The Impacts of the Oil Price and Policy Uncertainty on Canadian Real Economic Activities: An SVAR Approach

Final Oral Defense in Partial Fulfillment of the Requirements for the Degree of

MASTER OF ARTS
in the Department of Economics

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Outline

1. Introduction
2. Literature Review
3. Data
4. Methodology
5. Results
6. Conclusion & Further Studies

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1. Introduction

- Both the oil price and policy uncertainty are important determinants of economic development.

- The daily consumption of crude oil is around 1.5 million barrels in Canada (Canadian Association of Petroleum Producers, n.d.).

- If unexpected factors occur (e.g., recession, pandemic, disaster, etc.), the government might delay implementing effective policies, so policy uncertainty arises.

- My research build on the existing literature by examining the case in Canada and using several production variables (i.e., industrial, manufacturing, construction) as a proxy for real economic activity. This allows me to examine the impact of oil price movements and policy uncertainty on different aspects of economic activity.

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2. Literature Review

- **Killian (2009):**

a) Adopted the structural VAR (SVAR) approach to examine the associations among the oil supply shock, aggregate demand shock, and oil specific demand shock on a global scale.

b) Both demand shocks have a persistently positive effect on global real economic activity.

- **Kang and Ratti (2013):**

a) Extended Killian's (2009) SVAR model by incorporating policy uncertainty and real stock returns.

b) The IRFs indicated that U.S. real activity varies positively with oil specific demand shock and varies negatively with policy uncertainty shock.

c) The forecast error variance decompositions (FEVDs) revealed that oil specific demand shock and policy uncertainty shock jointly explain 30% of the variability in U.S. real stock return.

2. Literature Review

- **Elder and Serletis (2009)**:

a) Studied how the oil price volatility influences the outputs from four Canadian industries (i.e., good producing, service producing, industrial production, and mining, oil, gas extraction) through using a multivariate GARCH-in-mean SVAR model.

b) A higher volatility tends to significantly reduce the outputs from all but service producing sector.

- **Mehrara and Sarem (2009)**:

a) Discovered how the industrial output of three oil-exporting countries responded to oil price shocks.

b) Conducted Granger causality and cointegration tests.

c) An oil price shock Granger causes Iranian and Saudi Arabian output growth over both the short-run and the long-run.

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3. Data

- **Observations**: Monthly series from January 1986 to June 2020.

- **Data Source**:

a) Oil Price: the spot price of West Texas Intermediate (WTI) crude oil, from the *U.S. Energy Information*

b) Policy Uncertainty: Canadian economic policy uncertainty index, from the *Economic Policy Uncertainty* website

c) Real Economic Activity: production indices of Canadian industrial, manufacturing, and construction activities, from the *OECD Main Economic Indicators*

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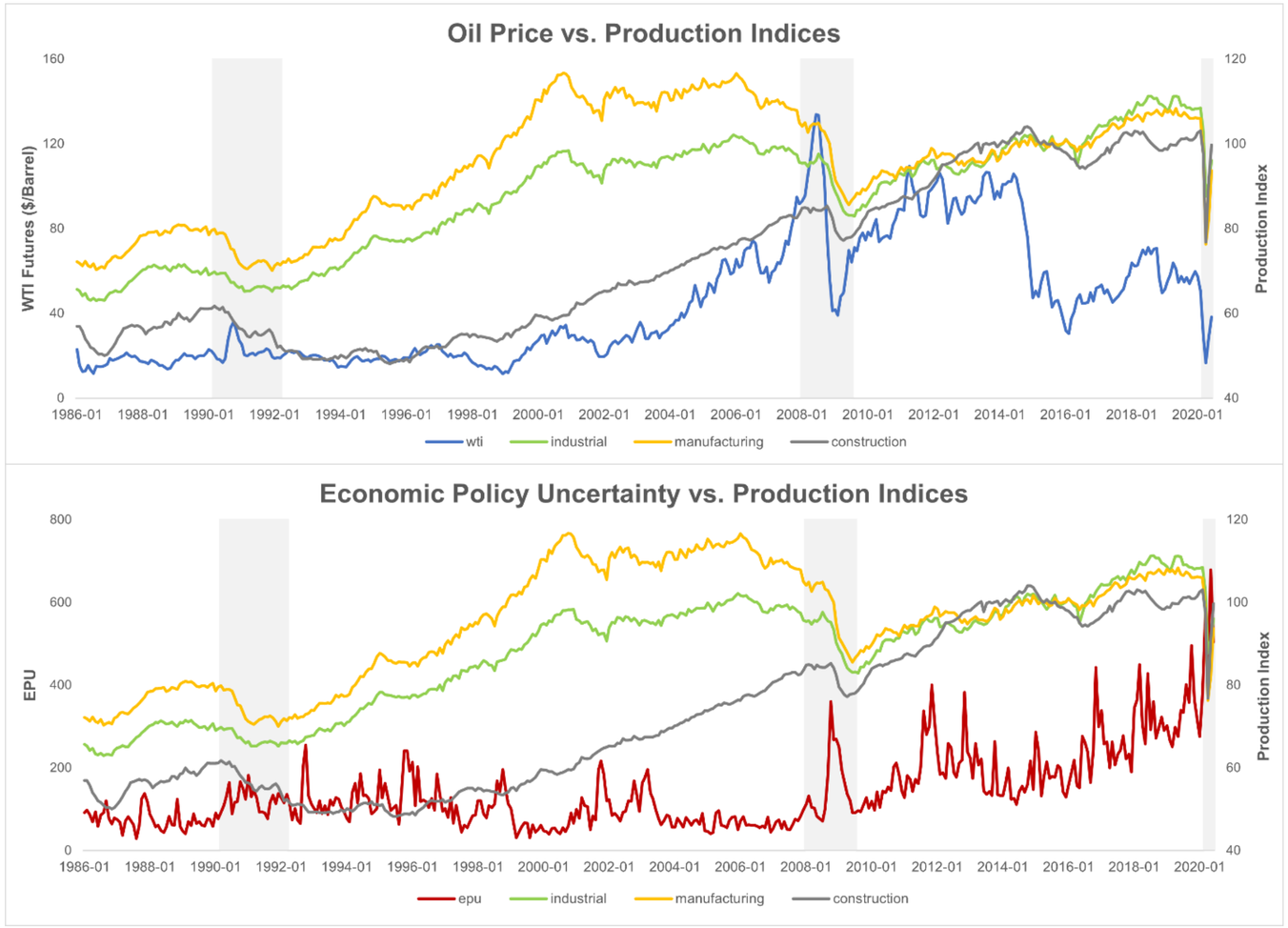
3.1 Time Series Plot



- **Trend**: each series has an overall upward trend except the oil price series.
- **Correlations**: economic policy uncertainty series seems to move in an opposite direction to other variables.
- **Cycles**: apparent cyclical patterns seems evident for each series.

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3.2 Covariance Stationarity

- Augmented Dickey Fuller (ADF), Dickey Fuller GLS (DFGLS), KPSS tests
- **Null Hypotheses (H_0)**:

a) ADF & DFGLS: the series has a unit root

b) KPSS: the series is covariance stationary

- I include 11 deterministic seasonal dummy variables and a linear trend in the testing equations as control variables
- I select 11 augmentation terms to ensure the validity of the tests while using monthly data.
- The critical value is based on α = 10% due to the low power of the tests.

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3.2 Covariance Stationarity

Series	ADF		DF-GLS		KPSS	
	Test Statistic	Crit. Val ($\alpha = 10\%$)	Test Statistic	Crit. Val ($\alpha = 10\%$)	Test Statistic	Crit. Val ($\alpha = 10\%$)
WTI	-2.096	-3.130	-2.100	-2.560	0.233	0.119
EPU	-1.232		-1.352		0.429	
Industrial	-1.707		-1.805		0.327	
Manufacturing	-1.186		-0.963		0.436	
Construction	-1.389		-1.252		0.402	

Note: The number of augmentation lags for both the ADF and the DF-GLS tests is set at 11 for each auxiliary regression. For the KPSS test, the #bandwidth is selected through using the Bartlett kernel, and is equal to 15 for EPU and 16 for the other series.

- Each of the series is **covariance non-stationary** with at least one unit root.

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3.3 Seasonal Unit Roots

Frequency	WTI	EPU	Industrial	Manufacturing	Construction
0 & 2π	-1.720	-0.137	-1.665	-1.872	-0.782
2π/12 & 22π/12	22.721***	25.918***	41.635***	22.168***	29.180***
4π/12 & 20π/12	30.366***	39.893***	24.255***	9.192***	5.872***
6π/12 & 18π/12	30.175***	55.041***	16.541***	11.692***	1.679**
8π/12 & 16π/12	43.438***	27.200***	19.990***	14.291***	4.022***
10π/12 & 14π/12	33.384***	22.870***	42.522***	35.132***	13.503***
π	-6.013***	-6.072***	-5.895***	-5.736***	-3.014**
All seasonal frequencies	606.388***	74.796***	30.020***	373.439***	215.603***
All frequencies	557.472***	71.682***	28.313***	348.928***	198.284***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

- I undertake HEGY test to detect the presence of seasonal unit roots
- **Null Hypotheses (H_0)**: the series has a unit root at the specified frequency (or degree).
- If a series has a unit root at the frequencies other than 0, we may say that the series exhibits a seasonal unit root.
- The test results indicate that all series have a **non-seasonal** unit root but no seasonal unit roots.

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3.4 Cointegration Test

- I perform Johansen's (1988, 1991) maximum-eigenvalue and trace tests to explore for possible cointegrating (long-term) relationships among the series in the same system.

- Each system contain three series: the oil price, economic policy uncertainty, each production type. Therefore, I undertake the test for each considered production variable.

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3.4 Cointegration Test

- **Maximum-eigenvalue Test**:

$$H_0^1: r = 0 \quad \text{vs.} \quad H_a^1: r = 1$$

$$H_0^2: r = 1 \quad \text{vs.} \quad H_a^2: r = 2$$

$$H_0^3: r = 2 \quad \text{vs.} \quad H_a^3: r = 3$$

- **Trace Test**:

$$H_0^1: r = 0 \quad \text{vs.} \quad H_a^1: r = 3$$

$$H_0^2: r = 1 \quad \text{vs.} \quad H_a^2: r = 3$$

$$H_0^3: r = 2 \quad \text{vs.} \quad H_a^3: r = 3$$

- r denotes the number of cointegrating vectors in the system.

- If we fail to reject H_0^1, we stop testing, concluding no cointegrating relationships.

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3.4 Cointegration Test

Production Series	Maximum-Eigenvalue Test (H_0: r = 0 vs. H_a: r = 1)		Trace Test (H_0: r = 0 vs. H_a: r = 3)	
	Statistic	Crit. Val (α = 5%)	Statistic	Crit. Val (α = 5%)
Industrial	4.662	21.132	8.361	29.797
Manufacturing	5.277		9.519	
Construction	11.232		17.629	

- There are **no** cointegrating relationships in each system, and using the first difference of each series in the VAR estimation seems reasonable.

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3.5 VAR Diagnostics

$$Y_t = \alpha + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{j=1}^{11} \psi_j D_{t,j} + \varepsilon_t$$

- $Y_t = [\Delta wti_t, \Delta epu_t, \Delta production_t^k]'$; k = industrial, manufacturing, or construction
- Y_{t-i}: lagged values at order i
- Φ_i: the (3 × 3) matrix of reduced-form autoregressive parameters
- $D_{t,j}$: binary variable for the j^{th} month
- ε_t: the (3 × 1) vector of reduced-form error terms

- Based on the Akaike's (1974) Info Criterion, choose p = 4 for the models consisting of industrial and manufacturing productions and p = 6 for construction production.

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3.5 VAR Diagnostics

Dependent Variable	Independent Variables	χ^2	p-value
Δind	Δwti	26.842	0.0000
	Δepu	4.927	0.2948
	All	39.374	0.0000
Δman	Δwti	19.604	0.0006
	Δepu	7.946	0.0936
	All	35.290	0.0002
Δcon	Δwti	17.976	0.0063
	Δepu	23.319	0.0007
	All	52.491	0.0001

- **Granger's (1969) non-causality test**: tests for one-period ahead predictability.
- **Null Hypothesis (H_0)**: the lagged independent variable does not help explain or Granger cause the current value of the dependent variable.
- The price of crude oil Granger causes all production types, while policy uncertainty only help explain construction production.

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4. Methodology

- Functional form

- Identifying restrictions

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4.1 Functional Form

$$A_0 Y_t = \alpha + \sum_{i=1}^{p} A_i Y_{t-i} + \sum_{j=1}^{11} \gamma_j D_{t,j} + u_t$$

- A_0: the (3 × 3) contemporaneous coefficient matrix between the endogenous variables
- A_i: the (3 × 3) matrix comprising the structural autoregressive parameters at order i
- u_t: the (3 × 1) vector of structural error terms

- I impose **short-run** restrictions via the error terms, as there are likely no cointegrating relationships amongst the oil price, policy uncertainty, and each real production.

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4.2 Identifying Restrictions – Expressions

$$\varepsilon_t = A_0^{-1} u_t$$

$$\begin{bmatrix} \varepsilon_t^{\Delta wti} \\ \varepsilon_t^{\Delta epu} \\ \varepsilon_t^{\Delta production} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} u_t^{\Delta wti} \\ u_t^{\Delta epu} \\ u_t^{\Delta production} \end{bmatrix}$$

$$\begin{bmatrix} \varepsilon_t^{\Delta wti} \\ \varepsilon_t^{\Delta epu} \\ \varepsilon_t^{\Delta production} \end{bmatrix} = \begin{bmatrix} a_{11} u_t^{\Delta wti} \\ a_{21} u_t^{\Delta wti} + a_{22} u_t^{\Delta epu} \\ a_{31} u_t^{\Delta wti} + a_{32} u_t^{\Delta epu} + a_{33} u_t^{\Delta production} \end{bmatrix}$$

- $u_t^{\Delta wti}$: Oil price shock
- $u_t^{\Delta epu}$: Policy uncertainty shock
- $u_t^{\Delta production}$: Shock in real activity

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4.2 Identifying Restrictions – Economic Reasonings

$$\begin{bmatrix} \varepsilon_t^{\Delta wti} \\ \varepsilon_t^{\Delta epu} \\ \varepsilon_t^{\Delta production} \end{bmatrix} = \begin{bmatrix} a_{11}u_t^{\Delta wti} \\ a_{21}u_t^{\Delta wti} + a_{22}u_t^{\Delta epu} \\ a_{31}u_t^{\Delta wti} + a_{32}u_t^{\Delta epu} + a_{33}u_t^{\Delta production} \end{bmatrix}$$

a. The oil price does not respond to shocks in Canadian economic policy uncertainty and real activity because it captures the oil market price of the entire world.

b. A change in the oil price can affect Canadian policy uncertainty, as we cannot anticipate the direction of that change.

c. Both the world oil price and economic policy uncertainty are necessary determinants of domestic real economic activities.

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5. Results

- I interpret and discuss my empirical findings based on:

a) Impulse response functions (IRFs)

b) Forecast error variance decompositions (FEVDs)

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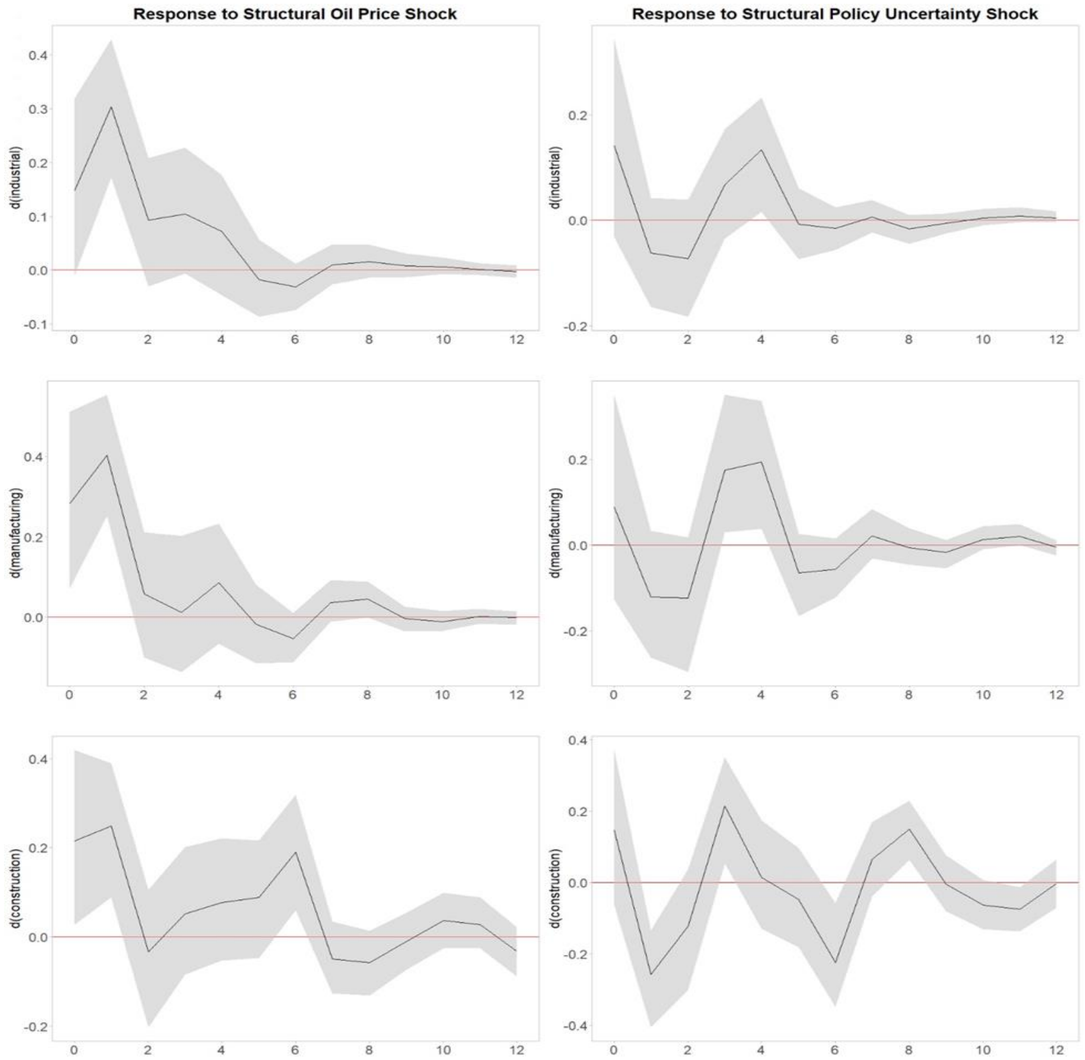
5.1 Impulse Response Analysis



- The oil price shock leads to an instantaneous **positive** response for all types of real productions, but this effect dissipates quickly.

- The policy uncertainty shock has a statistically significant impact on construction production, being negative instantaneously but becoming positive shortly thereafter.

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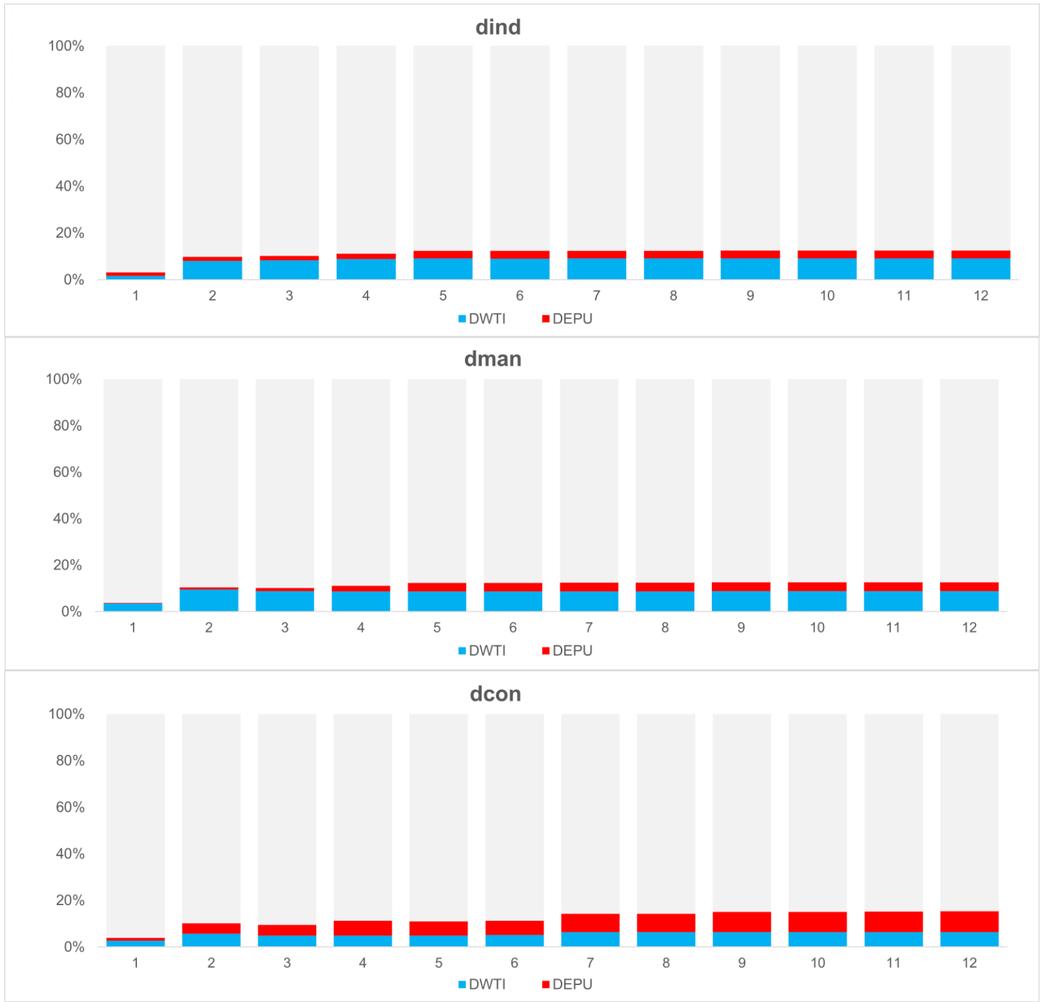
5.2 Forecast Error Variance Decomposition



- The structural shocks to the oil price and to policy uncertainty jointly explain **15-20%** of the forecast error variance in productions.

- The oil price shock contributes a higher proportion of the variability in industrial and manufacturing productions than policy uncertainty shock; This is the inverse *w.r.t.* construction production

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6. Conclusion & Further Studies

- Summary of main findings:

a) The oil price Granger causes each production measures, while policy uncertainty only Granger causes real construction activity.

b) The oil price shock has a positive and instantaneous influence on all production types, while policy uncertainty shock leads to a significant but directional response for the construction production.

c) The shocks in the oil price and policy uncertainty jointly contribute to nearly one-fifth of the forecast variability in real economic activities.

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6. Conclusion & Further Studies

- **Future works**:

a) Undertake structural break tests to examine whether economic recessions significantly affect the interactions amongst the oil price, economic policy uncertainty, and real economic activity.

b) Explore the case in developing countries using the same methodology and compare the results with the scenario in Canada.

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