

US Economic Policy Uncertainty and Chinese Macroeconomic Activity:
A Nonlinear Approach

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ABSTRACT

This paper aims at examining the spillover effects from the US policy uncertainty shocks on the Chinese aggregate variables in recessions and expansions. I adopt a Smooth Transition Vector Auto-Regression (STVAR) model with monthly series. The results from the impulse response functions and forecast error variance decompositions suggest that the US policy uncertainty has a negative impact on the Chinese aggregate variables such as industrial production, inflation rate, and export revenue, which is consistent with the previous studies. The effect is quantitatively significant on the Chinese export revenue. The results from FEVD show that the spillover effects depend on the state of the business cycles. The overall effects of the US EPU shocks on the Chinese industrial production and inflation rate are larger in recessions while the contributions of the US EPU shocks to the Chinese EPU and export are larger in expansions.

Key Words: Economic Policy Uncertainty, STVAR Model, China, US

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1 Introduction

In recent years, there has been a growing interest in assessing the possible effects of economic policy uncertainty (EPU). For example, Baker et al. (2016) demonstrate that a policy uncertainty shock increases the fluctuations in the stock market, and decreases investment rates and employment growth rate in government-sensitive sectors. Chi and Li (2017) conclude that as EPU increases, non-performing loan ratios, loan concentrations, and the normal loan migration rate also increase. What is more, Li and Yang (2015) analyze investment in the Chinese market and find that the listing firms' investments decline with an increase in EPU, especially for firms with "greater irreversibility in investment, lower learning capability, lower institutional shareholding and higher ownership concentration". Using commercial bank entity level data, Bordo et al. (2016) suggest that the impact of EPU on aggregate bank credit growth is significantly negative. They also mention that the impact has a connection with some bank characteristics, such as the capital-to-asset ratio. In short, EPU can negatively affect countries' economies at the macro-data level, the micro-data level, and the credit market level.

The major research questions of this paper are (i) "what are the spillover effects of policy uncertainty from the US on Chinese macroeconomic activity?" and (ii) "Do the effects depend on the state of the business cycle?".¹

There are several motivations driving this paper. Firstly, economic globalization strengthens the financial interaction between economies. An unexpected policy uncertainty

¹ The research idea is inspired by Fontaine et al. (2017).

shock in one country can have a global impact on the economies of other countries. Therefore, analyzing the spillover effects of EPU can help policy economists make better predictions and design appropriate strategies against unexpected shocks. This matches the objectives of macroeconomics. Secondly, there is a growing interest in examining the relationship of EPU between the US and China since their economies rank the first and second in the world, respectively. Additionally, as the US is one of the major trade partners of China, the fluctuations of the US economy are likely to slow down the Chinese economy through the US-China trade relationship. Nevertheless, studies on the spillover effects between the US and China are in their infancy (Fontaine et al., 2017). Therefore, it would be appealing for me to analyze the spillover effects from US EPU on Chinese aggregate variables.

Several studies, such as the work of Colombo (2013) and Alam (2015), have applied linear Structural Vector Autoregressive (SVAR) models to explore the existence of the spillover effects of EPU from the US on developed countries like the Euro area and Canada. Han et al. (2016) have applied linear Global Vector Autoregressive (GVAR) models to analyze the spillover effects of EPU from developed economies on the Chinese aggregates. In contrast, nowadays, some researchers like Fontaine et al. (2017) begin to employ a nonlinear model called a Smooth Transition Vector Auto-Regression (STVAR) model to investigate the spillover effects of EPU from China on the US macroeconomic activity. The model characterizes the nonlinearities by looking at two macroeconomic dynamics: one for recession periods and another for expansion periods (Fontaine et al., 2017). According to Caggiano et al. (2017b), the STVAR model especially suits the study of economic

uncertainty because it takes potential nonlinear features into account. In this paper, I choose to use an STVAR model instead of linear models to analyze the spillover effects of policy uncertainty from the US to the Chinese macroeconomic activity in recessions and in expansions. In this paper, I use monthly data over the period 1997M1-2017M8.

I examine the spillover effects from impulse response functions and forecast error variance decompositions. The spillover effect in this paper refers to an impact that an unexpected US EPU shock can have on the economy of China. Based on the results, an EPU shock in the US induces a fall in Chinese policy-related uncertainty, industrial production, the inflation rate and exports. The results imply that there exist negative spillover effects from US policy uncertainty on the key Chinese macro-variables. The negative impact from the US uncertainty shock on Chinese exports is significantly large. In addition, the results show that the spillover effects depend on the state of the business cycle due to differences in the nonlinear effects.

This paper is structured as follows. Section 2 describes the data used and provides a brief analysis of each indicator. Section 3 specifies the baseline STVAR model, section 4 presents the results and implications, and section 5 concludes.

2 Data

In this paper, I choose to use five variables - the US EPU index, the Chinese EPU index, the Chinese Industrial Production Index (IPI), the Chinese Consumer Price Index (CPI) and Chinese export revenue. All series are not seasonally adjusted and monthly spanning the period 1997M1- 2017M8. The sample is restricted by the data constraints in China. I select

the beginning and the end of the sample based on the availability of data on the Chinese IPI. Table 1 provides a list of all variables used in the model and related data sources. This section describes each index in detail and examines the stationarity of all series.

2.1 Measures of Variables

This paper focuses on the effects of economic policy uncertainty. The key variable is the EPU index. For further analysis, it is essential to understand the origin of EPU. Chi and Li (2017) point out that on the one hand, the reason for the generation of uncertainty shocks may be that the signal of government policies misleads participants to make the right decisions. On the other hand, it may be that governments take a side opposite to the policy's original objective after implementing the policies. The government may deliberately create uncertainty to motivate consumers. By definition, EPU refers to policy uncertainty. According to Baker et al.(2016), economic policy uncertainty includes monetary policy, fiscal policy and regulatory policy.

I rely on the economic policy uncertainty indexes constructed by Baker et al. (2016) to capture the degree of policy uncertainty for the US and China. The method that Baker et al. (2016) use is basically counting the frequency of keywords relating to the economy, policy, and uncertainty in the leading newspaper. They have constructed the index for twelve countries, including the US and China. Baker et al. (2016) state that policy uncertainty for the US is based on three observable components: (i) a news-based component measuring newspaper coverage on economic policy uncertainty, (ii) a measure of the federal tax code provisions, and (iii) a measure of disagreement among forecasters. In contrast, the Chinese

EPU index is based solely on the news-based component. For the sake of consistency, I use the news-based component of uncertainty index for both countries.² Figure 1 plots the time series of news-based policy uncertainty indices for the US and China in levels. It shows that there are some considerable comovements between US EPU and Chinese EPU.

To characterize Chinese macroeconomic activity, I choose three major indicators. The Chinese IPI is a proxy for the business cycle, and it helps to forecast the economic performance of China. The Chinese CPI is a measure of the price level. Since China plays an important role in the world exporting market, I adopt Chinese export revenue as a proxy for the export trading status of China. Figures 2 and 3 display the patterns for these Chinese aggregate series both in levels and in growth rates.³ Logarithmic transformations are applied to these five series prior to further analysis.

2.2 The Unit Root Test

It is essential to test the stationarity of all series before the specification of a model. This is done on the basis of the Augmented Dickey-Fuller (ADF) test.⁴ The ADF test is used to test for a unit root in time series, and the null hypothesis of the test is a unit root. I perform the ADF test for the levels as well as the first differences of all series. The logarithm of the first difference is a proxy for a growth rate.⁵ If the test statistics for the levels or the first differences are smaller than the critical value at the 10% significance level, the series are

² The news-based US EPU and Chinese EPU indices are obtained from Economic Policy Uncertainty website (<http://www.policyuncertainty.com>).

³ The Chinese aggregate series are accessed through Haver Analytics software.

⁴ The test is implemented by the JMulTi software. A constant term is included in the test equations. The number of lags applied is three based on the Hannan-Quinn Information Criterion.

⁵ Associated equation: $g_t = (\ln x_t - \ln x_{t-1}) * 100$

considered to be stationary. Based on the results, I can choose the appropriate transformations of the data for the baseline model.

Table 2 reports the results of the ADF unit root test for all time series. The second and third columns show the test statistics for the levels and the first differences, respectively. The table indicates that all variables' statistics for the level are greater than the critical values at the 10% significance level. For example, the statistics for the level of the US EPU is 0.0113, which is greater than -1.62 at the 10% significance level. The ADF test cannot reject a unit root, and the level in the US EPU series is non-stationary. However, the ADF statistic for the first difference of the US EPU is -4.1508, which is smaller than -1.62 at the 10% significance level and even smaller than -2.56 at the 1% significance level. The first difference of the US EPU series is stationary since the ADF test rejects the hypothesis of a unit root. Similarly, the statistics indicate that the first differences of the rest of the series are also considered to be stationary.

Therefore, to maintain the same magnitude and stationarity, the baseline model uses the logarithmic form of the first differences for the US EPU index ($\Delta \ln(\text{EPU}^{\text{US}})$), the Chinese EPU index ($\Delta \ln(\text{EPU}^{\text{CHINA}})$), Chinese export revenue ($\Delta \ln(\text{EXP}^{\text{C}})$), the Chinese IPI ($\Delta \ln(\text{IP}^{\text{C}})$), and the Chinese CPI ($\Delta \ln(\text{CPI}^{\text{C}})$).

3 Methodology

I use a regime switching Smooth Transition Vector Auto-Regression (STVAR) model from Auerbach and Gorodnichenko (2012) to identify macroeconomic effects in China in

response to US uncertainty shocks.⁶ This model assumes the existence of nonlinearities, and considers two states: a recession and an expansion. The underlying specification of the model can be written follows:

$$Y_t = F(z_{t-1})\Pi_R(L)Y_t + (1 - F(z_{t-1}))\Pi_E(L)Y_t + \varepsilon_t \quad (1)$$

with $\varepsilon_t \sim N(0, \Omega_t)$

$$\Omega_t = \Omega_R F(z_{t-1}) + \Omega_E (1 - F(z_{t-1})) \quad (2)$$

$$F(z_t) = \frac{\exp(-\gamma z_t)}{1 + \exp(-\gamma z_t)}, \text{ with } \gamma > 0 \text{ and } z_t \sim N(0,1) \quad (3)$$

The VAR coefficients Π_R and Π_E describe the dynamics of the system during recessions and expansions, respectively. The vector of reduced-form residuals ε_t have zero mean and time-varying covariance matrixes Ω_t . Ω_R and Ω_E are the covariance matrixes of the reduced form residuals for a recessionary regime and an expansionary regime, respectively.

Y_t is a set including all the endogenous variables in the model: $Y_t = (\Delta \ln(\text{EPU}^{\text{US}}), \Delta \ln(\text{EPU}^{\text{CHINA}}), \Delta \ln(\text{EXP}^{\text{C}}), \Delta \ln(\text{IP}^{\text{C}}), \Delta \ln(\text{CPI}^{\text{C}}))'$. I also estimate the specification with two more US variables: the logarithm first difference of the US IPI ($\Delta \ln(\text{IP}^{\text{US}})$) and the US interest rate (IR^{US}). The endogenous variables' set for the alternative specification is $Y_t' = (\Delta \ln(\text{EPU}^{\text{US}}), \Delta \ln(\text{IP}^{\text{US}}), \text{IR}^{\text{US}}, \Delta \ln(\text{EPU}^{\text{CHINA}}), \Delta \ln(\text{EXP}^{\text{C}}), \Delta \ln(\text{IP}^{\text{C}}), \Delta \ln(\text{CPI}^{\text{C}}))'$.

The index z represents the business cycle, with negative z indicating a recession. I quantify z by applying the same approach as in Caggiano et al. (2017a) for a six-term moving average of the first difference of the Chinese IPI.⁷ The parameter γ defines the smoothness of

⁶ This nonlinear model is using Matlab software.

⁷ I use 18-month moving average of the first difference of the Chinese IPI.

one regime switching to another. A faster switch corresponds to a higher γ . In this model, I assume γ is positive.

The switching variable γ is difficult to measure. Granger and Teravistra (1993) propose imposing fixed values of γ to make sure that the estimates Π_R , Π_E , Ω_R and Ω_E will not be sensitive to a relatively small number of observations in each regime. Auerbach and Gorodnichenko (2012) define a recession as a state when $F(z_t)$ is greater than 0.8. They calibrate γ equal to 1.5 to achieve the 20% time in recessions and their calibration is consistent with the NBER recession dates. For China, there is no deep recession according to NBER business cycle dates.⁸ However, the index z indicates that there were some downturns in China. I define these downturns to be periods when $F(z_t)$ is greater than 0.8 following the rule of Auerbach and Gorodnichenko (2012). Figure 4 shows the weight on a recession regime, $F(z)$, where the shaded regions are the periods of the downturns where the weight exceeds 0.8. I find that the shaded regions account for about 20% of all dates during the sample period. I regard the 20% of periods as “relative” recessions.⁹ Therefore, the shaded region implies that the Chinese economy spent 20% of the sample period in a “relative” recession.

This model is structured as the weighted sum of two linear VARs. The first one captures the linear macroeconomic interdependences among all series in a recession regime. The second one corresponds to an expansion regime. The specialty of this nonlinear model compared to the usual linear VAR model is reflected in $F(z_{t-1})$. The logistic transition

⁸ NBER business cycle dates are obtained via Haver Analytics (code: N924VRM2@EMERGEPR)

⁹ The 20% of periods in “relative” recessions can be calculated when γ equals to 1.5.

function $F(z_{t-1})$ describes the likelihood of being in a recession regime. As described by Auerbach and Gorodnichenko (2012), the model is estimated with a Monte Carlo Markov Chain approach.

Before using the nonlinear model, it is essential to test the linearity assumption. This is done in accordance with the Lagrange Multiplier (LM) test of Terasvirta and Yang (2014). They explain that the LM test is used to identify whether the linear model nested in the nonlinear model has generated any observations. The null hypothesis of this test is the linearity of the STVAR model. If the associated p-value is smaller than 5% significance level, the null hypothesis is rejected. My result returns a p-value of 0.0003, which is less than the 5% significance level.¹⁰ The null hypothesis is rejected and the STVAR model is nonlinear.

The identification of the EPU shock plays an important role in this model. There are several methods of identifying structural shocks reviewed by Ramey (2016). Individually, they are the Cholesky Decomposition, Other Contemporaneous Restrictions, Narrative Methods, High-Frequency Identification, External Instruments/Proxy SVARs, Restrictions at Longer Horizons, Sign Restrictions, Factor-Augmented VARs and Estimated DSGE Models. Among these methods, the Cholesky Decomposition method is widely used by many economists. The Cholesky Decomposition method, also called as “triangularization”, was first proposed by Sims (1980). This technique provides relatively easy way to obtain impulse response functions and forecast error decompositions.

This paper applies the Cholesky Decomposition method to the time-varying covariance matrixes Ω_t to identify a structural US policy uncertainty shock. This method transforms the

¹⁰ Based on the Hannan–Quinn Information Criterion, I use two lags to estimate the 5-variable STVAR model.

covariance matrix of residuals Ω_t to a lower triangular form. Thus, the order of the endogenous variables in Y_t is important. The Chinese aggregate variables are ordered after a US EPU shock. This implies that a US EPU shock contemporaneously affects the Chinese macro-variables whereas shocks in the Chinese macro indicators have no contemporaneous effects on the US EPU shock.

3.1 Correlation Analysis between EPU Indices for the US and China

To figure out the interaction between the two countries, I compute the correlations between the US EPU and the Chinese EPU. I summarize the basic statistics of the first differences of the EPU indices for the two countries in Table 3. The table shows two sample periods which are divided according to the global financial crisis of 2008. According to the table, the mean value of the first difference of the US EPU is higher than that of the Chinese EPU before the financial crisis, whereas the first difference of the Chinese EPU has a higher mean value after the crisis. Regarding the standard deviation, the Chinese EPU varies more around the mean for both of the periods. Lastly, there is a positive correlation between these two indices, and the relationship between the two indices is stronger during the post-financial crisis period.

Moreover, I carry out the Granger-causality test to examine the relationship between two EPU indices. The test is to show if one variable can explain the variation of another variable. One of the null hypotheses is that the US EPU does not Granger-cause the Chinese EPU while another one is that the Chinese EPU does not Granger-cause the US EPU.¹¹ If the

¹¹ After estimating a separate 2-variable VAR model, I choose to use the optimal lag length of four for the Granger-causality test based on the Hannan-Quinn Information Criteria.

results show that the p-value is less than the 5% significance level, this test rejects the null hypothesis. As indicated in Table 4, the p-values are 0.0075 and 0.0467, which are smaller than 5% significance level; thus, the null hypothesis is rejected. The results from the Granger-causality tests imply that the past behavior of the US EPU index contains information that helps to forecast the future Chinese EPU, and vice versa.

4 Results

Based on the studies from Han et al. (2016),¹² I expect that spillover effects from the US EPU to the Chinese aggregate variables do exist, and that US EPU shocks have a negative impact on Chinese macro-activities whatever the regime is. In addition, Caggiano et al. (2017a) and Fontaine et al. (2017) provide the robust evidence that shows the negative effects from EPU shocks are statistically and economically larger during recessions than during expansions. Therefore, I expect that this spillover effect from the US EPU on China depends on the state of the business cycle.

In this section, I examine the results from the impulse response functions (IRFs) and the forecast error variance decomposition (FEVD) to analyze the impact of a US EPU shock on the Chinese macro variables. Then, I discuss whether the results are consistent with the previous studies, and give possible explanations for the differences.

4.1 Impulse Response Functions

Impulse response functions (IRFs) in this scenario characterize the responses of each Chinese variable to a one percent US EPU shock. Figure 5 represents the impulse responses

¹² See details in literature review section on page 8.

of the Chinese macro variables to a US policy uncertainty shock in two regimes. The first column shows the responses in an expansion regime, and the second column indicates the reactions in a recession regime. The responses are reported in percentages, and the shaded area in each graph indicates the 90 percent confidence interval.

As the US EPU shock increase by 1%, the negative impact on the US EPU dies off after three quarters in expansions. In contrast, the impact persists longer in recessions with the response returning to pre-shock level after four quarters. The result implies that the US EPU recovers faster in expansions than in recessions.

The graphs in the second row suggest that the US EPU shock has a negative impact on the Chinese policy uncertainty in both regimes. The negative impact is slightly larger in a recession regime since the response is about 0.6% during recessions with respect to 0.4% during expansions. Furthermore, the overall response in expansions is nearly indistinguishable from zero due to the wide confidence intervals. The result manifests that the Chinese EPU is negatively affected by the US EPU shock, but the extent is larger in recessions than in expansions.

Chinese export revenue falls instantaneously with a positive US EPU shock. However, the reaction during expansionary regime is -4% whose absolute value is four times larger than the one in recessions. Although the negative effect is postponed during recessions, there is a decline starting at two quarters and approaching to a minimum -3% in three quarters. As previously mentioned in this paper, the direct link between the US and China is through export trading. The responses confirm that export revenue has an immediate negative reaction

to a US EPU shock. The initial response is more statistically significant in expansions than in recessions.

With an increase in the US EPU shock, Chinese industrial production declines and reaches the minimum -0.7% after three quarters during expansions. In a recession regime, a positive 0.2% is apparent in the graph at the beginning. There is a fall to -0.1% after seven quarters. These outcomes imply that a US EPU shock has no negative impact on Chinese industrial production initially, but a negative impact after seven quarters. Nonetheless, during expansions, Chinese industrial production negatively responds to a US EPU shock. The reason may be that Chinese investors tend to be more cautious and tend to choose to invest or produce less during expansions than during recessions.

On the impact of a US EPU shock, the Chinese inflation rate reaches its minimum value -0.5% in expansions. Conversely, the immediate response of the Chinese inflation rate in recessions is 0.2% during recessions, and there is a significant drop at quarter five of about -0.2%. The values of the Chinese inflation rate in the two regimes return to the pre-shock level over time. The results suggest that the US EPU shock may dampen the spending of Chinese consumers during expansions because the low inflation rate is a sign that spending has fallen. Also, the results imply there may be no negative effect on consumers' spending decisions at first during a recession regime. But, over time, consumers may tend to save more instead of spending.

To summarize, a US EPU shock has a negative impact on Chinese macro variables. The impact is more significant during an expansion regime than during a recession regime.

During a recessionary regime, the negative effect on the Chinese IPI and CPI is postponed. Figure 6 provides a robustness check by looking at the impulse responses of the first difference of the US EPU, the US IPI, the US interest rate and the key macro-indicators in China to a one percent US EPU shock.¹³ The results from figure 6 is almost similar to the ones from figure 5.

4.2 Forecast Error Variance Decomposition

The forecast error variance decomposition (FEVD) provides an assessment of the quantitative significance of the variations of the Chinese aggregate variables in response to a US EPU shock. It illustrates how much a US EPU shock contributes to explaining fluctuations in the Chinese aggregate variables. Table 5 reports the results of the FEVD up to a two-year horizon.

The first and second columns show that the US EPU shocks make almost no contribution to explaining the variation of the Chinese EPU. An exception is the one-month horizon, when the US EPU explains 5.76% of the fluctuations of the Chinese EPU during recessions, compared to 0.04% during expansions. By looking at the last main columns, a US EPU shock can explain about 15% of the variations of the first difference of the Chinese IPI during recessions, compared to 8% of the forecast variance during expansions. Likewise, the US EPU shocks contribute less than 3% in explaining Chinese inflation rate for both regimes except the results at the one-month horizon. At a one-month horizon, nearly 9% of the

¹³ The lag length of the 7-variable STVAR model is two.

Chinese inflation rate can be contributed to the impact of the US EPU shocks during expansions

However, table 5 reveals that a US EPU shock plays a vital role in explaining the Chinese export revenue. There is a non-negligible contribution of about 75% and 78% in recessions and expansions respectively, at various forecast horizons.

The outcome of the FEVD suggests that US EPU shocks contribute the most to the explanation of the variations in Chinese export revenue. This implies a US EPU shock significantly affects the volatility of Chinese export revenues. However, a US EPU shock has a less significant impact on the other series. Also, there are some nonlinear effects indicated from the FEVD analysis. The effects of the US EPU shocks on the Chinese industrial production and inflation rate are larger in recessions than expansions. However, the contributions of the US EPU shocks to the Chinese EPU and export revenue are larger in expansions than in recessions except for the one-month horizon. At a one-month horizon, the US EPU contributes more to explaining variations in the Chinese IPI during recessions and the CPI during expansions

4.3 Discussion

Previous studies like Colombo (2013), Alam (2015), and Han et al. (2016) suggest that an unexpected US EPU shock leads to negative spillover effects on the economies of other countries. To be specific, Colombo (2013) employs a two-country (SVAR) linear model to investigate the spillover effects from US policy shocks to European macroeconomic aggregates. Colombo's results indicate that a one-standard deviation US EPU shock

decreases European industrial production and consumer prices by -0.12% and -0.06%, respectively. The variations in the Euro-area economic variables is explained better by the US EPU shock than by the European uncertainty shock.

Moreover, Alam (2015) applies the SVAR model to examine the spillover effects of EPU in the US on Canadian aggregates. The results show that an increase in US EPU causes a fall in Canadian aggregate output, prices, and interest rates. Likewise, the effects on the Canadian aggregates of US policy uncertainty shocks is quantitatively more significant than those of Canada-specific uncertainty shocks.

Han et al. (2016) analyze the spillover effects of EPU from developed economies to Chinese aggregates, and then confirms the existence of international transmission of EPU. Precisely, they use the linear GVAR model and find that US EPU plays a dominant role in causing a fall in Chinese equity prices, exports, industrial production, and the exchange rate. Overall, all three studies show that the external US EPU shock has a significant negative effect on other countries' aggregate variables.

Similar to their findings, my IRF results indicate that a US EPU shock has a negative impact on Chinese aggregate indicators, specifically export revenue, IPI and CPI. My expectations with respect to the existence of spillover effects from the US EPU on the Chinese macro-variables are thus confirmed.

On the contrary, there also exist some differences in the results compared to those of previous studies. Most researchers, like Fontaine et al. (2017), Alam (2015) and Caggiano et al. (2017b), demonstrate that a US EPU shock reduces the time of recovery from a bad

economic environment during recessions. More specifically, Fontaine et al. (2017) reveal that US industrial production and inflation react asymmetrically to Chinese EPU shocks and their responses are significant in recessions, whereas no reaction is found in expansions. To summarize, the negative impact should be more statistically significant in recessions than in expansions. However, my IRF results for Chinese export revenue, the IPI and the CPI are the reverse of those of previous studies. The results show that the negative influence on these three variables is larger during expansions than during recessions. This influence is most significant for Chinese export revenue. Furthermore, the FEVD results indicate that the contributions of US EPU shocks to fluctuations in the Chinese variables depend on the state of the business cycle, except for the results in the very short-term, which meets my second expectation. Nevertheless, they do not work in the same direction as compared to the previous studies. The overall contributions of the US EPU shocks to the Chinese EPU and export revenue are relatively larger in expansions; however, the contributions to Chinese industrial production and the inflation rate are larger in recessions.

There are some possible interpretations of my results. From my perspective, the dependence of Chinese commercial and financial markets on the US may be not that large compared to countries like Japan, Canada, and the Euro-area. As the economic dependence between the US and China is primarily based on export trading, the variations in Chinese export revenue are more likely to respond significantly to a US policy uncertainty shock. The fluctuations in export revenue could affect other Chinese aggregate variables, like industrial production and the inflation rate. Therefore, I conclude that a US EPU shock may potentially

have an indirect negative impact on other Chinese macro indicators. Briefly, this is one reason why US EPU may contribute relatively less to explaining the first difference of the Chinese IPI and inflation rate.

Another explanation is that the Chinese government's macro-control may play a vital role in adjusting the country's economic environment. Once an external shock hits the Chinese economic system, the Chinese government could take effective measures immediately in case of adverse effects. For instance, China announced the 2008–09 Chinese economic stimulus plan in 2008 to mitigate the impact of the global financial crisis. Therefore, the prompt measures that the Chinese government implements may help to explain why the impact on the Chinese IPI and inflation rate show a delay in recessions. These possible explanations may contribute to an understanding of the differences mentioned above.

5. Conclusion

This paper examines the existence of spillover effects from US policy-related uncertainty shocks to Chinese aggregate variables during recessions and during expansions. Previous studies have developed several approaches to analyze the measurement of EPU and the estimation of its effects. In this paper, I use a nonlinear approach called a Smooth Transition VAR model with two regimes. The baseline model includes the US EPU index as well as the key indicators of the macroeconomic environment in China: the Chinese EPU, IPI, CPI and export revenue. The monthly data cover the period 1997M1-2017M8.

The results are derived from impulse response functions and forecast error variance decompositions. Looking at them together, I conclude that spillover effects do exist from US

EPU shocks to Chinese aggregate variables. This fits the results of Han et al. (2016) and Caggiano et al. (2017b). Specifically, the effects on Chinese export revenue are the most significant. Yet, there are some important differences compared to the previous literature. My IRFs show that the effects on the Chinese IPI and CPI are relatively higher during expansions than during recessions, whereas Caggiano et al. (2017b) state that the negative impact is significantly larger in recessions than expansions. Additionally, compared to the results from Fontaine et al. (2017), my results from the FEVD show that except for the one-month horizon, the contributions of US EPU shocks to the Chinese EPU and exports are slightly larger in expansions, whereas the contributions on the Chinese industrial production and inflation rate are larger in recessions. These differences imply that there are nonlinear effects related to the importance of US EPU shocks

There are some possible explanations for the results. The significant negative impact of US EPU shocks on Chinese export revenues may be because the US is the major export trading partner of China. The negative effect on the IPI and CPI suggests that investors in China are likely to become more cautious and tend to defer making investment and production decisions. On the consumer side, as mentioned by Fontaine et al. (2017), a US EPU shock may motivate consumers to consume less and save more. Nevertheless, this motive may not be strong if comparing to the effects of a US EPU shock on other countries. This may be due to the relatively strong level of macro-control in the Chinese government.

Over the past years, the Chinese government has been efficient in modifying economic policies when a crisis occurs, so the influence on some of the Chinese aggregate variables in

the short run may not be very significant. However, a question that should be brought up is will the way that the Chinese government responds to crises continue to be effective in the long run, or bring a potential danger for the long-term Chinese economy instead?

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APPENDIX

Table 1 List of Variables

The Variables in the Model			
Variable Name	Notation	Description	Sources
US Industrial Production Index (IPI)	$\Delta \ln(IP^{US})$	Logarithm first difference of US IPI	Haver Analytics Code: IP@USECON
US Interest Rate	IR^{US}	US Effective Federal Funds Rate	Haver Analytics Code: FFED@USECON
US EPU Index	$\Delta \ln(EPU^{US})$	Logarithm first difference of US EPU Index	Economic Policy Uncertainty website (http://www.policyuncertainty.com/)
Chinese EPU Index	$\Delta \ln(EPU^C)$	Logarithm first difference of Chinese EPU Index	
Chinese Industrial Production Index (IPI)	$\Delta \ln(IP^C)$	Logarithm first difference of Chinese IPI	Haver Analytics Code: H924D@EMERGEPR
Chinese Consumer Price Index (CPI)	$\Delta \ln(CPI^C)$	Logarithm first difference of Chinese CPI	Haver Analytics Code: CIEA@CHINA
Chinese Export Revenue	$\Delta \ln(EXP^C)$	Logarithm first difference of Chinese Export Revenue	Haver Analytics Code: H924IXD@EMERGE

Table 2 Results from the Augmented Dickey-Fuller Unit Root Test

The Augmented Dickey–Fuller unit root test (Sample range: 1997M1-2017M8)		
Variables	Test statistics for the levels	Test statistics for the first differences
US EPU Index	0.0113	-4.1508*
Chinese EPU Index	-0.0514	-9.7807*
Chinese IPI	4.0421	-7.2599*
Chinese CPI	-0.0657	-6.2478*
Chinese Export Revenue	3.8548	-7.3758*
*Significant at the 1%, 5% and 10% significance level		
Notes: The critical value is -2.58 at the 1% significance level, -1.94 at the 5% significance level, and -1.62 at the 10% significance level. A constant term is included in the test equations. Hannan-Quinn Information Criterion suggests a lag length of three for this test.		

Table 3 Summary Statistics and Correlation between the First Differences of the EPU Indices of the US and China

Sample period: 1997M1-2007M12						
Variable	Mean	Std. Dev.	Min	Max	Range	Correlation
US	0.33	23.75	-42.88	105.05	147.93	0.17
China	0.05	65.98	-179.01	194.66	373.67	
Sample period: 2008M1-2017M8						
Variable	Mean	Std. Dev.	Min	Max	Range	Correlation
US	0.10	29.57	-91.89	107.65	199.54	0.23

China	0.89	49.55	-176.69	165.61	342.3	
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Table 4 Results from the Granger-causality Test

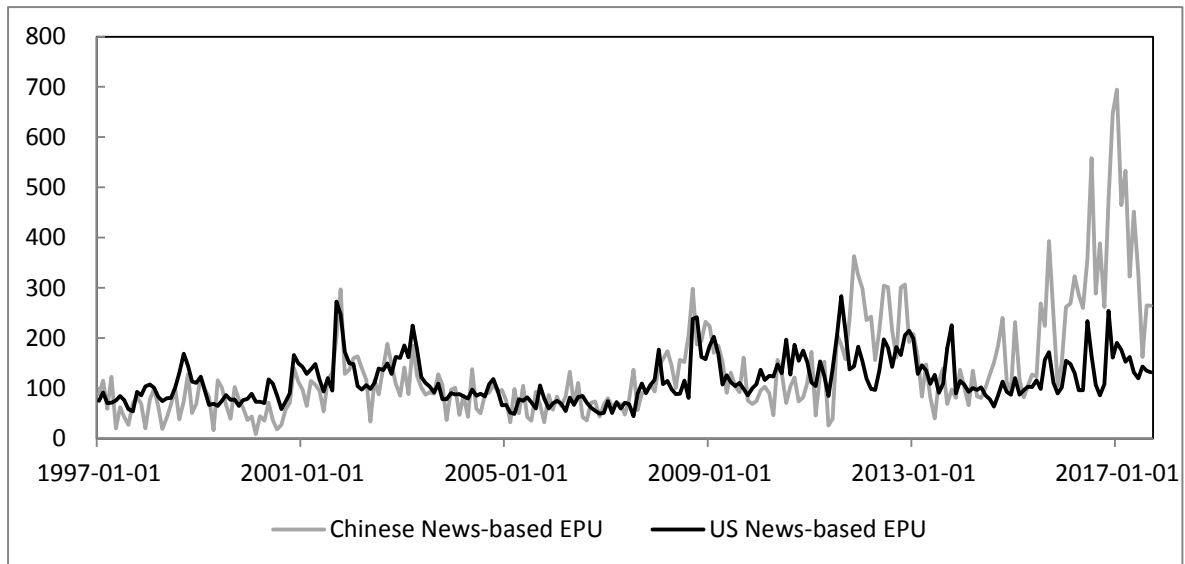
The Null Hypothesis	P-value
The US EPU does not Granger-cause the Chinese EPU	0.0075**
The Chinese EPU does not Granger-cause the US EPU	0.0467**
**Reject the null hypothesis at the 5% significance level	

Table 5 Forecast Error Variance Decomposition of the Chinese Aggregate Variables explained by a US EPU shock

horizon	$\Delta \ln(\text{EPU}^C)$		$\Delta \ln(\text{EXP}^C)$		$\Delta \ln(\text{IP}^C)$		$\Delta \ln(\text{CPI}^C)$	
	rec	exp	rec	exp	rec	exp	rec	exp
1	5.76	0.04	2.83	0.53	26.13	5.67	1.80	9.07
6	0.85	1.40	75.41	78.30	15.13	8.71	2.85	1.75
12	0.87	1.42	75.35	78.30	15.13	8.74	2.86	1.72
18	0.87	1.42	75.35	78.30	15.13	8.74	2.86	1.72
24	0.87	1.42	75.35	78.30	15.13	8.74	2.86	1.72

Notes: The time horizon is in months. The “rec” represents a recession regime and the “exp” represents an expansion regime. The numbers in the table are reported in percentage changes.

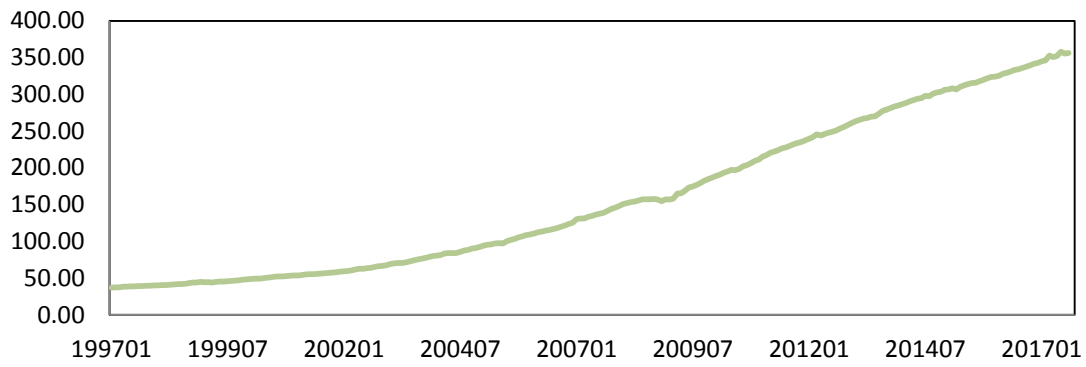
Figure 1 News-based Policy Uncertainty Indices for the US and China in Levels



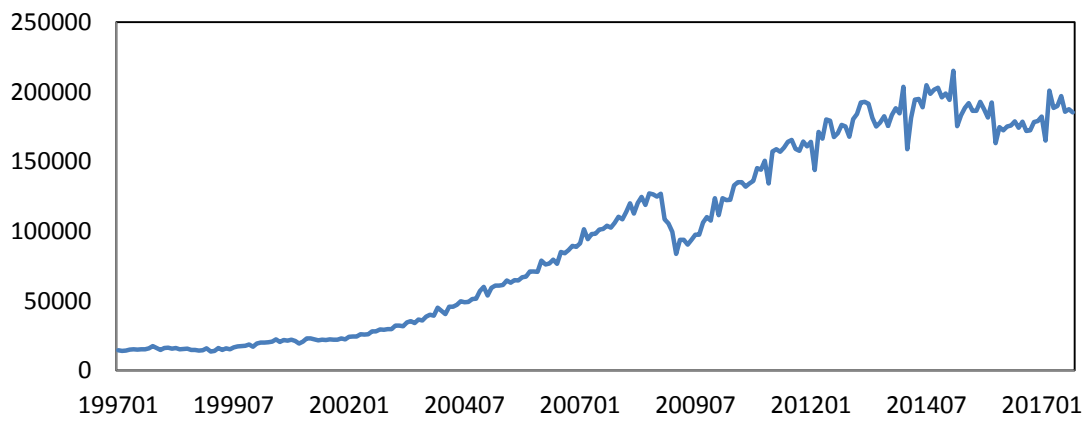
Source: Economic Policy Uncertainty website (<http://www.policyuncertainty.com/>)

Figure 2 The Key Chinese Macro-variables in Levels

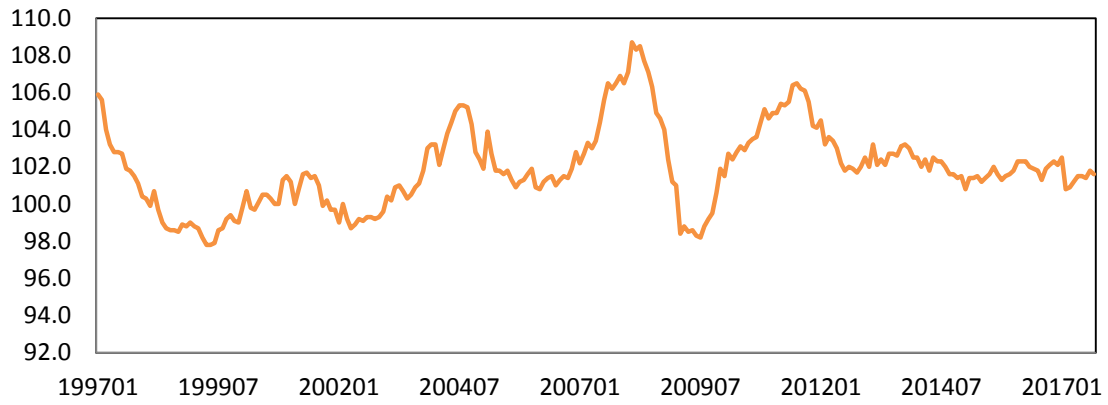
Industrial Production Index



Export Revenue in the US dollars



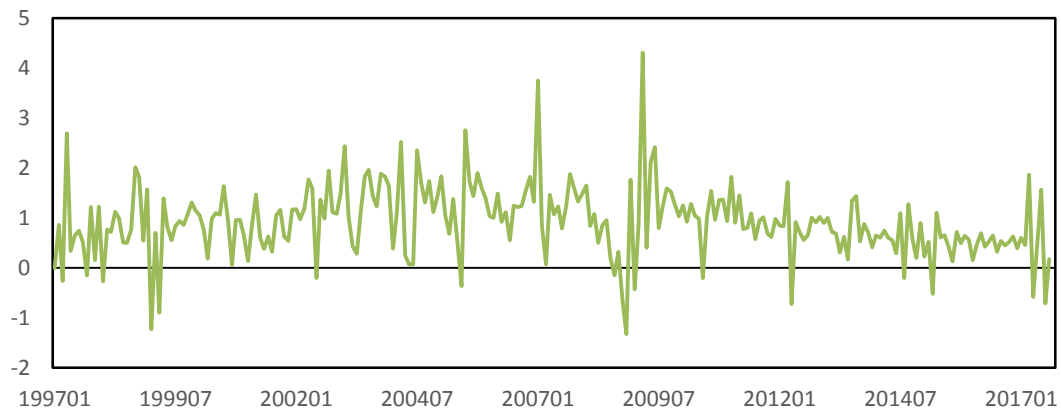
Consumer Price Index



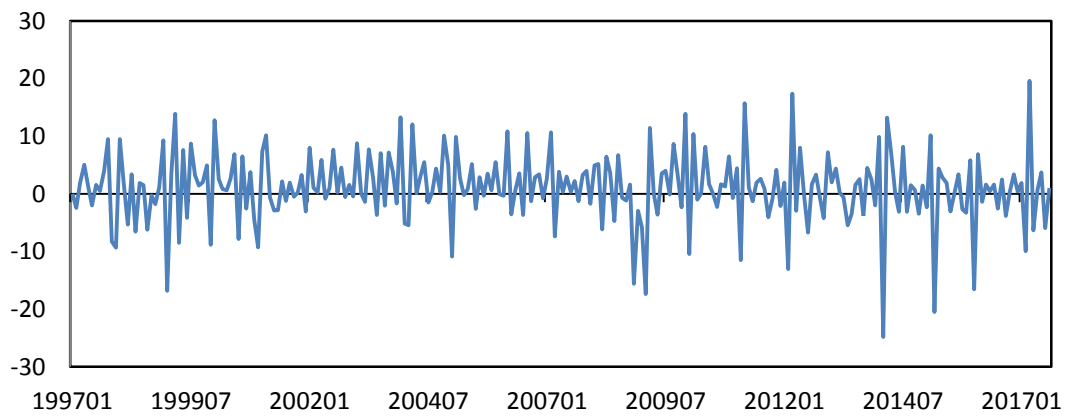
Source: Haver Analytics

Figure 3 The Key Chinese Macro-variables in Percentage Changes

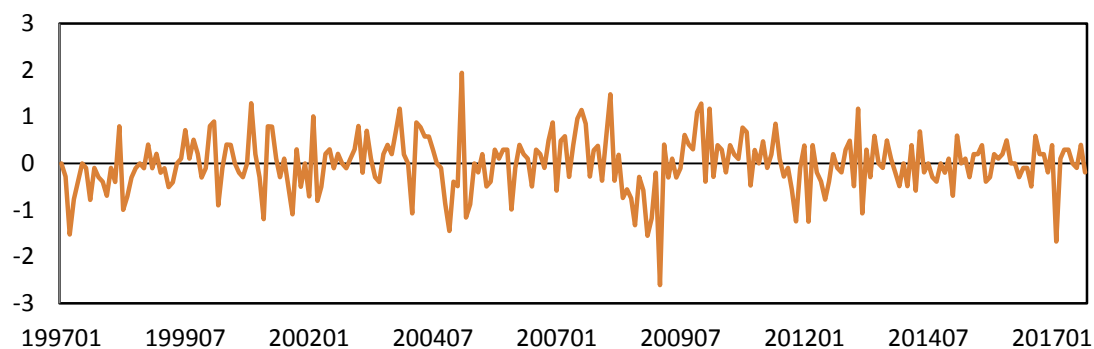
Industrial Production Index



Export Revenue



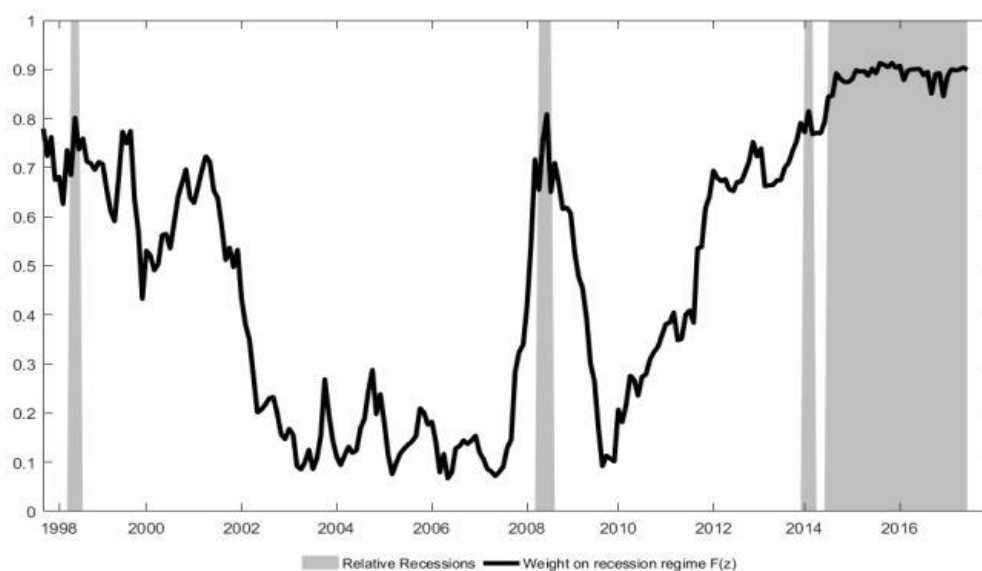
Consumer Price Index



Notes: the growth rate $g_t = (\ln x_t - \ln x_{t-1}) * 100$

Source: Haver Analytics

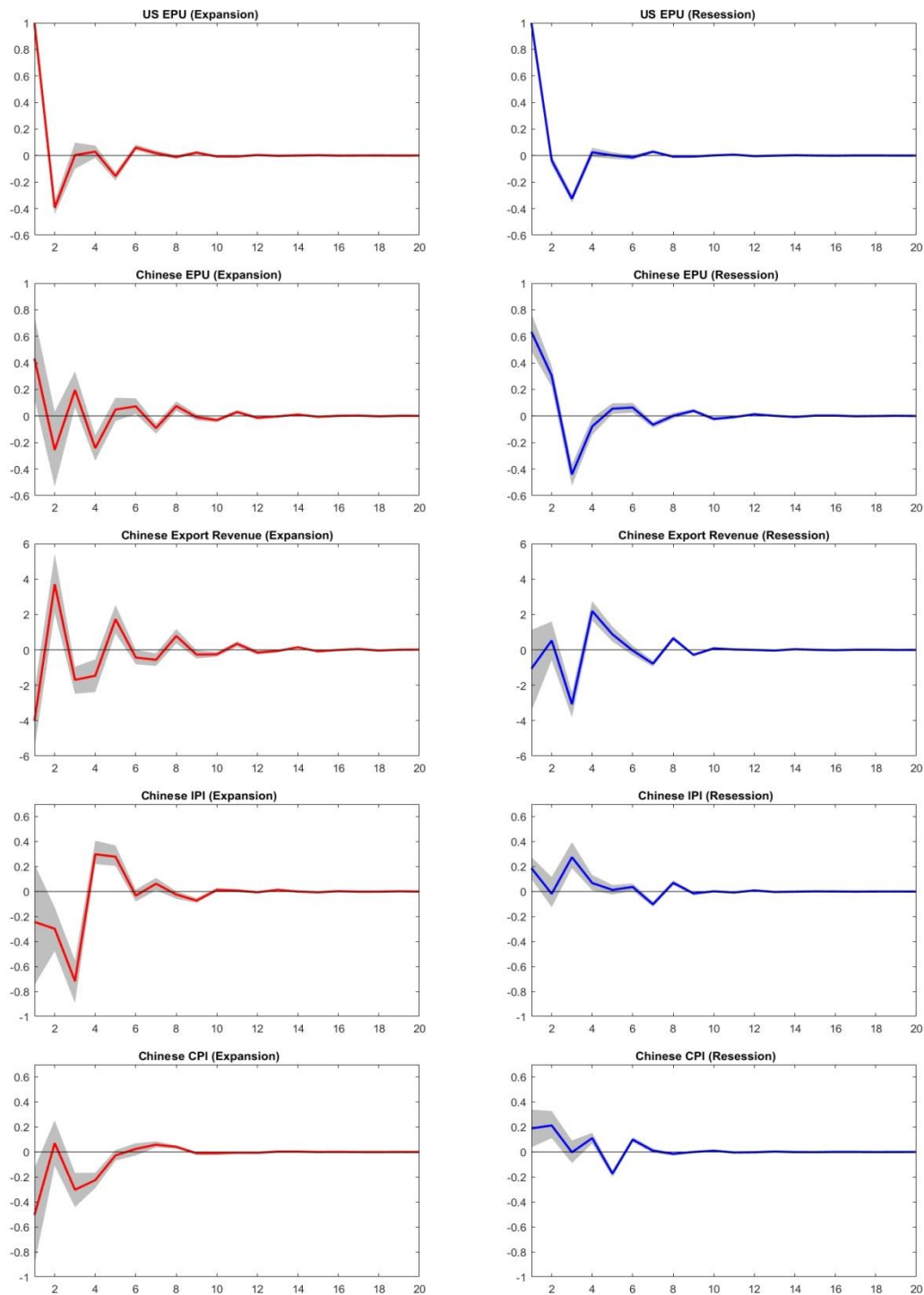
Figure 4 Weight on a Recession Regime $F(z)$ of China



Notes: The solid black line indicates the weight on a recession regime $F(z)$ of China. The shaded area shows relative recessions where $F(z)$ is greater than 0.8.

Source: Author's own calculations

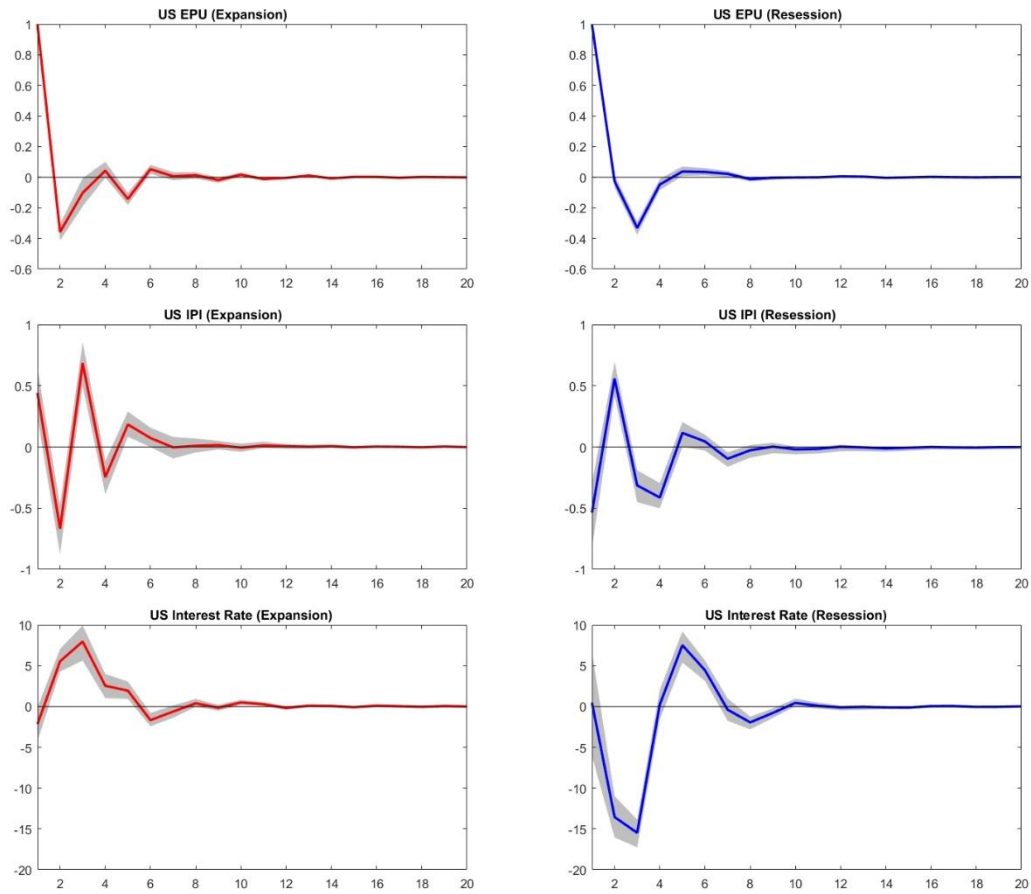
Figure 5 Impulse Responses of China's Macro-variables to a One-standard Deviation US Policy Uncertainty Shock (5-variable STVAR model)



Notes: The responses are reported in percent. The shaded region represents the 90% confidence interval.

Source: Author's own calculations

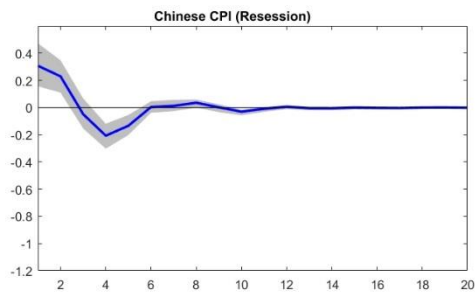
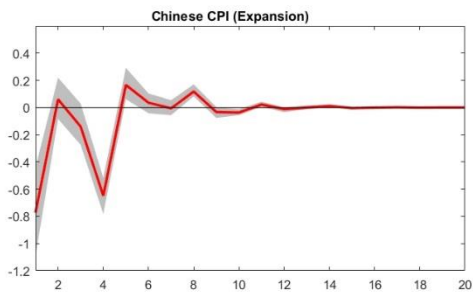
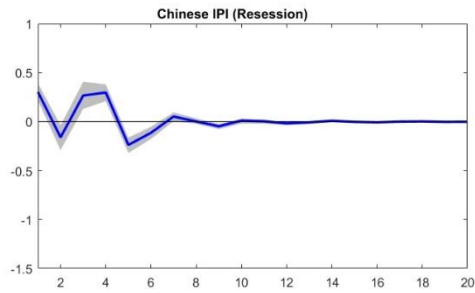
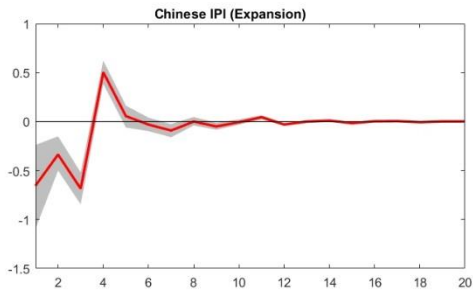
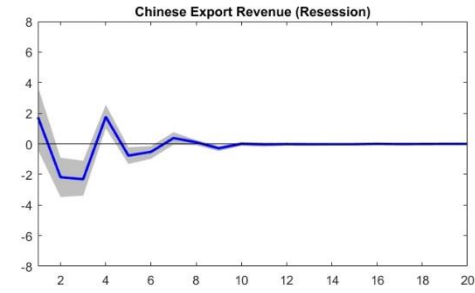
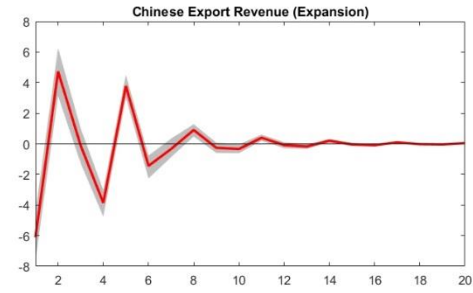
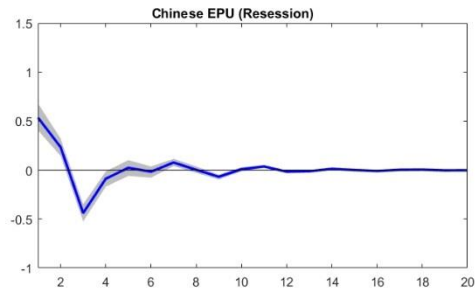
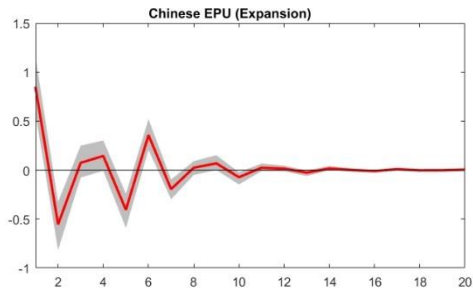
Figure 6 Impulse Responses of Key Macro-Variables of the US and China to a One-standard Deviation US Policy Uncertainty Shock (7-variable STVAR model)



Notes: The responses are reported in percent. The shaded region represents the 90% confidence interval.

Source: Author's own calculations

Figure 6 Impulse Responses of Key Macro-Variables of the US and China to a One-standard Deviation US Policy Uncertainty Shock (Continued)



Notes: The responses are reported in percent. The shaded region represents the 90% confidence interval.

Source: Author's own calculations