## 1. Introduction

The effectiveness of fiscal policy to stimulate output continues to be a widely debated issue in the academic literature. Recent papers by Romer and Romer (2010) and Cloyne (2013) use the narrative records from legislative and executive sources to produce a time series of exogenous shocks to U.S. and U.K. tax policy. Romer and Romer (2010) report a tax multiplier of approximately 3.0 for the U.S., and similarly Cloyne (2013) reports a tax multiplier of 2.5 for the U.K. Both papers continue to receive substantial attention in the literature due to the innovative approach undertaken to produce exogenous tax shocks, as well as, the fact that the tax multipliers are larger than many other tax multipliers estimated using SVAR methods (Blanchard and Perotti (2002), Barro and Redlick (2011), and Baunsgaard et al. (2012)).

Our extension of the Romer and Romer (2010) and Cloyne (2013) studies relaxes the linear framework in which positive and negative tax shocks have symmetric effects on output and its components. Thus, the main goal of this paper is to evaluate whether the Romer and Romer (2010) and Cloyne (2013) tax shock series exhibit asymmetric behavior in a nonlinear framework.[1] Economic intuition suggests tax increases and tax cuts may affect output and its components asymmetrically. For example, tax cuts or tax increases which target business investment may have long run supply-side effects whereas policies that change personal income taxes may only temporarily affect aggregate demand. We find that U.S. tax cuts have large, positive effects on output while tax increases have little effect, whereas in the U.K., tax cuts have no significant effect on output while tax increases have significant, adverse effects. We find these results surprising given the similarity in the tax multipliers reported in Romer and Romer

[1] We began this research in Februrary 2013. However, since then we have independently discovered that Hussain and Malik (2013) investigate a similar question using the Romer and Romer (2010) U.S. data. While our findings support those of Hussain and Malik (2013), we examine the effects for the U.K. as well as the U.S. and emphasize the differences between the two countries. Our methodology is also slightly different from Hussain and Malik (2013).

(2010) and Cloyne (2013).[2] We offer several hypotheses to explain these results at the end of the paper.

While Romer and Romer (2010) and Cloyne (2013) undertake tests to ensure the exogeneity of their series, the validity of their narrative tax shock series has been the subject of recent criticism. For example, Favero and Giavazzi (2012) challenge the specification of tax shocks used by Romer and Romer (2010) and find when estimated in the correct form the multiplier is approximately 0.5. Mertens and Ravn (2012) eliminate tax changes in the Romer and Romer (2010) series they deem likely to be anticipated because of implementation lags and find a multiplier of 2.0. Charhour, Schmitt-Grohé, and Uribe (2012) further investigate a claim made by Favero and Giavazzi (2012) regarding the difference between the Romer and Romer (2010) series and the SVAR series used in Blanchard and Perotti (2002) and conclude that the difference between the two series is likely the result of alternative assumptions regarding identification. Perotti (2012) uses Romer and Romer's (2010) tax series with an adjustment and finds that output tax multipliers are larger across various specifications than those in Blanchard and Perotti (2002) but smaller than those reported in Romer and Romer (2010). Mertens and Ravn (2013a) attempt to reconcile differences in the magnitudes of tax multipliers between narrative and SVAR approaches and conclude that the differences between the two approaches are likely a result of measurement errors within the narrative series. Furthermore, Mertens and Ravn (2013a) propose an estimator in which the narrative series are not viewed as mapping one-to-one into true structural shocks but are rather used to impose moment restrictions on a VAR covariance matrix.

We do not seek to contribute to the above debate regarding differences between SVAR and narrative approaches or whether the narrative accounts are truly exogenous. Instead, we

[2] We replicate the Romer and Romer (2010) and Cloyne (2013) results in Section 2.

follow Romer and Romer (2010) and Cloyne (2013) and take their narrative series as exogenous, but we examine whether each series exhibits asymmetric behavior. To our knowledge, our paper is the first to investigate whether positive and negative tax shocks affect output asymmetrically while also controlling for the state of the business cycle.[3] The rest of the paper proceeds as follows. In Section 2, we describe the data and replicate the results from Romer and Romer (2010) and Cloyne (2013). Section 3 examines the effect of asymmetric tax multipliers on U.S. and U.K. output, as well as, specific GDP components. We explore the role of anticipated versus unanticipated shocks developed by Mertens and Ravn (2012) in Section 4. Section 5 discusses our results, and Section 6 concludes.

## 2. Narrative Tax Multipliers

### *2.1 Data*

Romer and Romer (2010) and Cloyne (2013) argue that factors that give rise to tax changes are often correlated with other developments in the economy which complicate efforts to isolate the economic effects of tax changes. Thus, they use the narrative records from the U.S. and the U.K. to produce two series of legislated tax policy shocks and express each tax shock as a percent of nominal GDP in the quarter the shock occurs. For the U.S. the narrative analysis is based mainly on sources such as presidential speeches, the *Economic Reports of the President*, and reports of Congressional committees while in the U.K. the narrative analysis is mainly based on the annual budget.

Romer and Romer (2010) define four motivations for changes in the tax code: to offset a change in government spending, to offset some factor other than spending that is likely to affect output in the near future, to deal with an inherited budget deficit, and to achieve some long-run goal (e.g, higher normal growth, increased fairness, or a smaller role for government). The first

[3] Our methodology is similar to Cover (1992).

two motivations are correlated with other developments affecting output and are classified as endogenous. However, tax changes to deal with an inherited budget deficit or to achieve a long-run goal are unlikely to be correlated with other factors affecting output and are, therefore, considered exogenous.

Thus, the exogenous series of tax changes in Romer and Romer (2010) consists of 45 quarterly, exogenous tax shocks over the 1947-2007 time period. Of these 45 exogenous tax shocks, there are 22 tax increases and 23 tax cuts. Cloyne (2013) develops a similar classification scheme to distinguish between endogenous and exogenous tax shocks in the U.K. The U.K. exogenous tax shock series consists of 113 quarterly, exogenous tax shocks over the 1955-2009 time period with 72 of the tax shocks being tax cuts and 41 being tax increases. The two series are shown in Figure 1.[4]

*2.2 Methodology*

The primary model in Romer and Romer (2010) regresses real output growth on a constant and the contemporaneous value and lags of the chosen tax series as shown by equation (1). Equation (2) adds lags of real output growth which controls for the state of the business cycle. Thus, they estimate the following two models:

$$\Delta Y_t = a + \sum_{i=0}^{M} b_i \Delta T_{t-i} + e_t \quad (1)$$

$$\Delta Y_t = a + \sum_{i=0}^{M} b_i \Delta T_{t-i} + \sum_{j=1}^{N} c_j \Delta Y_{t-j} + e_t \quad (2)$$

where Y is the logarithm of real GDP and ΔT is the measure of tax changes. Romer and Romer (2010) select *M = 12* and *N = 11* and subsequently sum the $b_i$ coefficients to obtain the tax

[4] All data is obtained from the AER's website for each respective paper.

multiplier. Cloyne (2013), on the other hand, obtains the tax multiplier by estimating impulse response functions from the following VAR:

$$\mathbf{X_t} = \mathbf{A_0} + \mathbf{A_1 t} + \mathbf{B(L)X_{t-1}} + \mathbf{C(L)}d_t + \mathbf{e_t} \qquad (\mathbf{3})$$

where **B(L)** and **C(L)** are lag polynomials, $d_t$ is the Cloyne (2013) exogenous tax series, and $\mathbf{X_t}$ is a vector that contains log real per capita GDP ($y_t$), consumption ($c_t$), and investment ($i_t$).

We estimate (3) using the variables in growth rates rather than levels such that

$$\Delta\mathbf{X_t} = \mathbf{A_0} + \mathbf{B(L)}\Delta\mathbf{X_{t-1}} + \mathbf{C(L)}d_t + \mathbf{e_t} \qquad (\mathbf{4})$$

$\mathbf{X_t}$ is a vector that contains quarterly growth rates in real GDP, consumption, and investment. Figure 2 displays the tax multipliers obtained from estimating (4) and generating the cumulative impulse response functions using the Romer and Romer (2010) and Cloyne (2013) tax series. As noted in Cloyne (2013) and as can be seen from Figure 2, the tax multipliers are remarkably similar.

For U.S. GDP, the tax multiplier peaks at approximately 3.0 and is equal to 2.5 after three years, and in the U.K., the multiplier peaks at approximately 2.8 and is equal to 2.25 after three years. Interestingly, while the multipliers for both countries peak in quarter ten, the effects of the tax multiplier begin to be realized after only three quarters in the U.S. but after six quarters in the U.K. Note that while the consumption multiplier for each country is approximately equal after three years, the contemporaneous effects are quite different. In the U.S., the contemporaneous effect of a tax cut on consumption is less than 0.5 but doubles from the second to the third quarter and then peaks nine quarters after the shock. The contemporaneous effect on consumption in the U.K. is double that in the U.S. and steadily increases until nine quarters after the shock. However, after three years the overall effect of the tax cut on consumption is approximately 0.5 percent higher in the U.K. than the U.S. Investment in the U.K. experiences a

higher contemporaneous increase than that of the U.S. However, after three years the tax multiplier on investment in the U.S is approximately double the size of that in the U.K.

## 3. Asymmetric Tax Multipliers

### *3.1 Asymmetric Tax Multipliers Methodology*

To evaluate possible asymmetric effects, we create two separate series of positive and negative shocks using methodology standard in the asymmetric literature (for example, see Cover (1992)).[5] Call the complete series of Romer and Romer (2010) shocks *shock* and define the series *neg* to be equal to *shock* if *shock* is negative; otherwise, it is set equal to zero. Thus, *neg* = min(*shock*, 0). Likewise, we define *pos* to be equal to *shock* if *shock* is positive; otherwise, it is set equal to zero. Thus, *pos* = max (*shock*, 0).[6] First, we implement the methodology used in Romer and Romer (2010) to estimate the following time series regression:

$$\Delta Y_t = a + \sum_{i=0}^{M} b_i pos_{t-i} + \sum_{j=0}^{N} c_j neg_{t-j} + \sum_{k=1}^{P} d_k \Delta Y_{t-k} + e_t \qquad (5)$$

where $\Delta Y_t$ is the quarterly change in GDP growth. In addition, we examine how each respective U.S. and U.K. GDP component responds to positive and negative tax shocks. As such, we simply insert each country's respective GDP component in place of $\Delta Y_t$ in equation (5), such that (5) becomes

$$\Delta Com_t = a + \sum_{i=0}^{M} b_i pos_{t-i} + \sum_{j=0}^{N} c_j neg_{t-j} + \sum_{k=1}^{P} d_k \Delta Com_{t-k} + e_t \qquad (6)$$

where $\Delta Com_t$ is one hundred times the log quarterly change in investment and consumption.[7] As noted in Kilian and Vigfusson (2011), estimations that seek to examine asymmetric effects similar to those in (5) and (6) will produce unbiased estimates of the $b_i$ and $c_j$ coefficients so long as both the $pos_{t-i}$ and $neg_{t-j}$ series are included in the regression. Moreover, if the two series are

[5] Cover (1992) modifies the two step procedure employed by Barro (1977, 1978) and Barro and Rush (1980).
[6] An alternative way to define *neg* and *pos* is $neg_t = -1/2[abs(shock_t) - shock_t]$ and $pos_t = 1/2[abs(shock_t) + shock_t]$.
[7] All GDP components are obtained from the data used in Romer and Romer (2010) and Cloyne (2013).

truly exogenous, there is no need to control for any other factors. However, we include 11 lags of GDP growth as well as consumption and investment to control for business cycle and output gap effects. To obtain the multipliers from (5) and (6), we graph the sum of the $b_i$ and $c_j$ coefficients for positive and negative tax shocks, respectively. We subsequently implement two Wald tests to determine whether the sum of the positive and negative tax series are different from zero. That is we test whether $\sum_{i=0}^{12} b_i pos_{t-i} = 0$ and $\sum_{j=0}^{12} c_j neg_{t-j} = 0$.

In addition, we also estimate (4) as in Cloyne (2013) but replace the tax series, $d_t$, with our *pos* and *neg* series such that (4) becomes:[8]

$$\Delta \mathbf{X_t} = \mathbf{A_0} + \mathbf{A_1 t} + \mathbf{B(L)}\Delta \mathbf{X_{t-1}} + \mathbf{C(L)}pos_t + \mathbf{D(L)}neg_t + \mathbf{e_t} \quad (7)$$

where $\mathbf{X_t}$ is a vector that contains quarterly growth rates in real GDP, consumption, and investment. From this VAR we generate dynamic response functions from the $pos_t$ and $neg_t$ tax shocks for each country.

*3.2 Asymmetric Tax Multipliers Results*

Table 1 displays the Wald statistics from estimating (5) and (6) and testing whether $\sum_{i=0}^{12} b_i pos_{t-i} = 0$ and $\sum_{j=0}^{12} c_j neg_{t-j} = 0$. Figures 3 and 4 display the tax multipliers from generating the cumulative dynamic response functions of the positive and negative tax shocks on the U.S. and U.K. economies from equation (7).[9]

The results for the U.S. and U.K. are quite surprising. As can be seen in Table 1, we are not able to reject the hypothesis that the sum of the coefficients on the positive U.S. tax shock series is equal to zero, but we are able to reject that the sum of the coefficients on the negative tax shock series is significantly different from zero at the 1% level for U.S. GDP growth. On the

[8]Likewise, we undertake an identical procedure to identify our positive and negative tax shock series from Cloyne (2013).

[9] The resulting tax multipliers for the U.S. and U.K. economies from summing the $\sum_{i=0}^{12} b_i pos_{t-i}$ and $\sum_{j=0}^{12} c_i neg_{t-j}$ coefficients from equations (5) and (6) are similar to those shown in Figures 3 and 4.

other hand, the results for the U.K. are exactly the opposite. We are able to reject the hypothesis that positive tax shocks are equal to zero at the 1% level but are unable to reject the hypothesis for tax cuts. For U.S. consumption, again we are not able to reject the null hypothesis that the sum of the tax increase coefficients is significantly different from zero, and we are able to reject the hypothesis that the sum of the coefficients on the negative tax series is zero. However, for the U.K. the results again reverse. The sums of the tax increase coefficients are significantly different from zero whereas the sums of the tax cut coefficients are not. Investment follows a similar pattern in the U.S. in that the sum of the tax cut coefficients are significantly different from zero whereas the sum of the tax increases are not. In the U.K., neither sum of the coefficients is significantly different from zero.

As can be in Figure 3, in the U.S., the tax cut multiplier on GDP growth is between 2.0 and 2.5 and statistically different from zero after three years. However, the multiplier resulting from tax increases, shown in Figure 4, is statistically insignificant. Again, the results in the U.K. are reversed. The multiplier on GDP growth associated from increases in taxes is between -5.0 and -6.0 after three years and statistically different from zero whereas the tax cut multiplier is statistically insignificant. Consumption exhibits a similar pattern. Seen in the second panel of Figure 3 the tax cut multiplier on consumption in the U.S. is between 1.5 and 2.0 and statistically different from zero. In the U.K., Figure 3 suggests that the tax cut multiplier has no statistically significant effect on consumption. However, note that the tax increase multiplier on consumption in the U.K. is approximately -6.0 over a three year horizon whereas in the U.S. the tax increase multiplier is significantly smaller. Investment again displays a similar asymmetric behavior across both countries. In the U.S., as seen in the bottom panels of Figures 3 and 4, the tax cut multiplier on investment is statistically significant and equal to approximately 6.0. A tax increase

has no statistically significant effect. However, in the U.K., the bottom panel in Figure 3 suggests that tax cuts have no statistically significant effect on investment whereas the bottom panel of Figure 4 suggests that the tax increase multiplier on investment is -10.0.

For the U.S., the linear multiplier from Romer and Romer (2010) overestimates the effects of the tax increase multiplier. On the other hand, the linear multiplier estimated by Cloyne (2013) significantly underestimates the effect of tax increases in the U.K. and overestimates tax cuts. Comparing the U.S. and the U.K. shows how negatively tax increases hurt the British economy while tax cuts do little to stimulate growth. In the following section we follow Mertens and Ravn (2012) and evaluate whether our results are robust taking into account unanticipated and anticipated tax shocks.

**4. Unanticipated and Anticipated Tax Shocks**

Mertens and Ravn (2012) further classify the Romer and Romer (2010) exogenous tax shocks into unanticipated and anticipated tax shocks by distinguishing between the announcement date and the implementation date. [10] If these dates are more than 90 days apart Merterns and Ravn (2012) classify the shock as an anticipated tax shock. They find that unanticipated tax shocks have a larger initial impact than anticipated tax shocks, as well as, a greater peak response. We use this series developed by Mertens and Ravn (2012) to classify the U.S. exogenous tax shocks as unanticipated or anticipated tax shocks. For the U.K. we follow the methodology outlined in Mertens and Ravn (2012) and evaluate the narrative record in Cloyne (2012) to categorize shocks into anticipated or unanticipated tax shocks.

[10] Hussain and Malik (2013) pursue a similar approach to check the robustness of their U.S. asymmetric tax multipliers by splitting the tax shocks into personal income tax shocks and corporate income tax shocks estimated by Mertens and Ravn (2013b). Their results are consist with Mertens and Ravn (2013b) who show that personal income tax shocks dominate, but Hussain and Malik (2013) show that the multipliers for the U.S. are still asymmetric after accounting for the different types of tax shocks.

Figure 5 shows the tax shocks split between unanticipated and anticipated tax shocks in the U.K. and the U.S. In the U.S., the number of unanticipated and anticipated tax shocks is fairly even with 31 unanticipated tax shocks and 27 anticipated tax shocks. Out of the 31 unanticipated U.S. tax shocks, 14 are tax increases while out of the 27 anticipated tax shocks, 19 are tax increases. In the U.K., the number of tax shocks is greater than the U.S. but the magnitude of the tax shocks is often smaller. In the U.K., there are 63 unanticipated tax shocks with 19 being tax increases and 60 anticipated tax shocks with 24 being tax increases. We estimate (7) replacing the exogenous tax series with the unanticipated tax series and the anticipated tax series and split the series into positive and negative components. From this VAR we generate dynamic response functions for each country. The results are displayed in Figures 6-9.

The impulse responses in Figure 6 are very similar to the results of the tax multipliers before distinguishing between unanticipated and anticipated tax shocks shown in Figure 4. The U.S. tax increase multiplier is once again insignificant and the U.K. tax increase multiplier is highly significant and equal to approximately -6.0. Once we differentiate between the two types of tax changes, the U.S. anticipated tax cut multiplier is insignificant and the U.K. anticipated tax cut multiplier remains insignificant as can be seen in Figure 7. Figure 8 again indicates that the U.S. unanticipated tax increase multiplier is insignificant and the U.K. unanticipated tax increase multiplier is approximately -6.0. Finally Figure 9 demonstrates that the U.S. unanticipated tax cut multiplier is significant and approximately 4.0 at its peak whereas the U.K. unanticipated tax cut multiplier is insignificant for all three variables.

Our results from splitting the tax shocks into unanticipated and anticipated tax shocks are consistent with our earlier results. Tax increase multipliers in the U.K. are large and significant

while tax cut multipliers in the U.K. are insignificant. For the U.S., our results show only unanticipated U.S. tax cut multipliers are significant while tax increase multipliers remain insignificant which are consistent with the results in Mertens and Ravn (2012).

**5. Discussion**

While Cloyne (2013) reports results that are similar to those in Romer and Romer (2010), once we allow for asymmetric effects, we find that positive and negative tax shocks produce starkly different outcomes on GDP growth and the growth rate of GDP components for the U.S. and U.K. economies. We believe that a combination of four factors primarily explains the cross country results: differences in the nature of the tax shocks (i.e. especially the VAT in the U.K.), differences in the monetary environment during the quarters in which tax shocks occurred, the overall level of public and private debt, and differences in the centralization of taxation in the U.K. and the U.S.

First, we revisit Romer and Romer (2009) and Cloyne (2012) which provides a description of each of the exogenous tax changes. We examine the description of the exogenous tax changes in order to determine the degree to which differences in the goals and/or composition of tax cuts and tax increases shed light on our asymmetric results. In the U.S., twelve of the twenty-three exogenous tax cuts specifically mention increased investment as a primary goal. On the other hand, none of the exogenous tax increases list reducing investment as a motivating factor; rather, the majority of tax increases are aimed at deficit reduction or maintaining social security's solvency. Additionally, examination of the exogenous tax cuts by decade produces interesting insights. In the 1960s, five (1962Q3, 1963Q4, 1964Q2, 1965Q1, 1967Q3) of the seven exogenous tax cuts target investment while the other two (1965Q3, 1966Q1) seek to increase consumption of consumer durables. Of the five exogenous tax cuts in

the 1970s only one (1979Q1) targets investment. In the 1980s, four out of the six exogenous tax cuts target investment (1981Q3, 1982Q1, 1983Q1, 1984Q1) whereas the last two (1987Q1, 1987Q3) are primarily aimed at reforming the tax code. Surprisingly, after 1987 there is only one exogenous tax cut that targets investment, 2003Q3.

We also revisited Cloyne (2012) which provides a description of each of the exogenous tax changes in Cloyne (2013) and examine the description of the exogenous tax changes in order to determine the degree to which differences in the goals and/or composition of tax cuts and tax increases shed light on our asymmetric results. The most surprising aspect of a reading through Cloyne (2012) is the number of budgets in which income tax cuts are accompanied by increases in the VAT. Even budgets in which the chancellor explicitly states the goal for cutting taxes is to incentivize the "supply-side" side of the economy, these tax cuts are accompanied by increases in the VAT taxes regardless of the party in power. For example, as outlined in the Conservative budget in 1990 of Geoffrey Howe (Chancellor) and Margaret Thatcher (Prime Minister) income tax rates were cut but the V.A.T. was raised from 10% to 15%.

A second factor that may explain the asymmetric results are the differences in the monetary policy environment during quarters in which the tax shocks took place.[11] In the U.S., the average federal funds rate was 5.54% in quarters in which a tax cut occurred with the federal reserve easing policy in 43% of the those quarters. Whereas in the U.K., the average level of the policy rate when a tax cut occurred was 7.76% with the BOE easing in 35% of those quarters. Moreover, it should also be noted that the U.K.'s entrance, participation, and exit in the European Rate Mechanism during the late 1980s and early 1990s may affect its results.

[11] Jones and Olson (2014) find that the tax multiplier in the U.S. is substantially larger during times of accommodative monetary policy as opposed to tight monetary policy.

Third, the level of total external debt (public+private) in each respective economy was dramatically different over much of the time period. Figure 10 displays the total external debt as a percentage of GDP over the 1970-2007 time period. As can be seen, the overall level of debt in the U.K. is substantially higher than that in the U.S. for the entire sample period. The average total debt/GDP ratio in the U.S. was 31.4% whereas in the U.K. the total debt/GDP ratio was 156.1%.[12] As such, tax shocks may have different effects due to differences in the status of household balance sheets.

Finally, the U.S. and the U.K. taxation systems are substantially different. Moreover, regulatory structures and local regulatory burdens across the two economies are generally higher in the U.K., especially in the energy sector. In the U.K., the power of taxation is almost exclusively in the hands of Westminster; local authorities have little if any taxation powers whereas in the U.S., states and local authorities have substantial power regarding taxation.[13] However, state policy regarding income, investment, sales, and property taxation policy varies substantially across U.S. states. Moreover, a much larger portion of total government spending in the U.K. is handled by the central government rather than regional or state governments. In the U.K., the four largest sources of government revenue are the income tax, the VAT, the National insurance tax, and the corporation tax. In addition, the U.K. has additional fiscal laws it must abide by because of membership in the European Common Market. For example, the *minimum VAT rate* mandated by European Parliament is 15% and was recently raised to 20%. Figure 11 displays total tax revenue as a percentage of GDP in the U.S. and the U.K; the black area in each panel corresponds to the % of tax revenue collected by the central government whereas the gray

[12] Data on total external debt/GDP was obtained from Ken Rogoff's "This time is different" website. Data was not available before 1970 for the series.
[13] The possible exception is a small property tax that is based upon local authorities valuation of homeowner's property.

area corresponds to the % of tax revenue collected by state and local authorities. As can be seen in Figure 11, in the U.K, total tax revenue as a percentage of GDP is substantially higher than in the U.S. In the U.S., roughly half of the tax revenue is split between central and state/local governments whereas more than 2/3 of tax revenue is collected by the central government in the U.K. As such, changes in the tax code which either increase or decrease government revenue likely have different effects across countries due to the differences in the degree of centralization of government. In this context, our results would suggest that a high level of centralization magnifies the adverse effects of tax increases while dampening the positive effects of tax cuts. Moreover, while we are concerned with the national effects of changes in income taxes in the U.S., it seems reasonable to posit that changes in the federal income tax rate have different effects across the 50 U.S. states because of different state tax environments. An interesting follow up study would be to evaluate employment and growth in U.S. states that have little or no state taxes (i.e. no or low income taxes, low sales taxes, low property taxes etc.) compared to those with high taxes.

## 6. Conclusion

This paper employs a simple nonlinear VAR model to estimate the effect of tax shocks on GDP and its components for the U.S. and U.K. economies. Using the Romer and Romer (2010) and Cloyne (2013) series of exogenous tax shocks, we evaluate how positive and negative tax shocks affect output in each country. While Cloyne (2013) reports results similar to those in Romer and Romer (2010), we find substantially different results once we allow for asymmetric effects, and these results hold when separating the tax shocks into anticipated and unanticipated shocks. For the U.S. economy, we find that tax cuts have large, positive effects on output while tax increases have little or no effect. In the U.K., tax increases substantially reduce output while

tax cuts have no significant effect. Furthermore, our results show tax cuts in the U.S. have substantial, positive effects on investment and consumption while tax increases have little effect.

Given our asymmetric results between the U.S. and U.K. economies, the policy implications from our results are not clear. While in the U.S. it certainly appears that enacting tax cuts that target investment is the best way to increase output, our results from the U.K. do not support this conclusion. We believe that a combination of (1) differences in the nature of the tax shocks, (2) different monetary policy environments, (3) different levels of total debt relative to GDP, and (4) institutional differences in the centralization of the U.S. and U.K. economies are the substantial factors driving our results. Further research is needed to better understand how each factor may contribute to the efficacy of fiscal policy.

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Table 1: Wald Tests

| | US | | UK | |
|---|---|---|---|---|
| | Positive | Negative | Positive | Negative |
| GDP Growth | -.7030 | -2.583*** | -3.615*** | 0.4723 |
| | (0.48) | (0.01) | (0.00) | (0.63) |
| Consumption | -1.429 | -1.751* | -2.398*** | -0.040 |
| | (0.15) | (0.07) | (0.01) | (0.96) |
| Investment | -0.8363 | -2.451*** | -1.395 | 0.7409 |
| | (0.40) | (0.01) | (0.16) | (0.45) |

Note: The above tests are based on the following two restrictions: (1) positive: $\sum_{i=0}^{12} b_i pos_{t-i} = 0$ and negative: $\sum_{j=0}^{12} c_j neg_{t-j} = 0$ for each respective component of GDP and each economy. All regressions were estimated with Newey-West standard errors. ***, **, * correspond to significance at the 1%, 5%, and 10% levels.

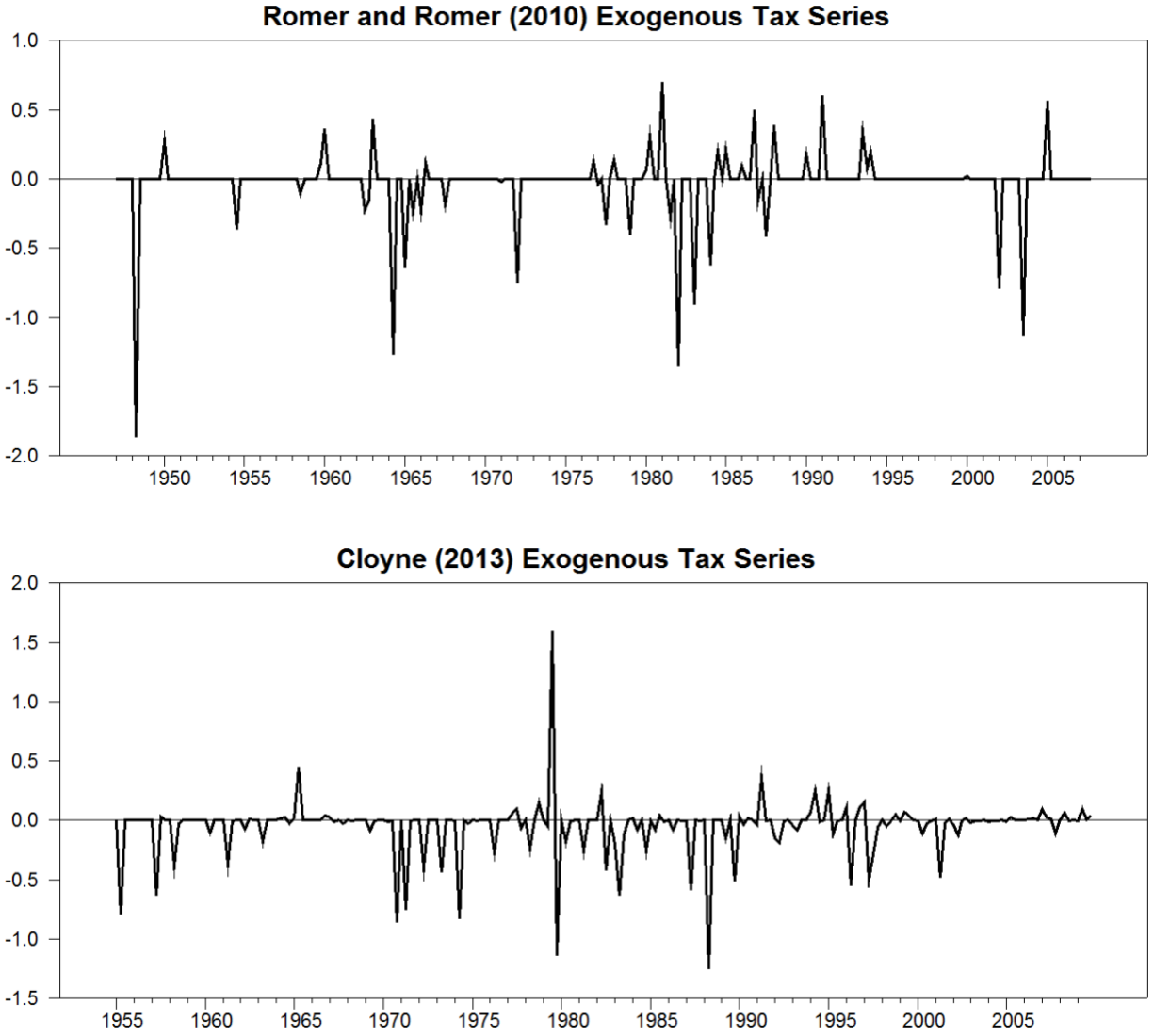


Figure 1. Exogenous Tax Series

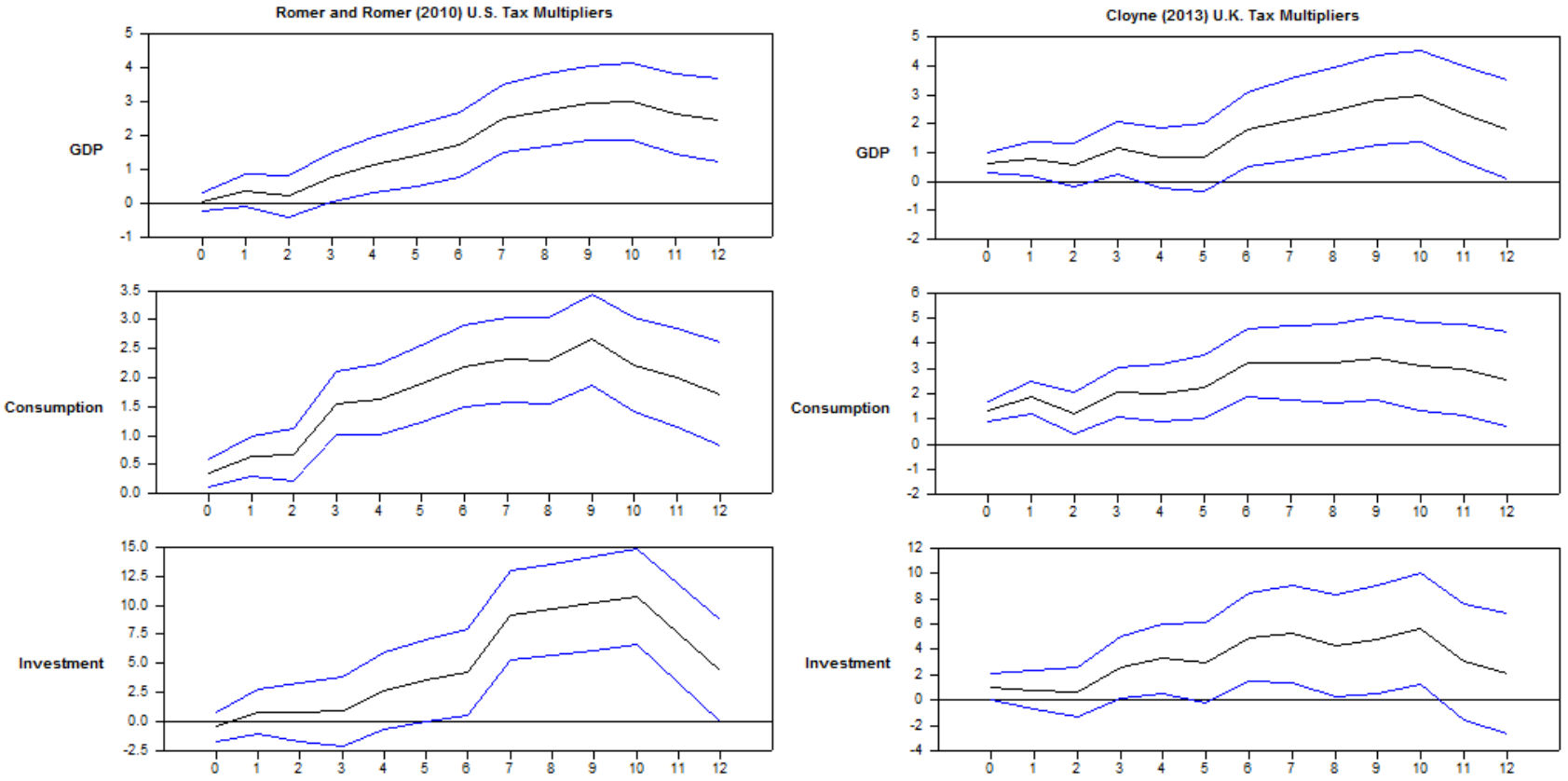


Figure 2. Tax Multipliers from Romer and Romer (2010) and Cloyne (2013)

Notes: Figure 2 shows the cumulative impulse response functions using the Romer and Romer (2010) and Cloyne (2013) tax series. The linear tax multipliers are obtained from equation (4).

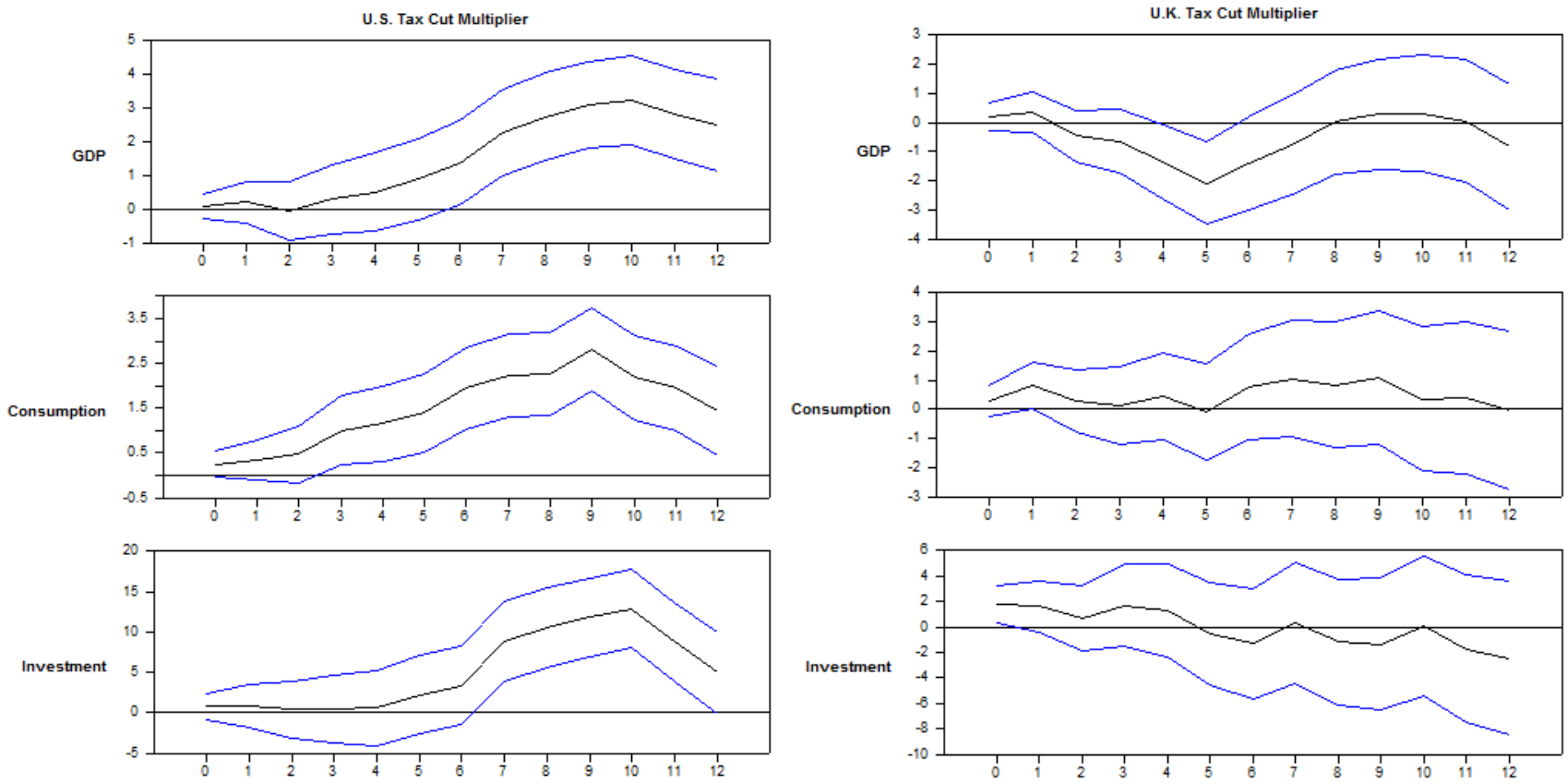


Figure 3. Impulse Responses: Tax Cut Multipliers

Notes: Figure 3 shows the asymmetric multipliers between the U.S. and the U.K. using cumulative impulse response functions. The tax cut multipliers for each country are obtained by estimating equation (7).

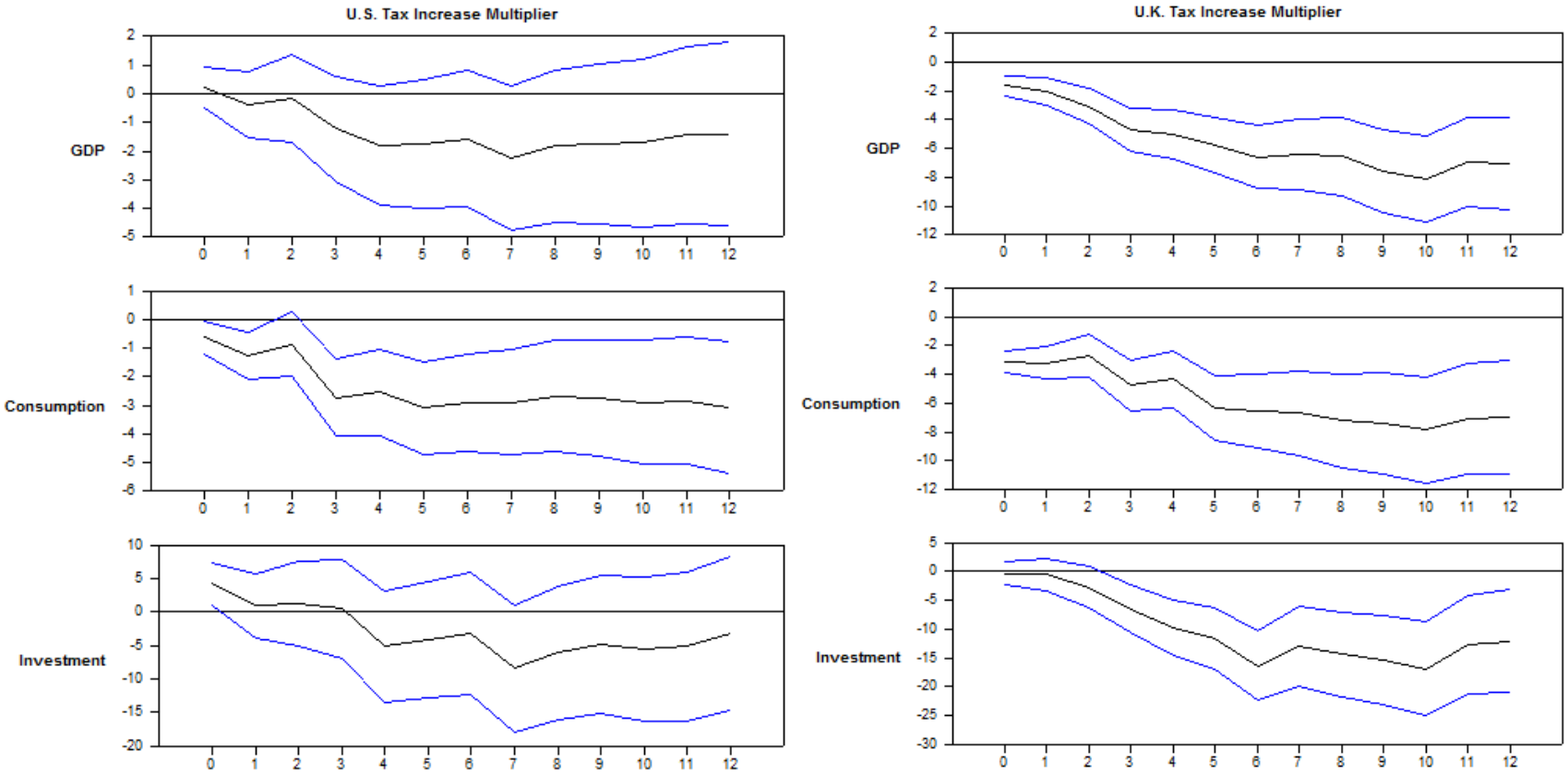


Figure 4. Impulse Responses: Tax Increase Multipliers

Notes: Figure 4 shows the asymmetric multipliers between the U.S. and the U.K. using cumulative impulse response functions. The tax cut multipliers for each country are obtained by estimating equation (7).

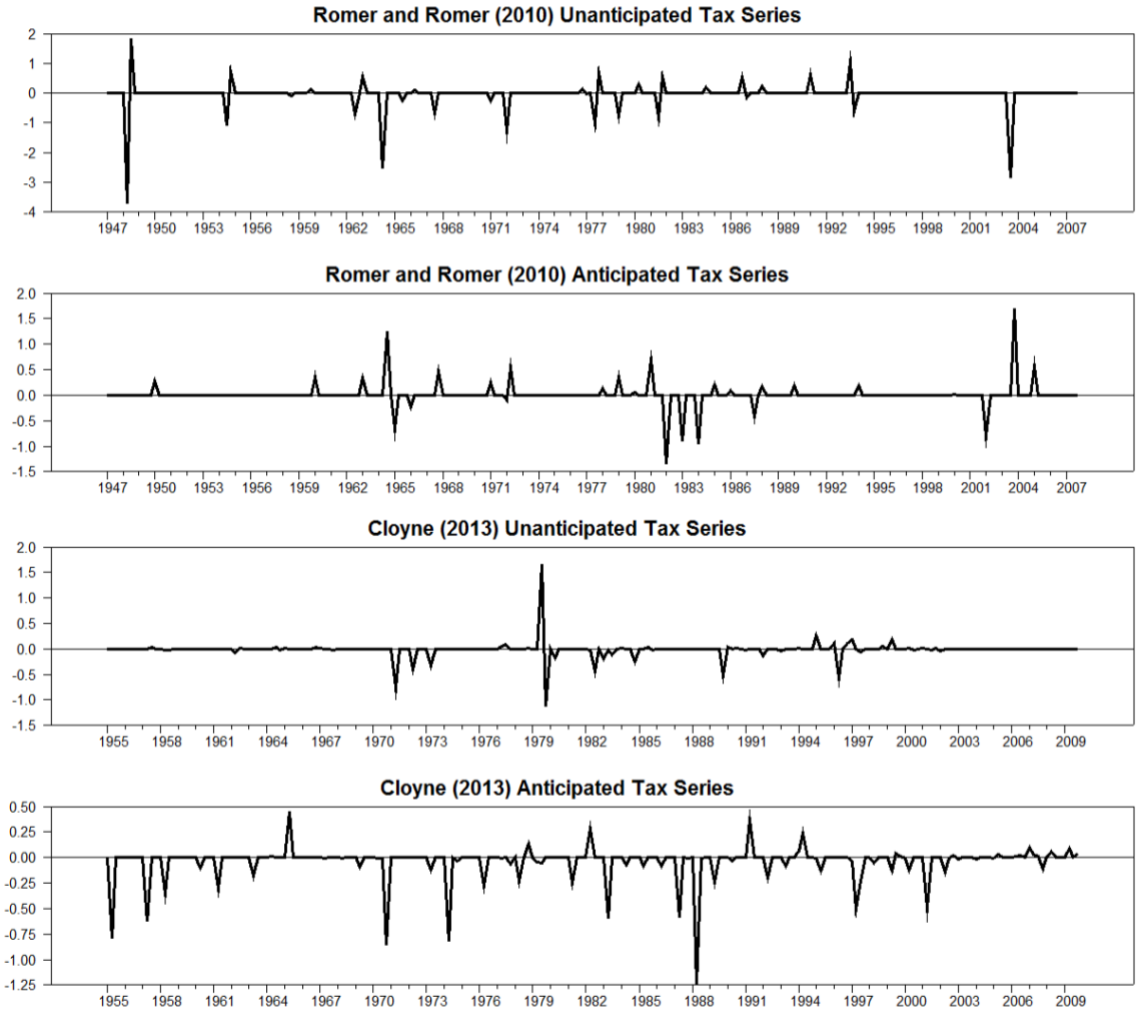


Figure 5. Unanticipated and Anticipated Exogenous Tax Series

Notes: Figure 5 shows the exogenous tax series split between unanticipated and anticipated tax shocks. For the U.S., the series come from Mertens and Ravn (2012). The U.K. series are based on the methodology of Mertens and Ravn (2012) applied to Cloyne (2012).

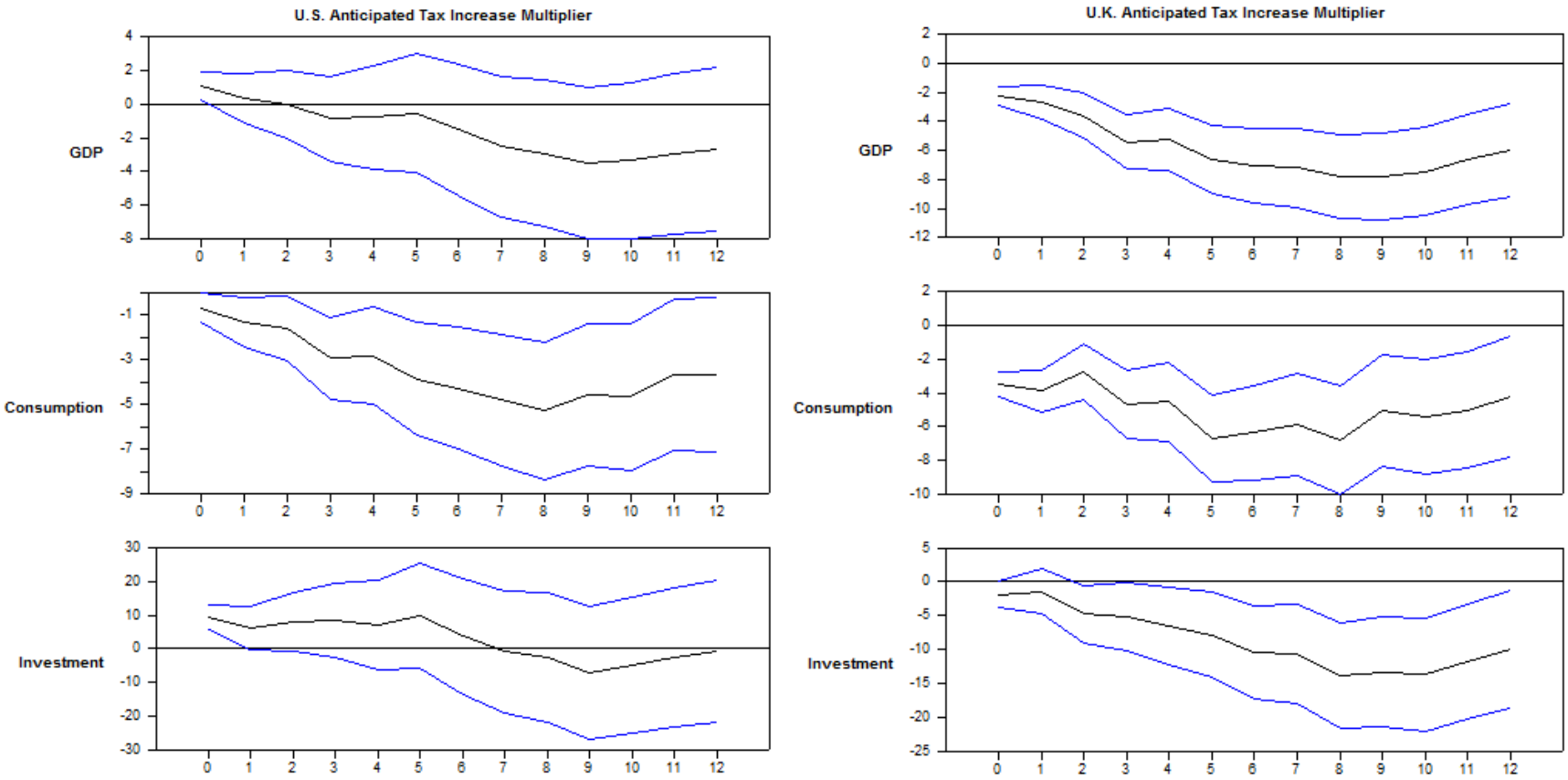


Figure 6. Anticipated Tax Increase Multipliers

Notes: Figure 6 shows the asymmetric multipliers between the U.S. and the U.K. using cumulative impulse response functions. The anticipated tax increase multipliers for each country are obtained by estimating equation (8).

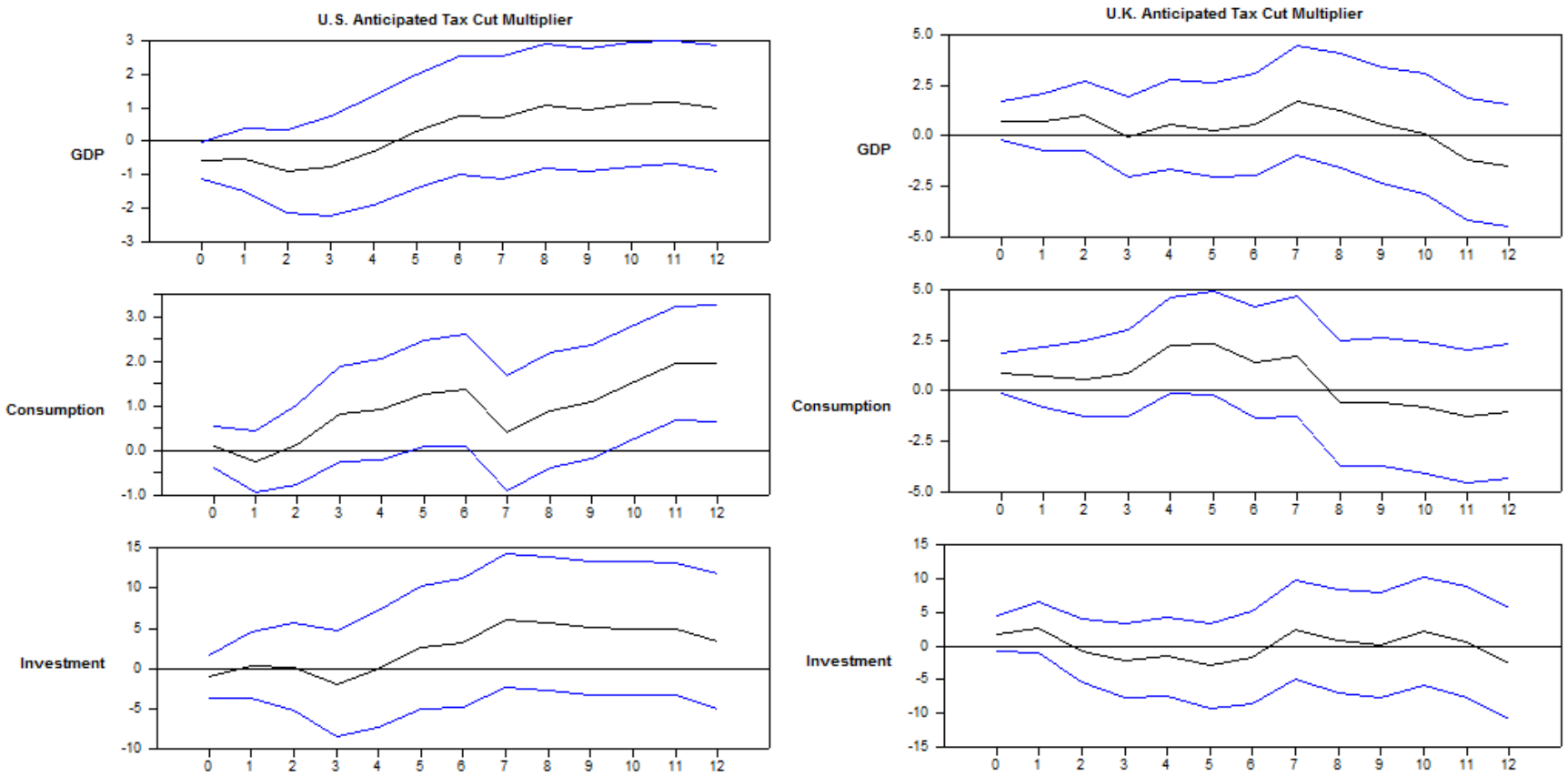


Figure 7. Anticipated Tax Cut Multipliers

Notes: Figure 7 shows the asymmetric multipliers between the U.S. and the U.K. using cumulative impulse response functions. The anticipated tax cut multipliers for each country are obtained by estimating equation (8).

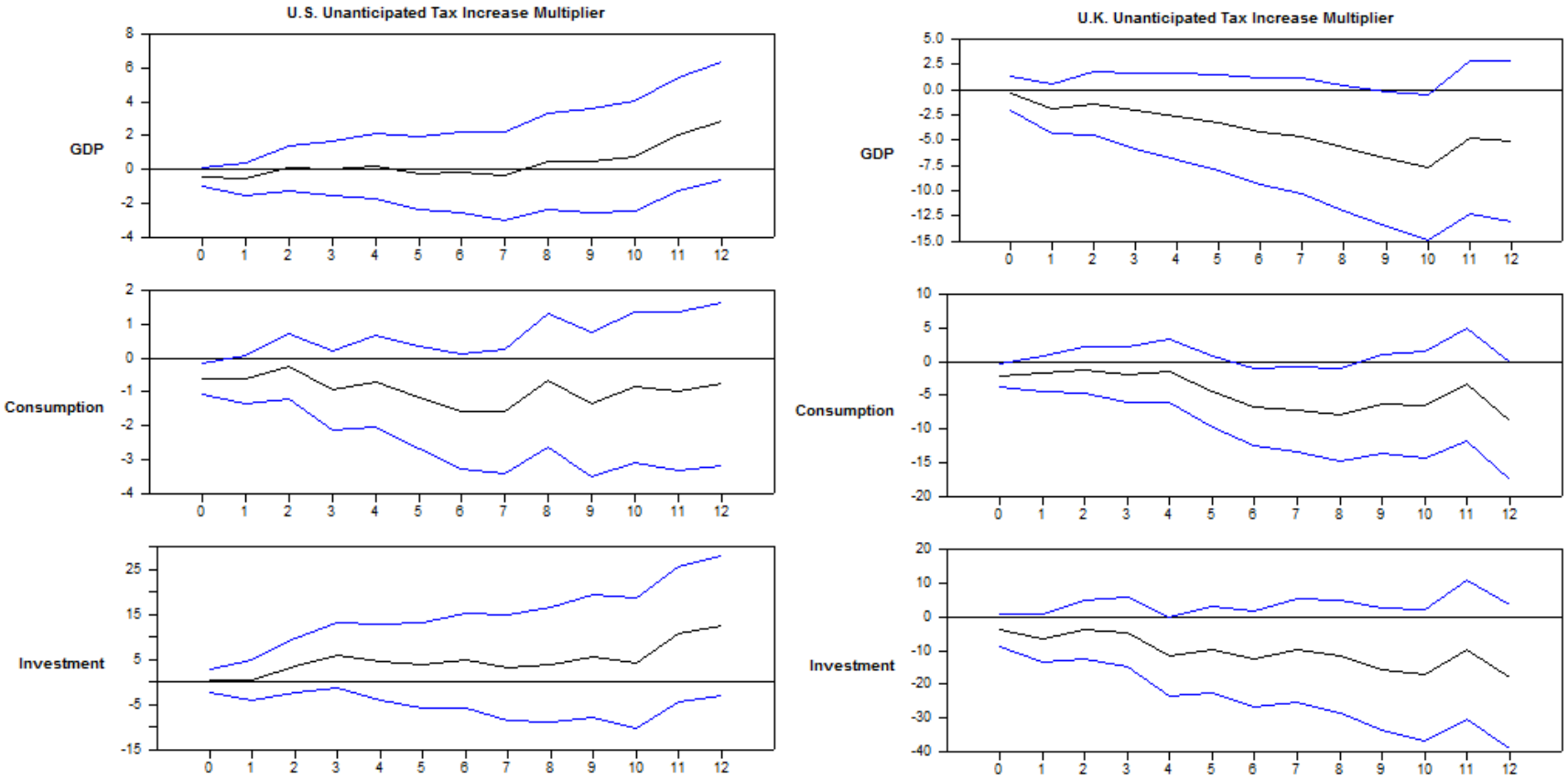


Figure 8. Unanticipated Tax Increase Multipliers

Notes: Figure 8 shows the asymmetric multipliers between the U.S. and the U.K. using cumulative impulse response functions. The unanticipated tax increase multipliers for each country are obtained by estimating equation (8).

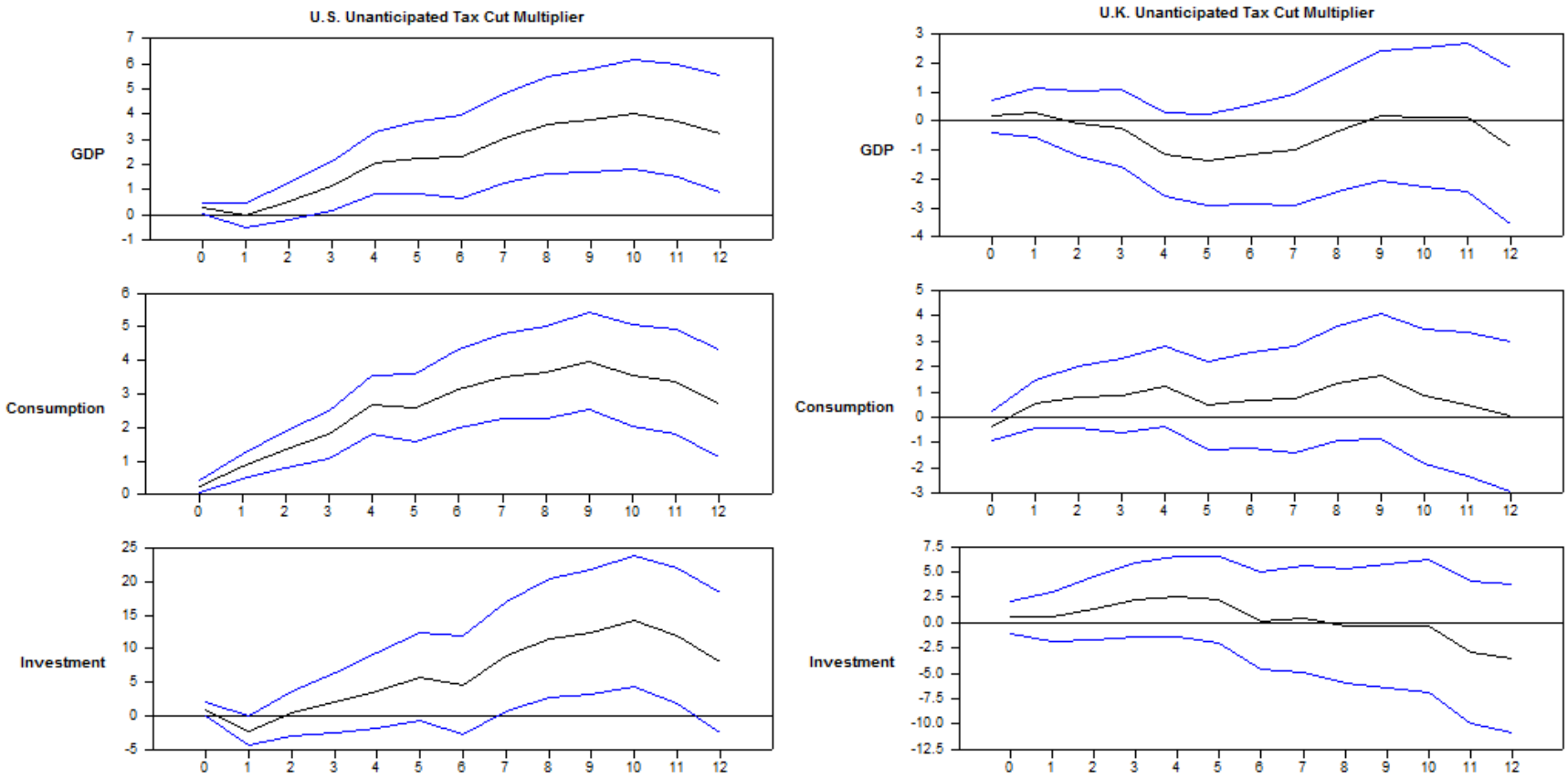


Figure 9. Unanticipated Tax Cut Multipliers

Notes: Figure 9 shows the asymmetric multipliers between the U.S. and the U.K. using cumulative impulse response functions. The unanticipated tax cut multipliers for each country are obtained by estimating equation (8).

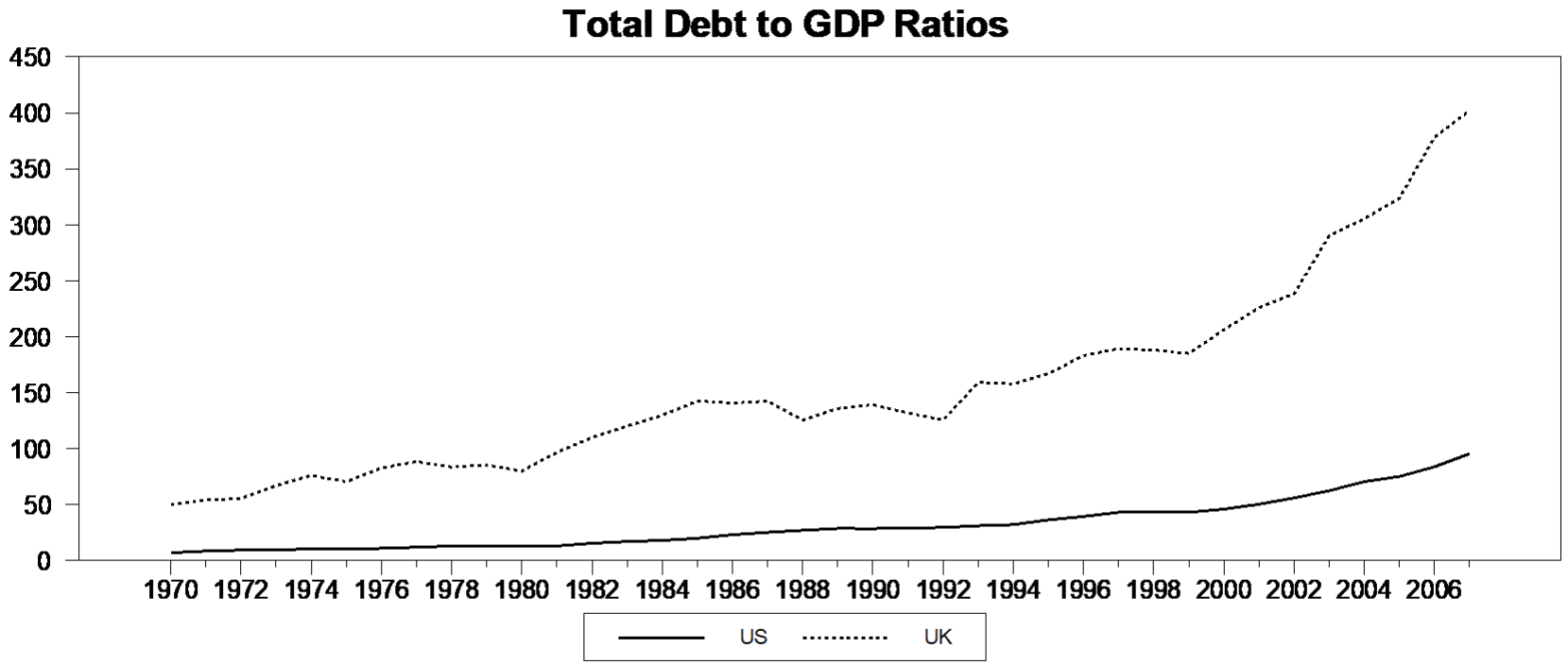


Figure 10. Total Debt as a Percentage of GDP

Notes: Figure 10 shows the total (Private+Public) debt as a percentage of GDP in the U.S. and the U.K. Data was obtained from Kenneth Rogoff and Carmen Reinhart's website http://www.reinhartandrogoff.com/.

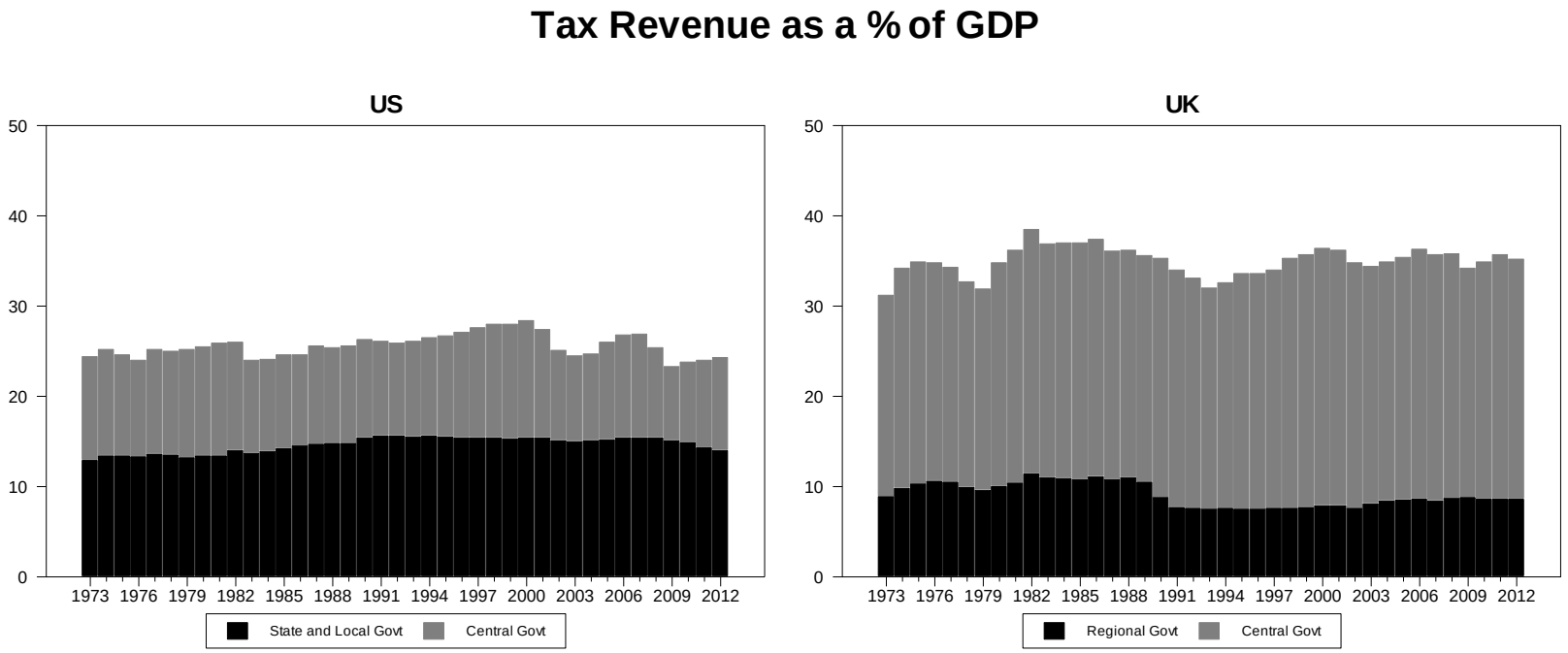


Figure 11. Tax Revenue as a Percentage of GDP

Notes: Figure 11 shows the total tax revenue as a percentage of GDP in the U.S. and the U.K. The black area corresponds to revenue that goes to state and local governments while the gray area is the tax revenue collected by the central government.