DEPARTMENT OF ECONOMICS
WORKING PAPER SERIES

2019-11

McMASTER UNIVERSITY

Department of Economics
Kenneth Taylor Hall 426
1280 Main Street West
Hamilton, Ontario, Canada
L8S 4M4

http://www.mcmaster.ca/economics/

Desperate times call for desperate measures: government spending multipliers in hard times[*]

Sokbae Lee[†]
Columbia University

Yuan Liao[‡]
Rutgers University

Myung Hwan Seo[§]
Seoul National University

Youngki Shin[¶]
McMaster University

September 19, 2019

Abstract

We investigate state-dependent effects of fiscal multipliers and allow for endogenous sample splitting to determine whether the US economy is in a slack state. When the endogenized slack state is estimated as the period of the unemployment rate higher than about 12 percent, the estimated cumulative multipliers are significantly larger during slack periods than non-slack periods and are above unity. We also examine the possibility of time-varying regimes of slackness and find that our empirical results are robust under a more flexible framework. Our estimation results points out the importance of the heterogenous effects of fiscal policy.

Keywords: fiscal policy, threshold regression, recession

JEL codes: C32, E62, H20, H62

[†]Address: 420 West 118th Street, New York, NY 10027, USA. E-mail: sl3841@columbia.edu.
[‡]Address: 75 Hamilton St., New Brunswick, NJ 08901, USA. Email: yuan.liao@rutgers.edu.
[§]Address: 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea. E-mail: myunghseo@snu.ac.kr.
[¶]Address: 1280 Main St. W., Hamiloton, ON L8S 4L8, Canada. Email: shiny11@mcmaster.ca.

1 Introduction

The debate over the role of fiscal policy during a recession has recently taken center stage again in macroeconomics. One particular topic that has received substantial attention is whether the multiplier effect of government spending is state-dependent. On the one hand, in a series of papers, Auerbach and Gorodnichenko (2012, 2013a,b) used data from the USA as well as from OECD countries and provided empirical evidence supporting that the fiscal multiplier might be larger during recessions than expansions. On the other hand, Ramey and Zubairy (2018) constructed new quarterly historical US data and reported that their estimates of the fiscal multipliers were below unity irrespective of the state of the economy.

In this note, we contribute to this debate by estimating a threshold regression model that determines the states of the economy endogenously. Auerbach and Gorodnichenko (2012) estimated smooth regime-switching models using a seven quarter moving average of the output growth rate as the threshold variable. Their primary results relied on a fixed level of intensity of regime switching. Instead of estimating the level of intensity jointly with other parameters in their model, they calibrated the level of intensity so that the US economy spends about 20 percent of time in a recessionary regime. In Ramey and Zubairy (2018), the baseline results assume that the US economy is in a slack state if the unemployment rate is above 6.5 percent. To check the baseline results, Ramey and Zubairy (2018) conducted various robustness checks using different thresholds.

To be consistent with the empirical literature, we build on Ramey and Zubairy (2018): we use their dataset and follow their methodology closely. Our main departure from the recent empirical literature is that we split the sample in a data-dependent way so that the choice of threshold level is determined endogenously. It turns out that the endogenized threshold level of the unemployment rate is estimated at 11.97 percent, which is much higher than 6.5 percent adopted in Ramey and Zubairy (2018). Using this new threshold level combined with the same data and specifications as in Ramey and Zubairy (2018), we find that the estimated fiscal multipliers are significantly different between the two states and above unity for the high unemployment state. Specifically, if the threshold level is 6.5 percent, the estimates of two-year integral multipliers are around 0.6 regardless of the state of the economy. However, if the threshold level is 11.97 percent, the estimates are 1.58 for the high employment state and 0.55 for the low employment state, respectively. If

we look at the data, there is no period after World War II with the unemployment rate higher than 11.97 percent. In fact, there is only one timespan of severe slack periods in 1930s. In other words, the period of the Great Depression is isolated from other periods, as an outcome of our estimation procedure. Therefore, our estimation results suggest that (i) the fiscal multiplier can be larger than unity if the slackness of the economy is very severe and that (ii) the post World War II period does not include the severe slack state and thus, our estimates for the high unemployment state are not applicable to recessions in the post WWII period. We also examine the possibility of time-varying regimes of slackness by including a time dummy for the post WWII period and find that our empirical results are robust under this more flexible framework.

The remainder of the paper is organized as follows. In Section 2, we describe the econometric model and present empirical results. In Section 3, we give concluding remarks.

2   Model and Empirical Results

In this section, we give a brief description of the methodology developed in Ramey and Zubairy (2018, RZ hereafter). They consider the state-dependent local projection method of Jordà (2005). Their baseline regression model for each horizon h has the following form (see equation (2) in RZ):

$$
\begin{aligned}
x_{t+h} =& I_{t-1}\left(\alpha_{A,h} + \psi_{A,h}(L)z_{t-1} + \beta_{A,h}shock_t\right) \\
& + (1 - I_{t-1})\left(\alpha_{B,h} + \psi_{B,h}(L)z_{t-1} + \beta_{B,h}shock_t\right) + \varepsilon_{t+h},
\end{aligned}
$$

where $I_t(\cdot)$ is a dummy variable denoting the state of the economy, x_t is the variable of interest, z_t is a vector of control variables including GDP, government spending, and lags of the defense news variable, $\psi(L)$ is a polynomial of order 4 in the lag operator, and $shock_t$ is the defense news variable.

Recall that RZ assume that the economy is in the slack state when the unemployment rate is above 6.5 percent. We instead adopt a threshold regression model and parameterize $I_t = 1\{unemp_t > \tau\}$, where $1\{\cdot\}$ is an indicator function and $unemp$ denotes the unemployment rate. In other words, we estimate the model that endogenously determines the slack states that fit the data best. Specifically, we estimate the

2

following model using the ordinary least squares (see, e.g., Hansen, 2000):

$$GDP_t = 1\{unemp_{t-1} > \tau\} (\alpha_A + \psi_A(L)z_{t-1} + \beta_A shock_t)$$
$$+ 1\{unemp_{t-1} \leq \tau\} (\alpha_B + \psi_B(L)z_{t-1} + \beta_B shock_t) + \varepsilon_t.$$

In our view, the threshold regression model above provides a natural way to endogenize the level of slackness since there is a change point at τ for GDP in the model. To estimate this model, it is necessary to specify the parameter space for τ. We set it to be the interval between the 5 and 95 percentiles of the unemployment rates.

2.1 Endogenous Sample Splitting

Using the same dataset constructed by RZ, we obtain $\hat{\tau} = 11.97\%$ for the threshold parameter. This estimate is even higher than 8 percent, which RZ used for their robustness check. To appreciate our estimation result, we plot the profiled least squares objective function $(1 - R^2)$ as a function of τ in the left-panel of Figure 1.

It can be seen that the minimizer is well separated at 11.97%, which gives the graphical verification of $\hat{\tau}$. On the contrary, there is even no local minimum around RZ's threshold value at 6.5%. To check the possibility of the second threshold level below 11.97%, we re-estimated the model with the subsample for which the unemployment rate is lower than 11.97%. The right-hand panel indicates that there could be a second threshold around 4 percent, but not around 6.5%.

We test for the existence of the threshold for the whole sample and for the subsample with $unemp < 11.97$ by adopting the sup-Wald test in Hansen (2000). We set the number of bootstraps to 2,000 and the trimming ratio to 5%. We use the heteroskedasticity-robust test statistic. The bootstrap p-value for the whole sample is 5.3% and we can reject the null hypothesis of no threshold effect at the 10% significance level. For the subsample with the unemployment rate below 11.97, the bootstrap p-value for the same test is 20.3%. Thus, we conclude that there is a mild evidence for the single threshold in the data. Finally, the 95% confidence interval for the threshold variable is $(11.97, 13.56)$.

The periods with high unemployment rates are relatively rare. The US economy spent less than 10 percent of time in the new slack regime defined by 11.97 percent. The shaded areas in Figure 4 show slack periods over GDP and unemployment rates. There is only one timespan of severe slack periods from 1930Q3 to 1940Q3, namely

the Great Depression. We call this new slack periods as severe slack states ("hard times") compared to moderate slack states in RZ. Note that there is no period after WWII that belongs to the hard times.

2.2 State-Dependent Cumulative Multipliers

We now report the estimation results of the cumulative multipliers under endogenous sample splitting. It turns out that the new regime classification produces quite different implications. Following RZ, we adopt the local projection method in Jordà (2005) and use the military news as an instrument. Figure 5 reports the cumulative multiplier over 5 years (20 quarters) in each regime. To make the comparison straightforward, we also show the estimation results of Ramey and Zubairy (2018) next to our results.

When the 6.5% threshold is used in classification of slack state (that is, the moderate slack state), the multipliers in the high-unemployment state are negative up to 3 quarters and are indistinguishable to those in the low-unemployment state after 6 quarters. It is counterintuitive to observe that the multipliers are higher for the low unemployment state. On the other hand, if the 11.97% threshold is adopted (that is, the severe slack state), the multipliers in the high-unemployment state are largely above those in the low-unemployment state and are around unity after 10 quarters. In other words, the multipliers are all less than unity in the case of the moderate slack state; however, they are substantially higher in the case of the severe slack state. These results are robust to the choice of the instrumental variable.

In Table 1, we report the 2-year and 4-year cumulative multipliers when we use the military news, Blanchard and Perotti (2002) shock, and the combined variable of these two as an instrument, respectively. The basic implication does not change. The estimates of the 2-year multiplier vary from 1.58 to 2.21 and the 4-year multipliers are around 1. The main implication from our empirical results is that fiscal multipliers can be significantly larger during severe recessions than in normal periods.

2.3 Possibly Time-Varying Regimes

In this subsection, we explore the possibility of time-varying regimes of slackness. One might be worried that the US economy changed after WWII such that the level of slackness changed from the pre WWII period to the post WWII period. To deal with

this issue, we extend the endogenous sample splitting to the following specification:

$$I_{t-1} = 1\{unemp_{t-1} + \tau_1 d_{t-1} - \tau_0 > 0\},$$

where $d_t = 1$ if t is greater than or equal to 1945Q4. The resulting regression model has the following form:

$$
\begin{aligned}
GDP_t =\ & 1\{unemp_{t-1} + \tau_1 d_{t-1} - \tau_0 > 0\} \left(\alpha_A + \psi_A(L)z_{t-1} + \beta_A shock_t\right) \\
& + 1\{unemp_{t-1} + \tau_1 d_{t-1} - \tau_0 > 0\} \left(\alpha_B + \psi_B(L)z_{t-1} + \beta_B shock_t\right) + \varepsilon_t.
\end{aligned}
$$

To estimate this model, we need to optimize the least squares objective function with respect to $(\tau_1, \tau_0, \alpha_A, \psi_A, \beta_A, \alpha_B, \psi_B, \beta_B)$ jointly. Intuitively, one may first estimate the slope parameters $(\alpha_A, \psi_A, \beta_A, \alpha_B, \psi_B, \beta_B)$ given (τ_0, τ_1) and then optimize the objective function over (τ_0, τ_1) by grid search. More efficient computational algorithms are developed in our previous work (Lee et al., 2018) with the aid of mixed integer optimization (MIO). By applying the joint and iterative algorithms proposed in that paper, we obtain the following results:

$$\text{Joint algorithm: } (\hat{\tau}_1, \hat{\tau}_0) = (-1.82, 11.97),\ obj = 0.0002636456,$$
$$\text{Iterative algorithm: } (\hat{\tau}_1, \hat{\tau}_0) = (0.56, 11.97),\ obj = 0.0002636456.$$

That is, two algorithms yield different estimates but the same objective function values. It turns out that the regimes determined by two estimates are identical; that is, $\hat{\tau}_1$ has no role in determining slack periods.

In addition, we apply the model selection algorithm proposed in our previous work (Lee et al., 2018). Specifically, we specify the penalized least squares objective function with the penalty term consisting of a tuning parameter $\lambda > 0$ times the number of non-zero coefficients in the specification of the endogenous sample splitting rule. We implement it using MIO with $\lambda = \hat{\sigma}^2 \log(T)/T$, where T is the sample size and $\hat{\sigma}^2 = 0.00027$ is estimated from the baseline model with a single threshold at 11.97%. When we apply the penalized estimation algorithm, we find that the τ_1 estimate becomes zero and is dropped from the model. Therefore, there is no empirical evidence that supports time-varying regimes of slackness.

3 Conclusions

We have investigated state-dependent effects of fiscal multipliers and have found that it is crucial how to determine whether the US economy is in a slack state. When the slack state is defined as the period of the unemployment rate higher than about 12 percent, the estimated cumulative multipliers are significantly larger during slack periods than non-slack periods and are above unity. Our estimation results emphasize the importance of endogenous sample splitting. Furthermore, the effect of the fiscal policy may be heterogenous with respect to the level of slackness in the economy, thereby calling for more research in understanding the heterogenous effects of fiscal policy.

References

Auerbach, A. J. and Y. Gorodnichenko (2012). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy 4*(2), 1–27.

Auerbach, A. J. and Y. Gorodnichenko (2013a). Fiscal multipliers in recession and expansion. In A. Alesina and F. Giavazzi (Eds.), *Fiscal Policy after the Financial Crisis*, pp. 63–98. University of Chicago Press.

Auerbach, A. J. and Y. Gorodnichenko (2013b). Output spillovers from fiscal policy. *American Economic Review 103*(3), 141–46.

Blanchard, O. and R. Perotti (2002). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. *Quarterly Journal of Economics 117*(4), 1329–1368.

Hansen, B. E. (2000). Sample splitting and threshold estimation. *Econometrica 68*(3), 575–603.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review 95*(1), 161–182.

Lee, S., Y. Liao, M. H. Seo, and Y. Shin (2018). Factor-driven two-regime regression. *arXiv preprint*. https://arxiv.org/abs/1810.11109.

Newey, W. and K. West (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica 55*, 703–708.

Ramey, V. and S. Zubairy (2018). Government spending multipliers in good times and in bad: Evidence from us historical data. *Journal of Political Economy 126*(2), 850–901.

Figure 1: Least Squares Objective Function
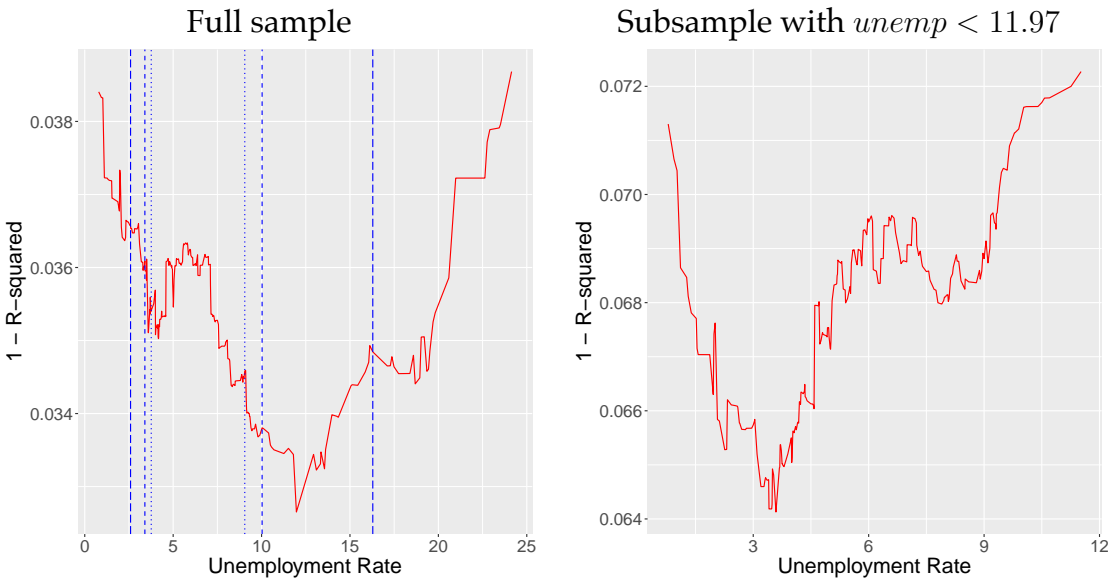
Note: In the left-hand panel, the long-dashed vertical lines are the 5 and 95 percentiles of the empirical distribution of the unemployment rate. The dashed vertical lines are the 10 and 90 percentiles and the dotted lines are the 15 and 85 percentiles, respectively.

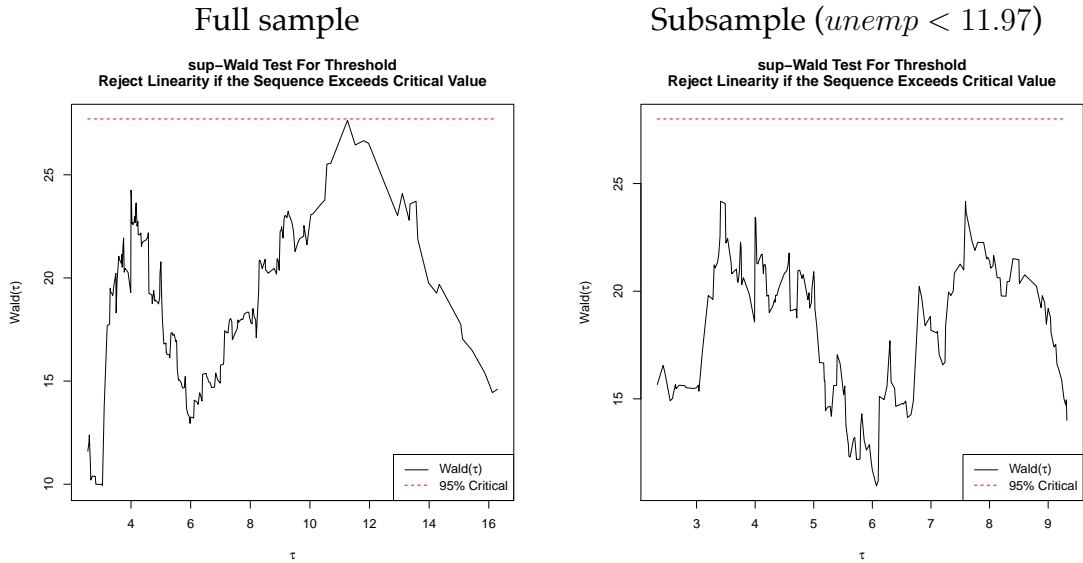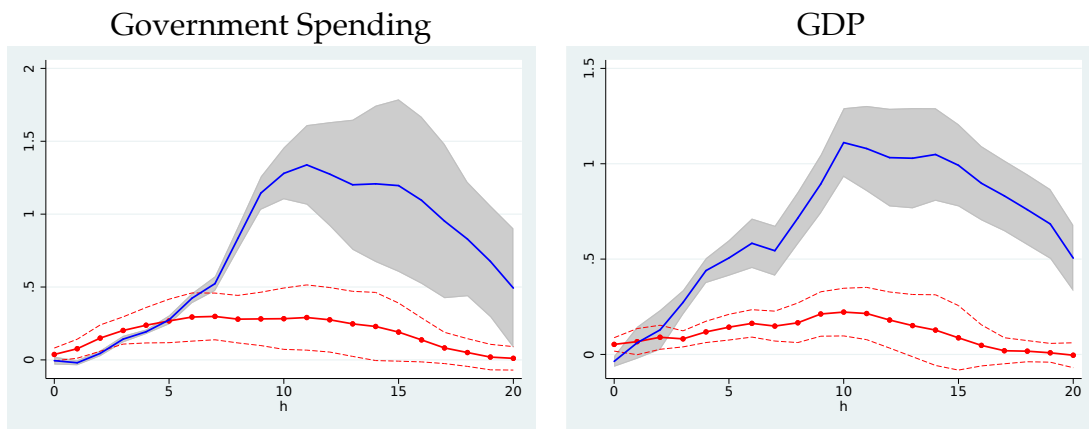## Figure 2: Inference for Multiple Regimes

Full sample

sup−Wald Test For Threshold
Reject Linearity if the Sequence Exceeds Critical Value

Subsample ($unemp < 11.97$)

sup−Wald Test For Threshold
Reject Linearity if the Sequence Exceeds Critical Value

Figure 3: Government Spendning and GDP Responses to News Shock

Government Spending

GDP

Note: A news shock is equal to 1 percent of GDP. The red line with circles denotes the impulse response function in non-slack periods and the blue solid line denotes the same function in slack periods. The related 95% pointwise confidence bands are also provided. The threshold point dividing slack/non-slack periods is $\hat{\tau} = 11.97$ estimated from the data.
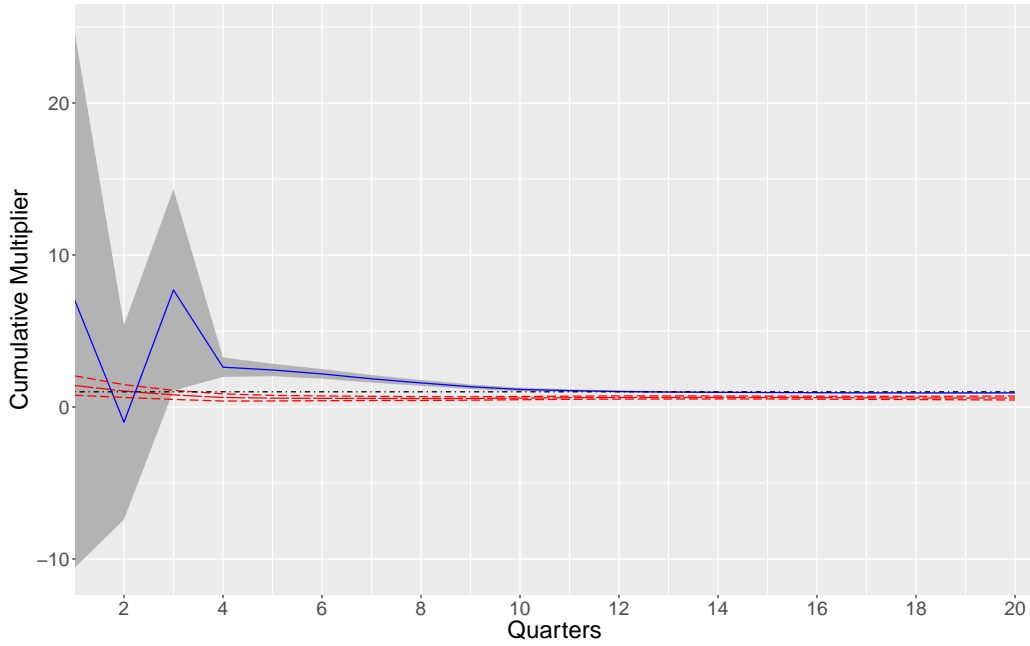
Figure 4: Periods of Slack States over GDP and Unemployment
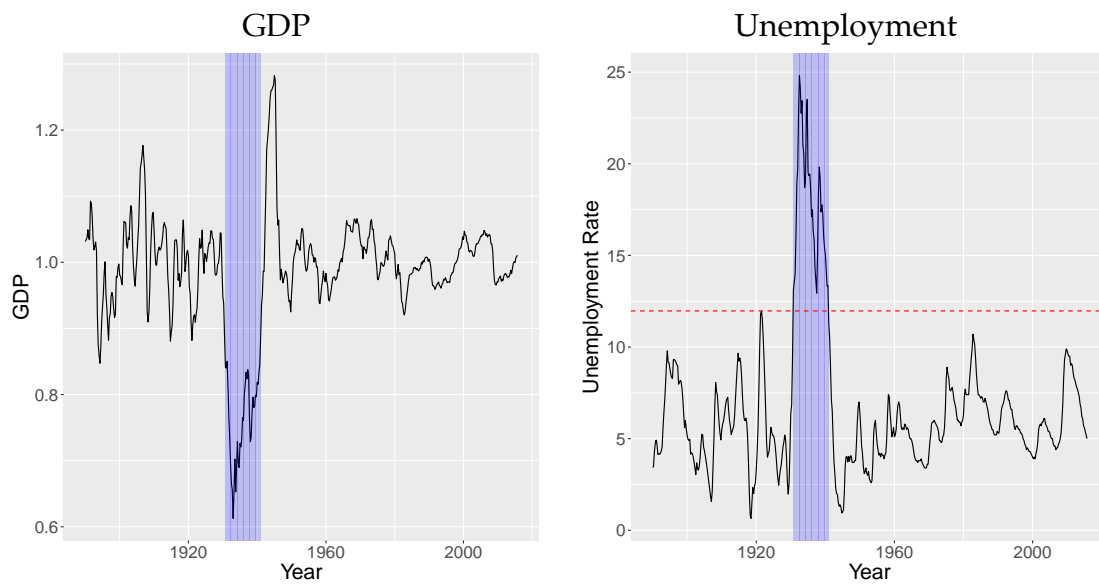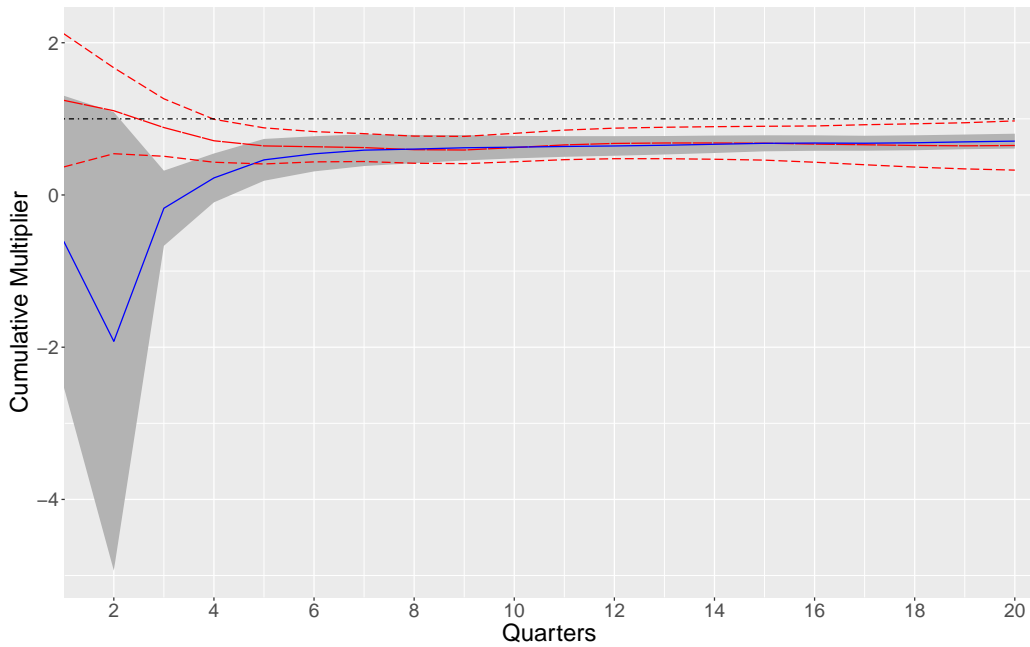

Note: GDP denotes real per capita GDP divided by trend GDP. The red dashed line in the right panel is the change-point estimate, $\hat{\tau} = 11.97$. The blue shaded area denotes the slack states estimated from the data.

Figure 5: Cumulative Multipliers

Threshold: 11.97%

Threshold: 6.5%

Note: The blue solid line denotes cumulative multipliers for slack states (high unemployment) and the red dashed line for non-slack states (low unemployment). The 95% pointwise confidence bands are also presented along with cumulative multipliers. We also draw a dot-dashed horizontal line at multiplier=1.

Table 1: Estimates of Cumulative Multipliers

	High Unemployment	Low Unemployment	P-value for difference in multipliers
Panel A: Threshold at 11.97%			
Military News Shock			
2 year integral	1.58	0.55	0.000
	(0.099)	(0.064)	
4 year integral	0.94	0.61	0.000
	(0.017)	(0.050)	
Blanchard-Perotti Shock			
2 year integral	1.65	0.34	0.005
	(0.425)	(0.105)	
4 year integral	1.23	0.40	0.000
	(0.130)	(0.104)	
Combined			
2 year integral	2.21	0.35	0.000
	(0.406)	(0.092)	
4 year integral	1.11	0.46	0.000
	(0.108)	(0.086)	
Panel B. Threshold at 6.5%			
Military News Shock			
2 year integral	0.60	0.59	0.954
	(0.095)	(0.091)	
4 year integral	0.68	0.67	0.924
	(0.052)	(0.121)	
Blanchard-Perotti Shock			
2 year integral	0.68	0.30	0.005
	(0.102)	(0.111)	
4 year integral	0.77	0.35	0.001
	(0.075)	(0.107)	
Combined			
2 year integral	0.62	0.33	0.099
	(0.098)	(0.110)	
4 year integral	0.68	0.39	0.021
	(0.052)	(0.110)	

Note: The p-values for difference in multipliers are calculated by the HAC-robust p-values in Newey and West (1987). Panel A is based on our threshold estimate (11.97%). Panel B comes from Ramey and Zubairy (2018) where the threshold point (6.5%) is chosen by the authors.