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Tax multipliers and monetary policy: Evidence from a threshold model

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HIGHLIGHTS

- We extend Romer and Romer (2010) and allow for nonlinearities between fiscal policy shocks and gdp.
- The best fitting threshold variable is the federal funds rate with a delay of 2.
- The tax multiplier is 4 times larger with accommodative monetary policy.

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ABSTRACT

Romer and Romer (2010) use the narrative record to generate a time series of exogenous shocks to fiscal policy. They report a tax multiplier of 3.0. We extend their analysis and allow for nonlinearities between their shocks and the effects on output by estimating a threshold regression model. Using Hansen's (1997) procedure, we find the best fitting threshold is changes in the federal fund rate with a delay of two quarters. Moreover, we find that the tax multiplier is approximately 4.3 if accompanied by an accommodative monetary policy and approximately 1.2 under tight monetary policy.

1. Introduction

Romer and Romer (2010)—henceforth, RR—use the narrative record—sources such as presidential speeches, the *Economic Reports of the President*, and reports of Congressional committees—to produce a time series of exogenous shocks to US tax policy. RR report that a tax increase of one percent of GDP reduces output by three percent over the subsequent three years which is approximately three times larger than multipliers estimated using vector autoregressions (VARs).[1] While the research examining the relationship between fiscal policy shocks and output is vast,[2] few, if any, papers allow for nonlinearities. The main goal of this paper is to evaluate the RR series of exogenous fiscal shocks allowing for nonlinearities using a threshold regression model. Using Hansen's (1997) procedure, we find that changes in the federal funds rate with a delay of two quarters is the best-fitting threshold variable; moreover, we find that the tax multiplier is approximately four times larger if accompanied by accommodative monetary policy.

2. Data and methodology

RR use legislative and executive branch reports to identify 54 quarterly, exogenous tax shocks. To standardize each shock, RR express each of the exogenous tax shocks as a percent of nominal GDP in the quarter the shock occurs. The primary regression equation estimated in RR is as follows:

$$\Delta Y_t = a + \sum_{i=0}^{M} b_i \Delta T_{t-i} + \sum_{j=1}^{N} c_j \Delta Y_{t-j} + e_t \tag{1}$$

where Y is the logarithm of real GDP and ΔT is RR's measure of exogenous tax changes. RR select $M = 12$ and $N = 11$ and sum the b_i coefficients to obtain the tax multiplier. Our primary extension is to allow (1) to follow a threshold process. Consider the

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1 Blanchard and Perotti (2002).

2 See Ramey (2011) for an extensive overview.

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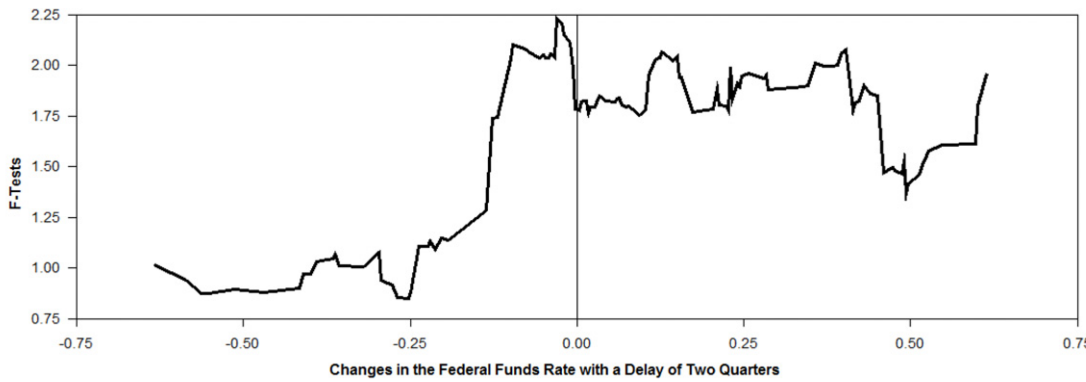

Fig. 1. Hansen's (1997) test for threshold effects.

following:

$$\Delta Y_t = I_t\left[a+\sum_{i=0}^{M} b_i \Delta T_{t-i}+\sum_{j=1}^{N} c_j \Delta Y_{t-j}\right] + (1-I_t)\left[\alpha+\sum_{i=0}^{M} \beta_i \Delta T_{t-i}+\sum_{j=1}^{N} \gamma_j \Delta Y_{t-j}\right]+\varepsilon_t \quad (2)$$

$$I_t = \begin{cases} 1 & \text{if } z_{t-d} \geq \tau \\ 0 & \text{if } z_{t-d} < \tau \end{cases} \quad (3)$$

where z_t is the threshold variable, τ is the value of the threshold, d is the delay parameter, and I_t is the Heaviside indicator function. When the threshold variable (z_{t-d}) exceeds the value of the threshold (τ), $I_t = 1$ and $\Delta Y_t = a+\sum_{i=0}^{M} b_i\Delta T_{t-i}+\sum_{j=1}^{N} c_j\Delta Y_{t-j}$. If the threshold variable (z_{t-d}) is less than the threshold (τ), $I_t = 0$ and $\Delta Y_t = \alpha+\sum_{i=0}^{M}\beta_i\Delta T_{t-i}+\sum_{j=1}^{N}\gamma_j\Delta Y_{t-j}$. However, it is possible for the coefficients to be equal; in such a case, the model would be linear, and the tax multiplier would be equivalent in both regimes (i.e., $\sum_{i=0}^{M}\beta_i = \sum_{i=0}^{M} b_i$).

The data used in RR (2010) was obtained from David Romer's website.[3] We follow RR and estimate Eq. (2) with $M = 12$ and $N = 11$ over the same sample period: 1950Q1–2007Q4.[4] However, we do not specify beforehand the threshold variable or the level of the threshold between regimes; rather, we let the data determine these parameters. Specifically, we implement Hansen's (1997) procedure to find the best-fitting threshold variable. As such, the potential threshold variables' observations are ordered such that

$$z^1 < z^2 < z^3 \cdots < z^t.$$

We allow each value of z^i to serve as an estimate of the threshold parameter (τ) and obtain the threshold using a grid search over the potential values of the threshold variable. As prescribed in Enders (2010), we eliminate the highest and lowest fifteen percent of the ordered values of the threshold to ensure an adequate number of observations on each side of the threshold. The level of the threshold which minimizes the residual sum of squares is the consistent estimate of the threshold. Under the null hypothesis of linearity the threshold variable is an unidentified nuisance parameter; therefore, the test statistic for linearity cannot be found using a standard F-test and must be bootstrapped as in Hansen's (1997) procedure. We consider lagged output growth and changes (and lagged changes) of the federal funds rate as possible threshold variables. Lagged output growth was considered to allow the tax multiplier to change depending on the state of the business cycle whereas changes in the federal funds rate was considered to allow the multiplier to change depending upon changes or recent changes in monetary policy.

Table 1
Unit root tests.

Unit root test[a]	Variable		
	RR's tax series	Real GDP growth	ΔFFR_{t-2}
Augmented DF test	−15.76*	−11.02*	−7.04*
Phillips–Perron	−15.83*	−11.07*	−12.20*
DF–GLS	−15.66*	−7.86*	−7.03*

* Denotes statistical significance at the 95% level.
[a] Under the null hypothesis, the series is a unit root process.

Table 2
Hansen's (1997) test for a threshold process.

Threshold variable	τ	F-test	Prob-value	BIC
ΔY_{t-1}	0.74	1.69	0.254	669.60
ΔY_{t-2}	0.39	1.82	0.155	666.27
ΔFFR	0.52	2.01	0.083	661.38
ΔFFR_{t-1}	0.52	1.65	0.315	670.73
$\boldsymbol{\Delta FFR_{t-2}}$	**−0.03**	**2.23**	**0.017**	**655.96**

3. Results

Before estimating a model, we implement unit root tests to ensure stationarity of our variables. Table 1 contains the results. Using augmented Dickey–Fuller tests, Phillips–Perron tests, and Dickey–Fuller GLS tests, all of the series are found to be stationary. Table 2 reports the estimated value of the threshold parameter, the value of the F-statistic for the null hypothesis of linearity, and the bootstrapped *prob*-value of Hansen's (1997) tests using the above mentioned as thresholds variables. As shown in Table 2, the only threshold variable significant at the 95% level is the change in the federal funds rate with a delay parameter of two quarters. Moreover, using the change in the federal funds rate with a delay parameter of two quarters as the threshold variable also yields the lowest BIC.

Fig. 1 shows the F-tests for each possible threshold value for the change in the federal funds rate with a delay parameter of two quarters. As can be seen, the maximum F-statistic occurs when $\Delta FFR_{t-2} = -0.03$; thus, we use this as the threshold value (τ) in (2). Interestingly, this estimated threshold corresponds well with

3 http://elsa.berkeley.edu/~dromer/.

4 For robustness, we also implement a procedure to pare down the number of insignificant lags using F-tests on the last four quarters of each variable. We repeat the procedure until the F-tests are significant at the 95% level. Using this procedure yields a model with eight lags of the exogenous shocks and three lags of output. In addition, we determine the lag length using t-tests on each coefficient as in Bernanke and Mihov (1998). Both procedures produce nearly identical results to those shown.

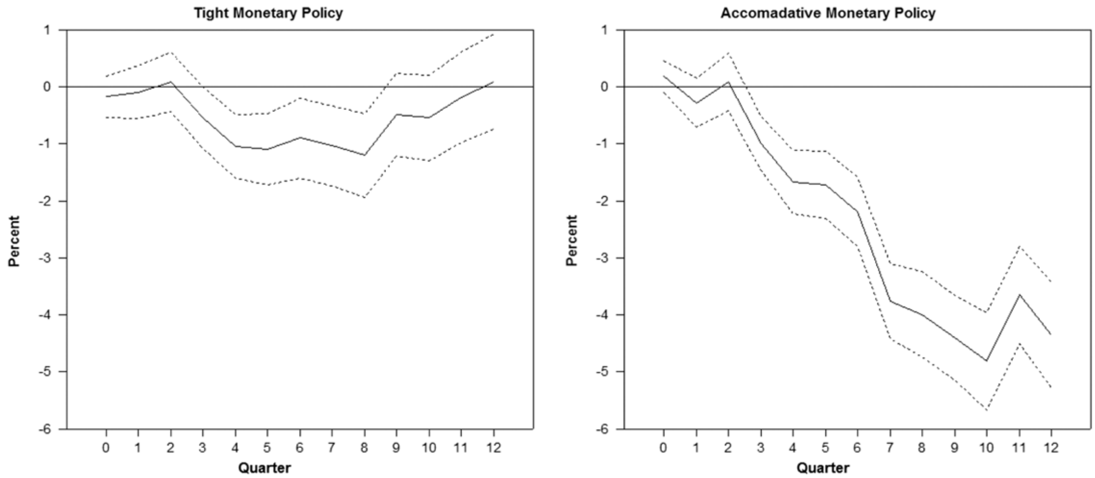

Fig. 2. Estimated impact of an exogenous tax increase of 1% of GDP on GDP. Note: the solid line is the sum of the coefficients of the RR shocks on the change in log output in each regime. Accommodative monetary policy means that $\Delta FFR_{t-2} < -0.03$. Tight monetary policy means $\Delta FFR_{t-2} > -0.03$.

Table 3
Ljung–Box Q-statistics (significance values in parentheses).

Standardized residuals (lags)	Tight monetary policy regime	Accommodative monetary policy regime
4	1.74 (0.78)	3.03 (0.55)
8	6.33 (0.61)	3.80 (0.87)
12	10.53 (0.57)	5.68 (0.93)

the well-known Friedman result that monetary policy affects output with approximately a six to nine-month lag. Table 3 contains the Ljung–Box Q statistics of the residuals from our threshold model. The residuals in both of the regimes are insignificant up to the twelfth lag which suggests that the model is well specified.

Given the estimated threshold ($\Delta FFR_{t-2} = -0.03$), our sample is essentially separated into two monetary policy regimes. We define the first regime ($\Delta FFR_{t-2} > -0.03$) as the tight monetary policy regime and the second regime ($\Delta FFR_{t-2} < -0.03$) as the accommodative monetary policy regime. The tight regime contains 143 observations and the accommodative regime contains 89. As noted above, if ΔFFR_{t-2} exceeds -0.03, $I_t = 1$, and $\Delta Y_t = a + \sum_{i=0}^{12} b_i \Delta T_{t-i} + \sum_{j=1}^{11} c_j \Delta Y_{t-j}$, meaning that the tax multiplier is $\sum_{i=0}^{12} b_i$ whereas if ΔFFR_{t-2} is less than -0.03, $I_t = 0$, and $\Delta Y_t = \alpha + \sum_{i=0}^{12} \beta_i \Delta T_{t-i} + \sum_{j=1}^{11} \gamma_j \Delta Y_{t-j}$, meaning that the tax multiplier is $\sum_{i=0}^{12} \beta_i$.
We follow RR and display the tax multiplier graphically by summing β_i and b_i for each respective regime. Fig. 2 displays the two tax multipliers resulting from the estimation of Eq. (2) using ΔFFR_{t-2} as the threshold variable; it shows the effect of a tax increase equal to one percent of GDP on real GDP growth in each regime with one-standard-error bands. The most striking feature of Fig. 2 is the stark difference in the estimated impact of RR's exogenous tax shocks in each regime. If the federal funds rate is cut two quarters prior to the shock, the effect is four times as large. The estimated impact of an exogenous tax increase of one percent in the tight monetary policy regime decreases output approximately 1.2% after eight quarters but is essentially zero after three years. On the other hand, the estimated impact of an exogenous tax increase of one percent in the accommodative monetary policy regime is -4.3% after three years and is clearly significantly different from zero and larger than the multiplier reported in RR. This indicates that accommodative monetary policy significantly magnifies the tax multiplier while tight monetary policy seems to dampen it. Thus, fiscal policy and monetary policy working in concert appear to produce significantly larger effects on output than fiscal policy operating independently.

4. Conclusion

This paper extends RR by re-estimating the main regression equation in RR in a threshold regression framework. Specifically, we use Hansen's (1997) procedure to test and estimate threshold effects. We find that the change in the federal funds rate with a two quarter delay is the best-fitting threshold variable and reject the null hypothesis of linearity. Moreover, our results suggest that the size of the tax multiplier is approximately 4.3 (which is larger than that reported in RR), if accompanied by accommodative monetary policy which suggests that monetary policy can substantially magnify or dampen the effects of fiscal policy. However, it should be noted that our results may be specific to the use of RR's measure of fiscal shocks and should be regarded cautiously due to the disagreement over the appropriate method (i.e., narrative vs. VARs) for measuring policy shocks. However, the stark difference in the tax multiplier across the monetary policy regimes suggests that nonlinear models can potentially add substantively to the multiplier literature.

References

Bernanke, Ben, Mihov, Ilian, 1998. Measuring monetary policy. Quart. J. Econ. 113, 869–902.
Blanchard, Olivier, Perotti, Roberto, 2002. An empirical characterization of the dynamic effects of changes in government spending and taxes on output. Quart. J. Econ. 117, 1329–1368.
Enders, W., 2010. Applied Econometric Time Series, third ed. J. Wiley, Hoboken, NJ.
Hansen, Bruce., 1997. Inference in TAR models. Stud. Nonlinear Dyn. Econom. 2, 1–14.
Ramey, Valerie A., 2011. Can government purchases stimulate the economy? J. Econom. Lit. 49, 673–685.
Romer, Christina, Romer, David H., 2010. The macroeconomic effects of tax changes: estimates based on a new measure of fiscal shocks. Amer. Econ. Rev. 100, 763–801.