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How Does the Economic Policy Uncertainty Affect the Gap Between WCS and WTI?

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ABSTRACT
Many studies have shown that the Economic Policy Uncertainty (EPU) has a significant effect on both West Texas Intermediate (WTI) and Western Canada Select (WCS) crude oil prices. This paper estimated the relationship between the EPU in both countries and the gap between WCS and WTI, specifically focusing on the effect changing in the different time periods. The result shows that Canada EPU has a fewer effect on the price spread than the US EPU. The maximum effect of EPU change in Canada and the United States on the price gap both appear at the 30th month. This paper also finds the different kinds of economic policy in the United States have different effect on the price gap in terms of time and size.

Keywords: *EPU, WTI, WCS, Lag effect, Price spread.*

1. INTRODUCTION

In these decades, crude oil has been considered a hard currency globally. The United States is the largest economic system globally and the largest importer of heavy oil from Canada. These two countries always have plenty of cooperation in the oil & gas industry. The West Texas Intermediate (WTI) crude oil is one of the main benchmarks in world oil pricing and a world reference price quoted in the media [1].

On the other hand, the Western Canadian Select (WCS) crude oil price is the primary benchmark in Canada's oil pricing [2]. The WTI and WCS oil prices and their price spread from 2005 to 2020 are shown in Figure 1 [3]. There is a noticeable fluctuation in the price spread. Under normal circumstances, the price difference between WTI and WCS oil price should be stable since the chemical composition of each crude oil is under its standard for example specific gravity and sulfur content. [4] However, in some specific periods, the prices spread highly enlarged, and the WCS price significantly deviates its actual value. In March 2018, the price spread was roughly 27 USD. The price of WTI is increasing slightly, but a dramatic drop can be seen in the WCS price. In Dec 2018, the price difference of WTI and WCS was about 43 USD, with WCS crude worth only 6 USD per barrel.

The supply-demand relationship affects the oil price and is largely impacted by political factors. For example, the three oil crises in history have led to the rapid growth of oil prices [5]. The price difference between WTI and WCS is also affected by Canada and the U.S. policies as a large supplement to the oil transportation capacity between Canada and the U.S. President Obama suspended the Keystone XL pipeline program in 2015 for the first time. Then in 2017, President Trump announced approval for the restart of this project. However, in 2021, President Biden canceled the project again on his first day in the White House [6].

After this introduction section and the literature review section (next section), the section3 shows the methodology which includes the regression model, data selection and modification. Section 4 shows the figure result and the discussion based on the regression results. In the end of this paper, section5 suggests the future work and the possible value of this results for the real world.

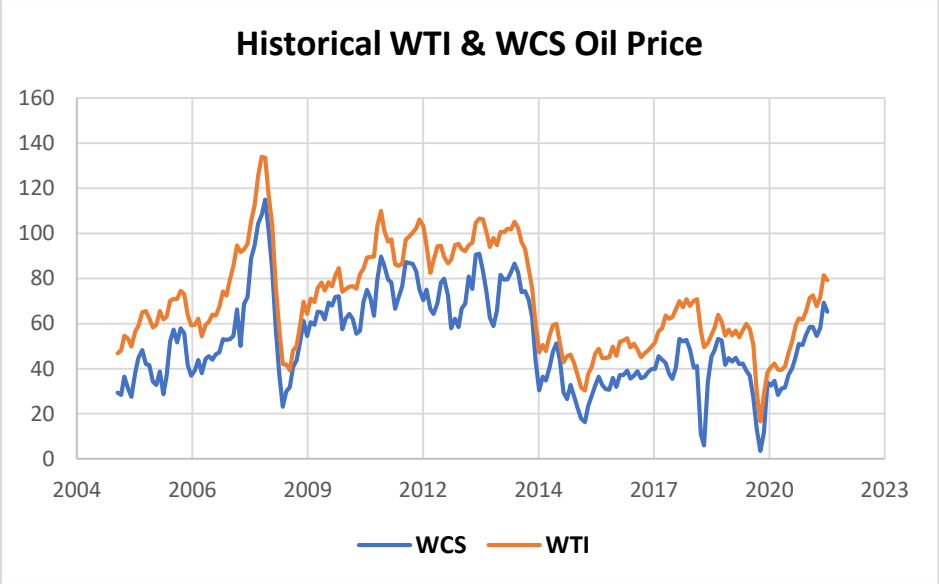

Figure 1. WTI and WCS oil price [3]

2. LITERATURE REVIEW

Many authors have studied the impact of policy uncertainties on oil price, and comprehensive results have been achieved.

Recently, Su et al. investigated the relationship between the United States Economic policy uncertainty and WTI crude oil price. They studied the effect between the U.S. EPU and WTI spot price fluctuations using VAR and BEKKGRARCH models, and both models had shown similar results. A one-way Granger causality link between US EPU and WTI oil price was revealed, and the correlation could have positive or negative directions. Also, a two-way volatility spillover effect between the two variables is proved, guiding both investors and policymakers to make their decision [7].

Zhang and Yan also conducted an econometric study of the relationship between US EPU and WTI oil price, and they took the frequency domains into account. The authors concluded that the US EPU and WTI oil prices are almost negatively correlated during the sampling period from 1985 to 2019. They also claimed that the scale of US EPU on WTI highly depends on the length of the frequency bands. At frequency bands of 1-6 and 6-12 months, most of the common EPU has an evident impact on WTI oil price [8]. However, at the frequency band of 12-24 months, only the monetary policy, regulatory, and national security policy uncertainty have an observable effect on the WTI oil price.

Based on the fact that most of the crude oil produced in Western Canada will be exported to the U.S for refining, Wall and Zheng studied the impact of insufficient pipeline capacity on WCS (Western Canadian Select) oil price [9]. The authors claimed that the discount of WCS oil prices relative to U.S. benchmark oil price would increase by 3.6% for a 1% increase in pipeline capacity constraints between Canada and United States. Though the Canadian refiners and refined products' consumers benefit from the lower crude oil price, the total gains are much less than the losses from the upstream oil extraction industry.

Wilmot and Taivan utilized oil production in the United States and Canada to estimate the causal relationship in the North American energy industry using different models [10]. The tests shows that North America is a highly integrated energy market. Also, a bidirectional relationship between the two countries' crude oil production is proved.

These papers mainly focus on either the EPU effect on the WTI or the real field output to estimate the relationship between the crude oil industries in Canada and United States. To the author's best knowledge, the impact of EPU on WTI and WCS price spread has not been studied before. Therefore, this paper will investigate how policy uncertainties, including different kinds of nominal factors, will affect the price spread of WTI and WCS.

3. METHODOLOGY

3.1 Regression model

This paper applies the estimation equation based on Ramey's public economic handbook chapter 2, Macroeconomic Shocks and Their Propagation [11]. This model is good at thinking about the lag of reaction of the price spread affected by the EPU.

$$spread\ of\ two\ prices_{t+h} = \alpha_h + \theta_{1h} * EPUCA_t + \theta_{2h} * EPUUS_t + control\ variables + \varepsilon_{t+h} \quad (1)$$

The θ_{ih} will give the response of spread of two prices at time $t+h$ to an EPU change at time t. Because this model estimates regressions of the dependent variable at

horizon $t+h$ on the shock in period t and uses the coefficient on the shock as the impulse response estimate. By Ramey, she also proved that ε_{t+h} will be serially correlated, so the standard errors must incorporate a correction. And the control variables will include the federal funds rate (overnight rate), industrial production, crude oil production, and CPI of both Canada and the United States.

3.2 Estimation Procedure

Firstly, as the time of the effect is more important in this model, the difference between each period of each variable is used as observations. Each variable change to

$$de_{variable\ t+1} = variable_{t+1} - variable_t \quad (2)$$

where the variables include EPU, federal funds rate, industrial production, crude oil production, and CPI of both Canada and The United States.

Secondly, as there is some decrease change in some of the variables, so $d_{variable}$ have some negative values and may leads to some offset in regression. By using the Newey-West standard errors regression method, the original data didn't show obvious and significant trend. (The original data may need more comprehensive model to analysis). Therefore, the absolute value of $d_{variable}$ is used. So this model only focus on the size of each variable difference.

$$d_{variable\ t+1} = |de_{variable}|_{t+1} \quad (3)$$

The study begins with the simplest regression (model 1).

$$d(spread\ of\ two\ prices)_{t+h} = \alpha_h + \theta_{1h} * d(EPUCA)_t + \theta_{2h} * d(EPUUS)_t + \varepsilon_{t+h} \quad (4)$$

The θ_{ih} is estimated by the OLS regression with Newey-West standard errors for the coefficients. The error structure is assumed to be heteroskedastic and possibly autocorrelated up to some lag. For this model, a long time series of lag is used. The largest lag is allowed to be 90. It means the maximum value of *h* is 90. For each length of lag *h*, the change of EPU of both Canada and the United States is used as the main shock. *i* = 1,2 where 1 indicates the coeffitients about Canada and 2 indicates coeffitents about the United States.

Then, three observations of them in the model like $EPU_t, EPU_{t-1}, EPU_{t-2}$ of these two countries is used to allow the effect of EPU on the price spread have some delay. The θ_{ihj} is still the estimated by the OLS with Newey-west standard errors for the coefficeients. Subscripts *i* and *h* maintain indicating the coutries index and the lag length. Subscript *j* indicates the independent variables (EPU of both countries) lag period. *j*=1,2,3 means the EPU index is from time $t,\ t-1, t-2$, separately.

$$d(spread\ of\ two\ prices)_{t+h} = \alpha_h + \theta_{1h1} * d(EPUCA)_t + \theta_{2h1} * d(EPUUS)_t + \theta_{1h2} * d(EPUCA)_{t-1} + \theta_{2h2} * d(EPUUS)_{t-1} + \theta_{1h3} * d(EPUCA)_{t-2} + \theta_{2h3} * d(EPUUS)_{t-2} + \varepsilon_{t+h} \quad (5)$$

To increase accuracy, some major macroeconomic indexes like industrial production, CPI, federal funds interest, and crude oil production are added to the model. Also, considering the lag of effect, three observations of these control independent variables like the mainshock variable EPU are incorporated.

$$d(spread\ of\ two\ prices)_{t+h} = \alpha_h + \theta_{1h1} * d(EPUCA)_t + \theta_{2h1} * d(EPUUS)_t + \theta_{1h2} * d(EPUCA)_{t-1} + \theta_{2h2} * d(EPUUS)_{t-1} + \theta_{1h3} * d(EPUCA)_{t-2} + \theta_{2h3} * d(EPUUS)_{t-2} + \overrightarrow{\theta_\iota} * \overrightarrow{d_{control\ variables\ \iota}} + \varepsilon_{t+h} \quad (6)$$

where $\overrightarrow{\theta_\iota}$ includes each coefficient of each macroeconomic index for both countries, $\overrightarrow{d_{control\ variable\ \iota}}$ indicates each macroeconomic index variable for each country.

This study also estimates the effect of each kind of economic policy uncertainty in the United States. It includes monetary policy, fiscal policy, taxes policy, government spending, health care, national security, entitlement programs, regulation, financial regulation, trade policy, sovereign debts, and currency crisis policy. The model is shown below:

$$d(spread\ of\ two\ prices)_{t+h} = \alpha_h + \theta_{1h1} * d(EPUCA)_t + \theta_{2h1} * d(EPUUS)_{(j)t} + \theta_{1h2} * d(EPUCA)_{t-1} + \theta_{2h2} * d(EPUUS)_{(j)t-1} + \theta_{1h3} * d(EPUCA)_{t-2} + \theta_{2h3} * d(EPUUS)_{(j)t-2} + \overrightarrow{\theta_\iota} * \overrightarrow{d_{control\ variables\ \iota}} + \varepsilon_{t+h} \quad (7)$$

The subscript *j* indicates 11 different kinds of the United States economic policy as shown in the index of Figure 6. This model considers Canada's economic policy uncertainty as a whole. Then the regression for each United States economic policy uncertainty is conducted, and the results are compared.

3.3 Graph

For graphs, h is used as the horizontal axis, and the coefficients (θ_{1h1} and θ_{2h1}) of the variables $d(EPUCA)_t$ *and* $d(EPUUS)_t$ is used as the vertical axis. Also, the 90% confidence interval is included for each lag period h. The cross median is calculated and fitted to a cubic spline to show the trend of effect of the EPU on the price spread in each country.

3.4 Data

The monthly level data from the U.S. and Canada, including the EPU, WTI crude oil price, WCS crude oil price, and common economic variables like the CPI index

and central bank rate, is collected. The data period is 2005 Jan-2021 April, with 196 monthly observations. The EPU index chosen is downloaded from the EPU website [12]. This index is news-based, which is a method for estimating economic policy uncertainty. WTI and WCS crude oil historical price data are downloaded from the Alberta government website [3]. The website uses the Source U.S. Energy Information Administration (Jan 1986 to present) for WTI crude oil price and the source Alberta Energy (Jan 2009 to present) for WCS crude oil price.

All of the macroeconomics indices are obtained from the FRED website [13] to maintain consistency. For the industrial production, the observations are normalized using the value 2015=100, under seasonally adjusted. The observations are normalized for the consumer price index using the value 2015=100, without seasonally adjusted. The nominal values are used for the federal funds interest rate in the United States, Canada's central bank interest rate, and crude oil production. Rather than more extended period annual data, more frequency data is used in the study. The WTI and WCS oil prices change quickly, and the slight change in the crude oil market has a significant effect in many different areas of the world economy. Therefore, investors and regulators need more time-sensitive conclusions to make their decisions. In addition, for the economic policy uncertainty of the United States, more specific data is necessary. The reason is that the U.S. has significant market power and discourse power in plenty of categories, including the crude oil market.

4. RESULTS AND ANALYSIS

4.1 Regression results of model 1 to model 3

The regressions using model 1, model 2, and model 3 are shown below from Figure 2 to Figure 5 and Table 1.

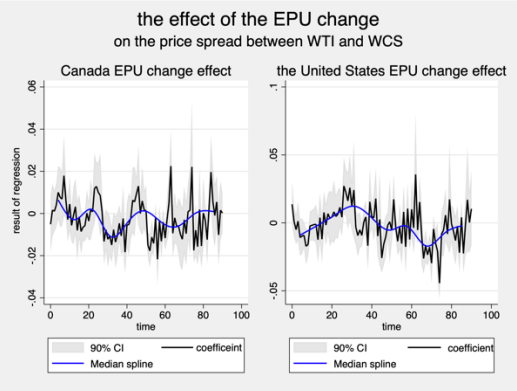

Figure 2. Result of simple linear regression

(Model 1)

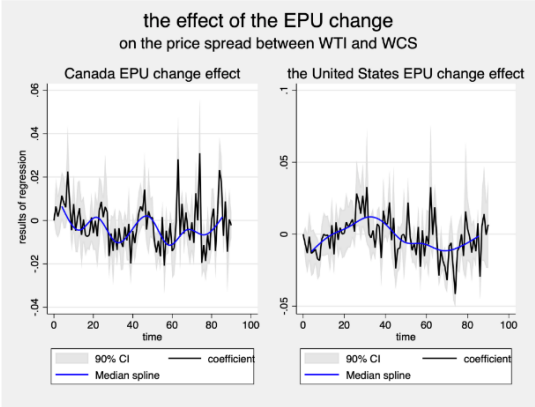

Figure 3. Result of linear regression allowing lag of the effect EPU (model 2)

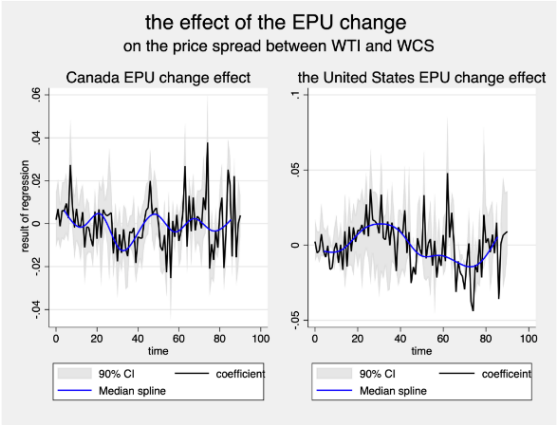

Figure 4. Results model 3 regression

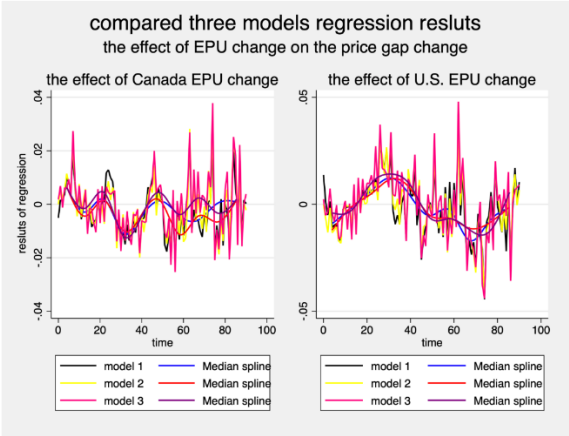

Figure 5. Results comparison among the 3 models

Table 1. Statistics summary of the regressions (Model 1, Model 2 and Model 3)

coefficientsθ_{1h}	mean	sd	min	max
Model1_CA	-0.0022	0.0093	-0.0217	0.0225
Model1_US	-0.0020	0.0138	-0.0444	0.0356
Model2_CA	-0.0017	0.0103	-0.0208	0.0310
Model2_US	-0.0019	0.0142	-0.0416	0.0328
Model3_CA	-0.0003	0.0115	-0.0254	0.0378
Model3_US	-0.0002	0.0162	-0.0440	0.0479

Figure 5 shows the change of regression coefficient of EPU change over time of Canada (left) and the U.S. (right), respectively. In the beginning, the coefficient of the absolute value of EPU change is positive for Canada, meaning that the absolute value of WTI and WCS price difference change is positively correlated with the independent variable. Then a decreasing trend can be seen in the figure for roughly 20 months and reaches its negative peak at 35 months. The EPU has the largest impact on the oil price difference. The negative value means that as the uncertainty of economic policy increases, the oil price difference tends to be more stable. After 35 months, though some small fluctuations can be seen, the coefficient is relatively stable and slightly below zero, meaning that the change of EPU has a negligible impact.

As for the U.S., the coefficient of EPU change of the U.S. shows a stronger trend than that of Canada. For the first 10 months, the regression coefficient is around zero, meaning that the impact of the U.S. EPU on oil price difference is small. Then the coefficient begins to increase until it reaches the positive peak at around 35 months. At 35 months, the change in EPU has the largest impact on the change in oil price difference. As the EPU change increases, the oil prices gap fluctuation will also be enlarged. This illustrates the lag effect of the regressor on the regress. The change in EPU will not show an immediate impact on the oil price difference, but the impact will reach its maximum after 35 months. Then we can observe a decreasing trend from 35 months to 70 months, demonstrating that the positive impact gradually changes to a negative impact. After 70 months, the value of the coefficient approaches zero, so the impact of the EPU change on oil price difference change diminished over time.

By comparing Canada and the U.S., the coefficient of Canada shows stronger fluctuations, and the coefficient of the U.S. shows a more obvious tendency. Also, the variation range of the coefficient of Canada is narrower than that of the U.S. Most of the values of the coefficients for Canada are close to or slightly below zero. However, the coefficient of the U.S. varies in a wider range. This means the impact of EPU change of the U.S. on price difference change is greater than that of Canada. Intuitively, the regression results are reasonable because as the largest oil producer, consumer, and refiner, the U.S. dominates the global crude oil market. Therefore, the changes in the EPU of the U.S. will significantly impact the changes in the oil price difference. Meanwhile, the coefficients of both Canada and the U.S. reach their peaks at approximately 35 months, showing the lag effect of the independent variable.

4.2 Regression results of the additional models

In the additional model, the impact of different policy uncertainties in the U.S. is studied. The following combined figure shows the regression coefficients.

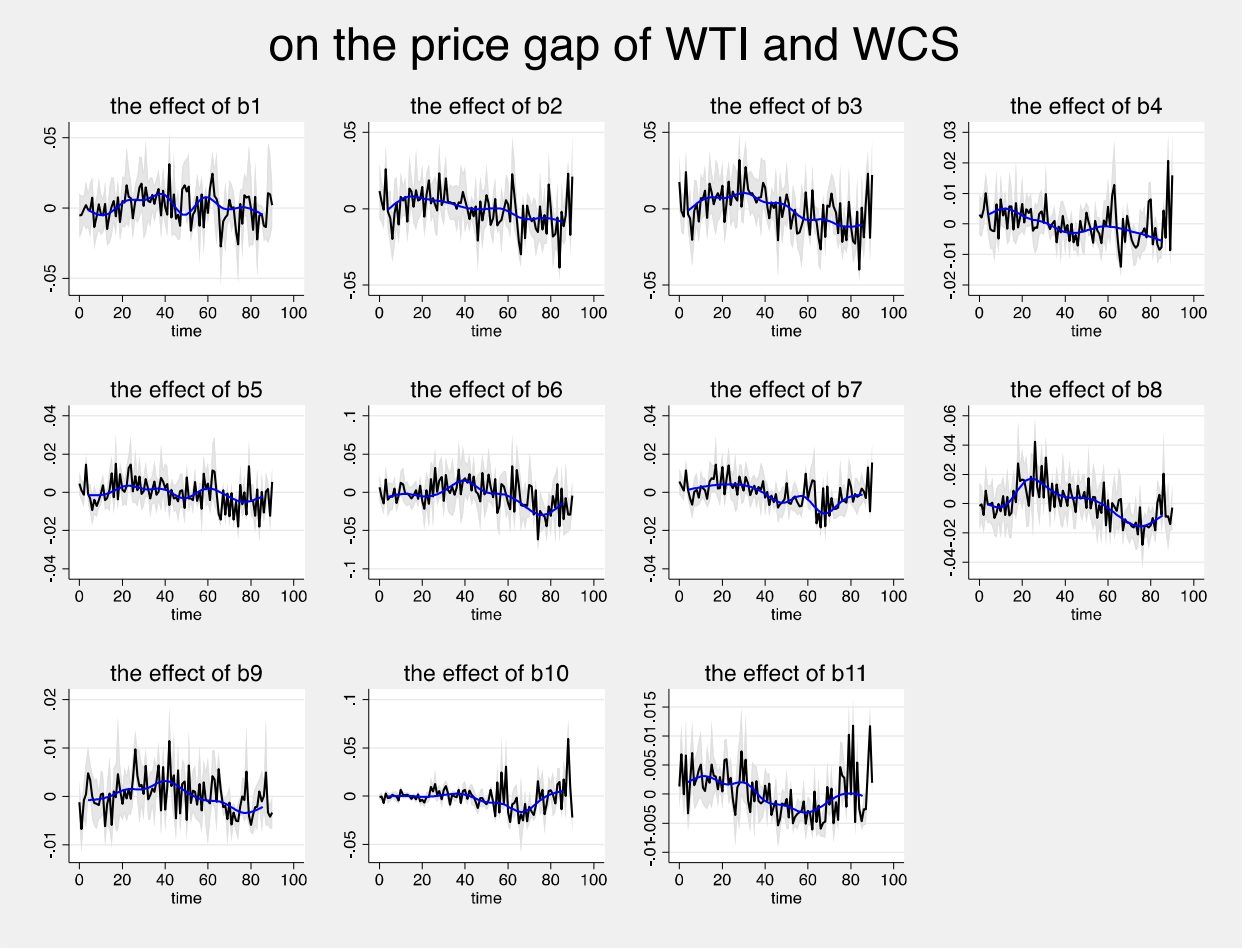

Figure 6. Regressed coefficients of different EPUs in the U.S. (Additional models)

b1 = monetary policy uncertainty
b2 = fiscal policy uncertainty
b3 = taxes policy uncertainty
b4 = government spending uncertainty
b5 = health care policy uncertainty
b6 = national security policy uncertainty
b7 = entitlement programs policy uncertainty
b8 = regulation policy uncertainty
b9 = financial regulation policy uncertainty
b10= trade policy uncertainty
b11= sovereign debts & currency crises policy

Table 2. Statistics summary of the regressions using additional models

coefficientsθ_{1h}	mean	sd	min	max
b1	0.0008	0.0107	-0.0275	0.0313
b2	-0.0003	0.0118	-0.0387	0.0258
b3	0.0001	0.0132	-0.0400	0.0317
b4	0.0001	0.0057	-0.0140	0.0206
b5	-0.0005	0.0073	-0.0181	0.0149
b6	-0.0033	0.0184	-0.0618	0.0344
b7	-0.0001	0.0067	-0.0185	0.0155
b8	0.0002	0.0123	-0.0282	0.0424
b9	0.0002	0.0036	-0.0068	0.0114
b10	-0.0014	0.0124	-0.0280	0.0593
b11	0.0003	0.0040	-0.0061	0.0118

For the amplitude shown in the figure, the health care (b5), entitlement programs (b7), financial regulation (b9), and sovereign debts&currency crises (b11) policy uncertainty's changes have a relatively small effect on the price spread of WTI and WCS. The ranges of these coefficients are all smaller than 0.03. And for the media spline, the coefficients of these four policy uncertainties fluctuate around 0. It means they do not affect the price spread very much during all the allowed lag periods.

For the effect of fiscal (b2), taxes (b3), government spending (b4), national security (b6), and regulation policy uncertainty (b8), the regression result shows the same trend during the whole allowed lag period. Firstly, the coefficients are positive and have an increasing trend. Then they decrease back to zero. It means that for the reaction of these policy uncertainty changes, the price spread of WTI and WCS will increase at the beginning. The price gap fluctuates more, and then the coefficient reaches its peak, and the price gap shows the least stability.

The effect of the b2, b3, b4, b6, and b8 change reaches the pick at the 19th month, 35th month, 13th month, 41st month, and 28th, respectively. The different policies will show their largest effect on the price spread. It means that the price spread reacts to the monetary policy and government spending policy uncertainty change faster, and other policies uncertainty will affect the price gap change after a longer period. Then the price gap change will tend to be stable for some period. After the coefficient decrease back to zero, the coefficients decrease to negative, and the absolute value of the coefficient increases. This means the price gap change begins to decrease and has some more fluctuations simultaneously. When the coefficient's absolute value increases more, the price gap change is less, which means the price gap change shows stability again. For the fiscal policy (b2), taxes policy (b3), government spending (b4), until the lag period 90, the coefficients still show decreasing trends. It means that even for a longer period, these policy uncertainties change still affect the price gap change. The change will be smaller and smaller over time. The price gap will be more and more stable. For the national security (b6) and regulation policy uncertainty (b8), their coefficient's absolute value decreases back to zero after a long period. This means, after a sufficiently long period, these two kinds of policy uncertainty change do not affect the price gap change. These two kinds of policy uncertainty change have a shorter effect than the other three kinds of policy (b2, b3, b4). In other words, the crude oil market can adjust its behavior faster to adapt to these policy uncertainty change.

For the monetary policy, the effect of the policy uncertainty change is fluctuating more frequently. The trend is not as clear as the policy mentioned above. This result can be explained by the role crude oil plays in each country's money market. For these decades, crude oil has been considered a hard currency in some countries. And the money market has a strict relationship with the foreign currency market, also the exchange rate between each country. The monetary policy uncertainty change will lead to a more complicated reaction on sufficiently reasonable crude oil prices.

In other literature, no significant conclusions were reached regarding the impact of trade policy uncertainty on oil prices. This is probably because the time period studied was so short that its impact has not yet appeared. However, in this study, trade policy shows a totally different trend from other policies. Before the time reaches the 50th month, the coefficient only fluctuates around zero slightly, which means at the first 50 months, the trade policy uncertainty change has a negligible effect on the price gap change. After 50 months, the coefficient's absolute value increases, and the fluctuation begins to change more frequently. Firstly, the trade policy uncertainty change hurts the price gap change. Then the effect approaches zero and increases to be positive and tends to increase further. The observation means the trade policy uncertainty change will lead to the price gap change after a longer lag. The trade policy uncertainty change will lead to a larger and larger change in the price gap for a long period. This result is reasonable based on the close link between Canada and the United States crude oil market. Canada exports 3.7 million barrels of oil per day to the U.S., 98% of all Canadian crude oil exports [14]. The crude oil trades are mostly based on oil futures, so the reaction of the price difference to the trading policy uncertainty change is relatively insensitive in a short period.

5. CONCLUSION

Through the previous analysis, the following conclusions can be drawn from the study:

1. The largest impact of EPU on oil price spread occurs at the 35th month for both Canada and the U.S. meaning that it is a lagged effect. However, the direction of their impacts at 35 months is different.

2.The average impact of the U.S. EPU is larger than that of Canada. Also, the EPU of the U.S. have a long-lasting impact on oil price spread until the end of studied period. However, the impact of EPU of Canada gradually diminished after 60 months. The U.S., as the dominator both in global crude oil market and in its trades with Canada, its EPU has a greater impact than Canada from both influence size and duration time perspective.

3. Similar results were obtained compared with Zhang and Yan (2020): monetary, regulation and national security policy uncertainty show a relatively longer and stronger impact on the price spread. However, in this study, policy uncertainties change about fiscal, taxes, and government spending are also found to have a significant impact on the price difference change among which fiscal

policy uncertainty change triggers the price gap change in the shortest time. The impact of trade policy uncertainty is not noticeable in the first 50 months but keeps increasing hereafter.

4. The impact of EPU change on price spread change highly depends on the types of the policies. To precisely predict the price gap change, a specific analysis of the changed policy is necessary.

Note that this research mainly focuses on the absolute changes in both the dependent variable and independent variable. The main purpose of this paper is to show that EPU will impact the price difference between WTI and WCS but not to predict the direction of the price difference change. In the future, more comprehensive researches will be conducted to investigate the direction of oil price difference change under different EPU conditions.

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