.02 ***	0.00	0.02	0.02	0.00	0.02

Note: For each region, the "**Total**" aggregate is shown in bold font, and the "***Goods***" and "***Services***" sectors are bolded and italicized. All remaining sub-aggregates are shown in standard font. Statistically significant increases and decreases are coloured green and red, respectively. Increases and decreases are relative to a forecast with no shock. One star (*) represents statistical signifcance at the 68 percent confidence level; two stars (**) represents statistical significance at the 90 percent confidence level, and three stars (***) represents statistical significance at the 95 percent confidence level.

Table 5: Impact on Real Wages from a Positive Shock to Energy Prices - 2 Year Horizon

Percentage change in real wages after two years, resulting from a one percent increase in the BoC's Energy Price Index

Shock: Energy Prices (1%)	**CAN**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**NB**	**NS**	**PEI**	**NFLD**
Total employees, all industries	**0.01** ***	**0.01** ***	**0.02** ***	**0.02** ***	**0.02** ***	**0.01** *	**0.01** *	**0.01**	**0.01**	**0.02** ***	**0.04** ***
Goods-producing sector	***0.02*** **	***0.01*** *	***0.04*** ***	***0.01*** *	***0.01*** *	***0.02*** ***	***0.02*** *	***0.00***	***0.01***	***0.02***	***0.04*** *
Agriculture	0.02 *	-0.03	0.03	0.06 *	0.03	0.04 *	-0.04 *	0.03	0.06 **	-0.02	0.08 *
Forestry, fishing, mining, quarrying, oil and gas	0.02 *	0.01	0.03	-0.01	-0.01	-0.02	0.02	-0.01	0.00	-0.01	0.05 *
Utilities	0.01	0.02	0.04	0.04 **	0.04 *	0.03	0.02	0.02	0.01	0.06	0.01
Construction	0.02 ***	0.01	0.04 ***	0.01	0.01	0.01	0.02 *	0.00	0.03 *	0.02	0.04 *
Manufacturing	0.01 *	0.01	0.01	-0.01	0.01	0.03 ***	0.01	-0.01	0.00	0.02	0.02
Services-producing sector	***0.01*** ***	***0.01*** **	***0.02*** ***	***0.02*** ***	***0.02*** ***	***0.01*** **	***0.01*** *	***0.02*** *	***0.01***	***0.03*** **	***0.04*** ***
Wholesale and retail trade	0.01 *	0.02 *	0.00	0.02 *	0.01 *	0.00	0.01	0.00	0.02	0.02 *	0.04 **
Transportation and warehousing	0.01	0.01	-0.02	0.01	0.01	0.02 *	0.01	0.00	0.00	0.02	0.04 *
Finance, insurance, real estate, rental and leasing	0.00	-0.01	0.02	0.03 *	0.02	0.00	0.02 **	-0.04 *	0.00	-0.02	0.05
Professional, scientific and technical services	-0.01 *	0.02 *	0.01	0.00	0.06 ***	0.00	0.00	0.00	-0.01	0.04	0.06 *
Business, building and other support services	0.01	0.01	0.05 ***	0.02	0.02	0.00	0.04 **	-0.02	0.02	0.04 *	0.00
Educational services	0.03 ***	0.02 *	0.05 ***	0.03 ***	0.01	0.03 ***	0.01 *	0.04 *	0.02	0.04 ***	0.04 *
Health care and social assistance	0.03 ***	0.02 *	0.04 **	0.05 ***	0.04 ***	0.03 ***	0.03 **	0.06 ***	0.02 *	0.06 ***	0.04 **
Information, culture and recreation	0.02 ***	0.04 ***	0.01	0.04 *	0.06 ***	0.02	-0.01	-0.01	-0.03 *	-0.03 *	0.09 *
Accommodation and food services	0.01 *	-0.01	0.00	0.05 ***	0.05 ***	0.02	0.03 *	0.03 *	0.05 ***	0.01	0.07 ***
Other services (except public administration)	0.01	0.00	0.06 ***	0.05 ***	0.04 ***	-0.02 *	0.00	0.04 *	0.04 ***	0.08 ***	0.13 ***
Public administration	0.01	0.04 ***	0.02 **	-0.01	-0.02 *	0.02 ***	-0.01	0.01	-0.02	0.00	0.03 *

Note: For each region, the "**Total**" aggregate is shown in bold font, and the "***Goods***" and "***Services***" sectors are bolded and italicized. All remaining sub-aggregates are shown in standard font. Statistically significant increases and decreases are coloured green and red, respectively. Increases and decreases are relative to a forecast with no shock. One star (*) represents statistical signifcance at the 68 percent confidence level; two stars (**) represents statistical significance at the 90 percent confidence level, and three stars (***) represents statistical significance at the 95 percent confidence level.

Table 6: Impact on Real Wages from a Positive Shock to Energy Prices - 5 Year Horizon

Percentage change in real wages after five years, resulting from a one percent increase in the BoC's Energy Price Index

Shock: Energy Prices (1%)	**CAN**	**BC**	**AB**	**SK**	**MB**	**ON**	**QC**	**NB**	**NS**	**PEI**	**NFLD**
Total employees, all industries	**0.05** ***	**0.05** ***	**0.09** ***	**0.09** ***	**0.05** ***	**0.05** ***	**0.03** ***	**0.09** ***	**0.06** ***	**0.05** ***	**0.12** ***
Goods-producing sector	***0.06*** ***	***0.09*** ***	***0.11*** ***	***0.11*** ***	***0.07*** ***	***0.04*** ***	***0.04*** ***	***0.09*** ***	***0.07*** ***	***0.02*** **	***0.14*** ***
Agriculture	0.08 ***	0.14 ***	0.04	0.09 ***	0.1 ***	0.14 ***	0.07 ***	0.1 ***	0.1 ***	0.04 *	0.23 ***
Forestry, fishing, mining, quarrying, oil and gas	0.11 ***	0.08 ***	0.11 ***	0.11 ***	0.11 ***	0.03 ***	0.08 ***	0.1 ***	0.07 ***	0.07 ***	0.19 ***
Utilities	0.04 ***	0.07 ***	0.14 ***	0.1 ***	0.02 *	0.04 ***	0.05 ***	0.07 **	0.06 **	0.06	0.14 ***
Construction	0.06 ***	0.08 ***	0.11 ***	0.14 ***	0.09 ***	0.03 ***	0.05 ***	0.13 ***	0.1 ***	0.05 ***	0.14 ***
Manufacturing	0.04 ***	0.07 ***	0.1 ***	0.1 ***	0.05 ***	0.03 ***	0.04 ***	0.08 ***	0.06 ***	0.04 ***	0.05 ***
Services-producing sector	***0.05*** ***	***0.04*** ***	***0.08*** ***	***0.08*** ***	***0.05*** ***	***0.05*** ***	***0.03*** ***	***0.09*** ***	***0.06*** ***	***0.06*** ***	***0.12*** ***
Wholesale and retail trade	0.05 ***	0.06 ***	0.06 ***	0.09 ***	0.05 ***	0.05 ***	0.05 ***	0.1 ***	0.07 ***	0.07 ***	0.1 ***
Transportation and warehousing	0.05 ***	0.07 ***	0.09 ***	0.1 ***	0.04 ***	0.04 ***	0.02 ***	0.04 ***	0.04 ***	0.03 *	0.1 ***
Finance, insurance, real estate, rental and leasing	0.02 **	0.04 ***	0.11 ***	0.1 ***	0.08 ***	0.02 *	0.04 **	0.07 ***	0.07 ***	0.03 *	0.14 ***
Professional, scientific and technical services	0.01 **	0.09 ***	0.14 ***	0.11 ***	0.09 ***	-0.01	0.01	0.05 ***	0.01	0.13 ***	0.1 ***
Business, building and other support services	0.06 ***	0.08 ***	0.14 ***	0.14 ***	0.12 ***	0.03 ***	0.07 ***	0.05 ***	0.06 ***	0.09 ***	0.21 ***
Educational services	0.06 ***	0.03 ***	0.07 ***	0.09 ***	0.08 ***	0.09 ***	0.03 ***	0.11 ***	0.07 ***	0.08 ***	0.11 ***
Health care and social assistance	0.05 ***	0.01	0.08 ***	0.08 ***	0.09 ***	0.06 ***	0.04 ***	0.09 ***	0.02 **	0.05 ***	0.11 ***
Information, culture and recreation	0.07 ***	0.07 ***	0.09 ***	0.04 ***	0.06 ***	0.06 ***	0.05 ***	0.13 ***	0.08 ***	0.05 ***	0.18 ***
Accommodation and food services	0.07 ***	0.04 ***	0.1 ***	0.12 ***	0.09 ***	0.08 ***	0.06 ***	0.12 ***	0.14 ***	0.08 ***	0.21 ***
Other services (except public administration)	0.05 ***	0.05 ***	0.11 ***	0.14 ***	0.07 ***	0.06 ***	0.04 ***	0.13 ***	0.14 ***	0.00	0.12 ***
Public administration	0.02 ***	0.07 ***	0.07 ***	0.02	0.00	0.03 ***	0.01	0.05 ***	0.05 ***	0.03 ***	0.08 ***

Note: For each region, the "**Total**" aggregate is shown in bold font, and the "***Goods***" and "***Services***" sectors are bolded and italicized. All remaining sub-aggregates are shown in standard font. Statistically significant increases and decreases are coloured green and red, respectively. Increases and decreases are relative to a forecast with no shock. One star (*) represents statistical signifcance at the 68 percent confidence level; two stars (**) represents statistical significance at the 90 percent confidence level, and three stars (***) represents statistical significance at the 95 percent confidence level.