WINPEC Working Paper Series No.E1724
March 2018
Revised, May 2018

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March 18, 2018

Abstract

Previous studies on the effects of oil price changes indicate that oil price pass-through to inflation has decreased in the United States since the Great Moderation. This paper investigates why oil price pass-through has decreased in the United States from the viewpoint of an inflationary environment. By estimating a smooth transition autoregressive model that considers past US inflation rates, I show that oil price pass-through is low in a low-inflation environment. Therefore, the pass-through has been low since the Great Moderation. This result suggests that the inflationary environment is important in explaining the declining oil price pass-through in the United States.

JEL Classification: E31; E37; Q43

Keywords: Oil prices, pass-through, inflation, smooth transition autoregressive models

*I am grateful to Hajime Tomura, Kozo Ueda, Munechika Katayama, Junko Koeda, Masato Shizume, Mitsuki Oikawa, Hisaki Kono, Shinichi Nishiyama, and Naoto Jinji for their helpful comments and suggestions. I acknowledge the financial support for Grants-in-Aid for Scientific Research and Waseda University Grant for Special Research Projects.

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1 Introduction

Previous studies on the effects of oil prices indicate that the effects of oil prices on the US economy have decreased since the mid-1980s (Edelstein and Kilian 2007; Herrera and Pesavento 2009; Baumeister and Peersman 2013). Furthermore, oil price pass-through to inflation has been low since the mid-1980s (Chen 2009; Edelstein and Kilian 2009; Blanchard and Galí 2010; Ramey and Vine 2011). The period when oil price pass-through has been, they indicate, low almost coincides with the Great Moderation, when inflation was relatively low and stable. These facts imply that oil price pass-through may depend on the inflationary environment.

This paper investigates why oil price pass-through has decreased in the United States from the viewpoint of an inflationary environment. To answer this question, I estimate a smooth transition autoregressive (STAR) model that considers past inflation rates. Most of the previous literature has employed linear models such as vector autoregressive models. However, the linear models cannot capture the differences in oil price pass-through between high- and low-inflation regimes. Moreover, compared with threshold models or models dividing the periods of analysis, the STAR models capture deviations of inflation rates from the mean inflation rate for each regime.

Estimation results show that oil price pass-through is low in a low-inflation environment. As a result, oil price pass-through has been low in the United States since the Great Moderation, when the average inflation rates were relatively low and stable. This result suggests that oil price pass-through may depend on the inflationary environment.

The rest of this paper is organized as follows. Section 2 introduces the model used in this paper. Section 3 discusses the estimation results. Section 4 concludes.

2 Model

In this study, I investigate whether oil price pass-through differs in the United States between high- and low-inflation regimes. By using an exponential STAR model for the estimation, Shintani et al. (2013) found that the degree of exchange rate pass-through depends on inflation. By estimating a logistic STAR model, Sekine and Tsuruga (forthcoming), likewise, showed that the effects of commodity price shocks might be low in a low-inflation environment.

To investigate the possibility of whether the effects of oil price changes differ between high- and low-inflation regimes, I estimate the following STAR model:

$$\begin{aligned} \pi_t = \alpha + F(z_{t-d})\Big[\sum_{i=1}^{q}\beta_{1,i}^{H}\Delta o_{t-i} + \sum_{i=1}^{q}\beta_{2,i}^{H}\pi_{t-i} + \sum_{i=1}^{q}\beta_{3,i}^{H}\Delta y_{t-i}\Big] \\ +\big[1-F(z_{t-d})\big]\Big[\sum_{i=1}^{q}\beta_{1,i}^{L}\Delta o_{t-i} + \sum_{i=1}^{q}\beta_{2,i}^{L}\pi_{t-i} + \sum_{i=1}^{q}\beta_{3,i}^{L}\Delta y_{t-i}\Big] + \epsilon_t, \end{aligned} \tag{1}$$

where Δo_t is the percent changes in oil prices, π_t is CPI inflation, Δy_t is percent changes in gross domestic product (GDP), α is a constant, and ϵ_t is an error term.[1] The coefficients β^j for $j = H, L$ indicate high- and low-inflation regimes, respectively.

In (1), $F(z_{t-d})$ is a transition function. I assume the transition function as the following logistic function:

$$F(z_{t-d}) = \frac{1}{1+\exp(-\delta z_{t-d})}. \tag{2}$$

Here, z_{t-d} is assumed to be a normalized inflation rate:

$$z_{t-d} = \frac{\pi_{t-d} - \overline{\pi}}{\sigma_\pi}, \tag{3}$$

where $\bar{\pi}$ is the mean inflation rate, and σ_π is the standard deviation of the inflation rates. The delay parameter d ranges from one to four in quarter units. The parameter δ is estimated in a range of $(0, 10)$ to minimize the sum of the squared residuals (SSR).[2]

I define time-varying oil price pass-through (OPPT) as

$$\text{OPPT} = F(z_{t-d})\beta_{1,1}^{H} + \big[1 - F(z_{t-d})\big]\beta_{1,1}^{L}. \tag{4}$$

Here, $F(z_{t-d})$ weights the coefficients on the high-inflation regimes.

The main variables are annual percent changes in (i) oil prices and (ii) consumer prices. Oil prices are West Texas Intermediate quarterly average crude oil prices. Consumer prices are consumer price index for all urban consumers: all items that is seasonally adjusted. As a control variable, I include annual percent changes in GDP that is seasonally adjusted. The data for all

[1] For a robustness check, following Blanchard and Galí (2010), I included two more variables into the baseline model: log changes in wages and employment. My result is robust even if these variables were included.

[2] When the selected δ is less than 0.1, it is rechosen so that the SSR is the next smallest because estimates of the coefficients in the model with very small δ are extraordinarily large.

Table 1: Estimates of the coefficients in the STAR model

High-inflation regimes				Low-inflation regimes			
Δo_{t-1}	Δo_{t-2}	Δo_{t-3}	Δo_{t-4}	Δo_{t-1}	Δo_{t-2}	Δo_{t-3}	Δo_{t-4}
0.0175**	0.0069	0.0085**	-0.0036	0.0010	-0.0086	−0.0169**	0.0022
(0.0086)	(0.0064)	(0.0041)	(0.0075)	(0.0072)	(0.0059)	(0.0067)	(0.0077)
π_{t-1}	π_{t-2}	π_{t-3}	π_{t-4}	π_{t-1}	π_{t-2}	π_{t-3}	π_{t-4}
-0.0967	-0.0727	0.7818***	−0.2912**	0.2376	0.0415	0.0661	-0.0558
(0.3621)	(0.1562)	(0.1563)	(0.1360)	(0.1806)	(0.1776)	(0.1322)	(0.1749)
Δy_{t-1}	Δy_{t-2}	Δy_{t-3}	Δy_{t-4}	Δy_{t-1}	Δy_{t-2}	Δy_{t-3}	Δy_{t-4}
0.2433***	0.1817	-0.0044	0.0869	-0.0034	-0.0827	0.0618	-0.0109
(0.0775)	(0.1240)	(0.1061)	(0.0788)	(0.0737)	(0.1004)	(0.0858)	(0.0835)

Notes: Estimated from (1). The numbers in parentheses show Newey-West HAC standard errors. Here, (***) and (**) indicate the statistical significance at the one and five percent levels, respectively.

three variables were obtained from Federal Reserve Economic Data. I use the US quarterly data ranging from 1947:Q1–2015:Q4.

3 Results

I estimate a logistic STAR model in (1). Following the previous literature regarding the effects of oil price changes, I take four lags for quarterly data used in this analysis.

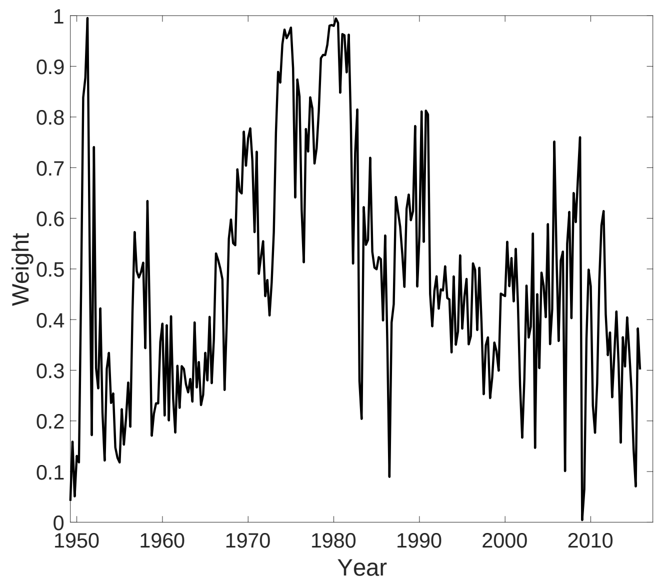
Estimation results show that oil price pass-through is low in a low-inflation environment.[3] Table 1 shows the estimates of the STAR model. The one-period-lagged coefficient on the high-inflation regimes, $\beta^H_{1,1}$, is estimated to be 0.0175 and significant. The three-period-lagged estimate of oil price changes is also significantly positive. By contrast, the one-period-lagged coefficient on the low-inflation regimes, $\beta^L_{1,1}$, is estimated to be 0.0010 and insignificant. Therefore, the effects of oil price changes on inflation would be low in a low-inflation environment.

Fig. 1 shows the evolution of $F(z_{t-d})$, which indicates the weight for high-inflation regimes. The value of transition function is relatively high for the 1970s through the mid-1980s, thus implying that high-inflation regimes dominated the era. After the mid-1980s, the value transition function is low, thus implying that low-inflation regimes dominated during the period.

Next, I focus on time-varying oil price pass-through. Fig. 2 represents the evolution of the time-varying oil price pass-through, defined as in (4). The figure shows that oil price pass-through

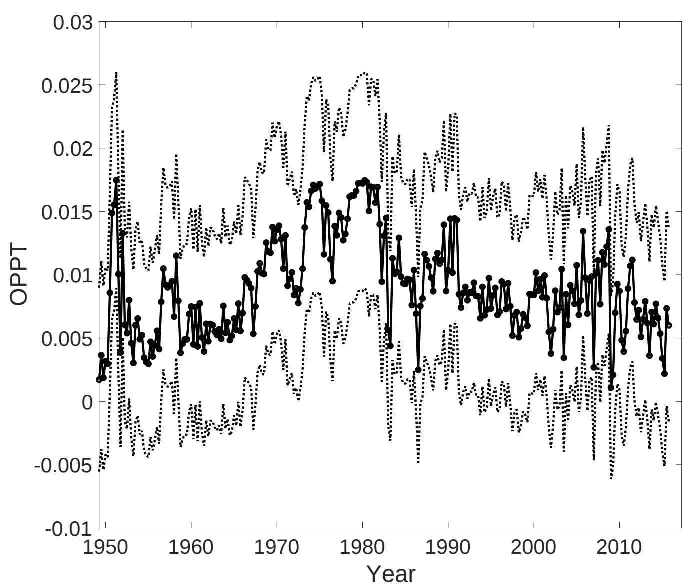
[3]The parameters d and δ were chosen and estimated to be 1 and 1.382, respectively.

Figure 1: Evolution of weights for high-inflation regimes



Notes: Computed in (2).

Figure 2: Time-varying oil price pass-through to inflation



Notes: Computed in (4). This figure shows the estimates of time-varying oil price pass-through (OPPT) and the 68% confidence interval.

Table 2: Average oil price pass-through to inflation in each period

Pre-GI	GI	GM	Post-GM
0.0063	0.0124	0.0086	0.0071

Notes: Pre-Great Inflation (Pre-GI): 1949:Q2-1964:Q4; GI: 1965:Q1-1983:Q4; Great Moderation (GM): 1984:Q1-2007:Q2; Post-GM: 2007:Q3-2015:Q4.

in the United States has decreased since the Great Moderation. The average estimate of the oil price pass-through during the Great Inflation is higher than after the Great Moderation. More than 89 percent of quarters in the Great Inflation were over the lower band of the 68 percent confidence interval. Moreover, 43 percent of quarters in the Great Inflation were significant at the 10 percent level. However, the rate of quarters in all of the other three periods is less than five percent in the 10 percent significant level, thus implying that there was no effect of oil price changes on inflation after the Great Moderation.

Table 2 shows the average oil price pass-through in each period. As shown in the table, the average oil price pass-through during the Great Inflation was the highest of the four periods. During the Pre-Great Inflation, the average oil price pass-through was 0.0063. Thereafter, it increased to 0.0124 during the Great Inflation. However, the average oil price pass-through has still decreased ever since the Great Moderation. The fact of the diminishing effects of oil price changes since the Great Moderation is consistent with Chen (2009) and Blanchard and Galí (2010). Therefore, an inflationary environment may matter considerably when analyzing oil price pass-through to inflation.

The result that pass-through is low in a low-inflation environment is consistent with previous studies on state-dependent price models (e.g., Taylor 2000). It also accords with the previous studies on exchange rate pass-through (e.g., Shintani et al. 2013). As Blanchard and Galí (2010) indicate, the US monetary policy may have played an important role in controlling the effects of oil price changes by controlling inflation.

4 Conclusion

I investigated the differences in oil price pass-through in the United States between high- and low-inflation regimes. By estimating a logistic STAR model that considers past inflation rates, I found that oil price pass-through is low in a low-inflation environment. As a result, the pass-through has decreased since the Great Moderation. These results suggest that inflationary environments may matter when trying to explain the declining oil price pass-through.

References

[1] Baumeister, C., and G. Peersman, 2013, "Time-Varying Effects of Oil Supply Shocks on the US Economy," *American Economic Journal: Macroeconomics*, 5 (4), pp. 1–28.

[2] Blanchard, O., and J. Galí, 2010, "The Macroeconomic Effects of Oil Price Shocks: Why Are the 2000s so Different from the 1970s?" in J. Galí and M. Gertler, eds. *International Dimensions of Monetary Policy*, pp. 373–421.

[3] Chen, S.-S., 2009, "Oil Price Pass-Through into Inflation," *Energy Economics*, 31 (1), pp. 126–133.

[4] Edelstein, P., and L. Kilian, 2007, "The Response of Business Fixed Investment to Changes in Energy Prices: A Test of Some Hypotheses about the Transmission of Energy Price Shocks," *The B.E. Journal of Macroeconomics*, 7 (1), pp. 1–41.

[5] Edelstein, P., and L. Kilian, 2009, "How Sensitive Are Consumer Expenditures to Retail Energy Prices?" *Journal of Monetary Economics*, 56 (6), pp. 766-779.

[6] Herrera, A. M., and E. Pesavento, 2009, "Oil Price Shocks, Systematic Monetary Policy, and the "Great Moderation"," *Macroeconomic Dynamics*, 13 (1), pp. 107–137.

[7] Ramey, V. A. and D. J. Vine, 2011, "Oil, Automobiles, and the U.S. Economy: How Much Have Things Really Changed?" NBER Macroeconomics Annual, 25 (1), pp. 333–368.

[8] Sekine, A., and T. Tsuruga, forthcoming, "Effects of Commodity Price Shocks on Inflation: A Cross-Country Analysis," *Oxford Economic Papers.*

[9] Shintani, M., A. Terada-Hagiwara, and T. Yabu, 2013, "Exchange Rate Pass-Through and Inflation: A Nonlinear Time Series Analysis," *Journal of International Money and Finance*, 32, pp. 512–527.

[10] Taylor, J. B., 2000, "Low Inflation, Pass-Through and the Pricing Power of Firms," *European Economic Review*, 44 (7), pp. 1389–1408.