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Government Spending Multipliers in Uncertain Times: U.S. Historical Time Series Data Evidence*

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Abstract

This paper examines whether the government spending multipliers vary depending on a level of macroeconomic uncertainty using U.S. historical quarterly time series data from 1900 onwards. The empirical findings reveal that the government spending multipliers in uncertain times are below unity and smaller than those in normal times.

Keywords : Government spending multipliers, Macroeconomic uncertainty, Local projection, State dependency

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1. Introduction

Does a high level of macroeconomic uncertainty reduce government spending multipliers? Fiscal policy has been actively discussed among researcher and policy makers as a possible way to stimulate depressed economy. The IMF and OECD emphasize the role of an active fiscal policy in overcoming low growth rates in advanced and emerging countries. U.S. has tried to increase its government spending including investment in infrastructure and defense spending. At the same time, macroeconomic uncertainty has increased significantly owing to recent events such as Brexit and the U.S. presidential election outcome. From a theoretical point of view, elevated macroeconomic uncertainty can reduce the stimulatory effects of government spending through several channels, such as the wait-and-see option channel. Specifically, risk-averse agents try to aviod uncertain situation, therefore they less respond to government stimulus. It can cause small multiplier effects.

Several literature empirically investigate multiplier effects of government spending. For example, seminar works by Blanchard and Perotti (2002) and Fatás and Mihov (2001), using vector autoregressive model (VAR) with short-run identification method and US data, estimate size of multipliers. Ramey (2011) claims that their identification scheme possibly leads bias and suggests the new identification method to mitigate this bias. Ramey and Zubairy (2018) extend this method and estimate size of government spending multipliers using US historical data from 1890 to 2010.

In addition to those studies, several studies estimate non-linear effects of government spending. For example, Auerbach and Gorodnichenko (2012), using local projection method and OECD data, show that multipliers vary depending on whether current status is recession or not. Christiano et al. (2011), using medium scale DSGE model, show multiplier can be larger in the zero lower bound situation. Ilzetzki et al. (2013), using panel data for 44 countries and VAR model, show that government spending multipliers depend on several economic situation such as exchange rate regime, strength of public finance and openness.

In line with those literature on non-linear effects of government spending, this study investigates the potential negative effects of macroeconomic uncertainty on government spending multipliers using U.S. historical times series and the local projection method. In contrast to existing studies, I investigate effects of uncertainty on government spending multiplies, which is potentially important factor to determine size of multipliers. The study most closely related to this work is Ramey and Zubairy (2018). They estimate the effects of slack in the economy and zero lower bound on government spending multipliers using U.S. historical data and the local projection method. However they do not consider macroeconomic uncertainty related issues. This study is first attempt to estimate the relation between macroeconomic uncertainty and size of multipliers using a nonliear econometric model.

2. Data and Econometric Methods

The macroeconomic data are obtained from Ramey and Zubairy (2018). They construct U.S. historical quarterly time series data on potential GDP, GDP, government spending, GDP deflator, population, defense news, and the average tax rate data from 1889.Q1 to 2015.Q4 using various sources. To identify times of uncertain, I use the U.S. historical economic policy uncertainty index (EPU index) obtained from the EPU index website[1]. This index is constructed based on the Baker et al. (2016). Basically they count how frequently terms related to uncertainty such as "economic uncertainty" appear in newspapers. The more frequently such terms appear in newspapers, the higher is the level of uncertainty prevailing in the economy. Historical EPU index data are available on a monthly basis. To match the data frequency, I use the average historical EPU index in each quarter. Since historical EPU index is available from Jan.1900 to Oct.2014, I use 1900.Q1 to 2014.Q2 data to obtain the baseline result. With this long time series, I can utilize richer variations including historical high uncertainty periods such as World War I (WWI), World War II (WWII), and the Great Depression.

Following Owyang et al. (2013) and Ramey (2016), I use the local projection method developed by Jordá (2005) to estimate impulse responses to government spending shocks. Consider the following set of regression equations:

$$\begin{aligned} y_{t+h} = {} & \Sigma_{f=1}^{4}\gamma_{j,h}t^{j} + I_{t-1}[\alpha_{1,h}^{U} + \Sigma_{i=1}^{4}\Gamma_{i,h}^{U}x_{t-i} + \beta_{h}^{U}shock_{t}] \\ & + (1-I_{t-1})[\alpha_{1,h}^{N} + \Sigma_{i=1}^{4}\Gamma_{i,h}^{N}x_{t-i} + \beta_{h}^{N}shock_{t}] + \epsilon_{t+h}, \qquad h = 0,1,2,\cdots \end{aligned} \tag{1}$$

In equation (1), h is a forecasting horizon and y is the variable of interest (discussed below). I assume a quartic trend for the baseline model, similarly to Owyang et al. (2013). I is an indicator variable that takes the value one when the historical EPU index exceeds its sample average, and zero otherwise. This means that uncertain times are defined as the periods when the historical EPU index exceeds its sample average. A set of control variables x includes log of real per capita government spending, real per capita GDP, and the average tax rate. In addition, $shock$ is a government spending shock identified by the defense news constructed by Ramey and Zubairy (2018). The defense news focuses on the expected discounted value of U.S. government spending related to oversea military events or purely political events, so that it is unlikely to be related to economic fundamentals and is unanticipated. Since the error term ϵ_{t+h} is serially correlated, I use the Newey and West (1987) error. In this model, $\{\beta_h^U\}_{h=0,\cdots}$ and $\{\beta_h^N\}_{h=0,\cdots}$ indicate a response of y in uncertain times and normal times, respectively.

Additionally, I use pre-transformed variables for y and x to avoid bias in calculating the multipliers following Gordon and Krenn (2010)[2]. Specifically, real per capita GDP and real per

1) http://www.policyuncertainty.com/media/US_Historical_EPU_data.xlsx. Aastveit et al. (2013) also use EPU index to identify uncertain periods in the US to investigate the effectiveness of monetary policy in such times.

2) Ramey and Zubairy (2018) point out that spending multipliers calculated by the way in the standard VAR can be biased.

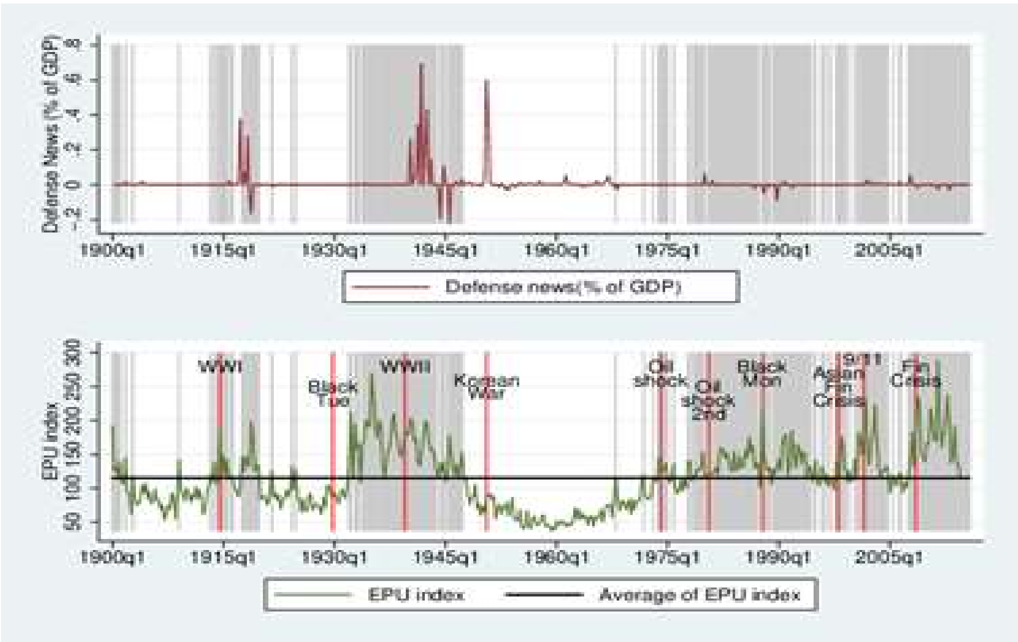
capita government spending in equation (1) are divided by the potential GDP. For the multipliers, changes in government spending and GDP must be measured in the same unit, which is the case here. Therefore, I can calculate cumulative multipliers, as follows:

$$CM_h^i = \frac{\sum_{i=0}^{h} \triangle GDP_i^j}{\sum_{i=0}^{h} \triangle Gov_i^j} = \frac{\sum_{i=0}^{h} \beta_{i,GDP}^j}{\sum_{i=0}^{h} \beta_{i,Gov}^j}, h = 0,1,2,\cdots, j = U,N \qquad (2)$$

where CM_h^j is the cumulative multiplier in horizon h in state j, and $\beta_{h,GDP}^i$ and $\beta_{h,GDP}^j$ are the estimated β_h in the GDP equation and in the government spending equation, respectively[3].

<Figure 1> shows the defense news normalized by GDP and the historical EPU index. Uncertain periods include WWI, WWII, the Great Depression, the Asian financial crisis, the 2007-2008 financial crisis, and the recent Great Recession episodes. The Korean War is not the part of uncertain periods, most likely because it was a relatively localized war and so had less effect on the U.S economy.

<Figure 1> News variable and EPU index.



Note: Shaded areas indicate uncertain periods (EPU index exceeds its sample average).

3) The cumulative equation is also estimated with the following:

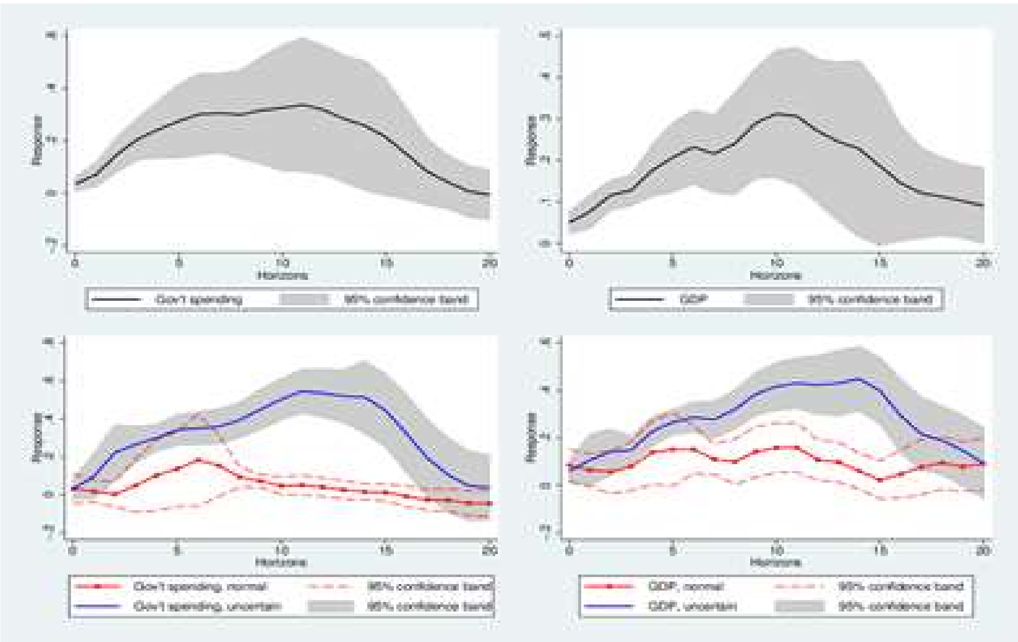
$$\Sigma_{j=0}^{h} GDP_{t+j} = \Sigma_{f=1}^{4}\gamma_{j,h}t^j + I_{t-1}[\alpha_{1,h}^U + \Sigma_{i=1}^{4}\Gamma_{i,h}^U x_{t-i} + m_h^U \Sigma_{j=0}^{h} Gov_{t+j}]$$
$$+ (1-I_{t-1})[\alpha_{1,h}^N + \Sigma_{i=1}^{4}\Gamma_{i,h}^N x_{t-i} + m_h^N \Sigma_{j=0}^{h} Gov_{t+j}] + \zeta_{t+h}, \qquad h = 0,1,2,\cdots \qquad (3)$$

where $\Sigma_{j=0}^{h} GDP_{t+j}$ is the sum of the GDP variable and $\Sigma_{j=0}^{h} Gov_{t+j}$ is the sum of the government spending variable. In this specification, I can get an -horizon unbiased cumulative multiplier in uncertain times, m_h^U, using $I_{t-1}\times shock_t$ in equation (2) as an instrumental variable for $\Sigma_j^h Gov_{t+j}$. Similarly, we get cumulative multipliers in normal times, m_h^N, with $(1-I_{t-1})\times shock_t$ as an instrumental variable for $\Sigma_j^h Gov_{t+j}$. The results are the same as those in the equation (2) as long as the sample periods are fixed. See Ramey and Zubairy (2018) for details.

In this specification, moreover, defense news is used as an instrument for (cumulative) government spending. Therefore, I test the relevance of the instrument at each horizon based on Olea and Pflueger (2013) method which is robust to serially correlated errors. The results indicate that the test statistics in uncertain times are well above the threshold after some horizons. However, the test statistics for the linear model and for normal times do not exceed the threshold, which can be a potential source of bias. To correct this bias induced by weak instruments, I also use Anderson and Rubin (1949) confidence interval to compute the p-values of differences in the multipliers across states.

3. Results

<Figure 2> Impulse response of government spending and GDP



Note: The response of government spending and GDP to defense news shock. Size of shock is normalized by 1% of GDP. The response of government spending is measured in percentage of GDP. The responses of GDP are measured in percentage deviation. 95% confidence intervals with Newey and West (1987) are reported.

<Figure 2> shows the impulse responses of GDP and government spending to defense news shocks from equation (1)[4]. The size of a shock is normalized to 1% of GDP. The upper panels are the responses in the linear model (threshold is set to 0) and the lower panels are the responses in the nonlinear model. Associated 95% confidence intervals using Newey and West (1987) errors are reported. The lower panel shows that the response of government spending to

4) To estimate impulse responses and cumulative multipliers, I use the data and the Stata code obtained from Ramey' s website. http://econweb.ucsd.edu/ vramey/research/Ramey Zubairy replication codes.zip.

a shock in uncertain times is stronger than that in normal times. As a result, the response of GDP in uncertain times is stronger than that in normal times. The peak response of government spending is 0.5% at horizon 5 in uncertain times, while it is 0.2% at horizon 6 in normal times. The peak response of GDP is 0.4% at horizon 14, while it is around 0.15% at horizon 6 in normal times.

However, this does not mean that an increase in government spending in uncertain times is more effective to stimulate the economy because size of government spending is different across the time. To compare the effectiveness of government spending across the states, I compute the cumulative multipliers. 〈Table 1〉 shows the estimated cumulative multipliers and the p-values of the difference between multipliers in uncertain times and in normal times. The results show that the multipliers in uncertain times are well below unity and smaller than those in normal times. For example, the 5-year cumulative multiplier in uncertain times is only 0.8, which is much smaller than that in normal times (1.35). Furthermore, this difference is statistically significant at the 5% level with Newey and West (1987) error and at the 15% level with the Anderson and Rubin (1949) confidence interval.

<Table 1> Cumulative government spending multipliers

	Linear	Normal	Uncertain	P-value(HAC)	P-value(AR)
1 year	0.81 (0.18)	2.83 (3.13)	0.72 (0.11)	0.53	0.09
2 year	0.76 (0.10)	1.16 (0.47)	0.75 (0.05)	0.40	0.20
3 year	0.83 (0.10)	1.29 (0.31)	0.77 (0.04)	0.09	0.15
4 year	0.84 (0.09)	1.26 (0.31)	0.79 (0.03)	0.03	0.14
5 year	0.91 (0.11)	1.35 (0.39)	0.83 (0.04)	0.01	0.12

Note: Linear, Normal, and Uncertain indicate that the results with in the linear model (threshold is set to 0), low uncertain periods, and high uncertain periods, respectively. Numbers in parenthesis are standard errors. P-Value(HAC) means that the p-value of differences between the cumulative multipliers in normal times and that in uncertain times with Newey and West (1987) errors. P-value(AR) indicates that estimated p-value with Anderson and Rubin (1949) confidence intervals. **, *, †: significant at 5%, 10%, 15%, respectively.

To check the robustness of the baseline results, I estimate the model with several alternative specifications. 〈Table 2〉 shows the results. First, I consider two alternative criteria to define uncertain periods. The first is the time-varying threshold. In this case, uncertain periods are defined as those when historical EPU index exceeds its HP filtered trends[5]. In addition, I consider stock market volatility as an indicator for uncertain times[6].

<Table 2> Robustness checks

	Linear	Normal	Uncertain	P-value(HAC)
	HP-filtered time-varying threshold (with)			
1 year	0.81 (0.18)	2.17 (1.91)	0.66 (0.09)	0.46
3 year	0.83 (0.10)	1.22 (0.26)	0.74 (0.04)	0.04
5 year	0.91 (0.11)	1.29 (0.41)	0.81 (0.03)	0.01
	Stock return volatility			
1 year	0.82 (0.18)	1.06 (0.44)	0.35 (0.18)	0.14
3 year	0.83 (0.10)	0.95 (0.18)	0.62 (0.07)	0.09
5 year	0.92 (0.11)	0.97 (0.16)	0.71 (0.09)	0.10
	Defense news and BP combined			
1 year	0.31 (0.12)	0.30 (0.36)	0.45 (0.14)	0.70
3 year	0.67 (0.07)	0.90 (0.19)	0.73 (0.04)	0.06
5 year	0.80 (0.78)	1.14 (0.42)	0.81 (0.04)	0.15
	Post WWII (after 1947)			
1 year	1.59 (0.62)	2.06 (0.88)	-6.69 (11.43)	0.44
3 year	1.00 (0.30)	1.39 (0.31)	-9.96 (18.06)	0.55
5 year	1.29 (0.45)	1.86 (0.36)	-6.22 (17.20)	0.63

Note: Linear, Normal, and Uncertain indicate that the results in the linear model, low uncertain periods, and high uncertain periods, respectively. Numbers in parenthesis are standard errors. HPfiltered time-varying threshold: Uncertain when EPU index HP filtered trend. Stock return volatility: Uncertain when standard deviation of stock return its sample sverage. Defense new and BP combined: Both of defense news and BP shocks as instrumental variables. Post WWII: sample periods start 1947.Q1. P-Value(HAC) means that the p-value of the difference between the cumulative multipliers in normal times and that in uncertain times with Newey and West (1987) errors. **, *, †: significant at 5%, 10%, 15%, respectively.

I compute the standard deviation of monthly real stock returns using S&P stock price and CPI index provided by Shiller (2005). Uncertain periods are defined as those periods when the standard deviation of the stock returns exceeds its sample mean. Since stock return data are

5) The smoothing parameter λ is set to 1,000,000 as in Ramey and Zubairy (2018).
6) Bloom (2009) also uses stock market volatility to identify level of macroeconomic uncertainty.

available from 1890.Q1 to 2015.Q4, the results are estimated for a longer sample[7].

The implications of the results with the alternative criteria are similar to those in the baseline model: The multipliers in uncertain times are below unity and smaller than those in normal times. In the defense news and BP combined case, I use both defense news and the Blanchard and Perotti (2002) shock (BP shock) as instruments for government spending in equation (1) to mitigate potential bias induced by weak instruments following Ramey and Zubairy (2018)[8]. The implications of the results are again similar to the baseline case. Finally, I estimate the model using a post WWII sample[9]. The multipliers in uncertain times are also negative in those cases.

4. Concluding Remarks

This study examines whether a high level of macroeconomic uncertainty reduces government spending multipliers using U.S. historical time series data and the local projection method. The empirical results reveal that the government spending multipliers in uncertain times are below unity and smaller than those in normal times. The results imply that an increase in government spending would not be as effective as expected in the current period of high uncertainty. Though this study provides evidence on the adverse effect of macroeconomic uncertainty on fiscal policy, detailed transmission channels are still unclear. Thus, it would be worth investigating which channel drives this adverse effect. To this end, it is necessary to construct more detailed historical data.

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7) The data are obtained from Shiller's website. http://www.econ.yale.edu/shiller/data/ie_data.xls. I provide time series plots of two alternative criteria in appendix.

8) Though BP shock could partly solve weak instruments problem, it costs exogeneity and unanticipation of shocks. See Ramey and Zubairy (2018) for details. To identify BP shock, I use the same specification of the baseline model.

9) Time trend is changed from quartic to quadratic.

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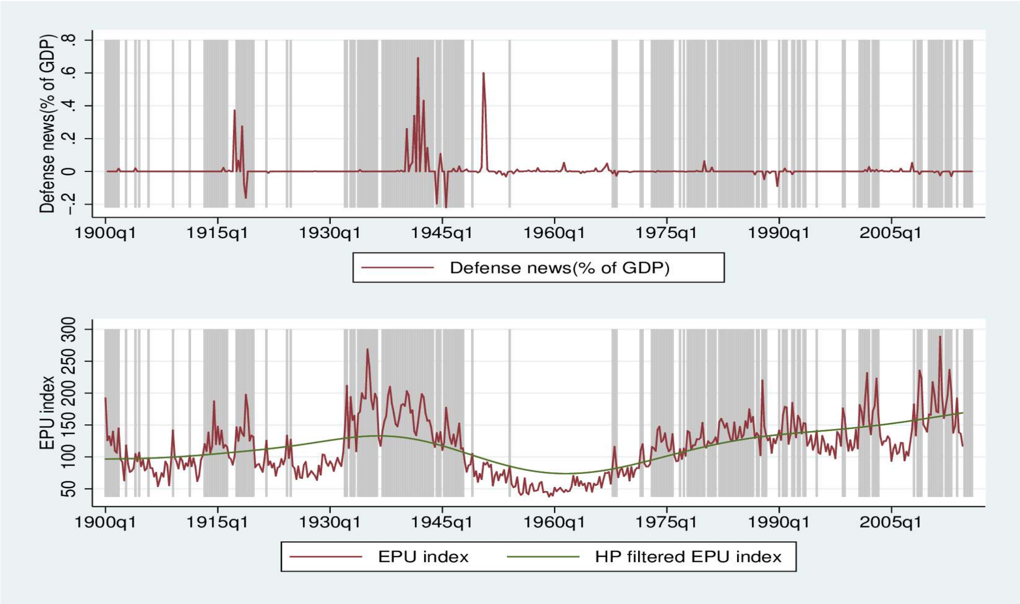
Appendix

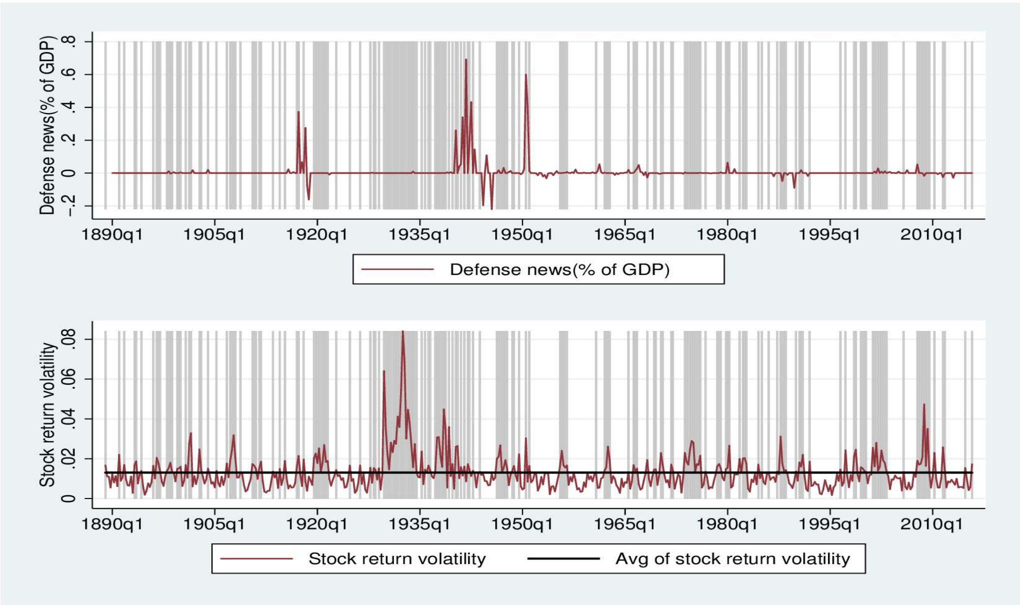
The following figures show the alternative criteria for uncertain times.

<Supplement figure 1> News variable and EPU index.



Note: Shaded areas indicate that EPU index exceeds HP filered trend.

<Supplement figure 2> News variable and standard deviation of stock return.



Note: Shaded areas indicate that the standard deviation of S&P stock return exceeds its sample average.

거시불확실성에 따른 정부지출승수: 미국의 장기시계열 데이터를 이용한 분석*

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요 약

이 논문은 1900년 1분기부터 2014년 2분기까지의 미국의 장기 시계열 데이터를 사용하여 거시 경제적 불확실성 수준에 따라 정부 지출 승수가 달라지는지를 검토한다. 장기시계열과 국소투영법(local projection)을 이용한 분석결과에 따르면, 불확실성이 높은 시기의 정부지출승수는 불확실성이 낮은 시기의 정부지출승수보다 작으며, 그 크기 또한 1보다 작은 것으로 나타났다.

핵심주제어 : 정부지출승수, 거시불확실성, 국소투영법, 국면의존성

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